



**MAHARASHTRA NATURAL GAS LIMITED  
(MNGL)**

**TENDER DOCUMENT  
FOR  
LAYING AND CONSTRUCTION OF U/G STEEL PIPELINE  
NETWORK AND ASSOCIATED WORKS FROM LNG-LCNG  
STATION ZODGE TO MALEGAON, GONDE TO IGATPURI AND  
GAIL'S SV 7 TO CGS DODI IN NASHIK GA OF MNGL.**

**UNDER OPEN DOMESTIC  
COMPETITIVE BIDDING  
(THROUGH E-TENDERING MODE)**

Bid Document No.: MNGL/CP/2023-24/58 dated 20.07.2023

**VOLUME II OF III**

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SPECIFICATION  
FOR  
MAINLINE CONSTRUCTION (ONSHORE)

SPECIFICATION NO. MNGL/Steel/TS/01

## **C O N T E N T S**

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## 1.0 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 WORKS
  - Staking of the pipeline route
  - Handling, hauling, stringing and storing of all materials
  - Trenching
  - Field-bending of line pipe
  - Lining-up
  - Pipeline laying
  - Backfilling
  - Tieing-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 CONTRACTOR shall be deemed to have obtained all necessary information subject as above mentioned as to risks, contingencies and all other circumstances, which may influence the WORK.
- 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.

## **2.0 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 words "Should", "May" and "Will" are non-mandatory, advisory or recommended.

### **3.0 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 land owners 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 safe-guard 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 effected 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 its 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.
- 3.1.1.4 DURING 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 foot-wear (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 centre of the high voltage system.**

If work is done at less than 50m from the centre 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 equipments 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 present all the time.
- 3.1.2.3 In the event that a vehicle, crane etc. should accidentally 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 possibly 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 land owner 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 Bench Marks, 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 centreline marker number with letters A (left side) and B (right side) added, (looking, in flow direction). Reference markers shall also carry the same information as its corresponding centreline markers.

Markers shall be of suitable material so as to serve their purpose and shall be 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 land owner or tenant,

and where practicable, the opening of the fences shall be in accordance with the wishes of said owner and tenant. In all cases where CONTRACTOR removes fences to obtain work route, CONTRACTOR shall provide and install temporary fencing, and on completion of construction shall restore such fencing to its original condition.

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

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

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

#### **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, land-owner and/ or tenant, and Government Authorities having jurisdiction and as soon as practical after the initial removal. In no case, it shall be left to interfere with the grading and laying operations. Whenever stumps are grubbed and a hole is left in the ground, CONTRACTOR shall back-fill the hole and compact it to prevent water from gathering in it and creating a big hole.

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.

#### **4.5 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.

##### **5.1.2 "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 equipments 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 due to unsuitable storage must be strictly complied with and, if required, an adequate heat conditioning shall be provided for these materials.

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

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

## **5.6 Identification**

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

All serial numbers shall be recorded in a list, which shall also state appurtenant pipe numbers.

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

Before a pipe length, pipe end, etc. is cut the painted serial number and stamped-in pipe number shall be transferred by CONTRACTOR in the presence of COMPANY to either side of the joint 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.

*MNGL/Steel/TS/01*

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. Cutting of bends are not permitted in any case.

### **7.3 Miter and Unsatisfactory Bends**

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

No miter bends shall be permitted in the construction of the pipe line. CONTRACTOR shall cut out and remove any bend or bends which do not meet the specifications and shall replace the same with satisfactory bends at no additional cost to the 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<sup>3/4</sup>" OD is 5mm and for pipes over 12 <sup>3/4</sup>" 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, etc., 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 equipments 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 there of 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 stablisation shall be atleast 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 over and tested for full and correct operation in the presence of and to the satisfaction of COMPANY. All work shall be carried out strictly in accordance with the appropriate codes, the approved drawings, and this and other related specifications.

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

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

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 :  $\pm 3$  mm.
- b) Inclination of flange face from true in any direction: 4 mm per meter.
- c) Displacement of branch connection from indicated location:  $\pm 1.6$ mm. 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 removed 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.

#### **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 at least 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.

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

gravel or other hard material which may be buried in the trench the provisions of the specifications shall apply with the understanding that the use of the land by the land-owner and/or tenant will not be interfered with.

#### **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 land slides. 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 geodetic 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 Computerised 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

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SPECIFICATION  
FOR  
WELDING OF ONSHORE GAS PIPELINES

SPECIFICATION NO. MNGL/Steel/TS/02

## **C O N T E N T S**

01. SCOPE
02. APPLICABLE CODES, STANDARDS & SPECIFICATIONS
03. MATERIAL SPECIFICATIONS
04. WELDING CONSUMABLES
05. EQUIPMENT & ACCESSORIES
06. WELDING PROCESSES
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## **C O N T E N T S**

Annexure-I : Electrode Qualification Test Record

Annexure-II : Stress Relief Heat Treatment Procedure Specification

Annexure-III : Welding Procedure Qualification Test Record

Annexure-IV : Welder Qualification Test Record

Annexure-V : Welders Identification Card

Annexure-VI : Radiographic Procedure for Pipe Welding

**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 alongwith 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% O<sub>2</sub>, 5% CO<sub>2</sub> the variation of such addition shall not exceed  $\pm 10\%$  of that stated. Moisture content shall correspond to a dew point of - 30°C or lower.

## **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, laminations etc. Pipe for welding shall be set up, correctly spaced, allowing for temperature changes during welding, in correct alignment and shall in no circumstances be sprung into position. Temporary attachments of any kind shall not be welded to the pipe. Welds joining the sections of the pipelines, valve installation or similar welds classified as tie-in welds shall be made in the trench. Otherwise the alignment and welding shall be made alongside the ditch with the pipe supported on skids and back pad or other suitable means approved by COMPANY, at least 500mm above the ground, unless approved by the COMPANY in specific cases.

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 off set may be checked from outside using dial gauges. Any branch connection, sleeve, etc. shall be at least 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 an external line-up clamp is used, all spaces between bars or at least 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 used 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. At least 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 at least 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 dyepenetrant tests which the COMPANY feels necessary. The pipe wall thickness after grinding shall not be less than the minimum thickness limit permitted for the pipe. Repair of arc-strikes by welding is prohibited.

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

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

## **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 at least 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 Postweld Heat Treatment**



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

The width of the heated band centred on the weld shall at least be equal to the width of weld plus 2" (50mm). The temperature gradient shall be such that the length of the material on each side of the weld, at a temperature exceeding half the heat treatment temperature, is atleast  $2.5 \sqrt{rt}$  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 alongwith the hardness test results on the weld joints (whenever required as per the welding specification chart) shall be submitted to COMPANY for its approval.
- 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/ Brinell hardness of the heat affected zone as well as of the weld metal, after heat treatment shall be measured using a suitable hardness tester and shall not exceed the maximum hardness specified in the welding specification chart. The weld joint shall be subjected to reheat treatment, when hardness measured exceeds the specified limit, at the CONTRACTOR's own expense.
- 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 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 weldings.

- V. To check whether shop/ field welding is being executed 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 at least 2 weeks before the commencement of actual work. Standard tests as specified in the code shall be carried out in all cases. In addition to these, tests, other tests like radiography, macro/ micro examination, hardness tests, dye penetrant examination, charpy V-notch etc. shall be carried out on specimens. It shall be the responsibility of the CONTRACTOR to carry out all the tests required to the satisfaction of the COMPANY's Inspector. The destructive testing of welded joints shall be as per Clause 14.0

## **12.3 Welder's Qualification**

- a) Welders shall be qualified 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 para 6.3.4 of API 1104 sixteenth edition May, 1983 (Ref. Fig. 13) 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 be 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 Diameter- 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 at least 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 propagating 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 Sixteenth Edition May 1983 except that the dimensions of the Jig for guided bend test Fig. 5 para 2.6 API 1104 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 shall however be as per para 2.643 and 2.653 of API 1104 Eighteenth edition May 1994.

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 50mm wide on both sides of the weld with steel wire brushes and anyhow the cleaned strip must be at least wide enough to allow full skip examination.

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

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

- ultrasonic equipment and coupling medium
- sample sections for calibration of instruments
- 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 at least 60 dB.
- the regulation control shall be accurate to within  $\pm 1$  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  $\pm 2$  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<sub>1</sub> and V<sub>2</sub> 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 :  $1 \pm 0.1\text{mm}$
- breadth (measured parallel to the 150mm side) :  $1 \pm 0.1\text{mm}$
- 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 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 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 cleanliness) 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 that 50% of the reference echo, will not be considered. If returns are above 50% but lower than 100% of the reference echo, and if the operator has good reasons to suspect that the returns are caused by unfavourably oriented cracks, the same shall be informed to the COMPANY. Moreover, when there is a defect to be repaired, such defect shall be removed for a length corresponding to the one where no more return echo is given.

#### **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 weld, 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 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.
- 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 to 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 to 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 its responsibilities and guarantees.

#### **16.4 Radiation Source**

- 16.4.1 Radiographic examination shall be carried out using x-radiations/Gamma 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 wire of the penetrameter turned towards the end of the film itself. When a complete weld is radiographed in a single exposure using a source inside the piping, four penetrameter approximately equally spaced around the circumference shall be used. During the procedure qualification, IQI shall be placed both on the source side and on the film side. The sensitivity obtained with IQI on the source side shall not be less than the values shown in Fig. 6 of this specification.

The sensitivity limit may be considered to have been reached when the outline of the IQI, its identification number and the wire of the required diameter show up clearly on the radiograph.

The COMPANY may authorise use of types of IQI other than those planned, provided that they conform with recognised standards and only if the CONTRACTOR is able to demonstrate that the minimum sensitivity level required is obtained. For this demonstration, a test shall be carried out comparing the IQI specified and the CONTRACTOR's, to show up the identification number and other details of the proposed IQI, which must be visible in the test radiograph.

## 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 marker 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 India in this regard and COMPANY shall not be responsible and shall be kept indemnified by the CONTRACTOR for default (s) of whatever nature by the CONTRACTOR. Safety equipment as considered adequate by the COMPANY for all necessary personnel shall be made available for use and maintained for immediate and proper use by the CONTRACTOR.

#### **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 Value 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 alongwith 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		Contractor	
Pipe and Coating Material			
Process			
Outside Diameter			
Pipe Thickness			
Joint Design (Sketch Attached)			
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: :		Vertical up/ Vertical down	
Root :		Vertical up/ Vertical down	
Second Run :		Vertical up/ Vertical down	
Other Runs :		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 of 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 penetrometer.

Approval of the COMPANY

Signature of CONTRACTOR with Seal

SPECIFICATION  
FOR  
HYDROSTATIC TESTING  
OF ONSHORE PIPELINE

SPECIFICATION NO. MNGL/Steel/TS/03

## **CONTENTS**

1.0	SCOPE
2.0	REFERENCE CODES, STANDARDS AND SPECIFICATIONS
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12.0	CALCULATION
13.0	PRECAUTIONS DURING THE TEST
14.0	PRESERVATION OF PIPELINE

## **FIGURES**

FIG.1	WATER COMPRESSIBILITY FACTOR VS PRESSURE AND TEMPERATURE.
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## **TABLES**

TABLE 1	DIFFERENCE BETWEEN WATER THERMAL EXPANSION FACTOR AND STEEL THERMAL EXPANSION FACTOR.
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## 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/precommissioning 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 to 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 along with 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
  - Calliper pigs with gauge plate diameter equal to 95% of the heavy wall pipe in the pipe sections. Gauging pig fitted with gauge plate.

The CONTRACTOR shall provide sufficient number of pigs including spares.

- b) Fill pumps : The CONTRACTOR shall determine the type and number of fill pumps in order to guarantee the following :  
Differential head 20% greater than the maximum required.  
Flow rate : 400m<sup>3</sup> min. ; 1000m<sup>3</sup> max.  
If a single pump is used, a standby unit must be available.
- c) Variable speed positive displacement pumps equipped with a stroke counter to pressurise the line with a known stroke and capable of exceeding the maximum test pressure by at least 20 bar.
- d) Two positive displacement meters to measure the volume of water used for filling the line. These meters shall be provided with a calibration certificate not older than one month.
- e) Portable tanks of sufficient size to provide a continuous supply of water to the pump during pressurizing.

- f) Bourdon pressure gauges of suitable pressure range and accuracy.
- g) Dead weight testers with an accuracy of 0.01 bar measuring in increments of 0.05 bar provided with a calibration certificate not older than one month.
- h) Two 48 hours recording pressure gauges tested with charts and ink gauges tested with dead weight tester prior to use. These shall be installed at the test heads.
- i) Pressure recording charts.
- j) Two temperature recorders for fill water.
- k) Thermocouples for measuring the pipe wall temperature.
- l) Two laboratory thermometers 0°C to 60°C range, accuracy  $\pm 0.1$  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 valving arrangements shall be available to allow launching and receiving of each pig independently. The test heads shall be sized in conformity with ASME specification Section VIII, Division 2 with particular reference to Appendices 4 and 5.
- 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 stabilisation and pressurisation can now be 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 from 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 from faulty COMPANY furnished materials, CONTRACTOR shall be reimbursed for furnishing all labour, equipment, materials, except those materials furnished by the COMPANY, and transportation necessary to repair and repressurize the section of the pipeline to the pressure at the time of recognition of leak or line failure. CONTRACTOR shall be entitled for compensation as per the provisions of the CONTRACT. All work of reinstalling line pipe, to replace pipe failures shall be done in accordance with the relevant specification included in the CONTRACT.
- 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 :  $\pm 0.1\%$  of the full-scale value

- Recording : continuous on tape or disk, graph width 100mm
- Feed : 20mm/h for tape diagrams, 7.5°/h for disk diagrams
- Recording : to be such as to record pressure between 50% and 90% of the diagram width.

The pressure recorder shall be checked by means of dead weight tester at the beginning, during and at the end of the hydrostatic test.

A pressure gauge tested with dead weight tester shall be connected in parallel to the dead weight tester at the test head.

### 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  $\pm 0.2^{\circ}\text{C}$ .

- 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  $\pm 1\%$  of the scale range
- Scale -  $10^{\circ}$  to  $+ 40^{\circ}\text{C}$
- 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  $\pm 1\%$  of the scale range

Scale -  $0^{\circ}$  to  $+ 60^{\circ}$  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:

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

Where:

$V_p$  = computed water amount required to raise by P the pressure in the section to be tested (m<sup>3</sup>).

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

$\Delta P$  = Pressure rise (bar)

$r_i$  = 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<sup>-1</sup>)  $\times 10^6$ .

(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:

- $\Delta P$  = pressure change resulting from a temperature change (bar)
- $\Delta T$  = algebraical difference between water temperature at the beginning of the test and water temperature as measured at the end of the test ( $^{\circ}\text{C}$ ).
- $B$  = value of the difference between the thermal expansion of water at the pressure and temperature as measured at the end of the test and that of steel ( $^{\circ}\text{C}^{-1}$ )  $\times 10^6$   
(Refer table – 1)
- $A$  = Isothermal compressibility value of water as estimated at the pressure and temperature values obtained at the end of test ( $\text{bar}^{-1}$ )  $\times 10^6$  (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/conservate 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	+49.22	+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	+108.43	+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	+256.18	+264.62	+272.92	+281.08
150	+231.03	+239.87	+248.55	+257.07	+265.44	+273.69	+281.78
160	+232.14	+240.91	+249.52	+257.97	+266.28	+274.46	+282.49
170	+233.26	+241.96	+250.49	+258.88	+267.12	+275.23	+283.20
180	+234.38	+243.01	+251.47	+259.79	+267.97	+276.01	+283.92
190	+235.51	+244.06	+252.46	+260.71	+268.82	+276.80	+284.64
200	+236.64	+245.12	+253.45	+261.63	+269.67	+277.59	+285.37
210	+237.77	+246.18	+254.45	+262.50	+270.54	+278.39	+286.11
220	+238.91	+247.26	+255.45	+263.49	+271.40	+279.19	+286.85
230	+240.06	+248.33	+256.46	+264.43	+272.28	+280.00	+287.59
240	+241.21	+249.41	+257.46	+265.37	+273.16	+280.82	+288.35
250	+242.36	+250.49	+258.48	+266.31	+274.04	+281.63	+289.11
260	+243.52	+251.58	+259.49	+267.27	+274.92	+282.46	+289.86
270	+244.68	+252.66	+260.52	+268.23	+275.82	+283.29	+290.64
280	+245.84	+253.76	+261.54	+269.18	+276.71	+284.12	+291.40
290	+247.01	+254.86	+262.57	+270.15	+277.61	+284.95	+292.18
300	+248.18	+255.96	+263.60	+271.11	+278.51	+285.79	+292.95

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. MNGL/Steel/TS/04

## **C O N T E N T S**

0.0	DEFINITION
1.0	SCOPE
2.0	GENERAL
3.0	TRENCHING
4.0	CONTINUOUS CONCRETE COATING
5.0	HYDROSTATIC PRE-TESTING
6.0	INSTALLATION
7.0	BACKFILLING AND BANK PROTECTION
8.0	FINAL HYDROSTATIC TEST
9.0	POST-CONSTRUCTION SURVEY
10.0	FINAL CLEAN-UP
11.0	DOCUMENTATION

## 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 is 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. MNGL/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 manothermograph. 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<sup>2</sup> 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. MNGL/Steel/TS/05

## **C O N T E N T S**

- 1.0 SCOPE
- 2.0 GENERAL
- 3.0 ROAD AND RAIL-ROAD CROSSINGS
- 4.0 CROSSINGS OF BURIED SERVICES
- 5.0 MINOR WATER COURSE CROSSINGS

## 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 read 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

- 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 piling, 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 suitability of the pipe and weld-coating of carrier pipes to be bored and for which coating and method of application are anyhow to be authorised by COMPANY without prejudice to CONTRACTOR's liability. In all other cases the carrier pipes shall be cased.

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 atleast 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 borepit, CONTRACTOR shall, if necessary in COMPANY's opinion, use a closed sheetpiling which shall extend atleast 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
- Sheetpiling
- 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 the approach 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 jurisdiction 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<sup>2</sup>. After backfilling and compaction, additional tests shall be conducted to determine if the casing is electrically shorted to the pipe. If the installation is found to be shorted, CONTRACTOR shall make the necessary corrections and repairs 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 stabilise 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 galvanised 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<sup>2</sup> and with a minimum elongation at failure of 10%. The minimum zinc coating of 200 gm-<sup>2</sup> 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 upto the top of bank whichever is higher.
- Upto the bottom of the crossing or 20m below the highest water level whichever is smaller.

Bank stabilisation 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. MNGL/Steel/TS/06

## **C O N T E N T S**

1.0 GENERAL

2.0 CODES OF PRACTICE

3.0 FABRICATION

4.0 WELDING

5.0 ERECTION

6.0 INSPECTION

7.0 PROTECTIVE COATING

8.0 FLUSHING

9.0 HYDROSTATIC TESTING

ANNEXURE-1

ANNEXURE-2

ANNEXURE-3

ANNEXURE-4

## 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 centre 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 centrelines so as to avoid forcing of union coupling during make up. Damaged threads shall be cut from the end of run and the pipe shall be rethreaded.
- 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 equipments, 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 under ground 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 values 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 offset should not exceed 1.6mm. Any branch connections sleeve shall be at least 150mm from any other weld. The welds for fitting shall 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-in-charge for a particular case.
- c) The root pass of butt 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

- c) 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 at least 2 weeks before the commencement of actual work. Standard tests as specified in the code shall be carried out in all cases. In addition to these tests, other tests like radiography, macro/ micro examination, hardness 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
- a) testing of welded joints shall be as per Annexure-2 and 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 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 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 are 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 alongwith 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
----	----	----	-----	-----	-----	-----	-----

Sheet 3 of 4

### 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
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Sheet 4 of 4

## 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 .....

- 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<sup>2</sup>) ..... Maximum Load .....  
 ..... Tensile S/ in. plate area .....  
 ..... Fracture Location .....  
 .....

Procedure  
 Welder

Qualifying Test  
 Line Test

Qualified  
 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, APIS 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 of NCL :

Welding Processes : Groove Joints : Butt

Root Pass SMAW Filler Pass SMAW Root Pass SMAW Filler Pass SMAW Filler Joints/

Socket Joints : SMAW

Welding Materials : Groove Joints : Butt

Root Pass E6010G/ E7010G Filler Pass F7010G/ E8010G/ E8818G

Root Pass E7010/ E7018G/ E8018G Filler Pass F7016/ E7018G/ E80118G

Filler Joints/ Socket Joints : E7016/ E7018/ E7018G/ E8018G

Backing Page \_\_\_\_\_ Consumable :

Gases : Purging \_\_\_\_\_ Sheilding

Gas Composition : Purging \_\_\_\_\_ Sheilding

Preheating : 10 min for all welds, 100°C Post heating

Sheet 2 of 2

Post weld heat treatment :

Holding temp. : 595-650 C

Rate of heating : 200 C/hr max.

Method of cooling : Controlled

Holding Time : 1 Hr. per inch thk

Min holding time : 1 hr.

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/mm <sup>2</sup>	20 ft. lb. at 0°C
E7018-I	52.7 kg/mm <sup>2</sup>	-
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 Diameter- 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 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.

#### 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 V10 . 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 $\leq$ 12	7.5
$\geq$ 7 and $\leq$ 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 then 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 sixteenth edition - May, 1983 except that the dimensions of Jig for guided bend test fig. 5 para 2.6 API-1104 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 sixteenth edition - May, 1983.

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 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.
- 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 70mm wide and at least 50mm high.
- Shall have various amplification, with steps of 1 or 2 dB over a range of at least 60 dB.
- The regulation control shall be accurate to within 1 dB and this accuracy shall be certified by the instrument manufacturer.
- May be powered by a battery or an electric generator. In the first case, the autonomy of operation (endurance) of the instrument shall be sufficient to carry on working without frequent interruptions, and the 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 stabilising 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<sub>1</sub> and V<sub>2</sub> 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 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.

## 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 response is obtained paying attention all the time to the probe tube 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 alongwith 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 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 to film distance used is a minimum of 12 inches.
- 3.7 Three copies of each acceptable radiographic procedure (as outlined in Specification no. MNGL/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 India in this regard and COMPANY shall not be responsible and shall be kept indemnified by the CONTRACTOR for default(s) of whatever nature by the Contractor. Safety equipment as considered adequate by the COMPANY for all necessary personnel shall be made available for use and maintained for immediate and proper use by the CONTRACTOR.

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. MNGL/Steel/TS/07

- 1.0 GENERAL
- 2.0 SCOPE
- 3.0 CODES & STANDARDS
- 4.0 EQUIPMENT
- 5.0 SURFACE PREPARATION
- 6.0 PAINT MATERIALS
- 7.0 PAINTING SYSTEMS
  - 7.1 PRE-ERECTION/ PRE-FABRICATION AND SHOP PRIMING FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL, STEEL STRUCTURES, PIPING AND EQUIPMENT ETC.
  - 7.2 REPAIR OF PRE-ERECTION/ FABRICATION AND SHOP PRIMING AFTER ERECTION/ WELDING FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL, ITEMS IN ALL ENVIRONMENTS.
- 8.0 FIELD PAINT SYSTEM FOR NORMAL CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL)
- 9.0 FIELD PAINT SYSTEM FOR CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL AND LOW ALLOY STEEL)
- 10.0 FIELD PAINT SYSTEM FOR HIGHLY CORROSIVE AREA (FOR CARBON STEEL, LOW ALLOY STEEL) EXTERNAL SURFACE OF UNINSULATED COLUMNS, VESSELS, HEAT EXCHANGERS, BLOWERS, PIPING, PUMPS, TOWERS, COMPRESSORS, FLARE LINES, STRUCTURAL STEEL ETC.
- 11.0 FIELD PAINT SYSTEM FOR CARBON STEEL STORAGE TANKS (EXTERNAL) FOR ALL ENVIRONMENTS
- 12.0 FIELD PAINT SYSTEM FOR CARBON STEEL AND LOW ALLOY STEEL STORAGE TANK (INTERNAL)
- 13.0 COATING SYSTEM FOR EXTERNAL SIDE OF UNDERGROUND CARBON STEEL, PLANT PIPING AND TANKS.
- 14.0 PAINTING UNDER INSULATION FOR (HOT, COLD & SAFETY) CARBON STEEL LOW TEMPERATURE CARBON STEEL & STAINLESS STEEL PIPING AND EQUIPMENT IN ALL ENVIRONMENT



- 15.0 INTERNAL PROTECTION OF CARBON STEEL WATER BOXES AND TUBE SHEETS OF COOLERS/ CONDENSERS.
- 16.0 FIELD PAINTING SYSTEM FOR GI TOWERS/ NON-FERROUS TUBE SHEET
- 17.0 STORAGE
- 18.0 COLOURS CODE FOR PIPING
- 19.0 IDENTIFICATION OF VESSELS, PIPING ETC
- 20.0 PAINTING FOR CIVIL DEFENCE REQUIREMENTS
- 21.0 INSPECTION AND TESTING
- 22.0 GUARANTEE
- 23.0 QUALIFICATION CRITERIA O PAINTING CONTRACTOR.
- 24.0 PROCEDURE FOR APPROVAL OF NEW PAINT MANUFACTURERS.

ANNEXURE-I- LIST OF RECOMMENDED MANUFACTURES

ANNEXURE-II- LIST OF RECOMMENDED MANUFACTURE'S PRODUCTS.

## 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, galvanised "piping", "gratings" and "handrails" etc. except G. I. Towers.

## **2.3 Documents**

- 2.3.1 The contractor shall perform the work in accordance with the following documents issued to him for 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 EIL 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 Surface Preparation Standards:

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:
- Instructions for storage to avoid exposure as well as extremes of temperature.
  - 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 exists, 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 sand, 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 thoroughly washed with water to remove acid & loose particles then dry completely before application of paint.

## **5.2 Procedure of Surface Preparation.**

### **5.2.1 Blast Cleaning**

#### **5.2.1.1 Air Blast Cleaning**

The surface shall be blast cleaned using one of the abrasives: AL<sub>2</sub>O<sub>3</sub> particles chilled cast iron or malleable iron and steel at pressure of 7kg. Cm<sup>2</sup> at appropriate distance and angle depending on nozzle size maintaining constant velocity and pressure. Chilled cast iron, malleable iron and steel shall be in the form of shot or grit of size not greater than 0.055" maximum in case of steel and malleable iron and 0.04" maximum in case of chilled iron. Compressed air shall be free from moisture and oil.

The blasting nozzles should be venturi style with tungsten carbide or boron carbide as the material for liners. Nozzles orifice may vary from 3/16" to 3/4". On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey white metallic lustre. Primer or first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall not be done outdoors in bad weather without adequate protection or when there is dew on the metal which is to be cleaned, surface profile shall be uniform to provide good key to the paint adhesion (i.e. 35 to 50µ). If possible vacuum collector shall be installed for collecting the abrasive and recycling.

#### **5.2.1.2 Water Blast cleaning**

Environmental, health and safety problems associated with abrasive blast cleaning limit the application of air blast cleaning in many installations. In such case water blast cleaning is resorted to. Water blast cleaning can be applied with or without abrasive and high pressure water blasting. The water used shall be inhibited with sodium chromate/ phosphate. The blast cleaned surface shall be washed thoroughly with detergents and wiped solvent and dried with compressed Air. For effective cleaning abrasives are used. The most commonly used pressure for high pressure water blast cleaning for maintenance surface preparation is 3000 to 6000 psi at 35-45 liters/ minute water volume and pressure upto 10000 psi and water volume of 45 liters/ minute provide maximum cleaning.

The water blast cleaned surface shall be comparable to SSPC-SP-12/ NACE No. 5. The operation shall be carried out as per SSPC guidelines for water blast cleaning. The indicative 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, grinding wheels or rotating 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 Manual or hand tool cleaning

Manual or hand tool cleaning is used only where safety problems limit the application of other surface preparation procedure and hence does not appear in the specifications of paint systems.

Hand tool cleaning normally consists of the following:

- a. Hand 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, scraping 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 paint system shall depend on condition of shop coat, if shop coat is in satisfactory condition showing

no major defects, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer-in- Charge.

- 5.4 Shop coated (coated with primer & finishing coat) equipment should not be repainted unless paint is damaged.
- 5.5 Shop primed equipment and 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 airborne 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 being sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.

- b. Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. The air from the spray gun impinging against the surface shall show 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 being painted.
- f. Paint shall be applied in a uniform layer, with overlapping at the edge of the spray pattern. The spray patterns shall be adjusted so that the paint is deposited uniformly. During application the gun shall be held perpendicular to the surface and 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 sheepskin 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 surfaces 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 results in more repaid coverage with less overspray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional air spray.

Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have an in-built agitator that keeps the paint uniformly mixed during the spraying. The unit shall consist of an in-built strainer. Usually very small quantities of thinning are required before spray. In case 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 not 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 shall be applied into all corners.
- d. Any runs or sags shall be brushed out.
- e. There shall be minimum brush marks left in the applied paint
- f. Surface not accessible to brushes shall be painted by spray, duubers, or sheepskin

- 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 long is held under the pipe by two men. Liquid coating is poured on the sling at each side of the pipe. The men holding this sling move it up and down and walk slowly forward while fresh coating is poured on the pipe and they manipulate the sling so that an even coating is obtained all round the bottom. This work shall be done very carefully and by experienced personnel. There shall not be any formation of "Whiskers" and holes in the coating. The coating film shall be inspected by mirror.

- 5.7.10 For each coat the painter should know the WFT corresponding to the specified DFT and standardise 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 until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat; if it exceeds the paint material has 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 or 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 details of weather condition, particular of application no of coats and type of materials applied, anomalies, 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 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 POWER TOOL CLEANING REMOVAL OF LOOSE RUST, LOOSE MILL SCALE AND LOOSE PAINT TO DEGREE SPECIFIED BY POWER TOOL CHIPPING, DESCALING, SANDING, WIRE BRUSHING AND GRINDING, AFTER REMOVAL OF DUST, SURFACE SHOULD HAVE A PRONOUNCED METALLIC SHEEN.	ST.3	SSPC-SP-3	-	-	<b>-DO-</b>

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-05-5900 1967	SSPC-SP USA	NACE USA	BRITISH STANDARD BS-4232: 1967	
3.3	<p>COMMERCIAL BLAST</p> <p>BLAST CLEANING UNIT AT LEAST TWO—THIRD OF EACH ELEMENT OF SURFACE AREA IS FREE OF ALL VISIBLE RESIDUES WITH DESIRED SURFACE PROFILE.</p>	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	<p>BRUSH-OFF BLAST</p> <p>BLAST CLEANING TO WHITE METAL CLEANLINESS, REMOVAL OF ALL VISIBLE RUST, MILL SCALE , PAINT &amp; FOREIGN MATTER, SURFACE PROFILE IS NOT SO IMPORTANT.</p>	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 plasticised with unsaponifiable plasticizer, pigmented with Zic phosphate	Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pigmented with zic tetroxy choromate.	Tow component polyamide cured epoxy resin medium, pigmented with zinc phosphate.
3.	Volume solids (approx)	40%	7-8%	40%
4.	DFT (Dry film thickness) per coat (approx)	40-50μ	8-10μ	40-50μ
5.	Theoretical covering capacity in M <sup>2</sup> / coat/ litre (approx)	8-10	8-10	8-10
6.	Weight 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 isocyanate cured acrylic finish paint	Single pack plasticised chlorinated rubber based medium with chemical and weather resistant pigments.	Tow- pack polyamide/ ployamine 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 film thickness) per coat (approx)	30-40μ	40-50μ	100-125μ	100-125μ
5.	Theoretical covering capacity in M <sup>2</sup> / coat/ litre (approx)	10-13	8-10	5-6	5-2-6.5
6.	Weight 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 Silicate 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 film 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.	Weight 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 resistance	-	-	250° C	500° C

F-14: Specially for mulated polyamine cured coal tal epoxy suitable for -45°C to 125°C for application under insulation

F-15: Two pack cold cured 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 BE 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<sub>2</sub>S, SO<sub>2</sub> 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-FABRICATION PRIMER 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<sub>2</sub>SO<sub>4</sub>, 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 & AS PER SMMS EIL SPEC. 6-06-203-REV.2	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 480 EXCEPTING -45 TO 120	SSPC-SP-10	NONE	1 COAT OF AMERCOAT 738 @ 150μ DFT/ COAT	150	
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 DE-MINERALISED WATER COOLING WATER BOILER FEED WATER CONDENSATE QUENCH WATER WASH WATER PROCESS WATER PROCESS WATER FIRE WATER SEA WATER	Sea Gree -do- -do- -do- -do- -do- -do- -do- -do- Fire red Sea Green	French Blue Gulf Red French Blue Gulf Red Light Brown Dark Grey Ganary Yellow Oxide Red Crimson Red White	Signal Red - - - Signal Red - - - - - -
18.1.2	STEAM VERY HIGH PRESSURE STEAM (VHP) HIGH PRESSURE STEAM (SH) MEDIUM PRESSURE STEAM (SH) LOW PRESSURE STEAM (SL) DILUTION STEAM/ PURGE STEAM	Aluminiumto IS2339 -do- -do- -do- -do-	Signal Red  French Blue Gulf Red Canary Yellow Grey	-  -  Canary Yellow
18.1.3	COMPRESSED AIR PLANT AIR INSTRUMENT AIR NITROGEN OXYGEN CO <sub>2</sub>	Sky Blue -do- -do- Canary Yello -do- -do-	Signal Red Silver Grey French Blue Black White Light Grey	- - - - - -



SR. NO.	DESCRIPTION	GROUND COLOUR	FIRST COLOUR BAND	SECOND COLOUR BAND
18.1.4	GASES FUEL GAS AND SOUR GAS CHARGE GAS RESIDUE GAS, LPG ACETYLENE SWEET GAS	Canary Yellow -do- -do- -do- -do-	Grey Signal Red Oxide Red Service Brown Grey	Dark Violet French Blue White - -
18.1.5	ACIDS AND CHEMICALS SULFURIC ACID NITRIC ACID HYDROCHLORIC ACID ACETIC ACID CAUSTIC CHLORINE	DARK Violet -do- -do- -dosmoke Grey Canary Yellow	Briliant Green French Blue Signal Red Silver Grey Light Orange Dark Violet	Light Orange -do- -do- -do- - -do-
18.1.6	HYDRO CARBONS NAPTHAS PROPYLENE PROPYLENE C.G. (LIQ) ETHYLENE GLYCOL ETHYLENE DICHLORIDE BENZENE BUTADIENE ETHANE(LIQ) PROPYLENE(LIQ) ETHYLENE(LIQ) TAR AROMATIC GASOLINE METHANOL (LIQ) PYROLYSIS GASOLINE MIXED C4(LIQ) LPG(LIQ) KEROSENE DIESEL OIL (WHITE) DIESEL OIL (BLACK)	Dark Admiralty Grey -do- -do- -do- -do- -do- -do- Dark Admiralty Grey -do- -do- -do- -do- -do- -do- -do- -do- Light Brown -do- -do- -do-	Brilliant Green -do- -do- -do- Gulf Red Canary Yellow Black Light Grey Signal Red Light Grey Signal Grey Brilliant Green White Brilliant Green Signal Green Brilliant Gren -do- -do- -	Black Smoke Grey Gulf Red - - - French Blue Black Black Brilliant Green Canary Yellow Gulf Red Black Light Brown Dark Violet - - -

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 long stretch/ yard piping at 50M interval.

e. At start and terminating points.

#### 18.4 Identification Sign

18.4.1 Flow direction shall be indicated by an arrow in the location stated in Para a,b,c & d and as directed by Engineer-in-charge.

18.4.2 Colours of arrows shall be black or white and in contrast to the colour on which they are superimposed.

18.4.3 Product names shall be marked at pump inlet, outlet and battery limit in a suitable size as approved by Engineer-in-charge.

18.4.4 Size of arrow shall be either of those given in 18.5.

#### 18.5 Colour Bands

18.5.1 As a rule minimum width of colour band shall conform to the following table:

Nominal Pipe Size	Width : L(mm)
3" NB and below	25mm
Above 3" NB upto 6" NB	50mm
Above 8" NB upto 12" OD	75mm
Above 12" OD	100mm

Note: For insulated pipes, nominal pipe size means the outside diameter of 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 per 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 in 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 gauge for checking of surface profile in case of blast cleaning. Holiday detectors and pinhole detector and positector whenever required for checking in case of immersion conditions.
- 21.7 Prior to application of paints on 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 gauge 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 to 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 any job for EIL, projects under this standard must have necessary equipments, 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 contractors capacity, capability and competency requirements for the job shall be quantified in the tender document and shall be assessed by an EIL 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 alongwith test report.

Sample batch. No. and manufacturer's test certificate should ne enclosed alongwith the report. Test reports contain details of observation and rusting if any, as per the testing code. Suggested government laboratories are:

RRL, Hayderabad  
 HBTI, Kanpur  
 DMSRDE, Kanpur  
 IIT, Mumbai  
 BIS Laboratory  
 UDCT, Mumbai  
 RITES, Calcutta  
 PDIL

24.4 Manufacturers should intimate the company, details of sample submitted for testing name of Govt. testing agency, date, contact personnel of the Govt. testing agency. At the end of the test the manufacturer should submit the test 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 MNGL

#### **ANNEXURE-I** **LIST OF RECOMMENDED MANUFACTURERS**

##### Indian Vendors

- 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 Shalimar Paints Ltd.
- 6.0 Sigma Coating, Mumabai
- 7.0 CDC Carboline Ltd.
- 8.0 Premier Products Ltd.
- 9.0 Coromandel Paints & Chemicals Ltd.
- 10.0 Anupam Enterprises
- 11.0 Grand Polycoats
- 12.0 Bombay Paints Ltd.

- 13.0 Vanaprabha Esters & Glycer, Mumbai
- 14.0 Sunil Paints and Varnishes Pvt. Ltd.
- 15.0 Courtaulds Coating & Sealants India (Pvt.) Ltd.
- 16.0 Mark-chem Incorporated, Mumbai (for phosphating chemicals only)
- 17.0 VCM Polyurethane Paint (for polyurethane Paint only)

#### FOREIGN VENDORS FOR OVERSEAS PRODUCTS

- 1.0 Sigma Coating, Singapore
- 2.0 Ameron, USA
- 3.0 Kansai Paint, Japan
- 4.0 Hempel Paint, USA
- 5.0 Valspar Corporation, USA
- 6.0 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**

<b>S. No</b>	<b>MANUFACTURER NAME</b>	<b>P2 CHLORINATED RUBBER Zp PRIMER</b>	<b>P4 ETCH PRIMER/ WASH PRIMER</b>	<b>P6 EPOXY ZINC PH. PRIMER</b>	<b>F9 INORGANIC ZINC SILICATE PRIMER/ COATING</b>
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 & NICHOLSON PAINTS LTD. AND CHOKUGU JENSON NICHOLSON	JENSOLAC CHLORINATED RUBBER HB ZN.PH. PRIMER	J & N ETCH PRIMER	EPILAC ZINC PHOSPHATE PRIMER	-
5.	SHALIMAR PAINTS LTD.	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...)**

<b>S. No</b>	<b>MANUFACTURER NAME</b>	<b>P2</b>	<b>P4</b>	<b>P6</b>	<b>F9</b>
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....)**

<b>S. No</b>	<b>MANUFACTURER NAME</b>	<b>F2 ACRYLIC-POLY YURETHANE FINISH PAINT</b>	<b>F3 CHLORINATED RUBBER FINISH PAINT</b>	<b>F6 HIGH BUILD FINISH PAINT</b>	<b>F7 HIGH BUILD COAL TAR EPOXY COATING</b>
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 COATING	EPILUX 04 AND 78 HB EPOXY COATING	EPILUX 555
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	ANUHLOR 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**

<b>S. No</b>	<b>MANUFACTURER NAME</b>	<b>F2 ACRYLIC-POLY YURETHANE FINISH PAINT</b>	<b>F3 CHLORINATED RUBBER FINISH PAINT</b>	<b>F6 HIGH BUILD FINISH PAINT</b>	<b>F7 HIGH BUILD COAL TAR EPOXY COATING</b>
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**

<b>S. No</b>	<b>MANUFACTURER NAME</b>	<b>F-8 EPOXY MASTIC COATING SURFACE TOLERANT</b>	<b>F-11 HEAT RESISTANCE SYNTHETIC MEDIUM ALUMINUM PAINT</b>	<b>F-12 HEAT RESISTANCE SILICON AL. PAINT</b>
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**

<b>S. No</b>	<b>MANUFACTURER NAME</b>	<b>F-8</b>	<b>F-11</b>	<b>F-12</b>
<b>11.</b>	GRAND POLYCOATS	GP PRIME GUARD 235		-
<b>12.</b>	BOMBAY PAINTS LTD. THEMPEL MAKINE PAINTS	HEMPADUR 1708	KANGAROO HHR ALUMINUM 4950	HEMPADUR HIGH BUILD 5520
<b>13.</b>	VANAPRABHA ESTERS & GLYCERIDES	VEGEPOX MASTIC 2255	VEG HR AL PAINT TO IS211339	VEG HHR AL PAINT TO 600°C
<b>14.</b>	SUNIL PAINTS AND VARNISHED PVT. LTD.	LPOXY HIGHBUILD P.S.901	-	-
<b>15.</b>	COURTAULDS COATING LTD.	INTERPLUX	-	INTERTHERM 50
<b>16.</b>	MARK-CHEM INCOPORATED, (FOR PHOSPHATING CHEMICAL ONLY)			
<b>17.</b>	VCM POLYURETHANE PAINTS (FOR POLY EURETHANE PAINTS ONLY)	-		
<b>18.</b>	JOTUN PAINTS	JOTUMATIC 87		SOLVELITT HEAT RESISTANT SILICON PAINT
<b>19.</b>	KCC PRODUCTS (KOREA)	EH 4158H		QT 606

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SPECIFICATION  
FOR  
REPAIR OF PIPELINE  
CORROSION COATING

SPECIFICATION NO. MNGL/Steel/TS/08

## **C O N T E N T S**

1. SCOPE
2. MATERIAL AND EQUIPMENT
3. APPLICATION PROCEDURE
4. INSPECTION/ TEST



## 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, rust 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. MNGL/Steel/TS/09

## **C O N T E N T S**

- 1.0 SCOPE
- 2.0 REFERENCE CODES AND DRAWINGS
- 3.0 GENERAL
- 4.0 AERIAL MARKERS
- 5.0 KILOMETRE MARKERS
- 6.0 PIPELINE WARNING SIGN
- 7.0 ROW BOUNDARY MARKERS
- 8.0 DIRECTION MARKERS
- 9.0 NAVIGABLE WATERWAY PIPELINE CROSSING WARNING SIGN

## 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 MNGL 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 be installed along the pipeline at every five (5) kilometres intervals and at places specified by COMPANY. Refer MNGL 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 MNGL 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, as shown in MNGL Standard Drawing No. MNGL/SD/05/62/10/05 for details.

## 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. Refer MNGL Standard Drawing No. MNGL/SD/05/62/10/02 for details.

## 8.0 DIRECTION MARKERS

Direction markers as shown in MNGL 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 MNGL 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. MNGL/Steel/TS/10



## **C O N T E N T S**

- 1.0 SCOPE
- 2.0 INSPECTION
- 3.0 FLUSHING
- 4.0 TESTING
  - 4.1 EXTENT OF TESTING
  - 4.2 GENERAL REQUIREMENT/TEST PREPARATION FOR TESTING
  - 4.3 TESTING MEDIA, TEST PRESSURE AND TEST PRESSURE GAUGES.
  - 4.4 TESTING PROCEDURE
  - 4.5 COMPLETION OF TESTING
  - 4.6 TEST RECORDS

## 1.0 SCOPE

This specification covers the general requirements for Inspection, flushing and testing of piping systems. However testing of steam lines falling under IBR shall also be governed by Indian Boiler Regulations.

Flushing and testing of all piping 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 in 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 compressed 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 be disengaged for this purpose shall be envisaged by the contractor and approved by the Engineer-in-Charge. These flanges shall be provided with temporary gaskets at the time of flushing.

After flushing is completed and approved, the valve, distance pieces, piping specials etc. shall be 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 in the proforma in Exhibit F.

#### 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 rotary 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 valves shall not be subjected to a pressure in excess of the maximum cold welding pressure of the valve. Test pressure applied to valves shall not be greater than the manufacturer's recommendation nor less than that required by the applicable code. Where 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 received 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<sup>2</sup> (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 core 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 chlorine 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  $\pm 2\%$  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 pressurising 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 stabilised 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 authorised 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. These gauges are to be checked by the standard test gauge before each pressure test.

Care shall be taken to avoid increase in the pressure due to 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. MNGL/Steel/TS/11

## **C O N T E N T S**

### **PART-A      CASING INSULATIONS**

1.0 SCOPE

2.0 FUNCTION

3.0 DESIGN

4.0 MATERIAL

5.0 INSPECTION AND TESTING

### **PART-B      CASING END-SEALS**

1.0 SCOPE

2.0 FUNCTION

3.0 DESIGN

4.0 MATERIAL

5.0 INSPECTION AND TESTING

### **PART-C      SUPPLEMENTARY REQUIREMENTS**

## **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 moulded high density polyethylene or other material equivalent or superior as approved by COMPANY and shall meet the following specifications:

<u>Property</u>	<u>Value</u>	<u>ASTM Test Method</u>
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-scale 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:

<u>Property</u>	<u>Minimum Value</u>	<u>Test Method</u>
a) Backing (Sleeve and closure patch)		
Tensile strength	2200 psi	ASTM D-638
Ultimate Elongation	400%	ASTM D-638
Heat Shock	No visual cracks, flow or drips (at 225°C, 4 hours)	ASTM D-2671
b) Adhesive		
Ring and Ball softening Point	90°C	ASTM E-28
Lap Shear	60°C - 25 psi 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. MNGL/Steel/TS/12



## **CONTENTS**

- 1.0 SCOPE
- 2.0 REFERENCE DOCUMENTS
- 3.0 MATERIAL AND EQUIPMENT
- 4.0 APPLICATION PROCEDURE
- 5.0 INSPECTION & TESTING
- 6.0 REPAIR
- 7.0 DOCUMENTATION

## 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 Substrates before Application of Paints and Related Products – Part-3 –Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure Sensitive Tape Method). |
| e) ISO:8503-1 | : | Part-1 : Specification and definitions for ISO surface profile comparator for the assessment of abrasive blast cleaned surfaces.   |
| f) ISO:8503-4 | : | Part-4 : Methods for calibration of ISO surface profile comparator and for the determination of surface profile – Stylus instrument procedure.   |
| g) SIS-055900 | : | Pictorial surface Preparation Standard for Painting Steel Surfaces.  |

h) SSPC-SP 1 : Steel Structure Painting Council.

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

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		On Weld Bead(Min.)
	Average	Min.	
Upto 10 <sup>3</sup> / <sub>4</sub> " (273.1mm)	2.0	1.8	1.6
Over 10 <sup>3</sup> / <sub>4</sub> " (273.1mm) to below 20" (508.0mm)			
From 20" (508.0mm) to below 32" (813.0mm)			
From 32" (813.0mm) and above	2.4	2.2	2.0

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/mm <sup>2</sup>	≥12	DIN EN 12068
b)	Ultimate Elongation @+ 25°C	%	≥250	DIN EN 12068
c)	Dielectric withstand with 1000 Volts/sec	kv	≥30	ASTM D 149
d)	Water absorption @+ 25°C for 24 hours	%	≤0.05	ASTM D 570
e)	Volume Resistivity @+25°C	Ohm-cm	≥10 <sup>15</sup>	ASTM D 257

### 3.2.2 Functional Properties of Joint Coating System (As applied)

As applied field joint coating system shall comply the requirements of DIN EN 12068. Table 1 and 2 corresponding to designation DIN EN 12068 – C HT 60 UV, except as modified below:

- a. Cathodic Disbondment Resistance at Tmax i.e. 60°C shall be 20mm when tested as per Annexure K of DIN EN 12068. Test shall be carried out at (+) 60°C.
- b. Peel Strength shall be as follows:

Peel Strength		Unit	Requirement for MNGlh Resistance Class C (Minimum)	Test Method as per DIN EN 12068
Inner to Inner + Outer to Inner	@23°C	N/mm	1.5	Annexure-B
	@T <sub>max</sub>	N/mm	0.3	
Outer to Outer	@23°C	N/mm	1.5	

	@T <sub>max</sub>	N/mm	0.3	Annexure-C
To Pipe Surface	@23°C	N/mm	3.5	
	@T <sub>max</sub>	N/mm	0.3	
To Factory Coating	@23°C	N/mm	3.5	
	@T <sub>max</sub>	N/mm	0.3	

(T<sub>max</sub> shall be (+) 60°C)

Contractor shall obtain prior approval from Company regarding the manufacturer of the joint coating material. Complete technical details alongwith 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) > 80% - 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 on every joint with a wet film thickness gauge prior to installation of sleeve. Thickness gauge shall be calibrated once per shift.
- 4.2.4 Immediately after application of epoxy primer, the wraparound sleeve shall be entirely wrapped around the pipe within the stipulated time recommended by the manufacturer. Sleeve shall be positioned such that the closure patch is located to one side of the pipe in 10 or 2 O'clock position, with the edge of the undergoing layer facing upward and an overlap of min. 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.
- 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.
  - Mobilise 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  
3-LAYER POLYETHYLENE COATING OF LINEPIPES

SPECIFICATION NO.: MNGL/Steel/TS/13

## **C O N T E N T S**

1.0	SCOPE
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5.0	FUNCTIONAL REQUIREMENTS AND PROPERTIES OF COATING
6.0	MEASUREMENT AND LOGGING
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12.0	REPAIR OF COATING
13.0	MARKING
14.0	QUALITY ASSURANCE

ANNEXURE-I : COATING SYSTEM/ MATERIAL PRE-QUALIFICATION

## 1.0 SCOPE

This specification covers the minimum requirements for supply/ arrangement of all materials, plant, equipment, plant sites, consumables, utilities and application including all labour, supervision, inspection and tests etc. for application of external anti-corrosion coating of pipes by using 3 Layer Side Extruded Polyethylene Coating conforming to DIN-30670, 1991, 'Polyethylene Coating of Steel Pipes and Fittings' and the requirements of this specification.

## 2.0 REFERENCE DOCUMENTS

Reference has also been made to the latest edition of the following standards, codes and specifications. The edition enforce at the time of floating the enquiry shall be termed as latest edition.

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-543	:	Standard Method of Test for Resistance of Plastics to Chemical Reagents
d)	ASTM D-570	:	Standard Method of Test for Water Absorption of Plastics
e)	ASTM D-638	:	Standard Test Method for Tensile Properties of Plastics.
f)	ASTM D-792	:	Standard Test Method of Specific Gravity and Density of Plastics by Displacement
g)	ASTM D-1238	:	Test Method for Low Rate of Thermoplastics by Extrusion
h)	ASTM D-1525	:	Test Method for Vicat Softening Temperature of Plastics
i)	ASTM D-1603	:	Test Method for Carbon Black in Olefin Plastics
j)	ASTM D-1693	:	Test Method for Environmental Stress Cracking of Ethylene Plastics
k)	ASTM D-2240	:	Test Method for Rubber Property – Durometer Hardness
l)	ASTM D-3895	:	Test Method for Oxidative – Induction Time of Polyolefins by Differential Scanning Calorimetry
m)	ASTM G-42	:	Tentative Methods for Cathodic disbonding of Pipeline Coatings Subjected to Elevated or Cyclic Temperatures

n)	API RP 5L1	:	Recommended Practice for Railroad Transportation of Linepipe
o)	API RP 5LW	:	Transportation of Line Pipe on barges and marine vessels
p)	DIN EN 10204	:	Metallic Products – Types of Inspection Documents
q)	DIN 53735	:	Testing of Plastics : Determination of Melt Index of Thermoplastics.
r)	ISO 8502-3	:	Preparation of Steel Substrates before Application of Paints and Related Products – Part-3 – Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure Sensitive Tape Method)
s)	ISO 9002	:	Quality Systems : Specification of Production and Installation
t)	ISO 11124	:	Preparation of Steel Substrates Before Application of Paints and Related Productsq
u)	SIS 055900		Preparation of Steel Substrates before Application of Paints and Related Products – Visual Assessment of Surface Cleanliness.
v)	APL 5L		Specification for Line Pipe w. ASME B 31.8 Gas Transmission and Distribution Piping Systems
x)	ASME B 31.4		Liquid Transportation systems for Hydrocarbons, Liquid petroleum Gas Anhydrous ammonia, and Alcohols
y)	CSA Z245.20-98		External Fusion Bond Epoxy Coating for Steel Pipe

The CONTRACTOR shall be familiar with the requirements of these documents and shall make them readily available at the coating plant to all persons concerned with carrying out the works specified in this specification.

### 3.0 PLANT SCALE AND INSTALLATION

3.1 CONTRACTOR shall size coating plant(s) after evaluating the scale of work and the time schedule required for the works. Coating plant(s), shall be installed into a yard whose geometry and dimensions are such as to allow the execution of a continuous work schedule. For this purpose the CONTRACTOR shall ensure non stop work execution owing to prohibitive adverse weather conditions and when required CONTRACTOR shall install requisite equipment and plant in roofed and adequately weather protected areas.

3.2 Plant equipment, machinery and other facilities shall be in first class operating condition to atleast meet the job requirements of quality and production. Worn out and improvised plants are not acceptable.



- 3.3 CONTRACTOR shall, at his own responsibility and cost, provide and prepare all necessary area for the storage of bare and coated pipe and all other materials, for coating yard, stock-piling and other temporary installation. For each area, CONTRACTOR shall provide to stipulate servitude agreements as required with the relevant Authorities, and, on work completion, to clean, restore and pay servitude and claims for damages, as applicable.
- 3.4 CONTRACTOR shall at its own responsibility and cost, provide for water and power supply and other utilities and consumables and obtain authorisation regarding access roads and other permits required for the execution of works conforming to all the requirements of the governing authorities.
- 3.5 CONTRACTOR shall at its own expense provide a fully equipped laboratory and test facilities with adequate inventory to carry out tests required for the procedure qualification and during regular production. Outside testing for qualification and regular production is not acceptable to COMPANY.
- 3.6 The CONTRACTOR shall be fully responsible for adherence to all statutory regulations applicable for handling and disposal of the hazardous chemicals during the coating works.
- 3.7 The CONTRACTOR shall be responsible for obtaining all statutory approvals/ clearances from relevant Authorities including Pollution Control Board, as applicable for the coating plant(s).

#### **4.0 MATERIALS**

- 4.1 The three layer coating system shall comprise of a powder epoxy primer, polyethylene adhesive and a polyethylene top coat. Coating materials shall be suitable for the service conditions and the pipe sizes involved. The coating materials i.e. epoxy powder, adhesive and polyethylene compound shall have proven compatibility. The coating system and materials shall be pre-qualified and approved by COMPANY in accordance with provision Annexure-I of this specification. CONTRACTOR shall obtain prior approval from COMPANY for the coating system and coating of all materials.
- 4.2 The coating materials Manufacturer shall carry out tests for all properties specified in para 5.3.1 and 5.3.2 for each batch of epoxy, adhesive and polyethylene compound. In addition, the Manufacturer shall also furnish Infra-red Scan for each batch of epoxy powder. The coating materials manufacturer shall issue test certificates as per DIN EN 10204, 3.1B for each batch of materials supplied to CONTRACTOR and the same shall be submitted to COMPANY for approval prior to their use.
- 4.3 In addition to Manufacturer's certificate, the CONTRACTOR shall draw samples from each batch of epoxy, adhesive and polyethylene in the presence of COMPANY Representative and test for the following properties at the coating yard at least one week prior to its use, to establish compliance with the Manufacturer's certificates.

**a) Epoxy Powder**

- i. Gel Time
- ii. Cure Time
- iii. Moisture Content
- iv. Thermal Characteristics (Tg1, Tg2,  $\Delta H$ )

**b) Adhesive**

- i. Specific Gravity
- ii. Melt Flow Rate
- iii. Vicat Softening Point

**c) Polyethylene**

- i. Melt Flow Rate
- ii. Specific Gravity
- iii. Vicat Softening Point
- iv. Moisture Content
- v. Oxidative Induction Time

In case of failure of any of the above tests in a batch, that batch of material shall be tested for all other tests required as per para 5.3.1 and 5.3.2 including the tests which failed. If all tests pass, the batch shall be accepted for coating. If any of the tests fail, entire batch of material shall be rejected and shall not be used for the coating.

- 4.4 All materials to be used shall be supplied in sealed, damage free containers and shall be suitably marked and identifiable with the following minimum information:
- a. Name of the manufacturer
  - b. Type of material
  - c. Batch Number
  - d. Place and Date of Manufacture
  - e. Shelf Life/ Expiry Date (if applicable)
  - f. Quantity

All materials noted to be without above identification shall be deemed/ suspect and shall be rejected by COMPANY. Such materials shall not be used for coating and shall be removed from site and replaced by CONTRACTOR at its expense.

- 4.6 CONTRACTOR shall ensure that all coating materials properly stored in accordance with the Manufacturer's recommendation at all times, to prevent damage and deterioration in quality prior to use.
- 4.7 CONTRACTOR shall be required to use all materials on a date received rotation basis, i.e. first in-first used basis.

**5.0 FUNCTIONAL REQUIREMENTS AND PROPERTIES OF COATING**

5.1 The coating must be able to withstand a maximum in service operating temperature of +65°C and shall conform to 'S' Type of coating as per DIN 30670. In addition, in open storage the coating must be able to withstand a temperature of atleast +80°C, without impairing its serviceability and properties specified.

5.2 The top coat polyethylene used shall be black readymade compound, fully stabilized against influence of ultraviolet radiation (.e. sunlight), oxygen in air and heat (due to environmental temperature as specified above). No appreciable changes shall occur during exposure to such environments up to at least a period of 6000 hours. The CONTRACTOR shall submit certificate from Manufacturer in this regard.

**5.3 Properties**

Properties of coating system and coating material shall comply the requirements indicated in subsequent paragraph. In case the coating/ material properties are tested as per test methods/ standards other than specified herein below, the same may be accepted provided the test procedures and test conditions are same or more stringent than the specified.

**5.3.1 Properties of Epoxy Powder and Adhesive**

CONTRACTOR shall choose such a brand of epoxy powder and adhesive that will achieve the functional requirements and properties of coating system as specified in para 5.1 and 5.3.3 of this specification respectively. Epoxy powder properties shall be as per CSA Z245.20.98. The colour of epoxy powder shall be either green or dark red or any other colour approved by COMPANY except grey colour. Copolymer grafted adhesive shall have the following properties.

Sl. No.	Properties	Unit	Requirement	Test Method
a.	Melt Flow Rate (190°C / 2.16 kg)	g/10 minutes	1.0	ASTM D1238
b.	Vicat Softening Point	°C	90 min	ASTM D1525
c.	Specific Gravity	-	0.926 min.	ASTM D792

**5.3.2 Properties of Polyethylene Compound**

Sl. No.	Properties	Unit	Requirement	Test Method
a.	Tensile Strength@+25°C	N/mm <sup>2</sup>	17 min.	ASTM D 638
b.	Melt Flow Rate (190°C / 2.16 kg)	g/10minute	0.25 min	ASTM D 1238 or DIN 53735
c.	Specific Gravity @+25°C	-	0.941 min.(HDPE)	ASTM D 792
d.	Hardness @+25°C	Shore D	50 min.	ASTM D 2240
e.	Water Absorption, 24 hours, @+25°C	%	0.05 max	ASTM D 570
f.	Volume Resistivity @+25°C	Ohm-cm	1015 min	ASTM D 257
g.	Dielectric withstand, 1000 Volt/sec rise @+25 °C	Volts/mm	30,000 min	ASTM D 149
h.	Vicat Softening Point	°C	110 min	ASTM D 1525

i.	Elongation	% 600	min.	ASTM D 638
j.	Oxidative Induction Time in Oxygen at 220°C, Aluminium pan, no screen	Min	10	ASTM D3895
j.	Environmental Stress Crack Resistance (ESCR) (for F50) Medium Density, Condition “C” High Density, Condition “B”	Hours	300 300	ASTM D1693
l.	Carbon Black Content	%	2 min.	ASTM D1603

### 5.3.3 Properties of Coating System

Sl. No.	Properties	Unit	Requirement	Test Method
a.	Bond Strength (using Type 2 Test Assembly i.e. Dynamometer) @ 20±5°C @ 60±5°C	Kg/cm	8.0 min 5.0 min.	DIN 30670
b.	Impact Strength (min. of 30 impacts on body along the length. No breakdown allowed when tested at 25 kV)	Joules per mm of coating thickness	7 min	DIN 30670
c.	Indentation Hardness @ 23±2°C @ 70±2°C	mm	0.2 max 0.3 max	DIN 30670
d.	Elongation at Failure	%	300 min.	DIN 30670
e.	Coating Resistivity (*)	Ohm-m2	108 min.	DIN 30670
f.	Heat Ageing (*)	-	Melt flow rate shall not deviate by more than 35% of original value	DIN 30670
g.	Light Ageing (*)	-	Melt flow rate shall not deviate by more than 35% of original value	DIN 30670
h.	Cathodic Disbondment @+65°C after 30 days @+65°C after 48 hr	mm radius of disbondment (**)	15 max. 7 max.	ASTM G42
i.	Degree of Cure of Epoxy Percentage Cure, ΔH ΔTg	% °C	95 +3/ -2	CSA Z245.20-98(*)

(\*) Test carried out in an independent laboratory of national/ international recognition on PE top coat is also acceptable.

(\*\*) Disbondment shall be equivalent circle radius of total unsealed area as per ASTM G42.

(\*\*\*) Temperature to which the test specimens are to be heated during cyclic heating shall however be as per the recommendations of epoxy powder manufacturer.

## 6.0 MEASUREMENT AND LOGGING

CONTRACTOR shall maintain records in computer using MS ACCESS database Software containing all the relevant data of individual pipe and pipe coating including heat number, diameter, length, wall thickness, defects, pipe number, batches of materials, materials balance, sampling, testing, damages, repairs, rejects and any other information that COMPANY considers to be relevant and required for all incoming bare pipes and COMPANY approved outgoing coated pipes as applicable. CONTRACTOR shall submit this information in the form of a report at the agreed intervals. The above data shall also be provided in MS EXCEL/MS ACCESS format in Compact Disc (CD). CONTRACTOR shall provide a Computer Terminal to COMPANY Representative for monitoring/tracking of the above. The CONTRACTOR shall also submit the material balance details to COMPANY for information at the end of shift.

## 7.0 COATING PROCEDURE AND QUALIFICATION

7.1 Upon the award of the CONTRACT, the CONTRACTOR shall submit within two(2) weeks for COMPANY approval, a detailed report in the form of bound manual outlining, but not limited to the following:

- a. Details of plant(s), locations, layout, capacity and production rate(s).
- b. Details of the equipment available to carry out the coating works including surface preparation, epoxy powder application and its recycling system, adhesive & polyethylene extrusion, moisture control facilities available for coating materials.
- c. Details of process control and inspection equipment required for the coating process such as temperature control, thickness control, holiday testers, etc.
- d. Details of chemicals pre-treatment facilities including process control and inspection equipment for phosphoric acid wash, de-ionised-ionised water wash and chromate wash.
- e. Facilities in the yard for unloading, handling, transport, production, storage, stockpiling, loading of bare and coated pipes and warehouses for storage of other coating materials.
- f. Plant Organogram Chart and availability of manpower including coating specialist
- g. Details of utilities/facilities such as water, power, fuel, access roads and communication etc. After approval has been given by COMPANY, no change in plant set-up shall be made. However, unavoidable changes shall be executed only after obtaining written approval from COMPANY

- 7.2 At least two(2) weeks prior to the commencement of production coating, a detailed procedure of CONTRACTOR's methods, material proposed, etc., shall be formulated by CONTRACTOR and submitted for COMPANY's approval in the form of a bound manual. The procedure shall include, but not limited to the following information and proposals:
- a. Pipe inspection at the time of bare pipe receipt.
  - b. Steel surface preparation, including preheating, removal of steel defects, method of pipe cleaning, dust removal, abrasive blast cleaning and surface profile, methods of measurements and consumables.
  - c. Complete details of chemical pre-treatment viz phosphoric acid wash, deionised water wash, and chromate wash including product data sheets, health and safety sheets and manufacturer's recommended application procedure.
  - d. Pipe heating, temperatures and control prior to epoxy application.
  - e. Complete details of raw materials including current data sheets showing values for all the properties specified together with quality control and application procedure recommendation from manufacturer(s).
  - f. Application of FBE powder, adhesive and polyethylene, including characteristics, temperature, line speed, application window, curing time, etc.
  - g. Quenching and cooling, including time and temperature.
  - h. Quality assurance system, Inspection and testing methods and reporting formats, including instrument and equipment types, makes and uses etc.
  - i. Detailed method of repair of coating defects duly classified depending upon nature and magnitude of defects and repairs thereof including coating stripping technique.
  - j. Details of instrument and equipment calibration methods including relevant standards and examples of calibration certificates.
  - k. Complete details and inventory of laboratory and equipment for procedure qualification and regular production.
  - l. Pipe handling and stock piling procedures.
  - m. Sample of recording and reporting formats, including laboratory reports, certificates and requirement as per clause 6.0 of this specification.
  - n. Complete details of test certificates for raw materials including test methods standards used.

- o. Test certificates from PE compound manufacturer for tests for thermal aging coating resistivity and aging under exposure to light. These test certificates shall not be older than three years.
- p. Health, safety and environment plans.
- q. Storage details of coating materials and chemicals.
- r. Continuous temperature monitoring at various stages of coating. Procedure Qualification Tests (PQT) shall be carried out only after obtaining written approval of the above procedure from COMPANY. No change in the procedure shall be made after approval has been given by the COMPANY. However, unavoidable changes shall be executed only after obtaining written approval from COMPANY.

7.3 Prior to start of production, CONTRACTOR shall, at his expense, carry out a coating procedure qualification trial for each pipe diameter, and for each plant, to prove that his plant, materials, and coating procedures result in a quality of end product conforming to the properties stated in clause 5.3, relevant standards, specifications and material manufacturer's recommendations. CONTRACTOR shall give seven(7) working days notice to witness procedures and tests. A batch representing a normal production run, typically 15 pipes, shall be coated in accordance with the approval coating procedure and the coating operations witnessed by COMPANY Representative. Out of these pipes, at least one pipe shall be coated partly with epoxy and partly with both epoxy and adhesive layers. Atleast 5 (five) test pipes shall be selected by Company Representative for coating procedure approval tests and shall be subjected to procedure qualification testing as described hereinafter. All tests shall be witnessed by COMPANY's representative. Out of 5(five) test pipes 1(one) pipe shall be coated partly with epoxy and partly with both epoxy and adhesive layers. Remaining 4(four) test pipes shall be coated with all three layers.

During PQT, the CONTRACTOR shall qualify various procedures forming a part of coating operations as detailed subsequently.

#### 7.4 **Qualification of Procedures**

##### 7.4.1 Epoxy Powder Application & Recycling

During pre-qualification, air pressure in the epoxy spray guns, satisfactory functioning of monitoring system, line speed vs coating thickness, etc. shall be established. Dew point of air used to supply the fluidised bed, epoxy spray system and epoxy recycling system shall be recorded during the PQT.

Also, the CONTRACTOR shall remove samples of reclaimed powder from the reclamation system. These of reclaimed powder shall be subject to a detailed visual examination, thermal analysis and moisture content tests. The properties of the reclaimed powder shall be within the

range specified by the Manufacturer of epoxy powder. In case the properties of the reclaimed powder are out of the range specified by the Manufacturer, CONTRACTOR shall not use the reclaimed powder during the regular production.

#### 7.4.2 Pipe Pre-Heating

The CONTRACTOR shall establish the temperature variation due to in-coming pipe temperature, line speed variation, wall thickness variation, emissivity, interruptions, etc. and document the same during the PQT stage. During PQT, proper functioning of pipe temperature monitoring and recording system including alarm/ hooter shall be demonstrated to the COMPANY Representative.

#### 7.4.3 Surface Preparation

The procedure to clean and prepare the pipe surface shall be in accordance with the requirements of this specification. The ratio of shots to grits shall be established during procedure qualification testing, such that the resultant surface profile is not dished and rounded. The qualification shall be performed through a visual inspection, measurement of roughness and check of the presence of dust in the abrasive blast cleaned pipe surface.

#### 7.4.4 Chemical Pre-Treatment

7.4.4.1 Phosphoric Acid Wash followed by De-ionised Water Wash The procedure to apply the chemical pre-treatment viz. phosphoric acid wash followed by de-ionised water wash shall be in accordance with the recommendation of the manufacturer and shall result in intended cleaning requirements of this specification. Working solution preparation, maintaining concentration, application procedure including method of spreading, spreading rate, drying times, etc. depending upon the cleanliness/ temperature of the incoming pipe and the line speed shall be established. Temperature of the chemical, pipe pre-heat temperature vs line speed vs dwell time, rinsing procedure, testing & control, rectificatory measures, drying procedure etc. shall be clearly established during PQT. Also the quality of the deionised water shall be established during PQT.

##### 7.4.4.2 Chromate Treatment

The procedure to apply the chromate treatment shall be in accordance with the recommendation of the manufacturer. Working solution preparation, maintaining concentration, application procedure including method of spreading, spreading rate, drying times, etc. depending upon the temperature of the incoming pipe and the line speed shall be established. Temperature of the chemical, pipe pre-heat temperature vs line speed, pipe heating after chromating and time limit within which the pipe to be heated, testing & control, rectificatory measures, shall be clearly established during PQT.



#### 7.4.5 Coating Application

The COMPANY Representative will check the correctness of each coating application operation, values of the main parameters of each operation, preheating pipe surface temperature prior to epoxy powder application temperature, line speed, fusion bonded epoxy curing time, temperature and flow rate of copolymer adhesive and polyethylene etc. and the same shall be recorded. These values shall be complied with during regular production.

### 7.5 Qualification of Applied Coating

#### 7.5.1 Tests on pipe coated partly with epoxy and partly with epoxy & adhesive Layers

##### a. Degree of Cure

Epoxy film samples (min 4 Nos.) shall be scrapped from the coated pipe using hammer and cold chisel and the samples shall be taken for cure test using Differential Scanning Calorimetry (DSC) procedure. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential ( $\Delta T_g$ ) and % cure ( $\Delta H$ ) shall comply the specified requirements.

##### b. Epoxy Layer Thickness

Epoxy layer thickness shall be checked at every one meter spacing at 3, 6, and 12 o'clock positions. The thickness shall comply the specified thickness requirements.

##### c. Adhesive Layer Thickness

Adhesive layer thickness shall be checked at every one meter spacing at 3, 6, 9 and 12 o'clock positions. The thickness shall comply the specified thickness requirements.

##### d. Holiday Inspection

Entire pipe shall be subject to holiday inspection and the test voltage shall be set to exceed 5 v/micron of epoxy thickness specified for the portion coated only with epoxy layer.

##### e. Adhesion Test

- i. Adhesion Test (24 hrs or 48 hrs) shall be carried out on the epoxy coated pipe. Test method, no. of test specimen and acceptance criteria shall comply CSA Z.245,20-98, Table 4.
- ii. Adhesion of FBE shall also be separately determined at ambient temperature at two locations by the "St Andrews Cross" method and the test shall comply with the specified requirements.

f. **2.5° Flexibility Test**

2.5° Flexibility test shall be carried out on the epoxy coated pipe at test temperature of 0°C. Test method, no. of test specimen and acceptance criteria shall comply CSA Z.245,20-98, Table-4.

g. **Cross-section & Interface Porosity Test**

Cross section porosity and interface porosity tests shall be carried out on the epoxy coated pipe. Test method, no. of test specimen and acceptance criteria shall comply CSA Z.245,20-98, Table-4.

7.5.2 **Tests on pipes coated only with all three layers**

a. **Bond Strength**

Three test pipes shall be selected for bond strength tests. On each of theselected pipes, three bond strength test shall be performed for each specified temperature i.e. one at each end and one in the middle of the pipe and specified requirements shall be complied with, i.e. bond strength as well as mode of separation. Length of peel shall be minimum 65mm. None of these samples shall fail.

b. **Impact Strength**

Three test pipes shall be selected for impact strength test and the test shall meet the requirement.

c. **Indentation Hardness**

Two samples for both the temperatures from all pipes shall be taken. If any one of these samples fail to satisfy the requirements, then the test shall be repeated on four more samples. In this case, none of the samples must fail.

d. **Elongation at Failure**

Six samples each from two coated pipes i.e. 18 samples in all shall be tested and the test shall comply the specified requirement. Only one sample per pipe may fail.

e. **Cathodic Disbondment Test**

Two CD test shall be carried out for the total lot of test pipes having all three layers. One test shall be carried out for 30 days duration and another test for 45 hours duration The tests shall comply the specified requirement. Whenever Procedure Qualification is necessitated for different pipe size with same coating material combination, 48 hours test only be conducted. 30 days CD test is not mandatory in this case.

f. **Holiday Inspection**

All the pipes shall be subject to holiday inspection. The test voltage shall be as specified in para 10.4(b)

g. **Coating Thickness Measurement**

All pipes shall be subject to coating thickness measurement. Acceptance criteria shall be as per para 10.3

h. **Air Entrapment**

One sample each from pipe body and on weld (if applicable) shall be taken from all four coated pipes and the specified requirements shall be complied with.

i. **Degree of Cure**

Epoxy film samples (minimum 4 no., equally spaced) shall be scrapped from one coated pipe and the samples shall be taken for cure test using Differential Scanning Calorimetry (DSC) procedure. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential ( $\Delta T_g$ ) and % cure ( $\Delta H$ ) shall comply with the specified requirements.

7.5.3 **Inspection of all test pipes**

All pipes shall be subject to the following inspections:

- a. surface cleanliness, surface roughness measurements and dust control immediately after second abrasive blast cleaning and salt test immediately after De-ionised water wash.
- b. pH of pipe surface before and after phosphoric acid wash.
- c. visual inspection of chromate coating.
- d. visual inspection of finished coating, cut back dimension, internal/ external cleanliness, end sealing and bevel inspection. Acceptance criteria for all inspection and testing shall be as specified in this specification.

7.6 After completion of the qualification tests and inspection as per para 7.4 and 7.5 above, the CONTRACTOR shall prepare and issue to COMPANY for approval a detailed report of the above tests and inspection including test reports/ certificates of all materials and coatings tested. Only upon written approval from COMPANY, CONTRACTOR shall commence production coating.

- 7.7 On successful completion of PQT, coating of all five(5) test pipes shall be removed and completely recycled as per the approval coating procedure specification, at CONTRACTOR's expense. Remaining pipes will be accepted by COMPANY provided they meet the requirements of this specification and need not be stripped and recycled.
- 7.8 The CONTRACTOR shall re-establish the requirements of qualification and in a manner as stated before or to the extent considered necessary by COMPANY, in the event of, but not limited to, the following :
- Every time there is a change in the previously qualified procedure.
  - Every time there is a change in the manufacturer and change in formulation of any of the raw materials and change in location of raw material manufacture.
  - Every time the coating yard is shifted from one location to the other or every time the critical coating equipments (induction heater, epoxy spray system, extruder, etc) are shifted.
  - Any change in line speed during coating application.
  - Any time when in COMPANY's opinion the properties are deemed to be suspect during regular production tests.
- 7.9 COMPANY reserves the right to conduct any or all the test required for qualification through an independent laboratory or agency at the cost of CONTRACTOR when in COMPANY's opinion, the results are deemed suspect. COMPANY's decision shall be final.

## **8.0 PIPE SURFACE PREPARATION**

- 8.1 Unless specified otherwise, the pipes shall be supplied free from mill applied oils but may be subject to contamination occurring during transit.
- 8.2 Prior to cleaning operation, CONTRACTOR shall visually examine the pipes and shall ensure that all defects, flats and other damages have been repaired or removed. The CONTRACTOR shall also remove marking stickers, if any, present within the pipe. Record shall be kept of such marking on the stickers of ensure traceability of pipe after coating.
- 8.3 Any oil, grease, salt or other contaminants detrimental to the formation of a good coating bond or coating quality shall be removed prior to coating application. Contaminants may be removed by the use of non-oily solvents. Gasoline or kerosene shall not be used for this purpose. Visible oil and grease spots shall be removed by solvent wiping. Solvents cleaning shall be in accordance with SSPCSP1. Steel surface shall be allowed to dry before abrasive cleaning.
- 8.4 All pipes shall be preheated to a temperature 65°C to 85°C prior to abrasive blast cleaning. The external surface of the pipe shall be cleaned using 2 no. dry abrasive blasting cleaning units to achieve the specified surface cleanliness and profile. After first abrasive blast cleaning, chemical

pre-treatment with phosphoric acid solution as per para 8.6 shall be carried out prior to second abrasive blast cleaning. However at the option of CONTRACTOR, chemical pre-treatment with phosphoric acid solution as per para 8.6 may be carried out after the second abrasive blaster.

The abrasive blast cleaning units shall have an effective dust collection system to ensure total removal of dust generated during blast cleaning from the pipe surface. The equipment used for abrasive blast cleaning shall meet the specified requirements and shall be free from oil, water soluble salts and other forms of contamination to ensure that the cleaning process is not impaired. Traps, separators and filters shall be checked for condensed water and oil at the start of each shift and emptied and cleaned regularly. During abrasive blast cleaning the metallic abrasive shall be continuously sieved to remove “fines” and “contaminates” and the quality checked at every four hours. Abrasive used for blast cleaning shall comply ISO- 11124.

- 8.5 Suitable plugs shall be provided at both pipe ends to prevent entry of any shot/grit into pipe during blast cleaning operations. These plugs shall be removed after blast cleaning. Alternatively the CONTRACTOR may link pipes suitably together to prevent the entry of any short/grit into the pipe.

8.6 Chemical Pre-treatment with Phosphoric Acid Solution

- 8.6.1 All pipes shall provided chemical pre-treatment with phosphoric acid solution. 10% solution of phosphoric acid, Oakite 31 / 33 or equivalent, shall be used to remove all soluble salts and other soluble contaminations.

The CONTRACTOR shall provide data sheets and supporting documentation for the phosphoric acid to be used. The documentation shall verify that the phosphoric acid is suitable for the treatment of line prior to the application of the specific fusion bonded epoxy powder being applied and the final wil meet fully the requirements of this specification.

- 8.6.2 The pipe temperature immediately prior to the phosphoric acid treatment shall be in the range of 45 to 75 °C. Phosphoric acid treatment shall be followed immediately by washing with de-ionised water. Deionised water used shall conform to the following requirements :

Sl. No	Properties	Unit	Requirement
a)	Turbidity	NTU	1 max.
b)	Conductivity	µmho/cm	5 max.
c)	Hardness	-	Nil
d)	Total Alkalinity as CaCO <sub>3</sub>	mg/l	2 to 3
e)	Chloride as Cl	mg/l	1 max.
f)	Sulphate as SO <sub>4</sub> =	mg/l	1 max.
g)	PH	-	6.5 to 7.5

Tests to determine the above properties shall be carried out in accordance with “Standard Methods for the Examination of Water and Wastewater” published jointly by American Public

Health Association, American Water Works Association and Water Pollution Control Federation.

Quality of the deionised water shall be monitored at the start of each shift and at every four hours interval. Non-compliance of deionised water wrt the above requirements shall cause for stoppage of the operations.

- 8.6.3 The pH of the pipe surface shall be determined both before and after the deionised water rinse initially on each pipe and in case of consistent results, the frequency may be relaxed to once per hour at the discretion of COMPANY Representative. The measured pH shall be as follows:

Before de-ionised water wash : 1 to 2

After de-ionised water wash : 6 to 7

- 8.6.4 After the de-ionized water wash, the pipe shall be dried with dry air and preheated to a temperature of 65°C to 85°C.

- 8.6.5 The salt tests shall be carried out after de-ionised water rinse. One test shall be carried out at one end of each pipe. The acceptance criteria shall be 2µg/cm<sup>2</sup>. An approved salt meter (SCM 400 or equivalent) shall be used to carry out salt tests and shall be calibrated in accordance with the equipment manufacturer's recommendation.

- 8.7 Abrasive cleaning carried out shall be such that the resultant surface profile is not dished and rounded when viewed with 30X magnification. The standard of finish for cleaned pipe shall conform to near white metal finish to Sa 2½ of Swedish Standard SIS 055900 latest edition. Surface of pipe after abrasive blast cleaning shall have an anchor pattern of 50 to 70 microns(Rz). This shall be measured for each pipe by a suitable instrument such as surface profile depth gauge. In addition the pipe surface after blast cleaning shall be checked for the degree of cleanliness (Sa 2½), degree of dust and shape of profile. Degree of dust shall comply the requirements of ISO:8502 – 3. Acceptance limit shall be either quality rating 2 or Class 2.

- 8.8 All pipes shall be visually examined for presence of any shot/ grit/ loose material left inside the pipe during blast cleaning. Suitable Mechanical means (stiff brush) shall be employed to remove the same before the pipes are processed further. In addition, inside surface of the pipe shall also be visually inspected for presence of any foreign material or shots and grit (free or embedded/ sticking to pipe inside surface). The pipe inside surface shall be examined using sharp floodlight focused at the middle of the pipe at one end while inspection is carried out visually from other end. Any foreign material or shots/ grit present in the pipe shall be completely removed by Mechanical/ brush, high pressure air jets, by tilting of pipe etc.

- 8.9 At no time shall the blast cleaning be performed when the relative humidity exceeds 85%. The CONTRACTOR shall measure the ambient conditions at regular intervals during blast cleaning and coating operations and keep records of prevailing temperature, humidity and dew point.

- 8.10 The blast cleaned surface shall not be contaminated with dirt, dust, metal particles, oil, water or any other foreign material, nor shall the surface or its anchor pattern be scarred or burnished. All blast cleaned pipe surface shall be kept in dust free enclosure prior to coating. After blast cleaning, all surfaces shall be thoroughly inspected under adequate lighting to determine anchor pattern, quality of blasting and identify any surface defects prior to coating application. All surface defects such as slivers, scab, burns, laminations, welds spatters, gouges, scores, indentations, slugs or any other defects considered injurious to the coating integrity made visible during blast cleaning shall be reported to the COMPANY Representative and on permission from COMPANY Representative, such defects shall be removed by filing or grinding. After any grinding or Mechanical repairs, the remaining wall thickness shall be checked and compared with specified thickness. Any pipes having thickness less than 95% of specified thickness shall be kept aside and disposed off as per the instructions of COMPANY Representative. The method employed to remove surface defects shall not burnish or destroy the anchor pattern or contaminate the surface. Pneumatic tools shall not be used unless they are fitted with effective air/ oil and water traps. Where burnishing results in destruction of anchor pattern, the anchor pattern shall be restored by suitable means. Pipes which have damages repaired by grinding and have ground areas more than 50mm in diameter shall be recycling-blasted.

Any dust or loose residues that have been accumulated during blasting and/ or during filing/ grinding operations shall be removed by vacuum cleaning.

If contamination of surface occurs, the quality of blast cleaning method and process shall be examined. If the surface roughness is outside the specified limit, the blast cleaning material shall be checked and replaced.

- 8.11 Upon Completion of the blasting operations, the quality control supervisor shall accept the pipe for further processing or return for re-blasting after removal of defects/ imperfections. In case imperfections are considered detrimental to the coating quality, the same shall be reported to COMPANY's Representative for final decision on rejection or re-blasting/ removal of defects. Re-blasting/ removal of defects or returning pipe to the yard shall be at the CONTRACTOR's cost.

COMPANY's Representative, in addition, reserves the right to initiate any of the above actions during periodic inspections for oil, dust, salt, imperfections, surface defects, lack of white metal finish etc.

- 8.12 In order to ensure that pipe with defects are not processed further, provisions shall be available to lift the pipes from inspection stand.

### 8.13 **Chemical Pre-treatment with Chromate Solution**

- 8.13.1 Following completion of abrasive blast cleaning, all pipe surface shall be chemically Pre-treated with a 10% strength chromate solution.

- 8.13.2 The CONTRACTOR shall provide data sheets and supporting documentation for the chemical to be used. The documentation shall verify that the chemical is suitable for the treatment of line pipe prior to the application of the specific fusion bonded epoxy powder being applied and the final coating will meet fully the requirements of this specification.
- 8.13.3 The chemical pre-treatment shall be applied fully in accordance with the chemical suppliers' instructions and in a manner that ensures 100% uniform coverage of the pipe surface without introducing surface contamination.
- 8.13.4 The CONTRACTOR shall check that the concentration for the chemical pretreatment solution remains within the range recommended by the chemical manufacturer for the pipe coating process. The concentration shall be checked at the make up of each fresh solution and once per hour, using a method approved by the chemical manufacturer. The CONTRACTOR shall also ensure that the chemical pre-treatment solution remains free from contamination at all times. Recycling of chemical pre-treatment solution is not permitted.
- 8.13.5 The CONTRACTOR shall ensure that the temperature of the substrate is maintained between 40°C and 80°C and the chromate solution temperature does not exceed 60° or as recommended by the manufacturer.
- 8.13.6 The chromate coating shall be smooth, even, free from runs, drips or excessive application and lightly adherent with no flaking of the coating. The chromate coated steel must be thoroughly dried immediately after application and shall be achieved by boiling off any residual solution on the surface.
- 8.14 The total allowable elapsed time between completion of the blasting operations and commencement of the pre-coating and heating operations shall be such that no detectable oxidation of the surface occurs. Relative humidity readings shall be recorded every half on hour during the blasting operations in the immediate vicinity of the operations. The maximum elapsed time shall not exceed the duration given below :

Relative Humidity %	Maximum elapsed time
> 80	2 hours
70 to 80	3 hours
< 70	4 hours

Any pipe not processed within the above time-humidity requirement shall be completely re-blasted. Any pipe showing flash rusting shall be re-blasted even if the above conditions have not been exceeded.

- 8.15 Pipe handling between abrasive blasting and pipe coating shall not damage the surface profile achieved during blasting. Any pipe affected by the damage to the surface exceeding 200mm<sup>2</sup> in area/ or having contamination of steel surface shall be rejected and sent for re-blasting.



## 9.0 COATING APPLICATION

The external surface of the cleaned pipe conforming to clause 8.0 of this specification shall be immediately coated with 3-layer extruded polyethylene coating in accordance with the procedures approved by COMPANY, relevant standards and this specification. In general, the procedure shall be as follows:

### 9.1 Pipe Heating

- 9.1.1 Immediately prior to heating of pipe, all dust and grit shall be removed from both inside and outside of the pipe by a combination of air blast, brushing and vacuum cleaning. Suitable arrangement shall be made to protect the bevel ends from getting damaged during the coating operation.
- 9.1.2 Induction heater or gas furnace shall be used for heating the pipe. The method shall be capable of maintaining uniform temperature along the total length of the pipe, and shall be such that it shall not contaminate the surface to be coated. In case of induction heating, appropriate frequency shall be used to ensure 'deep heating' and intense skin heating is avoided. Gas fired heating system shall be well adjusted so that no combustion products are deposited on the steel surface. This shall be demonstrated on bare pipes prior to start of PQT. Oxidation of the cleaned pipe surfaces prior to coating (in the form of bluing or other apparent oxide formation) is not acceptable.
- 9.1.3 External surface of the pipe shall be heated to about 190°C or within a temperature range (min. to max.) as recommended by the powder manufacturer. Required pipe temperature shall be maintained as it enters the coating chamber.
- 9.1.4 Temperature of the pipe surface shall be continuously monitored & recorded by using suitable instruments such as infrared sensors, contact thermometers, thermocouples etc. The recording method shall allow to correlate each line pipe. The monitoring instrument shall be able to raise an alarm/ activate audio system (hooter) in the event of tripping of induction heater/ gas fired heater or in the event of pipe temperature being outside the range recommended by the manufacturer. Any deviation from the application temperature range recommended by manufacturer shall be rectified. If immediate rectification is not feasible, the production shall be stopped until cause of deviation has been removed. Any pipe coated during the duration of temperature deviation shall be identified by marking and rejected. Such rejected pipes shall be stripped and recoated.
- 9.1.5 Temperature measuring & monitoring equipment shall be calibrated twice every shift and/ or as per COMPANY representative's instruction.

- 9.1.6 Contractor shall ensure that pipe surface emissivity variations are minimized during pipe heating. To avoid significant variance, more than once blasted joints should be coated at the same time and not mixed with joints blasted only once.

## 9.2 Pipe Coating

9.2.1 Subsequent to pipe heating, coating consisting of following layers shall be applied onto the pipe.

- i. Electrostatic application of epoxy powder of minimum dry film thickness 0.150 mm, unless otherwise specified. The maximum thickness shall not exceed the epoxy thickness specified by epoxy powder manufacturer.
- ii. Grafted co-polymer adhesive applied by extrusion, minimum thickness 0.200 mm.
- iii. Polyethylene coating by extrusion

The coated pipe shall be subsequently quenched and cooled in water for a period which shall sufficiently lower the temperature of pipe coating to permit handling and inspection.

9.2.2 Minimum total thickness of finished coating shall be as under :

Pipe Size Min., Specified outside diameter (mm)	Coating Thickness (mm)(*)
	Normal Type (n)
Upto 10 <sup>3</sup> / <sub>4</sub> " (273.1)	1.8
Over 10 <sup>3</sup> / <sub>4</sub> " (273.1) to below 20" (508.0)	2.0
From 20" (508.0) to below 32" (813.0)	2.25

(\*) HDPE material is to be used as top coat.

Required coating thickness shall be normal type (n), unless otherwise specified.

- 9.2.3 Coating materials shall be inspected in accordance with the manufacturer's recommendation prior to coating application and it shall be ensured that the materials are moisture free. In case the relative humidity exceeds 80%, the adhesive and polyethylene material shall be dried using hot air as per the directions of COMPANY representative.
- 9.2.4 Prior to starting the application of fusion bonded epoxy powder, the recovery system shall be thoroughly cleaned to remove any unused powder remaining from a previous line pipe coating application. The use of recycled powder shall be permitted subjected to:
- a) satisfactory qualification of the reclaimed system during PQT stage
  - b) the proportion of the reclaimed powder in the working mix does not exceed 20% at any one time.

- c) the quality of the recycled powder being routinely checked during production, at a minimum frequency of once per shift and consistently meets the requirements stated at para 5.3.1.
- 9.2.5 Dry air, free of oil and moisture shall be used in the coating chamber and spraying system and for this purpose filters, dehumidifier/ heater as required alongwith control & monitoring system shall be provided for this purpose. Dew point of air used to supply the fluidized bed, epoxy spray system and epoxy recycling system shall be at least (-) 40°C and this shall be shall monitored during the regular production.
- 9.2.6 Air pressure in the epoxy spray guns shall be controlled, continuously monitored and recorded by using suitable instruments. The air pressure shall be controlled within the limits established during coating procedure qualification. The monitoring system shall be able capable of raising an alarm/ activate audio system (hooter) in the event of change in air pressure beyond the set limits. Any deviation from the pre-set limits shall be rectified. If immediate rectification is not feasible, the production shall be stopped until cause of deviation has been removed. Any pipe coated during the duration of air pressure deviation shall be identified by suitable marking and rejected. Such rejected pipes shall be stripped and recoated.
- 9.2.7 Extruded adhesive layer shall be applied before gel time of the epoxy coating has elapsed. The application of the adhesive layer shall not be permitted after epoxy is fully cured. The CONTRACTOR shall establish, to the satisfaction of the COMPANY representative, that the adhesive is applied within the gel time window of epoxy and at the temperature recommended by the adhesive manufacturer. The CONTRACTOR shall state the minimum and maximum time interval between epoxy and adhesive application at the proposed pre-heat temperature and line speed.
- 9.2.8 Extruded polyethylene layer shall be applied over the adhesive layer within the time limit established during PQT stage and within the time/ temperature range recommended by the manufacturer. The extrusion temperatures of the adhesive and polyethylene shall be continuously recorded. The monitoring instruments shall be independent of the temperature control equipment. The instruments shall be calibrated prior to start of each shift.
- 9.2.9 CONTRACTOR shall ensure that there is no entrapment of air or void formation along the seam weld (where applicable) during application of coating. Air entrapment below the coating and also along the coating overlap shall be prevented by forcing the coating on to the pipe using high pressure roller of suitable design during coating application. In case it is not adequately achieved, CONTRACTOR shall supplement by other method to avoid air entrapment. The methods used shall be witnessed and approved by COMPANY.
- 9.2.10 Resultant coating shall have a uniform gloss and appearance and shall be free from air bubbles, wrinkles, holidays, irregularities, discontinuities, separation between layers of polyethylene & adhesive, etc.

- 9.2.11 Coating and/ or adhesive shall terminate 120mm (+)20/(-)0 mm from pipe ends. The adhesive shall seal the end of applied coating. CONTRACTOR shall adopt Mechanical brushing for termination of the coating at pipe ends. Edge of the coating shall be shaped to form a bevel angle of 30° to 45°.
- 9.2.12 Failure to comply with any of the above applicable requirement and of the approved procedure shall be cause for the rejection of the coating and such coating shall be removed in a manner approved by COMPANY at CONTRACTOR's expense.

## **10.0 INSPECTION AND TESTING**

### **10.1 General**

CONTRACTOR shall establish and maintain such quality assurance system as are necessary to ensure that goods or services supplied comply in all respects with the requirements of this specification. The minimum inspection and testing to be performed shall be as indicated subsequently herein.

### **10.2 Visual Inspection**

Immediately following the coated, each coated pipe shall be visually checked for imperfections and irregularities of the coating. The coating shall be of natural colour and gloss, smooth and uniform and shall be blemish free with no dust or other particulate inclusion. The coating shall not show defects such as blisters, pinholes, scratches, wrinkles, engravings, cuts swelling, disbonded zones, air inclusions, tears, voids or any other irregularities. Special attentions shall be paid to the areas adjacent to the longitudinal weld (if applicable), adjacent to the cut back at each of pipe and within the body of the pipe.

In addition inside surface of the pipe shall also be visually inspected for presence of any foreign material or shots and grit (free or embedded/ sticking to pipe inside surface). The pipe inside surface shall be examined using sharp floodlight focussed at the middle of the pipe at line end while inspection is carried out visually from other end.

### **10.3 Coating Thickness**

- a. The coating thickness shall be determined by taking atleast 10 measurement at locations uniformly distributed over the length and periphery of each pipe. In case of weld pipes, five of the above readings shall be made at the apex of the weld seam, uniformly distributed over the length of the coated pipe. All the readings must meet the minimum requirements. However, localised coating thickness of less than the permissible minimum thickness can be tolerated on the condition that it does not attain a total extent of more than 5cm<sup>2</sup> per meter length of coated pipe, and the actual coating thickness does not drop more than 10% below the permissible minimum coating thickness at these locations. The frequency of thickness measurement as stated above shall be initially on every pipe, which shall be further reduced

- b. depending upon consistency of results, at the sole discretion of COMPANY's representative. Results of all measurement shall be recorded.
- c. Thickness of epoxy and adhesive shall be measured at the beginning of each shift and whenever the plant re-starts after any stoppage for compliance. Coating of epoxy and adhesive on portion of pipe required for this purpose, stripping and recoating of such partly coated pipe shall be at CONTRACTOR's expense.
- d. Coated pipes not meeting the above requirements shall be rejected. The CONTRACTOR shall remove the entire coating and the pipe shall be recycled to the cleaning and coating operations as per the approved procedure and shall be to CONTRACTOR's expenses.

#### **10.4 Holiday Detection**

- a. Each coated pipe length shall be checked over 100% of coated surface by means of a "holiday detector" of a type approved by COMPANY for detecting holidays in the finished coating.
- b. The holiday detector shall be a low pulse DC full circle electronic detector with audible alarm and precise voltage control with DIN VDE 0433 Part 2. The set voltage for inspection shall be 25 kV. Travel speed shall not exceed 300 mm/s.
- c. CONTRACTOR shall calibrate the holiday detector at least once every 4 hours of production. CONTRACTOR shall have necessary instruments or devices for calibrating the holiday detector.
- d. Any pipe coating shall be rejected if more than 1(one) holiday & area more than 100 cm<sup>2</sup> in size are detected in its length attributable to coating process.
- e. Holidays which are lesser in number and size than those mentioned in (d) above, shall be repaired in accordance with a approved procedure and shall be to CONTRACTOR's expense.

#### **10.5 Bond Strength Test**

- a. CONTRACTOR shall conduct bond strength test for composite coating as per clause 5.3.3 (a) of this specification. A minimum of 65mm length shall be peeled. First 20mm and last 20mm shall not be counted for assessment of bond strength.
- b. The frequency of test for cut back portions shall be one pipe in every fifteen(15) pipes coated and for middle of pipe shall be one pipe in every sixty(60) pipes coated or one pipe per shift whichever is higher. On each selected pipe, bond strength shall be performed for each specified temperature. Test shall be performed at each cut back portion and one in the middle

of pipe. The system shall disbond/ separate cohesively either in adhesive layer or in polyethylene layer. Majority of the peeled off area on the pipe shall show presence of adhesive/ polyethylene interface shall not be permitted. The failure mode shall be recorded for each test.

- c. In case the above tests do not comply with the above requirement, CONTRACTOR shall test all the preceding and succeeding coated pipes. If both pipes pass the test, then the remainder of the pipe joints in that shift shall be deemed satisfactory. If either pipe fails to meet the specified requirements, all pipes coated during the shift shall be tested until the coating is provided acceptable. Rejected coated pipes shall be stripped and re-coated in accordance with approved procedure, at CONTRACTOR's expense.
- e. The frequency of bond strength test as per para 10.5(b) for cut back portion may be reduced depending upon the consistency of result to one pipe in every twenty five(25) instead of every fifteen pipes, at the sole discretion of the COMPANY Representative.

#### **10.6 Impact Strength**

- a. Impact resistance test shall be conducted as per clause 5.3.3 (b) of this specification. Initially the frequency of test shall be 2(two) coated pipes per shift, which may be further reduced and/ or waived depending upon consistently acceptable results at the sole discretion of COMPANY's representative.
- b. Minimum thirty(30) impacts located equidistant along the length of coated pipe shall be performed.
- c. Immediately after testing, the test area shall be subjected to holiday detection at the same voltage as used prior to impact strength test. The pipe shall be rejected if any holiday is noted in the test area.
- f. In case of test failure, retesting and disposal of coated pipe shall be as per 10.5(c) above.

#### **10.7 Indentation Hardness**

- a. Indentation hardness test shall be as per clause 5.3.3 (c) of this specification. The frequency of test shall be initially 2(two) coated pipes per shift which shall be further reduced to one test each on 2 coated pipes per week at random after 1 week of consistently acceptable results. Two samples for each temperature shall be taken from the cut back portion of coated pipe and one in middle of the pipe for this test.
- b. In case of test failure, retesting and disposal of coated pipe shall be as per 10.5(c) above.

## 10.8 Air Entrapment Test

- a. Strips from bond strength tests or coated pipe may be used to help determine the porosity of the finished coating. Strip shall be also cut from longitudinal weld (if applicable) at cut back portion and examined for the presence of voids.
- b. Bond strength strip shall be viewed from the side and at the failure interface. At the pipe bond strength test location, utility knife shall be used to cut the edge of the coating to a 45° angle and view with a microscope. Similar examination shall be done in the coating cut back area.
- c. One sample each either on the bond strength strip or coated pipe and strip cut from the longitudinal weld (if applicable) shall be examined for air entrapment per shift. Strips shall be viewed from the side.
- d. All examination shall done using a 30X magnification hand-held microscope. The polyethylene and adhesive layers shall have no more than 10% of the observed area taken up with air entrapment (porosity or bubbles). Air entrapment shall not occupy more than 10% of the thickness in each case. Bubbles shall not link together to provide a moisture path to the epoxy layer.
- e. In case of test failure, retesting and disposal of coated pipe shall be as per 10.5(c) above.

## 10.9 Degree of Cure

- a. Epoxy film samples shall be removed from cut back portion of the coated pipe using hammer and cold chisel and the samples shall be taken for cure test using DSC procedure. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential ( $\Delta T_g$ ) and % cure ( $\Delta H$ ) shall comply the specified requirements.
- b. Frequency of this test shall be once per shift. Pipe shall be selected randomly by COMPANY Representative during the middle of a shift. Suitable provisions/ arrangements as per the instructions of COMPANY Representative shall be made by the CONTRACTOR for this purpose.
- c. In case of test failure, production carried out during the entire shift shall be rejected, unless the CONTRACTOR proposes a method to establish the compliance with the degree of cure requirements of all pipes coated during that shift.

#### 10.10 Epoxy Layer Adhesive Test

- a. Adhesion of epoxy layer shall be determined at ambient temperature by the “St Andrews Cross” method i.e. by cutting two straight lines through the epoxy layer with a sharp knife. The incisions shall intersect at an angle of 30°/ 150°. The epoxy coating shall resist disbondment from the steel when attempts are made to flick/ lift the coating from the 30° angle with a sharp knife.
- b. Frequency of this test shall be once per shift. The test shall be carried out at the cut back portion of the pipe from which the Degree of Cure test has been carried out as per para 10.9 above.
- c. In case of test failure, retesting and disposal of coated pipe shall be as per 10.9(c) above.

#### 10.11 Cathodic Disbondment Test

- a. 48 hours CD test shall be conducted as per clause 5.3.3. (h) of this specification.
- b. The frequency of this test shall be once in every two weeks or one test representing each batch of epoxy powder used, whichever is more frequent.
- c. In case the test fails to conform to the specified requirement, at the option of the CONTRACTOR, all pipes coated after the previous acceptable test and prior to next acceptable test shall be rejected or the test shall be repeated or the shall be repeated using two additional samples taken from the same end of the affected pipe.

When both retests conform to the specified requirement, the lot of pipes shall be accepted. When one or both the retests fail to conform to the specified requirement, all coated pipes after previous acceptable test and prior to next acceptable shall be rejected. All rejected pipes shall be stripped, re-cleaned and re-coated. COMPANY may consider a further retest program to determine whether any of the affected pipe meet the criteria for acceptance upon written request by the CONTRACTOR.

- 10.12 Damages occurring to pipe coating during above tests shall be repaired in accordance with approved coating repair procedure.
- 10.13 Repairs occurring on account of the production test are however excluded from above mentioned limitations at para 10.4 (d) above.
- 10.14 COMPANY, reserves the right to perform inspection and witness tests on all activities concerning the pipe coating operations starting from bare pipe to finished coated pipe ready for dispatch and also testing of raw materials. CONTRACTOR shall give reasonable notice of time and shall provide without charge reasonable access and facilities required for inspection to the COMPANY's Representative. Inspection and tests performed or witnessed by COMPANY's



Representative shall in no way relieve the CONTRACTORs obligation to perform the required inspection and tests.

- 10.15 In case rate of defective or rejected pipes and/ or samples tests are 10% or more for a single shift (typically 8 hours), CONTRACTOR shall be required to stop production and carry out a full and detailed investigation and shall submit findings to COMPANY for approval. CONTRACTOR shall recommence the production only after getting the written permission from COMPANY. Under no circumstances any action or omission of the COMPANY's representative shall relieve the CONTRACTOR of his responsibility for material and quality of coating produced. No pipes shall be transported from the coating plants unless authorised by COMPANY in writing.

## **11.0 HANDLING, TRANSPORTATION AND STORAGE**

- 11.1 The CONTRACTOR shall be fully responsible for the pipe and for the pipe identification marking from the time of "taking over" of bare pipe from COMPANY until such time that the coated line pipes are 'handed over' and/ or installed in the permanent installation as the case may be according to the provisions of the Contract.

At the time of "taking over" of bare pipes CONTRACTOR shall inspect and record all the relevant details referred above including pipe defects in the presence of COMPANY. All pipes shall be checked for bevel damages, weld seam height, dents, gouges, corrosion and other damages. COMPANY Representative shall decide whether pipe defects/ damages are suitable for repair. Damage to the pipes which occur after the CONTRACTOR has taken delivery such as dents, flats, or damage to the weld ends shall be cut off or removed and pipes rebevelled and repaired again as necessary. The cost of this work, as well as that of the pipe lost in cutting and repair shall be to the CONTRACTOR's account. All such works shall be carried out after written approval of the COMPANY. Any reduction in length shall be indicated in the CONTRACTOR's pipe tracking system.

- 11.2 The CONTRACTOR shall unload, load, stockpile and transport the bare pipes within the coating plant(s) using suitable means and in a manner to avoid damage to pipes.

The CONTRACTOR shall stockpile the bare pipes at the storage area of the coating plant. The CONTRACTOR shall prepare and furnish to COMPANY a procedure/ calculation generally in compliance with API RP-5L1 for pipe stacking, which shall be approved by COMPANY prior to commencement.

- 11.3 The CONTRACTOR shall load, unload, transport and stockpile the coated pipes within the coating plant using approved suitable means and in a manner to avoid damage to the pipe and coating. The procedure shall be approved by COMPANY prior to commencement of work.
- 11.4 Coated pipes may be handled by means of slings and belts of proper width (minimum 60mm) made of non-abrasive/ non-metallic materials. In this case, pipes to be stacked shall be separated row by row to avoid damages by rubbing the coated surface in the process of taking off the

slings. Use of round sectional slings are prohibited. Fork lifts may be used provided that the arms of the fork lift are covered with suitable pads preferably rubber.

- 11.5 Bare/ 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 be stacked at a slope so that driving rain does not collect inside the pipe. Bare/ coated pipes may be stacked by placing them on ridges of sand free from stones and covered with a plastic film or on wooden supports provided with suitable cover. This cover can, 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 as to avoid permanent bending of the pipes.

Stacks shall consist of limited number of layers such that the pressure exercised by the pipe's own weight does not cause damages to the coating. CONTRACTOR shall submit calculations for COMPANY approval in this regard. Each pipe section shall be separated by means of spacers suitably spaced for this purpose. Stacks shall be suitably secured against falling down and shall consist of pipe sections having the same diameter and wall thickness. The weld seam of pipes shall be positioned always in a manner so as not to touch the adjacent pipes. The ends of the pipes during handling and stacking shall always be protected with bevel protectors.

- 11.6 The lorries used for transportation shall be equipped with adequate pipe supports having as many round hollow beds as there as pipes to be placed on the bottom of the lorry bed. Total width of the supports shall be at least 5% of the pipe length and min. 3 Nos. support shall be provided. These supports shall be lined with a rubber protection and shall be spaced in a manner as to support equal load from the pipes. The rubber protection must be free from all nails and staples where pipes are in contact. The second layer and all following layers shall be separated from the other with adequate number of separating layers of protective material such as straw in plastic covers or mineral wool strips or equivalent, to avoid direct touch between the coated pipes.

All stanchions of lorries used for transportation shall be covered by non-abrasive material like rubber belts or equivalent. Care shall be exercised to properly cover the top of the stanchions and other positions such as reinforcement of the truck body, rivets, etc. to prevent damage to the coated surface. Slings or non-metallic straps shall be used for securing loads during transportation. They shall be suitable padded at the contact points with the pipe.

- 11.7 Materials other than pipes and which are susceptible of deteriorating or suffering from damages especially due to humidity, exposure to high thermal excursions or other adverse weather conditions, shall be suitably stored and protected. Deteriorated materials shall not be used and shall be replaced at CONTRACTOR's expenses. These materials, shall always be handled during loading, unloading and storage in a manner so as to prevent any damage, alteration and dispersion.

When supplied in containers and envelopes, they shall not be dropped or thrown, or removed by means of hooks, both during the handling operations till their complete use. During unloading transport and utilization, any contact with water earth, crushed stone and any other foreign

material shall be carefully avoided. CONTRACTOR shall strictly follow Manufacturer's instructions regarding storage temperature and methods for volatile materials which are susceptible to change in properties and characteristics due to unsuitable storage. If necessary the CONTRACTOR shall provide for a proper conditioning.

- 11.8 In case of any marine transportation of bare/ coated line pipes involved, the same shall be carried out in compliance with API RP 5LW. CONTRACTOR shall furnish all details pertaining to marine transportation including necessary drawings of cargo barges, storing/ stacking, sea fastening of pipes on the barges/ marine vessels to the COMPANY for approval prior to undertaking such transportation works. In addition CONTRACTOR shall also carry out requisite analyses considering the proposed transportation scheme and establish the same is safe and stable. Ondeck overseas shipment shall not be allowed.

## 12.0 REPAIR OF COATING

CONTRACTOR shall submit to COMPANY, its methods and materials proposed to be used for executing a coating repair and shall receive approval from COMPANY prior to use. In open storage the repair coating materials must be able to withstand a temperature of atleast +80°C, without impairing its serviceability and properties. CONTRACTOR shall furnish manufacturer's test certificates for the repair materials clearly establishing the compliance of the repair materials with the applicable coating requirements indicated in this specification. All pipe leaving coating plant, shall have sound external coating with no holiday porosity on 100% of the surface.

Defects, repairs and acceptability criteria shall be as follows:

- Pipes showing porosities or very small damage not picked up during holiday test and having a surface less than 0.5 cm<sup>2</sup> or linear damage (cut) of less than 3 cm shall be repaired by stick welding using material of same quality.
- Damages caused to coating by handling such as scratches, cuts, dents, gouges, not picked up during holiday test, having a total reduced thickness on damaged portion not less than 2.0mm and an area not exceeding 20 cm<sup>2</sup> shall be rebuild by heat shrink patch only and without exposing to bare metal.
- Defects or size exceeding above mentioned area or holidays of width less than 300 mm shall be repaired with heat shrinks repair patch by exposing the bare metal surface.
- Defects exceeding the above and in number not exceeding 2 per pipe and linear length not exceeding 500mm shall be repaired using heat shrinkable sleeves of HTLP80 or equivalent.
- Pipes with bigger damage shall be stripped and recoated.
- In case of coating defect close to coating cut back, CONTRACTOR shall remove the coating throughout the entire circumference of the pipe down to the steel surface and increase the coating cut back length. Now if the coating cut back exceeds 140mm of linear length of pipe

then the coating shall be repaired by the use of heat shrinkable sleeves thereby making up the coating cut back length of 120mm.

Notwithstanding the above, under no circumstances, if the defects exceeds 70mm from the original coating cut back length, the entire coating shall be removed and the pipe shall be recycled through the entire coating procedure. Irrespective of type of repair, the maximum nos of repair of coating shall be as follows:

- Holiday repair of size  $\leq 100 \text{ cm}^2$  attributable to process of coating application shall be maximum of one per pipe.
- In addition to the above, defects to be repaired by heat shrink patch/ sleeve shall be maximum 2(two) per pipe.

Defects exceeding the above limits shall cause pipe coating rejection, stripping and recoating. The above is exclusive of the repairs warranted due to testing as per this specification.

All repairs carried out to coating for whatever reason shall be to the account of CONTRACTOR.

Cosmetic damages occurring only in the Polyethylene layer only need not be repaired by exposing upto steel surface, as deemed fit by the COMPANY representative. In any case the CONTRACTOR shall establish his material, methods and procedure of repair that results in acceptable quality of product by testing and shall receive approval from COMPANY prior to use.

Testing of repairs shall be in the same form as testing coating. All repairs shall result in a coating thickness no less than the parent coating thickness. CONTRACTOR shall test repairs to coating as and when required by COMPANY.

### **13.0 MARKING**

CONTRACTOR shall place marking on the outside surface of the coating at one end of the coated pipe, and marking shall indicate, but not limited to the following information:

- a. Pipe number, Heat number
  - i. Diameter & Wall Thickness
  - ii. Coated Pipe Number
  - iii. Colour band
  - iv. Any other information considered relevant by COMPANY.
  - v. Pipe Manufacturer Name
  - vi. Inspection Mark/ Punch

CONTRACTOR shall obtain prior approval on making procedure to be adopted from the COMPANY.

**14.0 QUALITY ASSURANCE**

- 14.1 The CONTRACTOR shall have established within the organisation and, shall operate for the contract, a documented Quality System that ensures that the requirements of this specification are met in all aspects. The Quality System shall be based upon ISO 9001/2 or equivalent.
- 14.2 The CONTRACTOR shall have established a Quality Assurance Group within its organisation that shall be responsible for reviewing the Quality System and ensuring that it is implemented.
- 14.3 The CONTRACTOR shall submit the procedures that comprise the Quality System to the COMPANY for agreement.
- 14.4 The CONTRACTOR's Quality System shall pay particular attention to the control of Suppliers and sub-contractors and shall ensure that the requirements of this specification are satisfied by the Suppliers and Sub-contractors operating Quality system in their organisation.
- 14.5 The CONTRACTOR shall, prior to the commencement of work, prepare and issue a Quality plan for all of the activities required to satisfy the requirements of this specification. The plan shall include any sub-contracted work, for which the subcontractors Quality plans shall be submitted. The plan shall be sufficiently detailed to indicate sequentially for each discipline the requisite quality control, inspection, testing and certification activities with reference to the relevant procedures and the acceptance standards.
- 14.6 The CONTRACTOR's Quality system and associated procedures may, with due notice, be subject to formal audits. The application of quality control by the CONTRACTOR will be monitored by the COMPANY Representatives who will witness and accept the inspection testing and associated work required by this specification.

**Coating combination/ Material Pre-qualification**

Coating material Manufacturers acceptable to Company are as follows :

Epoxy	:	BASF/Basepox Jotun 3M Dupont Bitumese Speciaux, France
Adhesive	:	BASF/Basell Boresalis Dupont SK Corporation

Polyethylene : Novacorp  
 BASF/Basell  
 Boresalis/Borouge  
 SK Corporation  
 Malaysian Polyethylene Malaysia (ETILINAS)  
 ELF ATOCHEM, FRANCE  
 GAIL (India) Ltd.

The bidder shall propose coating material combination indicating specific grade of epoxy, adhesive and polyethylene manufactured by any of the above mentioned material Manufactures and submit the details as per Table 1. The proposed combination shall be capable of meeting the functional requirements and properties of coating indicated in this specification. The coating combination must have been tested and pre-qualified by an independent internationally recognised test laboratory/ agency by actual application on minimum 5 pipes and must have been successfully fulfilled the tests as indicated in Table 2. After the procurement of raw materials by the bidder, the same shall also be tested by an independent test laboratory of national / international repute. The combination proposed by the bidder must have been used in previous pipeline project and the pipelines shall be in satisfactory operation for at least a period of five years, reckoned from the date of bid submission.

<b>Table – 1</b>			
<b>Manufacturers Data on Coating System and Materials</b>			
Coating System data	Epoxy	Adhesive	Polyethylene Compound
Coating System Designation	Manufacturer's Name	Manufacturer's Name	Manufacturer's Name
Coating Material combination (s)	Product Trade Name	Product Trade Name	Product Trade Name
Technical Data Sheet covering all properties as per specifications	Technical Data Sheet covering all properties as per specifications	Technical Data Sheet covering all properties as per specifications	Technical Data Sheet covering all properties as per specifications
Laboratory Test Reports in support of technical data	Laboratory Test Reports in support of technical data	Laboratory Test Reports in support of technical data	Laboratory Test Reports in support of technical data
Certificate of Compatibility of proposed materials	Certificate of Compatibility with Adhesive	Certificate of Compatibility with epoxy and polyethylene	Certificate of Compatibility with Adhesive
Application Procedure	Storage Instructions	Storage Instructions	Storage Instructions
	Shelf Life	Shelf Life	Shelf Life
	Safety Data Sheets and HSE instructions	Safety Data Sheets and HSE instructions	Safety Data Sheets and HSE instructions

<b>Table – 2</b>			
<b>S.No</b>	<b>Properties</b>	<b>Frequency (1)</b>	<b>Applicable Requirement</b>
1.	Bond Strength	5 Pipes	Para 10.5
2.	Impact Strength	3 Pipes	Para 10.6
3.	Indentation hardness	5 Pipes	Para 10.7
4.	Elongation at Failure	3 Pipes	Para 5.3.3(d) & 7.5.2(d)
5.	Cathodic Disbondment	2 Pipes	Para 5.3.3(h) & 7.5.2(e)(2)

6.	Degree of Cure	2 Pipes	Para 5.3.3(i) & Para 10.9(a)
7.	Coating Resistivity	2 Pipes	Para 5.3.3 (e)(3)
8.	Heat Ageing	2 Pipes	Para 5.3.3 (f)(3)
9.	Light Ageing	2 Pipes	Para 5.3.3 (g)(3)

- 1) Test frequency shall be as indicated in this table and the frequency indicated in the applicable paragraphs of the specific are not applicable.
- 2) Two tests each on the selected pipes i.e 30 days and 48 hours test shall be carried out on each test pipe.
- 3) Previously carried out tests in an independent laboratory of national / international recognition on PE top coat are also acceptable.

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SPECIFICATION

FOR

TRANSPORTATION OF GOODS  
INDEGENOUSLY

SPECIFICATION NO. : MNGL/Steel/TS/14



## **C O N T E N T S**

- 1.1 GENERAL
- 1.2 PACKING
- 1.3 MARKING
- 1.4 DESPATCH

### **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 as per current general rules of IRCA Goods Tariff Part I. 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 Despatch**

- 1.4.1 Despatch 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 despatch of GOODS immediately after they are inspected and released and shall intimate status of despatch by fax to: -
  - DGM (O&M), GAIL, Pondicherry - Fax no.: 0413-2200939
  - GM (Projects), MNGL, Pune – Fax No.: 020-25511522
- 1.4.2 The Contractor shall be responsible for despatch of materials through a reliable Transport company unless the Transport Company is named by Owner.
- 1.4.3 The Contractor shall ensure with Transport Company the delivery of materials within a reasonable transit period. Contractor shall also obtain from transporter particulars of Lorry Number, transporter's Challan Number, destination of Lorry, Transporter's Agent at destination, if any, etc. and intimate same to following: -
  - DGM (O&M), GAIL, Pondicherry - Fax no.: 0413-2200939
  - GM (Projects), MNGL, Pune – Fax No.: 020-25511522

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SPECIFICATION  
FOR  
TEMPORARY CATHODIC PROTECTION SYSTEM

SPECIFICATION NO. : MNGL/Steel/TS/15

## **C O N T E N T S**

1.0	SCOPE
2.0	CODES AND STANDARDS
3.0	CORROSION DATA
4.0	CATHODIC PROTECTION DESIGN PARAMETERS
5.0	CATHODIC PROTECTION DESIGN CRITERIA
6.0	SYSTEM DETAILS
7.0	INSTALLATION
8.0	CIVIL WORKS
9.0	TESTING AND INSPECTION AT WORKS
10.0	PACKING AND TRANSPORT
11.0	SYSTEM TESTING COMMISSIONING AND INTERFERENCE MITIGATION
12.0	SYSTEM MONITORING
13.0	DRAWINGS AND DOCUMENTS
14.0	INSTRUMENTS, TOOLS AND SPARES
15.0	INFORMATION REQUIRED WITH BID

## 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.
- ii. Diameter, wall thickness, pressure, pipeline coating against corrosion, soil cover used in case of pipelines.
- iii. 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.
- iv. Graphical representation of existing structure/ pipe-to soil potential records. T/R unit current/ voltage readings.
- v. Remedial measures existing on foreign pipeline/services to prevent interaction.
- vi. Possibility of intergration/isolation of CP system, Which may involve negotiations with owners of other services.
- vii. Crossing and parallel running of electrified and non-electrified traction (along with information regarding operating voltage, type AC/DC etc.) as well as abandoned tracks near ROW having electrical continuity with the tracks in use.
- viii. Crossing and parallel running of any HT/AC/DC overhead line (existing/proposed) along with details of voltage, type AC/DC etc.
- ix. Voltage rating, number of cores and sheathing details of under ground power cables, along ROW or in its vicinity.
- x. Information on existing and proposed DC/AC power sources and system having earth as return path, in the vicinity of the entire pipeline, route such as HV/DC sub stations, fabrication yards with electric welding etc.

- xi. Any other relevant information that may be needed in designing and implementing proper protection scheme for the proposed pipeline. Unless otherwise mentioned, 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.
- xii. 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.
- xiii. 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 ( $\mu\text{A}/\text{m}^2$ )	Permanent CP ( $\text{MA}/\text{m}^2$ )
Normal soil	50	0.120
Marshy area/ buried in sea water/ HDD crossing	100	0.120
High resistivity area (more than 100 $\Omega$ m)	25	100

(ii) Pipe lines having FBE Coatings

Pipeline surrounding	Protection current density*	
	Temporary CP ( $\mu\text{A}/\text{m}^2$ )	Permanent CP ( $\text{MA}/\text{m}^2$ )
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
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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 utilisation 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-CuSO<sub>4</sub>, 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:

<u>Element</u>	<u>Weight</u>
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 conform 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:

<u>Element</u>	<u>Weight</u>
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 spectographic 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  $\pm 5\%$ . The total weight of the anodes shall not have negative tolerance.

Recommended dimensional tolerance shall be as follows:

Length	$\pm 2.5\%$
Width/thickness	$\pm 5\%$

### 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 net works 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 transmissison 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 Arrestor

- Type : Spark gap
- Current, 8/20 wave : 100 kA
- Spark over AC voltage: : 1 kV
- 50 Hz : 1 kV
- Impulse (1.2/50) : 2.2 kV

micro sec)

- 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, 10mm<sup>2</sup> 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 25mm<sup>2</sup> 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 exothermic 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, carriage at site and outdoor storage during transit and at site. All packages shall be clearly, legibly and durably marked with uniform block letters giving the relevant equipment/material details. Each package shall contain a packing list in a water proof envelope. Copies of the packing list in triplicate, shall be forwarded to owner prior to despatch. All items of material shall be clearly marked for easy identification against the packing list.

#### **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 energisation 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 measures shall be provided depending on type of interference. These shall include installation of bond with variable resistor and diodes, installation of galvanic anodes for auxiliary drainage of current, adjustment/relocation (if possible) of offending interference source, provision of 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:
- Report on corrosion survey
  - Basis of system design calculations, equipment selection criteria and sizing calculations.
  - Bill of material, material requisitions, purchase requisitions
- 13.2.2 Detailed construction drawings (including as built drawings)
- Sacrificial anode fabrication drawings
  - Typical layout drawing for anode ground bed installation and connection
  - Equipment layout, cable layout and schedules
  - Fabrication, installation and connection scheme drawing for different types of test stations.
  - Fabrication and installation details of surge diverter, grounding cell and polarisation cell with its enclosure and housing
  - Cable-to-pipe joint details for charged and non-charged pipelines.
  - 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. : MNGL/Steel/TS/16

## **C O N T E N T S**

- 1.0 SCOPE
- 2.0 CODES AND STANDARDS
- 3.0 GENERAL
- 4.0 SOIL RESISTIVITY SURVEY
- 5.0 TESTS ON SOIL SAMPLES
- 6.0 ADDITIONAL DATA COLLECTION
- 7.0 REPORT
- 8.0 INFORMATION REQUIRED WITH BID

## 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 buried 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 depending on topography 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 be 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 existing 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.: MNGL/Steel/TS/17

## **C O N T E N T S**

1.0        GASKETS

2.0        NUTS AND BOLTS

## 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.
7. The nuts shall be double chamfered, heavy hexagonal type.
8. Heads of jack screws and M/C bolts by heavy hexagonal type. Jack screw end shall be rounded.

9. Each size of studs & M/C bolts with nuts and jack screws shall be supplied in separate bags marked with size and material specifications.
10. All items shall be inspected and approval (Stagewise) by Purchaser's Representative.

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SPECIFICATION  
FOR  
PIPING MATERIAL SPECIFICATION

SPECIFICATION NO.: MNGL/Steel/TS/18



## **C O N T E N T S**

1.0 SCOPE

2.0 CODES AND STANDARDS

3.0 MATERIAL SPECIFICATION

4.0 CLASS DESIGNATION CODE

5.0 PIPELINE

6.0 PIPING

7.0 FITTINGS

8.0 BENDS

9.0 FLANGES

10.0 GASKETS

11.0 BOLTING

12.0 THREAD SEALANT

13.0 VALVES

14.0 QUICK OPENING END CLOSURE

15.0 HYDROTESTING VENTS AND DRAINS

TABLE-1 PIPE WALL THICKNESS DETAILS FOR MAINLINE

TABLE-2 INDEX OF PIPING MATERIAL SPECIFICATION

**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, MNGL 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, nipplet 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/ MNGL 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 MNGL'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 1/4" to 1"	:	UNC-2B
Nuts for stud bolts dia 1 1/8" to 3 1/4"	:	8UN-2B

- 11.4 Threads for stud bolts shall be as per ANSI B 1.1, as follows.

Studs bolts dia 1/4" to 1"	:	UNC-2A
Stud bolts dia 1 1/8" to 3 1/4"	:	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**

<b>Piping Class</b>	<b>Service</b>	<b>Design pressure Kg/ cm2</b>	<b>Design Temp. °c</b>	<b>C .A. in mm</b>	<b>Basic Material</b>	<b>Design Code</b>	<b>Attachment Status</b>
AIA (150#)	NATURAL GAS	19	65	1.5	API 5L	ASME B 31.8	<b>Yes (As Annexure-I)</b>
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  
SEAMLESS FITTINGS AND FLANGES  
UPTO 400mm (16”) NB

SPECIFICATION NO. : MNGL/Steel/TS/19



## **C O N T E N T S**

- 1.0 SCOPE
- 2.0 REFERENCE DOCUMENTS
- 3.0 MANUFACTURER'S QUALIFICATION
- 4.0 MATERIALS
- 5.0 DESIGN AND MANUFACTURE
- 6.0 INSPECTION AND TESTS
- 7.0 TEST CERTIFICATES
- 8.0 MARKING
- 9.0 DOCUMENTATION

## 1.0 SCOPE

This specification covers the minimum requirements for the design, manufacture and supply of following items to be installed in pipeline system handling hydrocarbons in liquid or gaseous phase:

- Seamless fittings 400 mm (16”) NB and smaller, such as tees, elbows, reducers and caps.
- Flanges 400 mm (16”) NB and smaller, such as welding neck flanges and blind flanges.

The specification does not cover the above mentioned items which are to be installed in pipeline system handling sour hydrocarbons (liquid/ gas) service as defined in NACE standard MR-01-75-98.

## 2.0 REFERENCE DOCUMENTS

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

- a) ASME B 16.5 - Steel Pipe Flanges and Flanged Fittings
- b) ASME B 16.9 - Factory-Made Wrought Steel Butt Welding Fittings
- c) ASME B 16.11 - Forged Steel Fittings, Socket Welding and Threaded
- d) ASME B 31.4 - Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia and Alcohols
- e) ASME B 31.8 - Gas Transmission and Distribution Piping Systems
- f) ASTM A 370 - Mechanical Testing of Steel Products
- g) API 590 - Steel Line Blanks
- h) MSS-SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions
- i) MSS-SP-44 - Steel Pipeline Flanges
- j) MSS-SP-75 - Specification for High Test Wrought Welded Fittings

- k) MSS-SP-97 - Forged Carbon Steel Branch Outlet  
Fittings-Socket Welding, Threaded  
and Butt Welding Ends

### 3.0 MANUFACTURER'S QUALIFICATION

Manufacturer who intends bidding for fittings, must possess the records of a successful proof test, in accordance with the provisions of ASME B 16.9/ MSSSP- 75, as applicable. These records shall be submitted at the time of bidding.

### 4.0 MATERIALS

- 4.1 The basic material for fittings and flanges shall be as indicated in the Material Requisition. Additionally, the material shall also meet the requirements specified hereinafter.
- 4.2 Each heat of steel used for the manufacture of fittings and flanges shall have carbon equivalent (CE) not greater than 0.45% calculated from check analysis in accordance with following formula :

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

Carbon contents on check analysis shall not exceed 0.22%.

- 4.3 Unless specified otherwise, Charpy V-notch test shall be conducted for each heat of steel, in accordance with the impact test provision of ASTM A370 at 0°C temperature. The average absorbed impact energy values of three full sized specimens shall be 27 joules.

The minimum impact energy value of any one specimen of the three specimens analysed as above, shall not be less than 80% of the abovementioned average value.

- 4.4 Steel used shall be fully killed.
- 4.5 Hardness testing shall be carried out by Manufacturer in accordance with ASTM A 234. Hardness testing shall cover at least 10% per item, per size, per heat per manufacturing method.

### 5.0 DESIGN AND MANUFACTURE

- 5.1 Flanges such as welding neck flanges and blind flanges shall conform to the requirements of ASME B 16.5. Spectacle blind, spacer & blind shall conform to API 590.

- 5.2 Fittings such as tees, elbows and reducers shall be seamless type and shall conform to ASME B 16.9 for sizes 50 mm (2")NB and above and ASME B16.11 for sizes below 50mm(2")NB.
- 5.3 Fittings such as weldolets, sockolets, nippolets, etc., shall be manufactured in accordance with MSS-SP-97.
- 5.4 Type, face and face finish of flanges shall be as specified in Material Requisition.
- 5.5 Stub-in or pipe to pipe connection shall not be used in the manufacture of tees. Tees shall be manufactured by forging or extrusion methods. The longitudinal weld seam shall be kept at 90° from the extrusion. Fittings shall not have any circumferential joint.
- 5.6 All butt weld ends shall be beveled as per ASME B16.25.
- 5.7 Repair by welding on flanges and parent metal of the fittings is not allowed.

## 6.0 INSPECTION AND TESTS

- 6.1 The Manufacturer shall perform all inspection and tests as per the requirement of this specification and the relevant codes, prior to shipment at his works. Such inspection and tests shall be, but not limited to, the following:
  - 6.1.1 Visual inspection.
  - 6.1.2 Dimensional checks.
  - 6.1.3 Chemical composition, Mechanical properties and hardness examination.
  - 6.1.4 All finished wrought weld ends shall be 100% ultrasonically tested for lamination type defects. Any lamination larger than 6.35 mm shall not be acceptable.
  - 6.1.5 All other tests not specifically listed but are required as per applicable standard/ specification.
- 6.2 Purchaser's Inspector may also perform stage-wise inspection and witness tests as indicated in Clause 6.1 at Manufacture's Works prior to shipment. Manufacturer shall give reasonable notice of time and shall provide, without charge, reasonable access and facilities required for inspection to the Purchaser's Inspector.

Inspection and tests performed/ witnessed by the Purchaser's Inspector shall in no way relieve the Manufacturer's obligation to perform the required inspection and tests.

## 7.0 TEST CERTIFICATES

Manufacturer shall submit following certificates to Purchaser's Inspector:

- a) Test certificates relevant to the chemical analysis and Mechanical properties of the materials used for construction as per this specification and relevant standards.
- b) Test reports on non-destructive testing.

**8.0 MARKING**

Each item shall be marked with indelible paint with the following data:

- a) Manufacturer's marking
- b) Material Specification
- c) Size and schedule number
- d) Heat number

**9.0 DOCUMENTATION**

9.1 At the time of bidding, Manufacturer shall submit the following documents:

- a) Reference list of previous supplies of similar fittings of similar specification.
- b) Clausewise list of deviations from this specification, if any.
- c) Brief description of the manufacturing and quality control facilities at Manufacturer's works.
- d) Manufacturer's qualification requirement as per clause 3.0 of this specification.
- e) Quality Assurance Plan (QAP) enclosed with this tender duly signed, stamped and accepted.

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

9.3 All documents shall be in English language.

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SPECIFICATION  
FOR  
ASSORTED PIPES

SPECIFICATION NO. : MNGL/Steel/TS/20

## **C O N T E N T S**

1.0 GENERAL

2.0 IBR PIPES

3.0 HYDROSTATIC TEST

4.0 MARKING & DESPATCH

ANNEXURE-I : HYDROSTATIC TEST

## 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 the 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 length 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  $\geq$  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
Alloy Steel Stainless Steel & Low Temp. Carbon Steel	Upto 10 mm	Figure 4
	>10 mm & Upto 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

- 1.8 Gavanished pipes shall be coated with zinc by hot dip process conforming to IS:4736/ ASTM A 153.
- 1.9 All austenitic stainless steel pipes shall be supplied in solution annealed condition.
- 1.10 **I.G.C. Test for Stainless Steels**
- 1.10.1 For all austenitic stainless steel pipes, intergranular corrosion test shall have to be conducted as per following:
- ASTM A262 practice “ B “ with acceptance criteria of “60 mils/ year (max.)”
- ASTM 262 practice “ E” with acceptance criteria of “ No cracks as observed from 20X magnification” & “Microscopic structure to be observed from 250X magnification”.
- 1.10.2 When specifically asked for in MR for high temperature application of some grades of austenitic stainless steel (eg.SS 309, 310, 316, 316H etc.), ASTM A262 practice “C” with acceptance criteria of “15 mils/ year (max.)” shall have to be conducted.
- 1.10.3 For the IGC test as described in 1.10.1 & 1.10.2, two sets of samples shall be drawn from each solution annealing lot; one set corresponding to highest carbon content and the other corresponding to the highest pipe thickness. When testing in is conducted as per Practice “E”, photograph of microscopic structure shall be submitted for record.
- 1.11 All welded pipes indicated as ‘CRYO’ & ‘LT’ in MR shall be impact tested per requirement and acceptance criteria of ASME B31.3. The impact test temperature shall be –196° C & -45° C for stainless steel and carbon steel, respectively, unless specifically mentioned otherwise in MR.
- 1.12 Pipes under ‘NACE’ category shall meet the requirements given in MR-01-75.

1.13 Specified heat treatment for carbon steel & alloy steel and solution annealing for stainless steel pipes shall be carried out after weld repairs. Number of weld repairs at the same spot shall be restricted to maximum two by approved repair procedure.

1.14 For black or galvanised pipes to IS:1239, the minimum percentage of elongation shall be 20%.

## 2.0 IBR PIPES

### 2.1 IBR Documentation

2.1.1 Pipes under purview of IBR shall be accompanied with IBR certificate original in Form IIIA, duly approved and countersigned by IBR authority/ local authority empowered by the Central Boiler Board of India. Photocopy of the original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance.

2.1.2 For materials 1 ¼ Cr- ½ Mo (ASTM A335 Gr. P11/ A691 Gr. 1 ¼ Cr) & 2 ¼ Cr-1Mo (ASTM A335 Gr.P22/ A691 Gr. 2 ¼ Cr.), from III-A approved by IBR shall include the tabulation of  $E_t$ ,  $S_c$  &  $S_r$  values for the entire temperature range given below.  $E_t$ ,  $S_c$  &  $S_r$  values shall be such that throughout the temperature range

$$\begin{aligned} E_t / 1.5 &\geq \\ S_r / 1.5 &\geq \\ S_c &\geq S_a \end{aligned}$$

where,

$S_A$  : Allowable stress at the working metal temperature.

$E_t$  : Yield point (0.2% proof stress at the working metal temperature).

$S_c$  : The average stress to produce elongation of 1% (creep) in 1,00,000 hrs at the working metal temperature.

$S_r$  : The average stress to produce rupture in 1,00,000 hrs. at the working metal temperature and in no case more than 1.33 times the lowest stress to produce rupture at this temperature.

**$S_A$  (psi) Temperature (°F)**

Material	500	600	650	700	750	800	850	900	950	1000	1050	1100
A335 Gr. P11	17200	16700	16200	15600	15200	15000	14500	12800	9300	6300	4200	2800
A691 Gr. 1½ Cr	18900	18300	18000	17600	17300	16800	16300	15000	9900	6300	4200	2800
A335 Gr.P2/ A691Gr.2¼Cr	17900	17900	17900	17900	17900	17800	14500	12800	10800	7800	5100	3200

Note:  $S_A$  values given above are as per ASME B31.3-1999. Values shall be as per the latest edition prevailing.

2.2 For carbon steel pipes under IBR, the chemical composition shall conform to the following;

Carbon (max.) : 0.25%  
Others (S, P, Mn) : As prescribed in IBR regulation.

The chemical composition as indicated in this clause is not applicable for pipes other than IBR services.

### 3.0 **HYDROSTATIC TEST**

Refer Annexure – I.

### 4.0 **MARKING AND DESPATCH**

- 4.1 All pipes shall be marked in accordance with the applicable codes, standards and specifications. In addition, the purchase order number, the item code & special 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, clean and free from moisture, dirt and loose foreign materials of any kind.
- 4.5 Pipes shall be protected from rust, corrosion and Mechanical damage during transportation, shipment and storage.
- 4.6 Rust preventive used on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.
- 4.7 Both ends of the pipe shall be protected with the following material:
- |              |                                 |
|--------------|---------------------------------|
| Plain end    | : Plastic cap                   |
| Bevel end    | : Wood, Metal or Plastic cover  |
| Threaded end | : Metal or Plastic threaded cap |
- 4.8 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 galvanised pipes shall be galvanised.

**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**

<b>Material Standard</b>	<b>Test Pressure Standard</b>
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

**b) Seamless Alloy Steel**

<b>Material Standard</b>	<b>Test Pressure Standard</b>
ASTM A335 GR.P1, P12, P11, P22, P5,P9	ASTM A 530
ASTM A268 TP 405, TP410	ASTM A530

**c) Seamless Stainless Steel**

<b>Material Standard</b>	<b>Test Pressure Standard</b>
ASTM A312 Gr.TP304, 304L, 304H, 316,316L, 316H, 321, 347	ASTM A 530

**d) Seamless Nickel Alloy**

<b>Material Standard</b>	<b>Test Pressure Standard</b>
ASTM B161 UNS No.2200	ASTM B161
ASTM B165 UNS No.4400	ASTM B165
ASTM B167 UNS No.6600	ASTM B167
ASTM B407 UNS No.8800	ASTM B407

**e) Welded Nickel Alloy**

Material Standard	Test Pressure Standard
ASTM B725 UNS No.2200, 4400	ASTM B725
ASTM B517 UNS No.6600	ASTM B517
ASTM B514 UNS No.8800	ASTM B514

**3.2.2 Electric Fusion Welded****a) Carbon Steel & Alloy Steel E.FS.W. (16" & above)**

Material 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) Stainless Steel E.FS.W. (2" to 6")**

The hydrostatic test pressure in kg/ cm<sup>2</sup> for the following materials shall be as given below:

Material Gr.1:                   ASTM A312 TP304/ 304H/ 316/ 316H/ 321/ 347 welded

Material Gr.2:                   ASTM A312 TP 304L/ 316L welded

Size	Pipe Schedule: S10		Pipe Schedule : S40		Pipe Schedule : S80	
	Material Gr.1	Material Gr.2	Material Gr.1	Material Gr.2	Material Gr.1	Material Gr.2
2"	100	80	155	130	230	190
3"	80	60	155	130	230	190
4"	80	50	155	130	230	190
6"	65	35	90	75	155	130

**c) Stainless Steel E.FS.W. (8" and above).**

<b>Material Standard</b>	<b>Test Pressure Standard</b>
ASTM A358 TP 304L, 304, 304H, 316L, 316, 316H, 321, 347 (Classes 1, 3 & 4)	P = 2ST/D S = 85% of SMYS T = Nominal Wall Thickness D = O.D. of Pipe
ASTM A358 TP 304L, 304, 304H, 316L, 316, 316H, 321, 347 (Classes 2 & 5)	P = 2ST/D S = 72% of SMYS T = Nominal Wall Thickness D = O.D. of Pipe

**3.2.3 Carbon Steel Pipes to IS Standards**

<b>Material Standard</b>	<b>Test Pressure Standard</b>
IS :1239	IS :1239
IS :3589	IS :3589

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SPECIFICATION  
FOR  
PIPELINE PRE-COMMISSIONING AND  
COMMISSIONING OF PIPELINE PROJECT

SPECIFICATION NO. MNGL/Steel/TS/21

## **CONTENTS**

- 1.0 INTRODUCTION
- 2.0 GENERAL
- 3.0 THE WORK
- 4.0 PRE-COMMISSIONING CHECKS
- 5.0 DOCUMENTATION



## 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 markers, fencing around SV Stations etc. have been installed along the pipeline.

iv) Checking of Communications System

This is to check that there is proper communications 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 is 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 25%. 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. : MNGL/Steel/TS/22

## **C O N T E N T S**

- 1.0 SCOPE
- 2.0 REFERENCE DOCUMENTS
- 3.0 HEALTH, SAFETY AND ENVIRONMENT (HSE) REQUIREMENTS
- 4.0 DETAILS OF HSE MANAGEMENT SYSTEM BY CONTRACTOR

## **ANNEXURES**

- 1. ANNEX-A-RELEVANT I.S. CODES
- 2. ANNEX-B-REPORTING FORMATS – 5 NOS.
- 3. ANNEX-C-DO's & DON'T'S ABOUT SAFETY ASPECTS AS PER FACTORIES ACT

## 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.
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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.
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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/ MNGL & their representative's 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/ MNGL.
- 3.1.7 The Contractor shall evolve a comprehensive planned and documented system for implementation and monitoring of the HSE requirements. This shall be submitted to OWNER & MNGL 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/ MNGL 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 MNGL/ OWNER representative shall be resolved forthwith by Contractor. Compliance report shall be submitted to MNGL/ 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/ MNGL. The compliance of any observation shall be arranged urgently. Contractor shall assist OWNER/MNGL 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/ MNGL 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 & monetary penalty shall rest with MNGL/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/MNGL. OWNER/MNGL 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 trailers 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/ MNGL. 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/ MNGL.

#### **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/MNGL. The Contractor shall participate in the pre-start meeting with OWNER/MNGL 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 alongwith 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 out 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/MNGL requirements. Compliance of instructions on HSE shall be done by Contractor and informed urgently to OWNER/MNGL.

- Ensure that resident Engineers/Site-In-Charge of the Contractor shall amend all the Safety Committee/HSE meeting arranged by OWNER/ MNGL only in case of his absence from site, a seconds senior most person shall be nominated by him in advance and communicated to OWNER/MNGL.
- 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/MNGL review.
- Assistk in HSE audits by OWNER/ MNGL and submit compliance report.
- Generate & submit HSE records/ reports as per HSE Plan.
- Appraise OWNER/MNGL 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
<b>HOUSEKEEPING</b>				
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				
<b>PERSONNEL PROTECTIVE EQUIPMENT</b>				
Goggles: shields				
Face protection				
Hearing protection				
Safety Shoes provided				
Hand protection				
Respiratory Masks etc.				
Safety Belts				
Safety Helmets				
Other				
<b>EXCAVATIONS/ OPENINGS</b>				
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)**

<b>Item</b>	<b>Yes</b>	<b>No</b>	<b>Remark</b>	<b>Action</b>
<b>WELDING CUTTING</b>				
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				
<b>SCAFFOLDING</b>				
Fully decked platform				
Guard and intermediate rails in place				
Toe boards in place & tied properly				
Adequate shoring				
Adequate access				
Other				
<b>LADDERS</b>				
Extension side rails 1 m above				
Top of landing				
Properly secured at top & bottom				
Angle $\pm 70^\circ$ from horizontal				
Other				



**MONTHLY CHECKLIST CUM COMPLIANCE REPORT REGARDING HSE (3/6)**

Item	Yes	No	Remark	Action
<b>HOISTS, CRANES AND DERRICKS</b>				
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				
<b>MACHINERY, TOOLS AND EQUIPMENT</b>				
Proper instruction				
Saftey devices				
Proper cords				
Inspections and maintenance				
Other				
<b>VEHICLE AND TRAFFIC</b>				
Rules and regulations observed				
Inspection and mantinance				
Licensed drivers				
Others				

**MONTHLY CHECKLIST CUM COMPLIANCE REPORT REGARDING HSE (4/6)**

Item	Yes	No	Remark	Action
<b>TEMPORARY FACILITIES</b>				
Emergency instruction posted				
Fire extinguishers provided				
Fire-aid equipment				
Secured against storm damage				
General nemeses				
In accordance with electrical requirements				
Other				
<b>FIRE PREVENTION</b>				
Personnel instructed				
Fire extinguishers checked				
No smoking in prohibited areas.				
Hydrants clear				
Other				
<b>ELECTRICAL</b>				
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
<b>HANDLING AND STORAGE OF MATERIALS</b>				
Properly stored or stacked				
Passageways clear				
Other				
<b>FLAMMABLE GASES AND LIQUIDS</b>				
Containers clearly identified				
Proper storage				
Fire extingui HSErs nearby				
Other				
<b>WORKING AT HEIGHT</b>				
Erection plan				
Safety nets				
Safety belts tied properly				
Illumination				
No loose material at height				
NO body under working area				
All openings covered				
Other				
<b>ENVIRONMENT</b>				
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)**

<b>Item</b>	<b>Yes</b>	<b>No</b>	<b>Remark</b>	<b>Action</b>
<b>HEALTH CHECKS</b>				
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.				
<b>ERECTION</b>				
Slings/ D'shackle 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.....  
: RCM/SITE-IN-CHARGE, MNGL 1 COPY

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.....  
: RCM/SITE-IN-CHARGE, MNGL 1 COPY

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.....  
RCM/SITE-IN-CHARGE MNGL1 COPY  
1 COPY

\*\*\*\*\*

SPECIFICATION  
FOR  
QUALITY ASSURANCE SYSTEMS  
REQUIREMENTS

SPECIFICATION NO. MNGL/Steel/TS/23

## **CONTENTS**

- 1.0 INTRODUCTION
- 2.0 DEFINITIONS
- 3.0 CONTRACTORS SCOPE OF WORK
- 4.0 QUALITY ASSURANCE REQUIREMENTS

## **ATTACHMENTS**

TITLE	NUMBER
FORMAT FOR QUALITY PLAN	FORMAT 00001
FORMAT FOR OBSERVATION ON	FORMAT 00002



## 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 MNGL, at the stage of bidding and shall be resolved with MNGL, 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 MNGL/ 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 MNGL/ 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 MNGL. 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 MNGL 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 MNGL/ 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 MNGL 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 MNGL/ 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 MNGL including all subsequent changes, if any. MNGL 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 MNGL/ 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 MNGL/ 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 MNGL 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 MNGL shall be duly informed.

- 4.7 Bidder shall establish adequate methodology such that the materials supplied by the Owner/ MNGL 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 MNGL/ 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 MNGL/ 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 MNGL/ 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 MNGL/ 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 MNGL/ Owner for review.
- 4.18 For all special processes, bidder shall deploy only qualified performers. Wherever MNGL/ 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**

Job No. and Description Issued to :	No. : M/s Date :
Location of Work : Item of Work :	
Details of Observation(Deficiency)	Recommended Course of Action
Time Allowed for Correction :	

Issued by : _____ <div style="text-align: center;">Name of Signature of MNGL</div>			
Corrective Action taken report by Contractor/ Vendor :			
<div style="display: flex; justify-content: space-between;"> <span>Date :</span> <span>Name and Signature</span> </div>			
Distribution (before resolution) :			
Project Manager Owner	Chief Buisness Executive MNGL	MNGL Inpection New Delhi	Residential Construction Manager, MNGL Site
Verification of Resolution by MNGL:			
<div style="display: flex; justify-content: space-between;"> <span>Date :</span> <span>Name and Signature</span> </div>			
Distribution (before resolution) :			
Project Manager Owner	Chief Buisness Executive MNGL	MNGL Inpection New Delhi	Residential Construction Manager, MNGL Site

**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/ MNGL Review/ Audit Requirement

- Note: 1) The bidder ensures that the filled up format conforms to minimum requirements on Quality Plan/ Quality Assurance, specified by MNGL on drawings/ standards/ specifications/ write-up.
- 2) The bidder confirms that document is issued for information/ approval of Owner/ MNGL for the project implementation

SPECIFICATION  
FOR  
DOCUMENTATION FOR PIPELINE CONSTRUCTION

SPECIFICATION NO. MNGL/Steel/TS/24



## **C O N T E N T S**

- 1.0 SCOPE
- 2.0 RECORDS
- 3.0 AS-BUILT DRAWINGS AND PIPE BOOK

## 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 shall 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 thereof.
- Sequential number.
- Length brought forward (for pipes and other materials).
- Length to bring forward (for pipes and other materials).

Alignment sheet number and at least the location thereon of two welds on every page of the pipe Book.

Further,

- Diameter of pipeline
- Length of each pipe
- Wall thickness
- Pipe number
- Heat number, certificate number
- Cut and re-numbered pipe ends
- 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. CD ROM/ floppy diskettes.

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. MNGL/Steel/TS/25

## **CONTENTS**

- 1.0 SCOPE
- 2.0 REFERENCE DOCUMENTS
- 3.0 SPECIFICATION FOR FIELD JOINT COATING MATERIAL
- 4.0 APPLICATION PROCEDURE
- 5.0 INSPECTION
- 6.0 TESTING
- 7.0 REPAIR OF FIELD JOINT COATING
- 8.0 REPAIR OF PIPE COATING DEFECTS
- 9.0 DOCUMENT

## 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 here in 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, Ultra Violet (UV) radiation protected, 3 layer side extruded polyethylene coating conforming to DIN-30670. The sleeve width shall be suitable for cut back of  $120 \pm 20$  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 alongwith applicator pads.
- 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 specifications 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 fibre 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 heatshrinkable fabric, composed of a fibre glass reinforcement and polyolefin fibres, 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 <sub>2</sub> SO <sub>4</sub> @ 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 <sub>2</sub> SO <sub>4</sub> pH2 ground water solution:- 1.2% H <sub>3</sub> PO <sub>4</sub> 1.6% KOH 1.2NaCl 1.0% Fe <sub>2</sub> O <sub>3</sub>	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 <sup>2</sup> 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°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 <sup>2</sup> 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 <sup>-8</sup> 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 propagation	TEST METHOD- 1*		No cut 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 one 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°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 polyethylene 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 85%. 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. An 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 wraparound 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 wetprimer. At the time of application of the primer, the 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 a 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°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.
- Weld bead profile shall be visible over the sleeves.
- The entire closure patch shall have changed colour 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-incharge.
- 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 a 2500psi.

e) Coating thickness shall be checked by non destructive 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. : MNGL/Steel/TS/26



## **C O N T E N T S**

- 1.0 SCOPE
- 2.0 DESIGN AND ENGINEERING
- 3.0 CONSTRUCTION
- 4.0 DOCUMENTATION

## 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 hold.
  - 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, drain pipes, water mains, telephone conduits and other underground structures, the pipeline shall be installed with at least 500 mm free clearance from the obstacle or as specified in the drawing or such greater minimum distance as may be required by authorities having jurisdiction. Also in all cases, the minimum covers specified above shall be maintained within the entire limits of crossing.

- 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 optimise the crossing design in terms of pipeline stresses and power requirement

- 2.6.2 Contractor shall indicated what maximum shear stress in the pipeline coating will result from his choice of above parameters and other characteristics described in this section.

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 Maximum Longitudinal Stress During Installation

Total maximum longitudinal stress in the pipeline due to tension and bending at any location shall not exceed 90% of the SMYS of the pipe material. Contractor shall, in order to check this requirement, evaluate the maximum tensile forces to which the pipeline is subjected to at any phase of its installation during the pulling operation.

2.7.2. Maximum Equivalent Stress During Final Hydrostatic Test

After installation, the pipeline shall be hydrostatically tested to a minimum test pressure equal to 1.4 times the design pressure or at a pressure stipulated in the Special Conditions of Contract whichever is higher. However, during hydrostatic testing, the combined equivalent stress in the pipeline due to bending and test pressure shall not exceed 90% of the SMYS of pipe material.

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 stabilisation, pressure shall be retained in the pipeline for a period of 6 hours and recorded by manothermograph. 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 land owner's and authorities having jurisdiction. All such works shall be done at no extra cost to Owner. The Owner shall be indemnified against any/ all claims arising as a result thereof.

## 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. MNGL/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 confirm 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 confirm to IS:1077. Bricks shall have smooth, rectangular faces with sharp corners and shall be well burn, sound, hard, tough and uniform in color. These shall be free from cracks, chips, flaws and Florence. All tests shall confirm 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 pipe line 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 authorised disposal site

*Note: Demolition of RCC/PCC/road will be paid in Cu.m.*

**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 Existing road having black top the restoration shall be carried out as per following specification and attached drawing No. MNGL/Plng./Steel/31:**

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 an ascending order upto the top of road surface:

- Compacted murum layer of 200 mm thickness as per MORTH and PWD specification
- 300 mm thick layer of 60 mm metal with hard murum blindage as per MORTH and PWD specification
- 100 mm thick layer of 40 mm metal with stone screening blindage as per MORTH and PWD specification
- 75 mm thick bituminous bound macadam as per MORTH and PWD specifications

The above layers shall be constructed with specifications of relevant IS codes, MORTH and PWD specifications. and direction of Engineer In Charge

**3.02 Existing road having footpath covered with paver block the reconstruction shall be carried out as per following specification and attached drawing No. MNGL/Plng./Steel/32:**

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 as per PWD specification
- 300 mm thick layer of 60 mm metal with hard murum blindage as per PWD specification
- 100 mm thick layer of 40 mm metal with stone screening blindage as per PWD specification
- Hard murum filling as per PWD specification and mentioned in the drawing MNGL/Plng./Steel/32:
- Providing 1:4:8 CC layer as per PWD specification and mentioned in the drawing MNGL/Plng./Steel/32:
- Providing of precast stone kerbing and 1:4:8 cc layer shall be as per above mentioned drawing No. MNGL/Plng./Steel/32:
- 100 mm thick layer of paver block shall be provided at top as per PWD specification

The above layers shall be constructed as per specifications of PWD, relevant 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. MNGL/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 as per PWD specification
- 300 mm thick layer of 60 mm metal with hard murum blindage as per PWD specification
- 100 mm thick layer of 40 mm metal with stone screening blindage as per PWD specification
- 100 mm thick paving block layer as per PWD specification

The above layers shall be constructed as per specifications of PWD, 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. MNGL/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 as per MORTH and PWD specification
- 300 mm thick layer of 60 mm metal with hard murum blindage as per MORTH and PWD specification
- 100 mm thick layer of 40 mm metal with stone screening blindage as per MORTH and PWD specification
- 150 mm thick concrete paving (50 mm thick cc of 1:4:8 and 100 mm thick cc of 1:2:4 ) as per MORTH and PWD specification

The above layers shall be constructed as per specifications of MORTH, PWD, relevant 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. MNGL/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 as per MORTH and PWD specification
- GSB Grade I and II each of 125 mm thick layer as per MORTH and PWD specification
- 150 mm thick wet mix macadam layer with stone screening blindage as per MORTH and PWD specification
- 75 mm thick BBM layer as per MORTH and PWD specifications
- 75 mm thick BM (3.3%) as per MORTH and PWD specification
- 75 mm thick DBM layer as per MORTH and PWD specification
- 40 mm thick BC layer as per MORTH and PWD specification

The above layers shall be constructed as per specifications of MORTH, PWD, relevant IS codes and direction of Engineer In Charge.

**3.06 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. MNGL/Plng./Steel/36**

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 as per MORTH and PWD specifications
- 300 mm thick layer of 60 mm metal with hard murum blindage as per MORTH and PWD specifications
- 100 mm thick layer of 40 mm metal with stone screening blindage as per MORTH and PWD specification
- 75 mm thick BBM layer as per MORTH and PWD specification
- 50 mm thick BM layer as per MORTH and PWD specification
- 25 mm thick BC layer as per MORTH and PWD specification

The above layers shall be constructed as per specifications of MORTH, PWD, relevant 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 concreting work shall be suitable for drinking and shall conform to IS 456:2000. It shall be free from injurious substances.

Source of Coarse and fine aggregates shall be approved by Engineer-in-Charge.

Contractor 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:

##### PECIFIED CHARACTERISTIC COMPRESSIVE STRENGTH

##### 04.02 Grade strength of 15 cm cube in N/MM<sup>2</sup>

	<b>28 days</b>	<b>7 days,</b>
1:1.5:3 (Nominal Mix)	20	13.5
<b>Min Consumption</b>	<b>No. of Samples to be tested</b>	
1-6 m <sup>3</sup>	1	
6-15 m <sup>3</sup>	2	
15-30m <sup>3</sup>	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 mix proportions determined thus shall be followed at site and shall in no way relieve the contractor of his responsibility as regards the prescribed strength mix. The mix 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 loose 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 of 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 shuttered 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 slopes shown on drawings. The floating shall not be executed to the extent of bringing excess fine 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 <sup>3</sup>	Number of samples
1-5	1
6-15	2
16-30	3
31-50	4
51 & above	4 plus one additional sample for each additional 50 m <sup>3</sup> 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 mayM 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 Engineerin-N 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 is 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 fit 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 be 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 at least 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 manufacturer 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 be 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/redone 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

- b. inspection, the surface of weld metal shall be cleaned of all slag, spatter matter, scales etc. by using wire brush or chisel.
- c. 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.
- d. 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.

- e. Radiographic Testing (x-ray and  $\gamma$ -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 with American 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 on either 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 D1.1-96 Chapter 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  $\gamma$ -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/marketing 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 same 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:**

- j. Rolled Sections: 5% on the quantity by weight computed, based on fabrication drawings.
- i. 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, 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/m<sup>2</sup>/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 is complete 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 as per 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 and omissions 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

\*\*\*\*\*

SPECIFICATION  
FOR  
ANTI BUOYANCY MEASURES  
(CONCRETE WEIGHT COATING &  
SADDLE WEIGHT)

SPECIFICATION NO. MNGL/Steel/TS/28  
(CIVIL ENGINEERING SECTION)

## **C O N T E N T S**

1. SCOPE
2. REFERENCE DOCUMENTS
3. MATERIALS
4. COATING REQUIREMENTS
5. APPLICATION METHOD
6. EQUIPMENT
7. MEASUREMENTS & LOGGING
8. PROCEDURE QUALIFICATION
9. APPLICATION OF REINFORCEMENT & CONCRETE COATING
10. TOLERANCES
11. WEIGHING
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14. REPAIRS
15. MARKING
16. UNLOADING, TRANSPORT, STORING & HAULING
17. CONCRETE SADDLE WEIGHT

## 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 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.

- 3.4.2.1 Wire fabric manufactured in flat sheets shall be 50 x 100mm max. steel wire mesh, 13 gauge 2.5mm thickness.

- 3.4.2.2 Wire 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<sup>3</sup>

and the compressive strength shall not be less than 350 kg/cm<sup>2</sup> in 28 days and 235 kg/cm<sup>2</sup> 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 :

<b>`Quantity' of Concrete in the Work(m3)</b>	<b>Number of Samples</b>
Upto 25	3
26 to 50	4
51 and above	4 plus one additional sample for each additional 50m <sup>3</sup> 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<sup>2</sup>, coating shall be removed around the entire damaged area. A repair shall be made by satisfactorily restoring the reinforcement, forming the area with a metal form and pouring a complete replacement of materials similar to that from which the coating was made. The mixture shall be one (1) part of cement to three (3) parts of aggregate and the necessary water to produce a slump not to exceed 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. MNGL/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 as per specification no. MNGL/S/05/11/01.

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SPECIFICATION  
FOR  
FABRICATION, ERECTION AND PAINTING OF STEEL STRUCTURES,  
CHAIN LINK FENCING AND GATES

SPECIFICATION NO.: MNGL/Steel/TS/29



## **C O N T E N T S**

- 1. General**
- 2. Section – 1** Fabrication of steel structures
- 3. Section – 2** Erection of steel structures
- 4. Section - 3** Fabrication and erection of miscellaneous structures
- 5. Section – 4** Painting of Steel Structures

## **LIST OF ANNEXURES**

- Annexure - A** Permissible Deviation in pitch and gauge of holes or bolts of normal accuracy
- Annexure – B** Tolerance of assembled components of steel structures
- Annexure – C** Tolerance in erected steel structures
- Annexure – D** Material of Construction

## **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, physical and 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 900°C and 1100°C. 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 mismatch of 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 in conformity 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 and shall 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 be adversely affected. In the event CLIENT/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.

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 shall have 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 carry out 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 at the 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/marketing plan or shipping list.
- 17.1.4 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 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 Indian standards shall be followed.
- 17.3.3 Erection shall be carried out with the help of maximum MNGLhanization 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 and 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 25i/coat) of single pack type with 30-35% solids and covering capacity 12-13 m<sup>2</sup>/lit/coat.
- c. Finishing paint: Two coats of synthetic enamel in alkyd medium with superior quality water and weather resistant pigments (DFT 20i/coat) of single pack type with 30-40% solids and covering capacity 16-18 m<sup>2</sup>/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/m<sup>2</sup>/centimeter thick plate. The payments will be made on the basis of weights of members as per drawings. However, any changes on the above
  - a. 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						
		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.	$\pm 5\text{mm.}$
b	In lateral direction.	$\pm 5\text{mm.}$
2	Deviation in the level of bearing surface of structures at foundation top w.r.t. true level.	$\pm 5\text{mm.}$
3	Out of plumb of structure from true vertical axis and measured from structure top.	$\pm H/1000$ or $\pm 25\text{mm.}$ 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 6mmØ 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.

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SPECIFICATION  
FOR  
WARNING MATS

SPECIFICATION NO. : MNGL/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/cm <sup>2</sup>
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

**HIGHLY INFLAMMABLE GAS PIPELINE BELOW  
MAHARASHTRA NATURAL GAS LIMITED**

***MNGL***



**IN EMERGENCY PLEASE CONTACT**

**PHONE NOS. ....**

(Phone Nos. will be intimated later)

SPECIFICATION  
FOR  
INSTALLATION OF INSTRUMENTS

SPECIFICATION NO.: MNGL/Steel/TS/34

## **C O N T E N T S**

1.0 SCOPE

2.0 STANDARDS OF MATERIALS

3.0 INSTALLATION OF INSTRUMENTS

4.0 TESTING

5.0 CALIBRATION OF INSTRUMENTS

## **INSTALLATION, TESTING AND CALIBRATION OF INSTRUMENTATION AND CONTROL SYSTEM**

### **1.0 SCOPE**

- 1.1 The purpose of this specification is to define the general requirements for the installation, installation materials, testing and calibration of instruments and control system.
- 1.2 The work shall be carried out in accordance with the codes, standards and recommended practice listed in this specification and in accordance with local 'Statutory regulations'.
- 1.3 For installation of instruments and control system, of the new material where quality is of the prescribed standards and which is in every way fit for its intended purpose shall be used.
- 1.4 Unless otherwise specified all the materials shall be indicated in this specification except where it is not compatible with fluids being handled. In such cases the selection of the material shall be approved by MNGL.
- 1.5 Only the best trade practices shall be used. All the work shall be carried out in a neat, workman like manner and to the satisfaction of MNGL.

### **2.0 STANDARDS OF MATERIALS**

- 2.1 Instrument process piping/tubing upto and including the first block valve and 'in-line' instrument equipment shall conform to the line class or vessel rating concerned instrument piping or tubing after the first lock valve may use alternate materials consistent with service conditions. In general they shall conform to the following specification as a minimum.
  - 2.1.1 Stainless tubes shall be fully annealed and cold drawn seam less as per ASTM A 269 TP316 with size 1/2"OD x 0.65" WT (wall thickness).
  - 2.1.2 Monel tubing shall be fully annealed seamless as per ASTM B165 with size 1/2"OD x 0.35"WT.
  - 2.1.3 Carbon steel pipe shall be 1/2" seamless and shall be as per ASTM A106 Gr B min of sch 80 & dimensions as per ANSI B36.10.
  - 2.1.4 Seamless stainless steel pipes shall be as per ASTM A 312 Gr TP 316L Sch 80S, dimensions as per ANSI B 36.19.
  - 2.1.5 Instrument air supply piping from the main instrument air header shall be galvanized heavy class pipes to IS 1239.
- 2.2 Individual pneumatic signal and air supply tubing shall conform to the following specifications.
  - 2.2.1 Stainless tubes shall be used in general and shall be fully annealed and cold drawn seamless as per ASTM A269 TP 316 with 6mmOD x 1mmWT.
  - 2.2.2 Copper tubing where specified shall be seamless 6mmOD x 1.0mmWT soft annealed as per ASTM 868.74a Cd No. 122 (DHP) sheathed with PVC 1.0mm thick coloured Black.

2.3 All fittings shall be as a minimum of 100 rating except for tube fittings. The fittings shall have threading as per B2.1 and socketweld connections as per B 16.11. These shall conform to the following specifications in general.

2.3.1 Tube fittings shall be flare type compression fittings Swagelok or equivalent make double ferrule and pressure seat type.

All tube fittings in impulse lines shall be rated to 5000 PSIG at 38°C.

2.3.2 Carbon steel pipe fittings shall be forged as per ASTM A105 stainless steel pipe fittings shall be as per ASTM –182 GrF 316L.

2.4 Valve shall have normally Globe body and shall be fabricated out of Bar-stock and rated to min. of 1500. These shall be screwed bonnet type with 13% GSS trim and plug shall be integral with the stem. Face to face dimensions shall be approx. 80mm. End connections shall be socketweld to ANSI 16.11 and threaded to B2.1.

2.5 Multibore tubing shall have a maximum 19 single polyethylene tubes, 6mmODx1mm numbered for easy identification. The bundle shall be marked with inner and outer fire resistance PVC sheath. They shall carry a pair of telephone wire 0.6mm diameter flexible.

2.6 Single pair and multi pair extension cables for Thermocouples shall be matched and calibrated in accordance with ISA MC 96.1. Conductor size shall be AWG for single pair and 20 A for Multipair.

The cable shall be armored, each twisted pair shall be individually shielded with aluminium Mylar tape and a tinned copper drain wire. The wires and the cable shall be colour coded as per ISA recommended practices.

2.7 Instrument Electrical cables shall conform to the following specifications:

2.7.1 Instrument electronic signal cables single pair/ Multipair shall have copper conductor, twisted in pair and individually shielded with Aluminium Mylar tape with drain wire. In multipair cables, each pair shall be armoured with inner and cut PVC sheath. Minimum conductor size shall be 1.5 mm<sup>2</sup>.

2.7.2 Control Cables for control signal, alarms actuating devices and solenoid valves of the interlock and shutdown valves shall generally be 1.5 mm<sup>2</sup> copper conductor, armoured with inner and cut PVC sheath.

2.7.3 All power supply cables shall have copper/Aluminium conductor depending upon the conductor size. The cables shall be armoured with inner and cut PVC sheath. The cables shall be sized adequately. Minimum conductor size shall be 2.5 mm<sup>2</sup>.

2.7.4 2-core armoured cable shall be used for illuminator on level gauges.

2.7.5 The material and construction of all electrical cables shall conform to IS- 1554 part I or appropriate equivalent code and standard.

### 3.0 **INSTALLATION OF INSTRUMENTS**

#### 3.1 **Instrument Mounting**

- 3.1.1 No instrument shall be installed in such a way that it bends for support on the impulse piping or electrical connection on it.
- 3.1.2 Pressure gauges and temperature indicator shall normally be mounted directly on line. However direct on line mounting shall be avoided where vibrations are likely to be present.
- 3.1.3 Local mounted instruments shall be mounted on brackets, panels or placed on a suitable pedestal. Transmitters shall be mounted on 2" pipe supports where practical. Instruments to be mounted on steel columns, masonry structure etc. These shall not be mounted on heating equipments, pipelines and structures.
- 3.1.4 Blind transmitters shall be mounted at 130mm above graded platform. Local controllers, indicating transmitters and indicating instruments shall be mounted at approximately 1500 mm.
- 3.1.5 All the instruments shall be accessible from grade, ladder or platform etc. Pressures gauges and other local indicating instruments shall be readable from grade or operating level and if used for manual control shall be visible from the related valve. All the instruments shall be located such that they dont impede the process operation.
- 3.1.6 Local mounted instruments which are not available in weather proof housing shall be mounted inside a weather proof case.
- 3.1.7 Items such as pilot valves, solenoid valves etc. shall be located local to its point of application or near to the device being actuated by them.
- 3.1.8 For blind transmitters output meters shall be mounted on instrument supports.
- 3.1.9 Filter regulators shall be mounted on the instrument supports below pneumatic transmitter or on the control valve yoke.
- 3.1.10 Instruments or instrument lines shall not be supported on hand rails, in general.
- 3.1.11 The use of process piping to support instrument lines shall be avoided as far as possible.
- 3.1.12 The instrument impulse piping shall be kept as short as possible.
- 3.1.13 Instruments and impulse lines shall be protected against Mechanical damage.
- 3.1.14 In case of capillary tube instruments, capillary tube is to be supported and protected against Mechanical damage.
- 3.1.15 Orifice meters shall not be installed on the top of orifice fittings. On horizontal lines orifice pressure taps shall be located as follows:

- a) On top for air and gas service



b) Horizontal for liquid and condensible vapour service.

### 3.2 Instrument Piping & Tubing.

#### 3.2.1 Impulse Piping/tubing

3.2.1.1 The primary instrument block valves for all instruments shall be as per piping specifications.

3.2.1.2 3-Valve manifold in general shall be integral type. For pressure gauges, 2-valve manifolds shall also be acceptable instead of isolation valve, drain valve and pipe fittings.

3.2.1.3 Differential or static pressure sensing lines shall not exceed 6 Mtrs (20 feet) in general for direct connected or locally mounted instruments.

3.2.1.4 All impulse lines shall be run with a slope not less than 1 in 12 except where otherwise specified. Direction of slope is to be downward from the process for liquid service and upward from the process for gas service.

3.2.1.5 Tubing shall be joined by compression fittings.

3.2.1.6 Piping shall be joined by pipe fittings/flanges as per the piping specifications.

3.2.1.7 All instruments pipes and tubes shall run in horizontal and vertical planes only and shall run with minimum number of changes in direction, consistent with good engineering practices and neat appearance.

3.2.1.8 Tubing shall be bent with correct size tube bender as far as possible to avoid use of fittings. Hot bending shall be totally avoided. Tube cutter shall always be used to cut tubings. The use of short lengths of tubings in long runs shall be avoided in order to avoid the fittings.

3.2.1.9 All tubing shall run in such a manner as to give the maximum protection against Mechanical damage. Tubing runs shall be grouped together and clamped.

3.2.1.10 Tubing shall be arranged so that the unions can be tightened without distorting lines.

3.2.1.11 Instrument tubing or piping shall not run on trays intended for cables and shall not share the same transit.

3.2.1.12 No pipe or tube shall be left with Mechanical strain on them.

3.2.1.13 A Mechanical ferrule seater shall be used on tubing for 140 kg/cm<sup>2</sup> (2000 psi) or more.

3.2.1.14 Pipe bushings shall not be used.

3.2.1.15 Pipe plugs shall be fabricated out of bar stock and shall have hex-head.

#### 3.2.2 Air/Signal Tubing

3.2.2.1 Signal Transmission tubes shall be laid on perforated trays prefabricated out of min 2.5 mm. thick steel plate. The width of the tray shall be selected as per the number of tubes to be laid.

- 3.2.2.2 Where tubing is run in permanent enclosures, it should be ensured that entry and exit of such enclosures is clean and smooth.
- 3.2.2.3 Tubing run in permanent enclosures shall not have joints except at special junctions boxes provided for this purpose.
- 3.2.2.4 Where permanent enclosures are left with space for instrument tubing to be laid at some later date, a galvanised pull wire of adequate size shall be left in the tray.
- 3.2.2.5 Where the length of transmission tubing exceeds 60 mtrs (200ft) necessity of installing signal booster relays shall be considered.
- 3.2.2.6 In case of 'Skidded' equipment or vessels with instrumentation, where off- skid alarms shutdown or control functions are provided the signal tubes shall be terminated on the control bulk head near the skid boundary.
- 3.2.3 All threaded pipe joints shall be joined after applying teflon tape. It should be applied in a manner to ensure that the tape does not spill over the end of the male fitting. No other pipe joining compound shall be used except on high temperature service where graphite sealing compounds shall be used.
- 3.2.4 All reasonable precautions shall be taken to prevent foreign materials entering pipe lines or tubing before and during erection.
- 3.2.5 Pipes and tubes installed but not connected, shall have the ends clad in approved fashion to prevent the entry of foreign material. For a period upto one week adhesive tape may be used, for longer periods, caps or plugs shall be used.
- 3.2.6 Piping/Tubing supports
- 3.2.6.1 Piping and tubing shall be adequately supported and fixed at a distance not exceeding that in the following table:

Table

Single tubing/Piping	Max. distance between supports
3/8" OD or less	Continuous
1/2" to 3/4" Nom. Size	2 meters (6ft.)
3/4" to 1" Nom. Size	3 meters (9ft.)
Multitube bundle	3 meters (9ft.)

- 3.2.6.2 All field mounted instrument air tubing shall be supported with galvanised steel angles or channels of minimum 1/8" thickness fabricated to present neat appearance.
- 3.2.6.3 All instruments tubing supports shall be galvanised prior to installation

3.2.6.4 Trays shall be properly supported either from any rigid steel structure or concrete member. In case of non-availability of above, a suitable support shall be fabricated.

### 3.3 Instrument Air Supply Distribution

3.3.1 Piping material for instrument main and branched air headers upto the isolation valve at each take-off from main or branch header shall conform to piping specification.

3.3.2 The air header size shall be established in accordance with the table below, unless otherwise specified, for a header pressure of 4 to 8.5 kg/cm<sup>2</sup>

Table – 2

Max number of users	Nominal pipe size
upto 5	1/2"
upto 10	3/4"
upto 25	1"
upto 80	1-1/2"
upto 150	2"
upto 500	3"

3.2.3 All take off for branch lines are to be from the top of the main header with block valves equal in size to the branch line. All low point shall have a 1/2" valve installed as a drain and blow down point.

3.3.4 A minimum size of 1/2" pipe shall be run to the instrument with a 1/2" valve for each user. Tubing from the isolation valve to the instrument shall be 6.0 mm.

3.2.5 Union shall be provided at convenient location in the air header.

3.3.6 Filter regulator shall be provided for individual field mounted consumer and shall be complete with an output gauge.

3.3.7 In case of skid mounted equipments or vessels which incorporate instrumentation requiring pneumatic supply, on skid supply piping shall terminate at the skid boundary location and size of the supply connections shall be noted on the vendor approval drawings.

### 3.4 Installation of multitude and Multicore cables.

3.4.1 Multicore/Multitube cables shall generally be installed on trays or ducts and properly clamped. At bends minimum radius shall be maintained as per cable manufacturers standards.

3.4.2 All cables shall be rigidly supported on structural steel and masonry. Drilling of steel member should normally be avoided. However, if the drilling of steel must be resorted to, it must be drilled where minimum of weakening of structure will result cables shall be support at every 500 mm. At every vertical drop these shall be clamped at more frequent intervals max of 300 mm.

3.4.3 Directly buried cables shall be laid underground in excavated cable trenches. Trenches shall have sufficient depth and width to accommodate all cables correctly spaced and arranged with a view of heat

dissipation and economy of design construction of trenches laying of cables and filling up of trenches shall be as per relevant standard.

- 3.4.4 Each underground cable shall be provided with identifying tag of load securely fastened every 30 M of its underground length with at least one tag at each end before the cable enters the ground. Before cables are placed, the trench bottom shall be filled with a layer of sand. The cables shall be covered with 150 mm of sand on the top of the largest dia cable tube and sand shall be lightly pressed. A protective covering of 75 mm thick second class red bricks shall be laid flat and the balance portion of the trench shall be filled with soil, compacted and levelled.
- 3.4.5 At each road crossing and other places where cables enter pipe sleeves, adequate bed of sand shall be given so that the cables don't slack and get damaged by pipe ends after back filling.
- 3.4.6 At the entry into concrete blocks loops shall be provided at either end to prevent any damage to cable.
- 3.4.7 The cable entry to control room shall be suitably filled and sealed after laying of cables so as to achieve a positive sealing against the entry of gas/water.
- 3.4.8 All wiring, tubing, cables, junctions boxes and auxiliary equivalent shall be suitably identified as per applicable codes and practices. All pipings and tubing shall be tagged with slip-on or clip on wire marker at both ends.
- 3.4.9 Jointing of cables are generally not permitted. Cables shall be cut after the exact site measurements at the cable drums shall be so selected before cutting the lengths as to avoid any unnecessary wastage.
- 3.4.10 Low signal cables like alarms, analysers cables, special cables for turbine meter, thermocouple compensating cables etc. shall be layed separated from power supply cables in ducts/trenches/trays.
- 3.4.11 Electric signal lines for electronic transmitters to receive and to final control element shall be continuously shielded with the shield grounded at the same point as the signal circuit generally at the control instrument.
- 3.4.12 Separate junction boxes shall be used for intrinsically safe cables.
- 3.4.13 Different intrinsically safe system e.g., systems having different rounds shall not be run in the same multicore cable, in general.

Recommended minimum separation distance between twisted pair signal leads and AC Power Lines.

AC Power Cable		Minimum Distance to Signal Lead
Voltage (Volts)		Current (Am) in (cm)
0 to 125	0 to 10	12" (30)
125 to 250	0 to 50	15" (38)
250 to 440	0 to 200	18" (46)
5KV & Up	200 Amp. & Up	24" (61)

Different intrinsically safe circuits e.g., circuits having different voltage levels, of the same intrinsically safe system shall not be run in the same cable unless each conductor insulation is at least 0.25mm or no hazard can result from interconnection.

3.4.14 The physical separation of power and signal cables shall be as per API 550 Part I Section

VII. Cable in intrinsically safe circuits shall preferably be not run in the same tray where-- on intrinsically safe circuits cables are being run. If these are being run in the same tray, a metallic earthed separately shall be provided.

3.4.15 For temperature controllers, single pair thermocouple extension cable or cable for resistance thermometer, shall be layed directly from the element to the transducer in the control room without intermediate terminal blocks.

3.4.16 In case of skid mounted equipment or equipment which incorporate skid instrumentation like alarms, shutdown or control function shall terminate signals or control junction box near skid boundary for connection of off skid equipment.

3.4.17 No wire shall be terminated or left with Mechanical strain within any conductor.

3.4.18 Splices shall be made only at terminals, in instruments or approval equipment/ junction boxes using lugs and screwed connections. No intermediate splices shall be made in cable trays or in conduct. Number of junction boxes in any cable path shall be limited to only one.

### 3.5 Installation of Zener barriers

3.5.1 Zener barriers shall be installed in the circuit to make the system intrinsically safe provided:

- a) There is no energy storage system in excess to the minimum permitted by the barrier design on the hazardous side of the barrier. The same shall be met by taking intrinsically safe transmitters and selecting the cable electrical parameters like inductance L/R ratio & capacitance in accordance with the maximum parameters given in barrier specifications.
- b) No power source exceeding the voltage rating of Zener barrier shall be connected on safe side of the Zener barrier.
- c) No outside power source including other intrinsically safe circuits shall be connected to the hazardous side of the barrier.

3.5.2 Zener barriers shall be located as close as possible to the field wiring entry point in the control room.

3.5.3 Single barrier are bolted directly to copper bus bar and multiple barriers on the barrier mounting plates. Copper bus or barriers mounting plates shall be isolated from the panel frame.

3.5.4 The signal ground system for intrinsically safe system shall be separate from power ground system and shall be connected to the signal ground reference point. The maximum resistance allocable between the farthest point on intrinsically safe barrier ground bus and signal ground reference point shall be less than 1 ohm.

3.5.5 Field wires shall directly terminate at the barriers and not through intermediate terminals.

### 3.6 Installation of Analyser / Gas Chromatograph

3.6.1 Installation of all analyser shall be in general, as per APIP 550 Part II.

3.6.2 The analyser housing at its installation shall meet all safety requirements as per -- classifications.

3.6.3 Sampled process fluid, if not returned to the process shall be disposed to a safe location. Piping shall be provided so that vapors can be vented to a safe location and liquids shall be drained in a clean and orderly fashion to a safe place. Toxic vapors shall not be vented to atmosphere.

3.6.4 Analyser shall be located as near to the sampling point as possible.

3.6.5 Analyser equipment must be protected from the following:

- a) hot equipment
- b) severe ambient temperature changes
- c) shock
- d) Mechanical damage
- e) Vibration

3.6.6 If a separate vent for the analyser is used, the location of that vent shall be in area of minimum air Turbulence. If the vent of different analysers are vented into a common vent, a back pressure regulator shall be used.

3.6.7 Vent piping shall be designed to prevent condensate from accumulation in low point and obstruct a free vent flow.

### 3.7 Ducts, Trays and Supports.

3.7.1 Main cable duct shall be of bottom open type with flat/angle --- construction with side sheet and top cover of 3.2 mm thickness.

3.7.2 The ducts and trays shall be properly supported at regular intervals. Wherever insert plates are not available, support on concrete structure or ceiling shall be fixed with a minimum of 10 mm expansion bolts Angle supports for ducts shall be fabricated from minimum of 40 mm angle.

3.7.3 All supports shall be neatly cut with hacksaw only and not with gas cutting. Free ends of angle supports shall not have sharp ends and shall be properly rounded off.

3.7.4 Ducts and supports shall be painted with one coat of Red oxide Zinc chromate primer conforming to IS-2074 after cleaning to remove scale and then painted with 2 coats of final enamel paint as given below:

- a) Duct - Dark admirately Grey as per IS0632.
- b) Supports - Black.

### 3.8 Instrument Steam Tracing

- 3.8.1 Steam for Tracking of instruments shall be taken from main steam header take of valve through carbon steel pipes supported at regular intervals.
- 3.8.2 Steam tracing around individual instrument shall be by copper tube of 1/8" diameter.
- 3.8.3 Piping or tubing for steam tracing shall be installed in such a way as to avoid condensate pockets.
- 3.8.4 After steam tracing, the line is connected to drain funnel through steam trap.

### 3.9 Identification of Lines and Instruments

- 3.9.1 All site mounted instruments, junction boxes, air headers, tubing and wiring terminations shall be labelled or tagged.
- 3.9.2 Instruments shall be furnished with stainless steel name tags containing Tag no., manufacturers name, model no. serial number. This tag number shall be approximately 3"x1" size and shall be attached to the instruments with -- gauge stainless steel wire.
- 3.9.3 Unused cable entries in junction boxes and field instruments are to be plugged.

## 4.0 TESTING

### 4.1 Instrument Impulse piping/Tubing

- 4.1.1 All process impulse lines shall be disconnected both from the instrument and vessel/piping end and flushed with water.
- 4.1.2 After thorough flushing the impulse lines shall be isolated from the instruments and pressurised hydraulically to 1.5 times the maximum working pressure corrected for ambient temperature. They shall then be isolated from the pressure source and the pressure reading on a test pressure gauge shall not fall at a rate exceeding one psig/hour.

In case no isolation valve is provided near the instrument, impulse piping/tubing shall be pressurised along with the instrument to the maximum pressure of scale in case of pressure transmitter and max. operating pressure in case of differential pressure instrument with equalising valve open.

- 4.1.3 In special conditions where hydro- testing is not permissible due to service requirements, testing shall be carried out by using compressed air/nitrogen.
- 4.1.4 The external displacer type instruments and cage type level switches shall be tested to 1.5 times the operating pressure using air/nitrogen after thorough flushing.

### 4.2 Instrument Air lines/signal tubing.

- 4.2.1 Instrument air lines/signal tubing shall not be hydrostatically tested.
- 4.2.2 Instrument air tubing shall be disconnected upstream of all filter regulators and blown down to remove water, slag and mill scale, from lines at 7.0 kg/cm<sup>2</sup> G for fifteen minutes. Air filter shall be taken in line and tubing shall be disconnected at instrument end, and blown for 3 minutes to remove traces of dirt.

- 4.2.3 Testing of instrument air shall be carried out with instrument air at 7 kg/cm<sup>2</sup>G upto the upstream of the filter regulator after thorough flushing. All lines shall be checked with soap solution and bubbler unit for possible leak at joints.
- 4.2.4 All signal tubing shall be checked with 1.5 kg/cm<sup>2</sup> after proper flushing. After pressuring, source shall be cut off and rate of fall in pressure shall be less than IPSL for each 100 feet of tubing for a test period of 2 minutes as per instrument society of American RP 7.1 'Pneumatic Control Circuit Pressure Test'

#### **4.3 Cables**

- 4.3.1 All wiring shall be checked to ensure that it is correctly connected and properly grounded.
- 4.3.2 All cables shall be checked for continuity proper connection and insulation testing. Insulation test shall be carried out on all wiring with a certified megger after disconnecting the cables at both ends.
- 4.4 All the results of the above mentioned testing shall be recorded and submitted for check.
- 4.5 All the in line instruments like orifice plates, turbine meters, Rotameters, Target meters, vortex meters, control valves, safety valves etc. shall be removed and spool pieces shall be provided prior to the flushing of the lines.

#### **5.0 CALIBRATION OF INSTRUMENTS**

- 5.1 All instruments shall be calibrated strictly as per manufacturers instructions prior to the installation. In addition to calibration of instruments, setting of safety devices like process switches, safety valves etc. and simulation testing of all interlock and shutdown system shall be carried out.
- 5.2 In general, all tests shall simulate, as closely as possible, design process condition by the use of manometers, potentiometers, deadweight testers, test pressure gauges etc. Pour point callibration shall refer to the input signal to an instrument equivalent to 0,25,50,75,100% of instrument range upscale (rising) and 75,50,25,0% of instrument (downscale) (falling).

All instruments unless otherwise noted shall be calibrated in upscale and downscale direction and if necessary, adjusted until their accuracies conform to those limits state by the manufacturer.

Upon completion of these tests, the instruments shall be drained, completely.

#### **5.3 Temperature Instruments**

- 5.3.1 Temperature Gauges Filled type and Bi metallic dial type Thermometers shall be four point bench checked for proper operation and calibration using a temperature bath prior to installation.
- 5.3.2 Temperature Elements and Temperature Transmitters. Temperature Elements and Transmitter shall be four point bench calibrated using a temperature bath precision meter or precision gauge prior to installation.

#### **5.4 Pressure Instruments**

##### **5.4.1 Pressure Gauges**



- 5.4.1.1 Direct connected bourdan type pressure gauges shall be dead weight tested or tested against a test gauges prior to installation.
- 5.4.1.2 Receiver type pressure gauges shall be four point calibrated using a precision gauge and precision air regulator.
- 5.4.1.3 Pressure and Differential Pressure Transmitters. Pressure and differential pressure transmitters shall be four point calibrated using a hydraulic or dead weight tester or a precision pneumatic calibrator prior to the installation. A precision output meter or gauge shall be used to monitor the output.
- 5.5.1 Orifice plates shall be checked visually for the name plate and for an upstream sharp edge. Bore dia. Shall be checked for compliance with the specification.
- 5.5.2 Differential pressure type of flow instruments shall be four point callibrated using precision pneumatic callibrator or a manometer and precision regulator. A precision output meter or gauge shall be used to monitor the output of the transmitter.

### 5 5 3

- a) Rotameters shall be installed as received A check shall be made to confirm that shipping stops have been removed and float has been installed.
  - b) Where rotameters have transmitting MNGLhanism, the float shall be raised and lowered Mechanically and output shall be checked. Vendor calibration data/ curve shall be checked.
  - c) A check shall be conducted with plumb for a vertical installation.
- 5.5.4 Turbine meters, Annubar, positive displacement meters, vortex meter, ultrasonic flow meter, etc. shall be installed as received.
  - 5.5.5 Target meters shall be checked for calibration using calibration weights. Output shall be monitered using precision output meter.

## 5.6 Level Instruments

### 5.6.1 Level Gauge Glasses

Gauge glasses shall be installed as received installation of illuminators, frost protectors and other accessories shall be checked.

### 5.6.2 Displacer Type, Level Transmitter

- Displacer type level transmitter shall be checked by raising and lowering Mechanically the displacement and checking the pilot or transmitter action. Check transmitter with out put gauge or meter for smooth and full output change.
- A check shall be conducted with plumb for a vertical installation.

- 5.6.3 Differential pressure type level transmitter Differential pressure type level transmitter shall be calibrated with pneumatic calibrator at four points prior to installation. A precision meter or gauge shall be used to monitor the output of the transmitter.
- 5.6.4 Tank level gauges
- a) Tank level gauges shall be checked by raising and lowering Mechanically the displacer and checking the indicator on the gauge board.
  - b) Check for proper liquid seal prior to installation in case of liquid seal tank gauges.
  - c) In case of servo type gauges, the displacer is hoisted from the tank into the calibration chamber.
- 5.7 Control Valves, shutdown valves and self actuated valves
- 5.7.1 All diaphragm and piston operated control valve shall be stroked pneumatically using a pressure regulator and pressure gauge against the spring range specified on the name plate of the valve.
- 5.7.2 Mechanical seating and travel of the valve stem shall be checked against the side indicator and the name plate
- 5.7.3 Valve positioner shall be calibrated with the control valve in accordance with the name plate data and specifications with the help of pneumatic calibrator or gauge with precision regulator. Zero position or fully close position of the valve shall be a live zero i.e., the plug shall be just off the seat at the minimum setting.
- 5.7.4 Volume bottles, where used shall be checked for proper filling. The signal line shall be bled to zero pressure and failure action shall be confirmed.
- 5.7.5 Control valve accessories such as handwheels, boosters, relays etc. shall be checked operationally. Declutchable handwheel shall be operable both with and without an air signal to the diaphragm.
- 5.7.6 Self actuated control valves shall be installed as received, checking inlet and outlet points and name plate data. Regulators with external pressure connections shall be inspected for proper installation.
- 5.7.7 Butterfly shall be checked carefully to see that the vane moves freely into the upstream and down stream piping. Proper vane movement to stroke shall be confirmed.
- 5.7.8 All control valves and regulators shall be removed from the line prior to flushing and during hydrotesting.
- 5.8 Safety Relief Valves
- 5.8.1 Safety relief valves shall be installed as received after carefully checking the name plate data. Pilots, if used, shall be checked carefully for installation on the proper safety valve.
- 5.8.2 Valves, which are installed in such a manner as to permit on line testing, shall be pressure tested after installation to determine proper operation and setting. Compressed air or nitrogen shall be used for testing of safety relief valves.
- 5.9 Switches

- 5.9.1 Level Switches shall be actuated Mechanically for switch operation but shall not be calibrated for level setting.
- 5.9.2 Pressure switches shall be calibrated using hydropic or dead weight tester or precision air regulator and gauge. The setting/trip point shall be checked using a continuity tester.
- 5.9.3 Temperature switches shall be calibrated using a temperature both prior to installation and set to the required alarm/ trip point using a continuity tester.
- 5.10 Receiver Instruments
  - 5.10.1 Receiver Indicator/Recorders
    - 5.10.1.1 Pneumatic indicators/ Recorders shall be calibrated using pneumatic calibrator/ precision pressure regulator and gauge.
    - 5.10.1.2 Electronics indicators/ Recorders shall be calibrated using a current generator and a precision meter.
    - 5.10.1.3 Chart drive assembly shall be checked for proper operation.
  - 5.10.2 Controllers
    - 5.10.2.1 Proper balancing of the controller shall be checked as per the manufacturers catalogues.
    - 5.10.2.2 Controllers shall be checked for manual and Auto operation and Transfer. The transfer from manual to Auto and vice versa shall be bumpless and smooth.
  - 5.10.3.1 Manual loader station Output of the manual loader shall be checked with a precision meter.
  - 5.10.4.1 Multipoint Temperature Recorders

Each point shall be calibrated using a temperature simulator/ decade box for RTD / voltage generator and precision meter for the thermocouples.
  - 5.10.4.2 Point synchronisation shall be checked.
  - 5.10.5 Pneumatic receiver switches shall be calibrated using precision air regulator and gauge. The setting/alarm/trip point shall be checked using continuity tester.
  - 5.10.6 Trip Amplifiers Trip amplifiers shall be calibrated using a temperature simulators or voltage generator and precision meter for thermocouple or Resistance box for RTDs. The required setting/ alarm point/ trip point shall be checked using a continuity tester.
  - 5.10.7 Receiver Switch module Receiver switch modules shall be calibrated using a current source and a precision meter. The required setting/alarm/trip point shall be checked using a continuity tester.
  - 5.10.8 Alarm and Annunciator system
    - 5.10.8.1 Alarm and annunciator system shall be checked for visual and Audio alarm operation using dummy signals. Full alarm sequence of each alarm point shall be checked.

5.10.8.2 Each point shall be checked for proper engraving.

5.10.9 Shutdown System

5.10.9.1 Operation of final actuating elements shall be checked for proper operation using dummy signals.

5.10.9.2 All timers, push buttons and switches shall also be checked for their proper operation.

5.11 Analytical Instruments

5.11.1 Check the full analyser system including sample handling system for leakage.

5.11.2 Check the full sample handling system for its proper operation. Calibrate and check completely all analysers using zero and span samples as per vendor catalogues.

5.12 Flow computer / Volume corrector

5.12.1 Corrected flow values shall be checked for various D.C. inputs and pressure and temperature variations for upscale and downscale ranges.

5.13 The list of test and calibration instruments with tracability certificates shall be submitted to MNGL for approval before carrying out the tests / calibration of instruments at site.

5.14 The formats / description of tests / calibration of all instruments shall be submitted to MNGL for approval.

5.15 Daily / weekly reports shall be submitted during execution of work at site.

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SPECIFICATION  
FOR  
INSTRUMENT TUBING

SPECIFICATION NO.: MNGL/Steel/TS/35

# **C O N T E N T S**

1.0 GENERAL

2.0 CONSTRUCTION

3.0 TESTING

4.0 SHIPPING

5.0 REJECTION

1.0 GENERAL

1.1 Scope

1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, testing and shipping of Instrument Tubing which includes the following types:-

- a) SS tubes
- b) Copper tubes

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of Purchaser's enquiry:

ASTM A 269 - Specification for seamless and welded ferritic stainless steel tubing for general services.

ASTM B 251 - Specification for general requirements for wrought seamless copper and copper alloy tube.

ASTM B 251M - Specification for general requirements for wrought seamless copper and copper alloy tube (Metric)

ASTM B 68 - Specification for seamless copper tube, bright annealed.

ASTM B 68M - Specification for seamless copper tube, bright annealed. (Metric)

1.1.3 In the event of any conflict between these specifications, data sheets, related standards, codes, etc., the vendor shall refer the matter to the purchaser for clarifications and only after obtaining the same shall proceed with the manufacture of the items in question.

1.2 Bids

1.2.1 Vendor's quotation shall include a detailed specification sheet for each type of tube which shall provide the following information:

- a) All the details regarding the type, construction, materials etc. of the items.
- b) Overall the dimensions in mm.

1.2.2 All the units of measurement and material specifications for various parts in the vendor's specification sheets shall be to same standards as in purchaser's data sheets.

1.2.3 Vendor shall attach a list of items, typewise, summing up all the deviations from this specification and purchaser's data sheets if there are any. Also vendor shall provide reasons for these deviations.

1.2.4 Vendor shall enclose catalogues giving detailed technical specifications and other information for each type of tube in the bid.

1.2.5 Vendor's quotation, catalogues, drawings etc. shall be in English language.

1.3 Drawings, Data and Certification

Detailed drawings, data, catalogues and manuals etc. required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducibles and prints shall be despatched to the address mentioned, adhering to the time limits indicated.

## 2.0 CONSTRUCTION

### 2.1 Stainless Steel Tubes

2.1.1 SS tubes of the tubes shall be Rockwell RB 70-70. Tubes shall be free from scratches and to be suitable for bending.

2.1.3 Tube wall thickness shall be 0.049" for 1/2" OD and 1mm for 6 mm unless otherwise specified.

2.1.4 Maximum working pressure shall be 153.0 kg/cm<sup>2</sup> at 38°C for 1/2" OD Tube, unless otherwise specified and 80.0 kg/cm<sup>2</sup> at 38°C for 6mm OD tube.

2.1.5 Tubes shall be supplied in minimum length of 6 metres without brazing in between.

2.1.6 Dimensional tolerances shall be as per ASTM A 269.

2.1.7 The following shall be marked on the tube:

- a) Name of manufacturer
- b) Type and material grade of tube
- c) Tube O.D. and wall thickness

### 2.2 Copper Tubes

#### 2.2.1 Copper Tubes (PVC Jacket)

2.2.1.1 The tube shall be soft annealed copper with 6mm OD and a wall thickness of 1.0 mm as per ASTM B 68M Copper No.C12200.

2.2.1.2 The tube shall be jacketed with black PVC. The jacket thickness shall be 1.6mm. The PVC jacket shall confirm to ASTM D-1047.

2.2.1.3 The tube ends shall be plugged prior to transportation.

2.2.1.4 The tube shall be of continuous length without any brazing in between for 100 metres length.

2.2.1.5 Minimum length of single tube shall be 100 metres.

2.2.1.6 The dimensional tolerances shall be as per ASTM B 251M.

#### 2.2.2 Bare Copper Tubes (For Steam Tracing)

2.2.2.1 The tube shall be soft annealed copper with 3/8" OD or 6mm OD with a wall thickness of 1.0 mm as per ASTM B68 copper No.C12200.

2.2.2.2 The tube ends shall be plugged prior to transportation.



2.2.2.3 The tube shall be of continuous length without any brazing in between for 100 metres length.

2.2.2.4 Minimum length of tube shall be 100 metres.

2.2.2.5 The dimensional tolerances shall be as per ASTM B 251.

### 3.0 TESTING

3.1 The following tests shall be done for SS tubes.

a) Hardness test

b) Hydrostatic test at 153.0 kg/cm<sup>2</sup> at 38° C for 1/2" tube and at 80.0 kg/cm<sup>2</sup> at 38°C for 6mm tube, unless otherwise specified.

3.2 PVC jacketed copper tubes shall be tested at 7.0kg/cm<sup>2</sup>g with dry air for leak check.

3.3 Bare copper tubes shall be hydrostatically tested at 80.0 kg/cm<sup>2</sup>g at 38°C.

3.4 Final test before delivery shall include ball test to ensure clear opening of the tube for copper tubes. The O.D.of the ball shall be minimum 1mm for 6mm O.D tube and 2mm for 3/8" tube.

### 4.0 SHIPPING

4.1 The tubes shall be plugged at both ends to avoid entry of foreign matter. The tubes shall be packed carefully so as to avoid damage during transport.

### 2.0 REJECTION

Vendor shall make his offer in detail, with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summarily rejected.

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SPECIFICATION  
FOR  
INSTRUMENT TUBE FITTINGS

SPECIFICATION NO.: MNGL/Steel/TS/36

# **C O N T E N T S**

1.0 GENERAL

2.0 CONSTRUCTION

3.0 TESTING

4.0 SHIPPING

5.0 REJECTION

## 1.0 GENERAL

### 1.1 Scope

1.1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, testing and shipping of instrument tube fittings which includes the following types:-

- a) SS compression fittings (SS tube)
- b) Brass compression fittings (copper tube)

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of Purchase's enquiry:

ANSI B 2.1	-	Pipe Threads
B16.11	-	Forged steel fittings-socket welding and threaded.
IS:319	-	Specification for free cutting brass bars, rods and sections.
ISA RP 42.1	-	Nomenclature for instrument tubing - fittings.

1.1.3 In the event of any conflict between these specifications, data sheets, related standards, codes etc., the vendor shall refer the matter to the purchaser for clarifications and only after obtaining the same shall proceed with the manufacture of the items in question.

### 1.2 Bids

1.2.1 Vendor's quotation shall include a detailed specification sheet for each type of tube fittings which shall provide the following information:

- a) All the details regarding the type, construction, materials, etc. of the items.
- b) Overall dimensions in mm.

1.2.2 All the units of measurement and material specifications for various parts in the vendor's specification sheets shall be to same standards as in purchaser's data sheets.

1.2.3 Vendor shall attach a list of items, typewise, summing up all the deviations from this specification and purchaser's data sheets if there are any. Also vendor shall provide reasons for these deviations.

1.2.4 Vendor shall enclose catalogues giving detailed technical specifications and other information for each type of fitting in the bid.

1.2.5 Vendor's quotation, catalogues, drawings, etc. shall be in English language.

### 1.3 Drawings, Data and Certification

Detailed drawings, data, catalogues and manuals etc., required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducibles and points shall be despatched to the address mentioned, adhering to the time limits indicated.

## 2.0 CONSTRUCTION

### 2.1 SS Tube fittings:

2.1.1 Nomenclature of all tube fittings shall be as per ISA RP 42.1.

2.1.2 Fittings shall be flareless compression type and of three piece construction with ferrule, nut and body suitable for use on SS tubes conforming to ASTM A 269 TP316, hardness not exceeding RB80.

2.1.3 All parts shall be of SS 316.

2.1.4 Hardness of the ferrules shall be in the range of RB 85-90 so as to ensure a minimum hardness difference of 5 to 10 between tube and fittings, for better sealing.

2.1.5 Nuts and ferrules of particular size shall be interchangeable for each type.

2.1.6 Spanner hold shall be metric.

2.1.7 Threaded ends of fittings shall be NPT as per ANSI B 2.1.

#### 2.1.8 Copper Tube Fittings

2.2.1 Nomenclature of all tube fittings shall be as per ISA 42.1.

2.2.2 Fittings shall be of flareless compression type and of three-piece construction consisting of ferrule, nut and body suitable for use on copper tubes conforming to ASTM B 68/B 68M hardness not exceeding RB 50.

2.2.3 All parts shall be manufactured from Brass as per IS 319 barstock and Nickel plated.

2.2.4 For better grip, vendor shall maintain hardness difference between tube & ferrule and indicate the same along with the offer.

2.2.5 Nuts & ferrules of particular size shall be interchangeable for each type.

2.2.6 Threaded ends of fittings shall be NPT as per ANSI B 2.1.

2.2.7 Spanner hold shall be metric.

2.2.8 Vendor shall ensure that the ferrules and nuts supplied for fittings shall be suitable for sample tube which shall be supplied during manufacture.

### 3.0 TESTING

3.1 Random samples of SS tube fittings shall be hydrostatically tested as follows:-

For 6 mm fittings at 80.0 kg/cm<sup>2</sup>, 1/2" fittings at 153.0 kg/cm<sup>2</sup> at 38°C unless otherwise specified.

3.2 Random samples of brass compression fittings shall be hydrostatically tested as follows:-

For 1/4" fittings, at 10 kg./cm<sup>2</sup>, 3/8" at 80.0 Kg/cm<sup>2</sup> and all at 38°C.

### 4.0 SHIPPING

4.1 All thread/ends shall be protected with plastic caps to prevent damage/entry of foreign matter.

### 5.0 REJECTION

Vendor shall make his offer in detail, with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summarily rejected.

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SPECIFICATION  
FOR  
INSTRUMENT VALVES AND MANIFOLDS

SPECIFICATION NO.: MNGL/Steel/TS/37

# **C O N T E N T S**

1.0 GENERAL

2.0 CONSTRUCTION

3.0 TESTING

4.0 SHIPPING

5.0 REJECTION



## 1.0 GENERAL

### 1.1 Scope

1.1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, testing and shipping of Instrument Valves & Manifolds which includes the following types:-

- a) Miniature instrument valves
- b) Instrument valve manifolds
- c) Instrument air valves

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of Purchaser's enquiry:

ANSI B 2.1 - Pipe threads

ANSI B 16.11 - Forged steel fittings-socket welding and threaded.

1.1.3 In the event of any conflict between these specifications, data sheets, related standards, codes etc, the vendor shall refer the matter to the purchaser for clarifications and only after obtaining the same shall proceed with the manufacture of the items in question.

### 1.2 Bids

1.2.1 Vendor's quotation shall include a detailed specification sheet for each type of Valves & Manifolds which shall provide the following information:

- a) All the details regarding the type, construction, materials etc. of the items.
- b) Overall dimensions in mm.

1.2.2 All the units of measurement and material specifications for various parts in the vendor's specification sheets shall be to same standards as in purchaser's data sheets.

1.2.3 Vendor shall attach a list of items, typewise, summing up all the deviations from this specification and purchaser's data sheets if there are any. Also vendor shall provide reasons for these in the bid.

1.2.5 Vendor's quotation, catalogues, drawings etc. shall be in English language.

### 1.3 Drawings, Data and Certification

Detailed drawings, data, catalogues and manual etc. required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducibles and prints shall be despatched to the address mentioned, adhering to the time limits indicated.

## 2.0 CONSTRUCTION

### 2.1 Instrument Valves (Miniature)

- 2.1.1 The instrument valves shall be globe pattern-needle valves forged/ barstock with inside screwed bonnet.
- 2.1.2 Body and trim material shall be 316 SS unless otherwise specified.
- 2.1.3 The valve body rating shall be 3000 lbs unless specified in piping material specification which shall govern in in case it is specified.
- 2.1.4 The end connection shall be 1/2" NPTF to ANSI B2.1.
- 2.1.5 The packing material shall be teflon unless otherwise specified.
- 2.1.6 The hand wheel material shall be carbon steel zinc plated.
- 2.1.7 Flow direction shall be marked on the body.
- 2.1.8 The valve dimension shall be as follows:
  - a) End to end dimensions 76 mm (approximately).
  - b) Height in fully open condition - 135mm maximum.

## 2.2 VALVE MANIFOLDS

### 2.2.1 3-Valve & 5-Valve manifolds:

- 2.2.1.1 3 Valve manifold shall be designed for direct coupling to differential pressure transmitters having 2 bolt flanges with 54 mm (2-1/8") centre to centre connections and 41.3 mm (1-5/8") bolt to bolt distance. The manifold shall contain two main block valves and an equalizing by-pass valve. The valves shall be needle valves. They shall use self aligning 316SS ball seats.
- 2.2.1.2 5 Valve manifold shall contain two main line block valves and a combination double block and bleed for the bypass line.
- 2.2.1.3 The manifold shall be suitably for mounting directly on the stanchion (2" pipe).
- 2.2.1.4 All bonnets shall have teflon packings unless otherwise specified.
- 2.2.1.5 The material of construction shall be 316 SS unless otherwise specified.
- 2.2.1.6 The flanges shall be integral part of the block.
- 2.2.1.7 The process connection shall be 1/2" NPTF to ANSI B2.1.
- 2.2.1.8 The manifolds shall be supplied alongwith mounting accessories. The bolts and nuts shall be alloy steel as per ASTM A 193 Gr B ASTM A 194 GR 2H respectively. rings shall be teflon and other accessories shall be cadmium plated.
- 2.2.1.9 Vendor shall furnish the material certificate for body.
- 2.2.2 3 Way 2 Valve Manifold for pressure gauges.)

2.2.2.1 The manifold shall be designed for use with pressure gauges.

2.2.2.2 The valve shall be a ball valve.

2.2.2.3 The body shall be either straight or angle as specified in data sheets.

2.2.2.4 The body and trim material shall be 316SS, packing material shall be teflon unless otherwise specified.

2.2.2.5 The inlet connection shall be 3/4" plain end (female) for socket weld as per ANSI B 16.11.

2.2.2.6 The gauge connections shall be with union nut & tail piece threaded 1/2" NPT(F).

2.2.2.7 The drain connection shall 1/2"NPTF.

### 2.3 Instrument Air Isolation Valves

2.3.1 The valves shall be full bore ball valves.

2.3.2 Body material shall be Nickel or Cadmium plated carbon steel.

2.3.3 Trim material shall be 316SS.

2.3.4 The end connection shall be 1/2" NPTF to ANSI B2.1 unless otherwise specified.

2.3.5 The packing material shall be teflon.

2.3.6 The handle/wrench material shall be cadmium or nickel plated carbon steel.

2.3.7 The valve body rating shall be ANSI 800 lb.

2.3.8 End to end dimensions shall be 70mm (approximately).

### 3.0 TESTING

3.1 The instrument valves (miniature) shall be hydrostatically tested at 200kg/cm<sup>2</sup> g at 38°C.

3.2 All manifolds (3 valve, 5 valve and 3 way, 2 valve ) shall be hydrostatically tested at 200 kg/cm<sup>2</sup> at 38°C.

3.3 The instrument air valves shall be hydrostatically tested at 15.0 kg/cm<sup>2</sup>g at 38°C and at 10.5 kg/cm<sup>2</sup>g with dry air.

### 4.0 SHIPPING

4.1 All threads/ends shall be protected with plastic caps to prevent damage/entry of foreign matter.

### 5.0 REJECTION

Vendor shall make his offer in detail, with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summarily rejected.

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SPECIFICATION  
FOR  
JUNCTION BOXES AND CABLE GLANDS

SPECIFICATION NO.: MNGL/Steel/TS/38

# **C O N T E N T S**

1.0 GENERAL

2.0 JUNCTION BOXES

3.0 CABLE GLANDS & PLUGS, REDUCERS/ ADAPTORS

4.0 NAME PLATE

5.0 SHIPPING

6.0 REJECTION

## 1.0 General

### 1.1 Scope

1.1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, nameplate marking, testing and shifting of junction boxes & cable glands which include the following types:

- a) Electrical junction boxes.
- b) Pneumatic junction boxes
- c) Cable glands (whenever specified)

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

- ANSI B 2.1 : Pipe threads
- IS-5 : Colours for ready mixed paints and enamels
- IS-2147 : Degrees of protection provided by enclosures for Low voltage switchgear and control gear.
- IS-2148 : Flame proof enclosure of electrical apparatus.

1.1.3 In the event of any conflict between specifications, data sheets, related standards, codes etc., the vendor shall refer the matter to the purchaser for clarifications and only after obtaining the same should proceed with the manufacture of the items in questions.

### 1.2 Bids

1.2.1 Vendor's quotation shall include a detailed specification sheet for each type of junction box and cable gland which shall provide the following information:

- a) All the details regarding the type, construction, materials, housing, entries, etc.
- b) All dimensions in millimeter.
- c) Sketch for each type of JB with dimensional details showing the terminal and entries arrangement.
- d) Mounting details.
- e) Vendor shall furnish certificate from statutory body for explosion proof enclosure, indicating the gas group and temperature class.

1.2.2 All the material specifications for various parts in the vendor's specification sheets shall be to the same standards as those in purchaser's data sheets (e.g. BS, IS, etc.)

1.2.3 Vendor shall attach a list of items, tag numberwise, summing up all the deviations from the purchaser's data sheets, if there are any. Also vendor shall furnish reasons for these deviations.

1.2.4 Vendor shall enclose catalogues giving detailed technical specifications and other information for each type of JB/cable glands and its accessories covered in the bid.

1.2.5 Vendor's quotation, catalogues, drawings, etc. shall be in English language.

### 1.3 Drawings, Data and Certification

1.3.1 Detailed drawings, data, catalogues required from the vendor are indicated in vendor data requirements sheets. The required number of reproducibles and prints shall be despatched to the address mentioned, adhering to the time limits indicated.

1.3.2 After placement of purchaser order, vendor shall submit certified drawings and specifications sheets for each type of JB/cable gland which shall include the following:

- a) Detailed dimensional drawings
- b) Weight of each in grams/Kg.
- c) Certificate from statutory body suitable for installation in specified hazardous area.

## 2.1 Junction Boxes

2.0 Junction boxes shall be either of the following type as specified in data sheets.

- I. Weather proof junction boxes.
- II. Weather proof & Explosion proof junction boxes.

2.2 The enclosure shall be as per IS-2147 for weather proof junction boxes and for Explosion proof it shall be as per IS-2148 suitable for the area classification specified.

2.3 Number of entries and locations shall be as per data sheets.

2.4 Junction boxes shall be provided with telephone sockets and plugs for connection of hand powered telephone set.

## 2.5 Electrical Junction boxes

2.5.1 Material shall be die-cast aluminium of minimum 5 mm thick (LM-6 alloy)

2.5.2 Explosion proof junction boxes shall have detachable cover which is fixed to the box by means of cadmium plated triangular head/hexagonal head screws.

2.5.3 Weather proof junction boxes shall have doors which shall be hinged type and these shall be fixed with cadmium plated countersunk screws.

2.5.4 Explosion proof junction boxes shall have a warning engraved/integrally cast on the cover as given below:

"Isolate power supply elsewhere before opening"

2.5.5 Terminals shall be spring loaded, vibration proof, clip-on type, mounted on nickel plated steel rails complete with end cover and clamps for each row.

2.5.6 All terminals shall be suitable for accepting minimum 2.5 sq. mm copper conductor, in general. However for power supply distribution boxes, terminal detail shall be as per job specification/Data sheets.

2.5.7 Sizing shall be done with due consideration for accessibility and maintenance in accordance with the following guidelines.

- i) 50 to 60 mm between terminals and sides of box parallel to terminal strip for upto 50 terminals and additional 25mm for each additional 25 terminals.
- ii) 100 to 120mm between terminals for upto 50 terminals and additional 25mm for each additional 25 terminals.
- iii) Bottom/top of terminal shall not be less than 100 mm from bottom/top of the junction box.

2.5.8 Terminals shall be marked as per the various types indicated in data sheets.

2.5.9 Shall be provided with external earthing lugs.

## 2.6 Pneumatic junction boxes

2.6.1 Pneumatic junction boxes shall be made of 3mm thick hot rolled steel. They shall have necessary neoprene gasket between door and body. Door shall be flush with the box and shall be hinged type and provided with wing nuts.

2.6.2 Single tube entries shall be suitable for 6mm O.D. copper tube with bulk head fittings. Multi tube bundle entry shall be suitable for the data furnished in data sheets.

## 2.7 Painting

2.7.1 Surface shall be prepared for painting. It shall be smooth and devoid of rust and scale.

2.7.2 Two coats of lead-free base primer and two final coats of lead free epoxy based paint shall be applied both for interior and exterior surfaces.

2.7.3 The colour shall be as specified in data sheets.

## 3.0 Cable glands & plugs, Reducers/Adaptors

3.1 Cable glands shall be supplied by vendor whenever specified.

3.2 Cable glands shall be double compression type for use with armoured cables.

3.3 The cable glands shall be of Nickel plated brass.

3.4 The cable gland shall be weather proof. Whenever specified they shall be explosion proof and certificate from statutory body shall be furnished.

3.5 Cable glands shall be supplied to suit the cable dimensions indicated along with tolerance indicated in data sheets. Various components like rubber ring, metallic ring, metallic cone and the outer/inner nuts etc. shall be capable of adjusting to the above tolerances of cable dimensions.



3.6 Reducers/Adaptors shall be supplied as per details indicated in data sheets. They shall be nickel plated brass. These shall be weather proof in general. These shall also be explosion proof wherever specified and certificate from statutory body for explosion shall be furnished.

3.7 Plugs shall be provided wherever specified. They shall be of Nickel plated brass.

3.8 Plugs shall be certified explosion proof when used with explosion and junction boxes.

#### 4.0 Name Plate

4.1 Each junction box shall have an anodised aluminium name plate permanently fixed to it at a visible place bearing the tag no. & enclosure. The name plate shall also bear the stamp of certifying agency with certificate number.

#### 5.0 Shipping

5.1 All threaded openings shall be suitably protected to prevent entry of foreign material.

5.2 All threaded components shall be protected with plastic caps to prevent damage of threads.

#### 6.0 Rejection

Vendor shall furnish his offer in detail, with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summararily rejected.

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SPECIFICATION  
FOR  
SIGNAL CABLES

SPECIFICATION NO.: MNGL/Steel/TS/39

## **C O N T E N T S**

1.0 GENERAL

2.0 CONSTRUCTION

3.0 ELECTRICAL CHARACTERISTICS

4.0 TESTING

5.0 SHIPPING

6.0 REJECTION

## 1.0 GENERAL

### 1.1 Scope:

This specification together with the job Specifications attached herewith forms the requirements for design, materials, manufacturing, testing and shipping of PVC insulated signal cables.

### 1.2 Standards:

The cables shall conform to the latest editions of the various standards mentioned in the specification.

In case of any conflict between any standard and this - specifications the matter shall be referred to the purchaser before proceeding with the manufacture of the cables.

### 1.3 Bids:

1.3.1 Vendor's quotation shall include the following as a minimum. Completed job specs., Pair identification method, type test certificates, technical literatures, various testing methods and cross sectional dimensional drawings. All information/data shall be in English language.

1.3.2 Vendor's quotation shall include a list of deviations if any from purchaser's specifications and shall also indicate the reasons for such deviations for consideration to arrive at mutually agreed deviations. However vendor shall note that no deviation shall be accepted in respect of the permissible limits of resistance capacitance and L/R ratio of cables.

1.3.3 Vendor shall quote unit price per metre for each type of cable.

### 1.4 Instructions to Bidder:

1.4.1 The quantity indicated against each type of cable in the job specification may vary by  $\pm 25\%$  at the time of placement of order. Vendor shall confirm that there shall be no price implication on this account in unit prices typewise.

1.4.2 Drum length for each type of cable shall be 500 to 1000 metres. Vendor shall indicate the maximum drum length possible for each type of cable in his bid. Exact requirements of drum length will be specified after purchase order during detailed engineering and vendor shall confirm that the same shall not affect the price or delivery schedule. The actual produced drum length shall not vary by more than  $\pm 5\%$  from the value indicated in the purchase order.

1.4.3 Tolerance over the total ordered length shall be as follows:

- $\pm 5\%$  for total length less than 5 km.
- $\pm 2\%$  for total length 5 km or more.

1.4.4 Cable dimensions furnished by vendor in his bid shall be firm. Vendor shall comply with all the values during execution.

1.5 All cables shall be suitable for laying in open air, corrosive hydrocarbon plant atmosphere, direct sun and in trenches. The cable shall also be designed for prolonged use in tropical atmosphere.

1.6 On demand vendor shall furnish documents such as invoice and test certificates to prove the quality and composition of the materials used for manufacturing the cable to the satisfaction of client/ consultant or authorised representative during various stages of expediting and inspection.

## 2.0 Construction :

### 2.1 Type 1 (single pair/triad shielded cable)

2.1.1 Each core shall be 1.5 sq. mm made of 7 stranded annealed electrolytic copper conductor. Each strand shall be 0.53 mm dia.

2.1.2 Primary insulation shall be 85°C polyvinyl chloride (PVC) as per IS-5831 Type C. Thickness shall be 0.5 mm minimum.

2.1.3 Each wire shall have twisted cores and No. of twists shall be not less than 10 per metre. Colour of cores insulation shall be black blue in a pair and black, blue and brown in a triad.

2.1.4 Individual pair and triad shall be shielded. Shield shall be Aluminium backed by mylar/polyester tape bonded together with the metallic side down helically applied with either side 25% overlap and 100% coverage. Minimum shielded thickness shall be 0.05mm. Drain wire shall be 0.5 sq.mm multistrand bare tinned annealed copy conductor. The drain wire shall be in continuous contact with Aluminium side of the shield.

2.1.5 Inner and outer jacket shall be made of extruded flame retardant 90°C PVC to IS 5831-Type ST2 Oxygen index of PVC shall be 30. Temp. Index shall be over 250°C. Inner jacket colour shall be black. Outer jacket colour shall be black except for cable to be used in intrinsically safe systems it shall be light blue.

2.1.6 Armour over inner jacket shall be of galvanised steel wire/flat as per IS-1554 part-I.

2.1.7 A pair or triad identification shall be with numbers at interval of not more than 250 mm as per vendor's standard.

2.1.8 Tolerance in overall diameter of cable shall be within  $\pm 2$ mm over offered value for cables with OD less than 30mm and  $\pm 3$ mm for cables with OD more than 30mm.

### 2.2 Type-II

(Multipair/multitraid cable with individual pair shield and overall shield)

The cable shall be same as single pair shielded cable except conductor size shall be 0.5 sq.mm made of 16 strands of annealed electrolytic copper conductor. Each strand shall be of 0.2mm dia.

Additional feature shall be as follows:

2.2.1 Overall shield shall be of Aluminum backed up by mylar/polyester tape helically applied with the metallic side down either side 25% overlap and 100% coverage. Minimum shield thickness shall be 0.075mm Drain wire shall be similar to individual pair drain wire and shall be in continuous contact with the Aluminium side of the overall shield.

2.2.2 Overall twist of all pair/triads shall be as per vendor's standard.

2.2.3 A pair of communication wire shall be provided for multipair/multitriad cables. Each wire shall be 0.5 sq. mm of plain annealed single or multistrand copper conductor with 0.4 mm thick 85°C PVC insulation. Insulation shall be green and red colour coded.

### 2.3 Type-III

(Multipair/Multitriad cable with only overall shield)

These cables shall be same as type-II cables except that the individual pair/triad shall not have shielding.

### 2.4 Type-IV

(Multipair/ multitriad cable with individual pair shield and overall shield)

The cable shall be same as Type II except conductor size shall be 1.5 sq.mm made of 7 stranded annealed electrolytic copper conductor. Each strand shall be 0.53 mm dia.

### 2.5 Type-V

(Multipair/ Multitriad cable with overall shield only)

The cable shall be same as type IV except that the individual pair/triad shall not have the shielding.

## 3.0 Electrical Characteristics

3.1 Maximum d.c. resistance of the conductor of the completed cable shall not exceed 12.3 ohms/km at 20°C for cables with 1.5 sq.mm conductor and 39.7 ohms/km at 20°C for cables with 0.5 sq.mm conductor.

### 3.2 Capacitance

#### 3.2.1 Mutual Capacitance

The mutual capacitance of the pairs or adjacent cores shall not exceed a maximum of 250 pF/Meter at a consequence of 1KHz.

#### 3.2.2 Capacitance between any core or screen.

The capacitance between any core or screen shall not exceed a maximum of pF/Meter at a frequency of 1KHz.

3.3 L/R ratio of adjacent core shall not exceed 40 micro henry/ohm for cables with 0.5 sq. mm conductor.

3.4 The drain wire resistance including shield shall not exceed 30 ohms/km.

3.5 Electrostatic noise rejection ratio shall be over 76 dB.

## 4.0 Testing

4.1 Type test: Cable shall be flame retardant to IEC 332 Part III Cat. A. For qualification certificates from third party or client /consultants authorised representative for this test shall be furnished by vendor for cables similar to those being offered.

4.2 Routine tests: (To be carried out by vendor during various stages of manufacture. Purchaser shall review the related documentation).

4.2.1 Insulation and jackets: All tests as per IS-5831 except insulation resistance, voltage and spark test shall be as per BS-5308. Part-II(1986)

4.2.2 Armour test as per IS-3975.

4.2.3 Conductor resistance.

4.2.4 Cable capacitance and L/R ratio.

4.3 Acceptance test (The test shall be carried out in the presence of purchaser or his authorised representative.

4.3.1 Continuity test

4.3.2 Voltage test as per BS-5308 Part II (1986)

4.3.3 Conductor resistance and drain wire resistance.

4.3.4 Cable capacitance and L/R ratio test.

4.3.5 Tests for uniformity of galvanisation of armour as per IS 2633.

4.3.6 Oxygen and temp. index test as per ASTM D 2863-1974.

4.3.7 Dimensional check for overall diameter and under armour/over armour diameter.

4.3.8 Overall finishcheck. In case of any lump purchaser will have the right to cut outer sheath for lump portion and reject the cable.

4.3.9 Check of drum length and overall length tolerances.

Immediately after completion of electrical tests, the ends of the cable shall be sealed to prevent ingress of moisture with suitable PVC/Rubber caps.

## 5.0 Shipping

Cables shall be despatched in wooden drums, securely battened with take off end fully protected against damage. Each drum shall be marked with following:

- a. Manufacturer's name.
- b. Details of the cable.
- c. Length of the cable contained in the drum in metres.
- d. Gross wt.
- e. Direction of rotation of drum for unwinding by means of an arrow.
- f. Purchase order no.

## 6.0 Rejection

Vendor shall make his offer in detail with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summarily rejected.



SPECIFICATIONS  
FOR  
INSTRUMENTATION

SPECIFICATION NO.: MNGL/Steel/TS/40

## **C O N T E N T S**

- 1.0 GENERAL
- 2.0 DEFINITIONS
- 3.0 SCOPE OF WORK
- 4.0 DESCRIPTION OF WORK
- 5.0 DRAWINGS AND DOCUMENTS TO BE PROVIDED BY OWNER
- 6.0 DRAWINGS AND DOCUMENTS TO BE PROVIDED BY CONTRACTOR
- 7.0 SCRAP AND EXCESS MATERIAL
- 8.0 SPECIAL INSTRUCTIONS TO CONTRACTOR

## 1.0 GENERAL

### 1.1 INTRODUCTION

1.1.1 This part of the technical specifications covers in general, definitions, standards, scope of works, specifications of work, documentation, scope of supply of materials and scrap and excess materials and different requirements to be adhered to during the course of execution of instrumentation works.

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

## 2.0 DEFINITIONS

### 2.1 Manifolds

2.1.1 For close coupled instruments "Manifold" shall mean complete piping of instruments from first block valve upto the instruments, if the distance of the Instrument is within 2 feet (0.6m), from the Instrument tapping. If the distance of instrument is more than 2 feet (0.6m) from primary tapping such as orifice, then the installation is to be considered under remote installation.

2.1.2 For remote mounted instrument, "Manifold" shall mean the assembly of nipples, valves and fittings around the instrument to form a block and bleed or by pass manifold or drain manifold as the case may be. These shall be generally according to the hook up drawings enclosed with tender. Wherever the instruments are with 3--way-valve manifold, this definition shall not be applicable as 3-way manifold forms part of instrument.

### 2.2 First block valve

First block valve shall mean the valve/valves that are mounted directly on equipment, columns, pipe, standpipe etc. and shall be operated to isolate the instrument and connected instrument piping from the above items.

### 2.3 Supports

Supports shall mean the MS angles, flats, channels that are generally provided to support the main cable ways, cable ducts, junction boxes, angle trays, perforated trays, instrument piping, signal tubing, instrument air supply lines etc., at specified intervals from the structures, concrete columns etc. to keep all items firmly secured against vibration, warping, bending etc.

### 2.4 Scrap

#### 2.4.1 Salvageable scraps

Salvage scrap shall mean lengths of tubes, pipes, multicables, other cables etc. that can be used one time or other at later date and normally they are recovered from the cut-pieces of tubes, pipes, multicables, cables, etc.

#### 2.4.2 Non Salvageable Scrap

Non salvagable scrap shall mean the lengths of tubes, pipes, multicables, cables, etc. that cannot be used at all one time or other.

## 2.5 Standards

The instrumentation erection and calibration works shall be carried out generally in accordance with various international and Indian standards in instrumentation listed below but not limited to the following:

2.5.1 API-RP-550 Manual on Practices for instrumentation.

2.5.2 ISA standards and Practices for instrumentation

2.5.3 Instrumentation hook-up standards enclosed.

2.5.4 Instrumentation supports standard enclosed.

2.5.5 Manufacturer's standards and Practices.

## 3.0 SCOPE OF WORK

3.1.0 The Scope of work shall consist of supply of instrument items (as per schedule of quantities/rates and SCC), instruments, their erection, testing, calibration and commissioning and making it ready for commercial operation. The scope covers various jobs listed under the schedule of quantities/rates. However to ensure proper execution and completeness of instrument-work any or all of the following shall also form the part of the scope and shall be covered in the quoted rates.

3.1.1 Fabrication of pipe nipples, including threading whenever required.

3.1.2 Fabrication of seal pot/syphon/drain pot as per standards. Filling of seal pots with filling liquids as per instructions from Engineer-in-charge.

3.1.3 Back/seal welding of screwed fittings as required by standards.

3.1.4 Laying of cable underground including excavation, sand filling, brick laying and back filling.

3.1.5 Connection of purging devices for instruments to the systems provide as per drawings.

3.1.6 Civil works including the casting of foundation as per requirements for instruments supports where paved surface do not exist.

3.1.7 Minor civil works like chipping of pavement and grouting on the pavements the instrument panels/supports/stanchions, and chipping and refilling of the pavement for conduits.

3.1.8 Sealing of cables/tube entries into the control room after laying and testing of all tubes, cables etc.

3.1.9 Degreasing of handwheels of control valves, stud bolts, nuts of side and bottom flange of control valves, orifice plates, other primary elements flanges, oxygen service impulse lines, instruments as per manufacturers instructions and other items as required by Engineer- in-charge.

3.1.10 Rotation of control valve bonnet wherever required.

3.1.11 Reversing the action of control valves either a) replacement of springs, accessories or in positioner wherever required.

3.1.12 Minor modification/repairs required to be done on the instruments namely, changing the dial, glasses for pressure gauges, temperature gauges and other instruments, replacement of rotameter tubes, level gauge glasses, replacement of damaged signal tubes, threads, couplings etc.

3.1.13 Painting of all structural supports for trays, pipes, junction boxes, instruments, etc, as per painting specification.

3.1.14 Identification with approved colour of paint the instruments/impulse, lines manifold connected with alarm/trap circuit. Also, punching of tag numbers on items shall be carried out as per instructions of Engineer-in-charge.

3.1.15 Coordination with Mechanical and other sub-contractors for proper installation of line/vessels/equipment mounted instruments like control valves, orifice assemblies, turbine meters, PD meters, level transmitters, level gauges, level switches etc. which involves removal of instruments, disconnection of tubes/cables, reconnection for alignment proper installation etc.

3.1.16 Drilling holes on all panels, shut down cabinets, power supply cabinets, control panels pneumatic enclosures etc., for cables/ multitubes/ glands/ groomats.

3.1.17 Grounding of shield of all shielded cables to respective instruments earth bus provided in the control room/local panel/thermocouple head.

3.1.18 Laying and termination at both ends between instrument earth buses provided in control room/local panel to instrument earth pit provided by others.

3.1.19 Supply of all types of consumables required for the execution of the job.

3.1.20 Submission of monthly material appropriation statements for cables, piping materials fittings, including the quantity issued and expended in standard proforma.

3.1.21 Completion of owners drawings/documents, as per the execution of work at site.

3.1.22 Preparation and submission of as built drawings as required.

3.1.23 Start-up and commissioning.

3.1.24 Submission of final material appropriation statements for all the materials issued by the owner.

3.1.25 Any other work not mentioned above, but required for the proper execution of the works.

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

3.1.27 Sealing of safety valves/switches with standard lead seals after final setting in the presence of Engineer- in-charge.

#### 4.0 DESCRIPTION OF WORK

##### 4.1.0 INSTRUMENT PIPING

4.1.1 All primary piping shall be installed in the best workman like manner and shall follow installation standards in each case. Where there is no installation standard, the instruction of the Engineer-in- charge shall be followed.

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

4.1.3 Unless otherwise specified in the drawings pipelines shall have a slope of 8% on the horizontal runs.

4.1.4 All welding shall be carried out as per welding procedures and codes with electrodes approved by Engineer-in-charge. Only qualified welders approved by Engineer-in-charge shall carry out welding. Charges for non-destructive testing like radiography, Dye penetration tests, post heat treatment tests and stress relieving shall be carried out on the basis of actual man hours spent towards these works and manhour charges with cost of all materials, test equipments, etc. shall be used. However, any materials like electrode, equipments etc. shall be used. However, any materials like electrode, equipments, testing charges for various tests, etc., required for the initial qualification of the welder/welders shall be or the scope of the contractor.

4.1.5 Pipe shall be bent using pipe benders only and any bending will be totally rejected. Pipes shall be cut using pipe cutting device. Hot cutting will not be allowed.

4.1.6 Piping for steam tracing shall be installed according to the standards and avoiding condensate pockets.

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

4.1.8 All primary piping shall be properly supported at regular intervals of 1.0 meters. Angle supports shall be fabricated from 40mmx40mmx5mm MS angles as minimum.

##### 4.2.0 PVC COVERED/BARE TUBE (COPPER/SS/ALUMINIUM)

4.2.1 Single copper/SS/Aluminum tubes shall be laid as per standards on trays. Fabricated out of 2.5 mm thick perforated steel plate. The width of the trays shall be selected as per the number of tubes laid. Tubes shall be clamped to the trays at every 300 mm using clamps made of galvanized steel/Aluminum strips. The practice of flattening tubes for clamping purposes shall be avoided. In case of PVC covered tubes, any exposed portion at ends and connection shall be neatly taped to appropriate thickness.

4.2.2 Trays shall be properly supported either from any rigid steel structure or concrete member as detailed under trays and supports below.

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

#### 4.3.0 INSTALLATION OF MULTITUBES AND MULTICORE CABLES

4.3.1 Multiple cables/multitubes shall always be installed on ducts/trays and properly clamped. At every vertical drop to junction boxes, they shall be clamped at more frequency intervals (Maximum of 300mm). They shall be connected inside junction boxes strictly according to the number system as mentioned in cable schedule. At bends minimum radius shall be maintained as per manufacturer's standard. The angle tray supports shall be fabricated from 40mmx40mmx5mm angles minimum size.

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

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

4.3.4 In the field, the cables shall be laid in perforated trays as per layout drawings. Cables shall also be buried or laid in concrete trenches. Inside control room, these shall be laid in concrete trenches or under false floorings.

4.3.5 In the field, the cables shall be laid in perforated trays as per layout drawings. Cables shall also be buried or laid in concrete trenches. Inside control room, these shall be laid in concrete trenches or under false floorings.

#### 4.4.0 INSTALLATION OF INSTRUMENTS

4.4.1 All instruments shall be generally installed on supports as per installation standards in each case, and shall be accessible.

4.4.2 Receiver gauges shall be mounted on instrument support itself as per tubing hook up standards.

4.4.3 Filter regulators shall be mounted on the instruments support itself below the instruments or on the control yoke.

#### 4.5.0 INSTRUMENT AIR SUPPLY

4.5.1 The main instrument air header in each area is laid by other contractor. Air supply from the main air header take off valve to individual instrument shall be through either galvanized steel pipe or 1/4" OD PVC covered copper tube or SS tubes.

4.5.2 Individual takes off valves shall always be located on top of the main air header. Unions shall be provided at convenient locations. There shall be one isolation valve at each instrument end. The galvanised pipe shall be supported at a minimum interval of 1000 mm with 40mmx40mmx5mm MS angles. Final connection to be instrument shall be copper/SS tubing as per tubing hookup standards.

4.5.3 Teflon tapes shall be used on all threaded joints.

#### 4.6.0 INSTRUMENT STEAM TRACING

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

4.6.2 Electrical tracing shall be done by others.

#### 4.7.0 PERFORATED TRAYS AND SUPPORTS

4.7.1 The perforated trays/angle trays shall be properly supported at a regular interval of max. 1000mm from insert plates or steel structures. Wherever insert plates are not available supports on concrete structures on ceiling shall be fixed with a minimum 10mm diameter expansion bolts. Angle supports for perforated trays/angle trays shall be fabricated from 40mmx40mmx5mm M.S. angles minimum size.

4.7.2 All supports shall be cut with hacksaw and any work executed by gas cutting for cutting and drilling holes will be totally rejected. Free ends of angle support shall not have sharp edges and shall be properly rounded off.

4.7.3 Perforated trays/angle trays shall be used for branching cables and tubes from main trays. Perforated trays shall be used for branching cables and tubes from main trays. Perforated trays shall be fabricated out of 2.5 mm perforated steel sheet. Width of trays shall be selected according to number of tubes and cables. Trays shall be laid generally as per site conditions with the approval of Engineer-in-charge.

#### 4.8.0 LAYING OF CABLES

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

4.8.2 All cables routes shall be carefully measured and cables cut to the required lengths, leaving sufficient amount for the final connection of the cable to the terminals on either end. The various



cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. Sufficient extra length of cable shall be kept at the terminal on points.

4.8.3 Cables shall have complete uncut lengths from one terminal to the other.

4.8.4 All cables shall be identified close to their termination point by cables number as per cable schedules/junction boxes schedules. PVC ferrule/tag plate shall be used and these identification tags shall be securely fastened to the cables.

4.8.5 All cores of electrical cables shall be identified by their wire numbers by means of the PVC ferrules. Wire numbers shall be as per schedules. All temporary ends of cables shall be protected against dirt and moisture. For this purpose, ends of all PVC insulation cables shall be taped with an approved PVC or rubber insulating tape. Use of function type or other fabric type is not permitted.

4.8.6 The cable shall be bent in a large radius. Cables installed above ground shall be run exposed on walls, ceilings, structures and shall run parallel or at right angles with beams, walls or columns.

4.8.7 Cables shall be rigidly supported on structural steel and masonry individually or in groups as required using galvanised clips, multiple cable supports or cable trays. If drilling of steel must be resorted to, approval must be obtained and steel must be drilled where the minimum of weakening of the structure will result. Cable shall be supported at every 500 mm.

4.8.8 All special cables and power supply cables will be laid directly to the field instrument without any junction boxes, unless otherwise specified.

4.8.9 While laying cable in trenches or burying them care shall be taken to ensure that low signal cables like alarm, analyser cables, special cables, special cables from turbine meters, compensating cable etc. are separated from other power supply cables.

4.8.10 Each underground cable (either in concrete trenches or burried) shall be provided with identifying tag of lead securely fastened every 30m of its underground length with atleast one tag at each end before the cable leaves/enters the ground.

4.8.11 Directly buried cables shall be laid underground in excavated cable trench wherever specified in layout drawings. Trenches shall have sufficient depth and width to accommodate all cables correctly spaced. Before cables are placed the trench bottom shall be filled with 100 mm layer of sand and leveled. Each layer of cables shall be covered with 150 mm of sand on top and sand shall be lightly pressed. A protective covering of 75 mm thick second-class red bricks shall be placed flat on the final layer of sand and cable. The remaining portion of the trench shall be then back filled with soil compacted and leveled. On complete of every group of cable laying and before sand filling, every cable shall be given insulation test in the presence of Engineer-in-charge. Any cable proved to be defective should be replaced before the next groups of cables are laid. Cable route markers indicating number of cables, depth and direction will be placed enroute, on crossovers/turnings, etc. to mark the cable route.

4.8.12 At each road crossings and other places, where cables enter pipe sleeves, adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends after pack filling.

4.8.13 At the entry into concrete blocks at road crossings cable loops shall be provided at either end to prevent any damage to cables. Each cable shall have one tag at each end before the cable enters/leaves conduct pipes

4.8.14 After laying of all the cables and multitubings, cables, the cable entry to control room shall be suitably filled and sealed so as to achieve a positive seal against the entry of gas/water.

4.8.15 All cables and tubes shall be laid in accordance with the layout drawings with sand and precast concrete slabs shall be placed on the trench.

4.8.16 On completion of cable laying in concrete trenches, the trenches shall be filled with sand and precast.

#### 4.9.0 EARTHING

4.9.1 Earthing of junction boxes, local cabinets as per the documents and instruction from Engineer-in-charge.

#### 4.10.0 PAINTING

4.10.1 This part of the specification is applicable to cable ducts, MS cable ways, angle trays, instrument supports, perforated trays, all structural supports for the above items, etc.

4.10.2 The surface to be painted shall be thoroughly cleaned with wire brush, sand paper to remove all scales. After cleaning, the surface is painted with one coat of red oxide zinc chromate primer conforming to IS- 207 and allowed to dry completely.

4.10.3 Primer coated surface is painted with one coat of paint to the colour nearest to the final paint and allowed to dry. The colour number shall be specified from IS-5.

4.10.4 Final second coating shall be with the paint of desired colours and shall be selected from IS-5.

4.10.5 It shall be noted that final second coating of external surfaces not covered by cables, copper tubes etc. shall be applied just before handling over the plant or commissioning of the plant whichever is earlier.

4.10.6 The name of manufacturer, colour and quality of all types of primer paint shall be subject to approval of Engineer-in-charge.

#### 4.11.0 TESTING

4.11.1 Electrical cables for signal power supply alarms, and compensating cables for thermocouples; resistance thermometer cables shall be checked for megger values and continuity before proper termination and ferruling.

4.11.2 Testing shall be carried out after the installation of instrument with primary piping complete in all respects and approved by Engineer-in-charge.

4.11.3 Primary piping shall be tested hydraulically pneumatically to 1.5 times the operating pressure after isolating the instruments. Flushing of piping shall be carried out as per instructions of Engineer-in-charge. Lines shall be blown after hydro-testing. All external displacement /float type level instrument level gauges shall also be tested as per instructions of Engineer- in-charge.

4.11.4 Tubes and air line shall be tested with compressed air to 7 kg/cm<sup>2</sup> upto the filter regulator. The down steam side of the filter regulator shall be tested for 1.5kg/cm<sup>2</sup>. The lines shall be blown with the instrument air upto the regulator for 15 minutes to remove any traces of oil, dust & moisture. All lines shall be checked with soap solution and bubbler unit for possible leak at joints. After pressurizing, source shall be cut off and rate of fall in pressure shall be less than 1 p.s.i. for each 100 ft. of copper tubing for a test period of 2 minutes as per I.S.A.R.P.7-1 "Pneumatic control circuit pressure test".

4.11.5 All test results shall be recorded in the approved format.

#### 4.12.0 CALIBRATION

4.12.1 All instruments shall be calibrated strictly as per manufacturer's instructions prior to installation. The scope of calibration includes all field and control rooms of all types namely, pneumatic, electronic, electrical etc.

4.12.2 Contractor shall use his own oil free instruments, air compressor for calibration purposes.

4.12.3 The level switches (external cage type) shall be set by filling the cage with water to the desired alarm/trip level, while setting the switches, it shall be ensured that the micro switches do not reset for full rated travel of the float.

4.12.4 Control valves and positioners shall be checked for hysteresis and linearity and calibration for rated strokes. Prior to calibration, valves shall be cleaned externally. The stem is then lubricated if required, and stroked few times to extreme positions of plug to ensure that movement is free from friction. The valve shall then be calibrated for rated stroke and linearity also. Subsequently the valves shall be checked for hysteresis to the accuracy of 1% FS with positioners and 5% FS without positioners. Stroke speed has to be evaluated for all trip/shutdown valves.

4.12.5 All calibrations reading shall be recorded in the enclosed format and submitted to Engineer-in-Charge for approval. Where significant deviations from specifications are obtained, the matter shall be brought to the immediate notice of the Engineer-in- Charge for corrective actions.

4.12.6 Furnished hereunder is a list of recommended calibration and test equipments required as a minimum for calibration work. The contractor shall clearly state in his offers the complete list of calibration and test equipments along with the range, accuracy and quantity, which he proposes to use for this job. Contractor should also ensure that any equipment not listed below but required at the time of calibration shall be made available at his own cost.

4.12.7 All test equipments/kits shall be approved by NPL authorities.

4.12.7.1 Controller test stands

Mft. Standard

4.12.7.2 Indicator/recorder test stands	-do-
4.12.7.3 Squeeze bulb (Flow calibrator)	-
Range: 0-770, 10,000 mm wg.	
4.12.7.4 Dead weight testers (Budenberg or equivalent) - For ranges upto 350 kg/cm <sup>2</sup>	+/- 0.1%
4.12.7.5 Gauge comparator for pressure gauges Rating : upto 350 kg/cm <sup>2</sup>	-
4.12.7.6 Oil bath for temperature calibrations max. Temp 350°C.	Mfr's Std
4.12.8.7 Standard Mercury in glass thermometers Range : -50 to + 50°C. 0 to 100°C (NPL certified) 0-250°C, 0-350°C	+ <sub>-</sub> 0.25%
4.12.7.8 Standard gauges for Ranges upto 350kg/cm <sup>2</sup>	+ <sub>-</sub> 0.25%
4.12.7.9 U-tube differential manometers/inclined tube manometer Static pr. rating : 7 kg/cm <sup>2</sup>	+ <sub>-</sub> 1mm
4.12.7.10 Single leg manometers Scale: -1500 mm water and 1500 mm hg. Static pr. rating : 7 kg/cm <sup>2</sup> .	+ <sub>-</sub> 1mm
4.12.7.11 Decade resistance box	MFR' std.
4.12.7.12 Millimeters	+ <sub>-</sub> 0.05Mv
4.12.7.13 Potentiometer	-
(Cable of generating and measuring mV)	
4.12.7.14 Meggers 500V/1000V	-
4.12.7.15 Air hydro pump/hydraulic pump	-
4.12.7.16 Vacuum pump	-
4.12.7.17 Instrument air compressor with filters and Regulators and deoilers.	-
4.12.7.18 Current generator (instrument checker)	-
4-20mA dc(YEW make or equivalent)	
4.13.0 LOOP TEST	

4.13.1 Loop test shall be performed after calibration of all instruments and leak test of signal lines. Loop tests are conducted to check the functional performance of all elements comprising the loop, thereby ensuring proper connections and operations.

4.13.2 Before proceeding for loop tests the calibration results of individual elements shall be recorded on the enclosed proforma and shall get it approved by Engineer-in-Charge for correctness of installation, measurements and calibration results.

4.13.3 Loop testing for all control loops shall be generally by simulation of process conditions and shall fix points namely 0%, 25%, 50%, 75% and 100% of full scale inputs. Detailed procedure shall be submitted to Engineer-in-charge for approval before proceeding with the loop testing.

4.13.4 In case of shutdown system field/receiver pressure switches are simulated for abnormality by disconnecting the wires at terminal and function of all associated systems are checked.

4.13.5 Performance of individual loops may be accepted for an overall accuracy of  $\pm 1.5\%$  where deviations exist, contractor shall recalibrate the instruments, which form part of loop testing wherever required, at no extra cost.

4.13.6 After the loop test is complete, the contractor shall connect back any terminations and connections removed for loop test.

4.13.7 A loop shall be considered as handed over only after measurements in that particular loop are complete and certified by Engineer-in-Charge, in addition to loop sheets being duly filled in all respects and approved and accepted by Engineer-in-Charge and client.

4.13.8 In case of loops in which certain instruments of the loops are calibrated by other agency, loop testing shall be performed in coordination with the agency involved. Any defect in the calibration of the instrument in contractor's scope is observed, it shall be rectified to the satisfaction of the Engineer-in-Charge. However, defect in calibration of the instruments in the scope of other agency, same shall be rectified by the agency involved. After the calibration has been rechecked by the other agency/agencies the loop checking would be performed to the satisfaction of Engineer-in-Charge, and this part covers under the scope of the contract.

4.13.9 Final certified loop sheets shall be submitted in 4 copies and one transparency.

#### 5.0.0 DRAWINGS AND DOCUMENTS TO BE SUPPLIED FOR EXECUTION BY OWNER/ENGINEER IN CHARGE

5.1.1 Piping and Instrumentation diagrams.

5.1.2 General layout plan for all units, showing all information like position of field instruments junction boxes indicative routes of cables, main ducts/cable trays.

5.1.3 Cable schedules for alarm, signal, shutdown, power supply and pneumatic cables, earthing guide lines.

5.1.4 Termination details/drawings for connecting at control room end.

5.1.5 Individual Instrument specifications

5.1.6 Bill of materials

5.1.7 Installation standards/ Hook-up

5.1.8 Manufacturers hand book with instructions for installation and calibration wherever necessary for reference.

## 6.0 DRAWINGS AND DOCUMENTS TO BE PROVIDED BY CONTRACTOR

6.1.1 The drawings for materials that are included on their supply and erection scope namely local control, panel, junction boxes, local cabinets.

6.1.2 The detailed engineering drawing wherever such drawing is assigned.

6.1.3 Two sets of layout drawings, standards bill of materials cable schedules etc., duly incorporating the changes/modification carried out during the course of execution of works.

6.1.4 Final material appropriation statement for all free issue materials indicating shortages of any in the proforma duly approved by Engineer-in-Charge.

## 7.1.0 SCRAP AND EXCESS MATERIAL

7.1.1 Every month, the contractor shall submit an account for all the materials issued by the Owner in the standard proforma prescribed for this purpose by the Engineer- in-Charge.

7.1.2 On completion of the work, the contractor shall submit 'Material appropriation' statements for all materials issued by the Owner in the proforma prescribed by the Engineer-in-Charge.

7.1.3 The following scrap allowances are permissible.

Length below 0.5 mm	Non-salvageable	Unaccountable
Steel pipes, SS Tubes single pair/ Twocore three Core cables.	2%	0.5%
length below 20 m	Non-salvageable	Unaccountable
Multitube, Multicables	2%	0.5%

**8.0 SPECIAL INSTRUCTIONS TO CONTRACTOR :**

8.1.4 All excess materials and scrap shall be returned after duly accounting for, to the storage points designated by the Owner. Where materials are to be weighed before return, the contractor shall be responsible for making the necessary section obtained during the course of construction for fabricating temporary supports or other items, without prior permission of the Engineer- in-Charge.

8.1.5 If the contractor fails to return the surplus material as aforesaid, the owner will charge the contractor for such unreturned materials at panel rates, which will be deducted from whatever amount is due to the contractor. In case any material issued by the Owner deteriorates during storage by the contractor, new materials will be issued to him at penal rates, but the delay in procuring such materials will be at the contractor's account only.

SPECIFICATION  
FOR  
VENTS, DRAINS AND WELLS

SPECIFICATION NO.: MNGL/Steel/TS/41



## C O N T E N T S

SL. NO.	DESCRIPTION OF DRAWING	DRAWING NO.
1.	Vent & Drain for Line 2" & above	MNGL/PIng./Steel/31
2.	Wells Installation 1½ Dia Taps	MNGL/PIng./Steel/32 (Sheet 1 of 2)
3.	Wells Installation 1½ Dia Taps	MNGL/PIng./Steel/32 (Sheet 2 of 2)
4.	Vent & Drain for lines 1½" & below	MNGL/PIng./Steel/33
5.	Pressure Tapping	MNGL/PIng./Steel/34

STANDARD SPECIFICATION  
FOR  
BLASTING

SPECIFICATION NO.: MNGL/Steel/TS/42

## **C O N T E N T S**

<b>Sl.No.</b>	<b>Description</b>
1.0	SCOPE
2.0	REFERENCE DOCUMENTS
3.0	GENERAL
4.0	MATERIALS
5.0	PERSONNEL
6.0	STORAGE OF EXPLOSIVES
7.0	PREPARATION OF EXPLOSIVES
8.0	PREPARATION OF PRIMERS
9.0	CHARGING OF HOLES
10.0	ELECTRICAL FIRING
11.0	VIBRATION RECORDING
12.0	MISFIRES
13.0	DISPOSAL OF DETERIORATED EXPLOSIVES

## 1.0 SCOPE

☐ This specification covers the minimum requirements for materials, personnel, transportation, storage and use of explosives for grading of Right of Use (RoU) and excavation of trenches for onshore pipeline installation in rocky terrain.

☐ This specification does not cover the construction or operation of permanent magazines.

## 2.0 REFERENCE DOCUMENTS

Reference has also been made to the latest edition of the following standards, codes and specifications. The edition enforce at the time of floating the enquiry shall be termed as latest edition.

a) BS-5607 : Safe use of Explosives in the Construction Industry

b) IS4081 : Safety Code for Blasting and Related Drilling Operations

c) NFPA-495 : Manufacture, Transportation, Storage & Usage of Explosive Materials.

d) Safety Rules of Chief Controller of Explosives, Nagpur

## 3.0 GENERAL

☐ The Contractor shall acquaint himself and comply with all the applicable local laws and regulations concerning storing, handling and the use of explosives. All such laws, regulations and rules etc., as enforced from time to time shall be binding upon the Contractor. National / Local Laws and Regulations shall take precedence over this specification in the event of conflict. All conflicts shall be brought to the notice of the Company.

☐ The requirements stated herein however in no way relieve the Contractor of his responsibility of carrying out safe blasting operations. The Contractor shall be solely responsible for damages and claims thereof.

□ The use of explosives requires an approval from the Chief Controller of Explosives and/or his authorized Inspector. It shall be the responsibility of the Contractor to obtain all such permits and approvals and comply all requirements regarding the safe storage, handling and use of explosives. All expenses incurred in this regard shall be to Contractor's account.

□ Contractor shall inform the Company in writing at least four (4) weeks prior to planned use of explosives.

□ Contractor shall notify the Company prior to any blasting in the proximity of overhead power lines, roads, communication lines, pipelines, utility services or other services and structures above and below ground. Before, starting blasting operations, local authorities and owners of utilities shall be consulted to check on the presence of services, which could be damaged and their approval obtained to undertake blasting operations. The distances to nearest structures (houses, offices, factories) or service shall also be taken into consideration when, planning blasts so that ground vibration and air-over pressure is kept within acceptable levels as given in section 11.0 of this specification

□ Contractor shall prepare an Explosives Handling and Usage Procedure for the information of the Company, which shall include the following:

- Detailed procedure and calculations.
- Nature of blasting operations, including hole diameter, depth and presence of cavities
- Rock characteristics
- Type of explosives
- Temperature likely to be encountered in use

□ Unless specified otherwise, blasting shall not be allowed within 20 m of any above ground or underground structure, pipelines or other facilities. However, in case it is necessary to carry out blasting operation within 20 m from any under ground or above ground structures, pipelines or other facilities, the blasting may be allowed, at discretion of Company, subjected to the following :

- a) Minimum clear distance from the facility is 5 m.
- b) Contractor demonstrates the blasting technique proposed by him doesn't result in any damage to the existing facility. (Contractor shall carry out mock demonstration as per the direction of Company Representative for this purpose).
- c) Contractor fulfills the conditions laid out by the Owner of the existing facilities.
- d) Contractor fulfills the requirements laid-out by National / Local Laws and Regulations and other statutory/regulatory Authorities.

In case of presence of overhead power lines/cables, specific approvals shall be obtained by Contractor from the concerned Authorities having jurisdiction over it.

#### **4.0 MATERIALS**

- ☐ All materials such as explosives, detonators; fuses, tamping materials etc. that are proposed to be used by the Contractor in blasting operations, shall be as approved for use in the Country.
- ☐ All electric detonators used in the blast shall be of the same electrical sensitivity and be produced / procured from the same manufacturer.
- ☐ The detonators used shall be capable of giving effective blasting of the explosives. Damaged explosive materials shall be destroyed by a responsible person as per manufacturer's instructions or returned to the manufacturer.
- ☐ No explosive material shall be abandoned.
- ☐ All blasting materials and testing equipment shall be regularly tested for correct performance. The intervals between test shall be decided after consideration of the local factors, but tests shall always be carried out if the blasting materials and / or test equipment have been subjected to abnormal conditions, or following any misfires. Guidelines / recommendations of the manufacturer shall be adhered to.
- ☐ All packaging and other waste materials gathered together during blasting operation shall be burnt after the blast has been fired. The burning site shall be chosen at a safe distance with due respect to prevailing wind strength and direction, at least 100 meters

from explosives stores and other premises. A minimum of two fire extinguishers shall be on hand during burning activities.

## **5.0 PERSONNEL**

- ☐ Excavation by blasting will be permitted only under personal supervision of competent and licensed persons and by trained workmen.
- ☐ The storage of explosives shall be in the charge of a person approved by the Company. Company may, if necessary, ask police inquiries being made as to his reliability, antecedents etc.

## **6.0 STORAGE OF EXPLOSIVES**

- ☐ The Contractor shall build a magazine for storing the explosives. The site of the magazine, its capacity and design shall be subject to approval by the Company and the Inspector of Explosives before the fabrication is taken up. As a rule the explosives should be stored in a clean, dry, well ventilated, bullet proof and fire proof building, at an isolated site. Adequate security shall be provided to ensure no unauthorized entry into the magazine. A notice shall be hung next to magazine entrance prohibiting entry of unauthorized persons.
- ☐ Contractor shall comply with National / Local Regulations and specifications for truck mounted mobile explosives store. Mobile stores shall only carry ONE DAY's Explosives requirements and shall be parked overnight inside the compound at the authorized magazine
- ☐ All safety precautions and necessary equipment for maintenance, operation of mobile stores, as required by local authorities or regulatory bodies shall also be installed / provided on the Mobile Store.
- ☐ A careful and day-to-day account of all explosives shall be kept by the Contractor in a register and in an approved manner. The register shall be produced by the Contractor, for the inspection of the Company / Inspector of Explosives when so required by the later.

Any loss, damage or theft shall be reported immediately to the necessary local authorities and to the Company.

☐ The magazine shall on no account be opened during or on the approach of a thunderstorm and no person shall remain in the vicinity of the magazine during such period.

☐ Magazine-shoes without nails shall, at all times, be kept in the magazine, and a wood-tub or cement trough, filled with water shall be fixed near the door of the magazine.

☐ Persons entering the magazine must put on the magazine-shoes and shall comply to following:

I) not to put their feet on the clean floor unless they have magazine-shoes on.

II) not to allow the magazine-shoes to touch the ground outside the clean floor.

III) not to allow any dirt or grit to fall on the clean floor.

☐ No matches or inflammable material shall be allowed in the magazine. Light shall be obtained from an electric storage battery lamp.

☐ No person having articles of steel or iron on him shall be allowed to enter the magazine. No tools or implements other than those of copper, brass, gun metal or wood shall be allowed inside the magazine. Oily cotton. rags, waste and articles liable to spontaneous ignition, shall not be allowed inside the magazine.

☐ Boxes of explosives shall not be thrown down or dragged along the floor and shall stacked on wooden trestles. Open boxes of explosives shall never be exposed to the direct rays of the sun. Empty boxes or loose packing materials shall not be kept inside the magazine.

☐ The magazine shall have a lightning conductor, which shall be got tested periodically, by an officer authorized by the Company, the testing fee shall be to the Contractor's account.

☐ The magazine shall be inspected periodically by an officer representing the Company, who will see that all the rules are strictly complied with. He will notify all omissions etc. to the Contractor, who shall rectify the defects within a period of 3 days from the date of



receipt of the notice, failing which the Company may take whatever actions it considers suitable.

## 7.0 PREPARATION OF EXPLOSIVES

☐ Contractor shall submit the following procedures for INFORMATION of the Company as a minimum.

- Loading of explosives
- Drilling of new holes and extending existing holes
- Handling of explosives at site
- Tamping explosives into holes,
- Machines, tools and cables required
- Initiation of blasting
- Safety of personnel
- Vibration control
- Blast pattern and shot size establishment
- Misfires
- Emergency procedures

☐ Trial blasts in conjunction with vibration recording shall be carried out for each rock and trench type, in order to assess rock breakability and vibration levels. These trial blasts shall be carried out prior to actual trench blasting of the pipeline route. Contractor shall conduct trial digs as directed by Company in order to check suitability of the blasting pattern and to measure vibration levels to ensure vibration levels are below the allowable maximum.

☐ "Weight per Distance Tables" shall be drawn up from these trials.

☐ The detonators shall never be forced into the primer cartridge. It shall be inserted in a hole

made by a wooden, copper, brass or aluminum pricker. The detonator shall be firmly embedded in the primer so that it is not pulled out of place during loading.

- ☐ Detonators shall be activated electrically. In proximity of electric over-head power lines, Contractor may use non-electric system with the approval of Company. Fly rock shall be minimized by the use of approved blast mats and by careful selection of shot size and drill hole configuration.
- ☐ Use of explosives is prohibited in areas exposed to flammable gasses or dust.
- ☐ Explosive and detonators shall be carried in separate boxes, tightly closed, and transported separately. For the conveyance of primers special containers shall be used.
- ☐ Explosives shall be stored and used chronologically to ensure that the ones received earlier are being used first.
- ☐ A make-up house shall be provided at each working place in which cartridges shall be made up by experienced men as required. The make-up house shall be separated from other buildings. Only electric storage battery lamps shall be used in this house.
- ☐ No smoking shall be allowed in the make-up house.

## **8.0 PREPARATION OF PRIMERS**

The primers shall not be prepared near open flames or fires. The work of preparation of primers shall always be entrusted to the qualified and approved personnel. Primers shall be used as soon as possible after they are ready.

## **9.0 CHARGING OF HOLES**

- ☐ The work of charging shall not commence before all the drilling work at the site is completed and the Company has satisfied itself to that effect by actual inspection.
- ☐ The lead wires shall be kept away from conductors or sources of stray current. While charging, open lamps/flames shall be kept away.
- ☐ Only wooden tamping rods without any kind of metal on them shall be used.
- ☐ Only one cartridge shall be inserted at a time and gently inserted to the required depth with the tamping rod. The sand, clay or other tamping material used for filling the hole completely shall not be tamped too hard.

- ☐ Blasting shall not take place after sunset or before sunrise unless specific approval is first obtained by Contractor from local authorities and the Company.
- ☐ The site of blasting operations shall be prominently demarcated by red danger flags. The order of fire shall be given only by the Supervisor-In-Charge of the work and this order shall be given only after giving the warning signal three times, so as to enable all the labor, watchmen etc. to reach safe shelter and after having ascertained that nobody is within the danger zone.
- ☐ A buegle with a distinctive note shall be used to give the warning signals. The buegle shall not be used for any other purpose. All the labor shall be made acquainted with the sound of the buegle and shall be strictly warned to leave their work immediately at the first warning signal and to take safe shelters, and not to leave the shelters until the all clear signals have been given.
- ☐ All the roads and footpaths leading to the blasting area shall be watched. All the escape routes shall have been clearly marked.

## **10.0 ELECTRICAL FIRING**

- ☐ Only the Supervisor-In-Charge shall keep the key of the firing apparatus and shall keep it always with himself.
- ☐ Special apparatus shall be used as source of current for the firing operations. Power lines shall not be tapped for the purpose.
- ☐ The firing cable shall have a proper insulating cover so as to avoid short circuiting due to contact with water, metallic parts or rock.
- ☐ The use of earth as a return line shall not be permitted.
- ☐ The firing cable shall be connected to the source of current only after ascertaining that nobody is in the area of blasting.
- ☐ Before firing, the circuit shall be checked by a suitable apparatus.
- ☐ After firing, whether with or without an actual blast, the contact between the firing cable and the source of current shall be cut off before any person is allowed to leave the shelter.

☐ During storms, charging with electrical detonators shall be suspended. The charges already placed into the holes shall be blasted as quickly as possible after taking all the safety precautions and giving necessary warning signals. If this is not possible, the site shall be abandoned till the storm has passed.

## **11.0 VIBRATION RECORDING**

☐ Contractor shall use Company approved vibration recording system capable of measurement in three axes (tri-axial). The device shall have an accuracy of 0.0025 mm and a resonance of 2 Hz.

- The device shall measure both frequency and amplitude of vibration.

☐ All the measurement devices shall be calibrated by an APPROVED certification body.

☐ Particle velocity shall not exceed the following:

- Areas beyond 500 m of proposed pipeline centerline

- 50 mm/sec at a surface distance of 15 m from trench centerline.

- Areas with existing buried or above ground facilities within 500 m of proposed pipeline centreline.

- 20 mm/sec at a surface distance from the trench centre line towards the nearest existing facilities.

☐ The particle velocity levels are provided for the guidance only, Contractor shall be responsible and liable for any injury to life or damage to property/facilities.

☐ Air-over pressure/sound levels shall be limited to 100 db in inhabited areas.

## **12.0 MISFIRES**

☐ If it is suspected that part of the blast has failed to fire, or is delayed, sufficient time shall be allowed to lapse before entering the danger zone. When fuse and blasting caps are used, a safe time should be allowed and then the Supervisor alone shall leave the shelter to see the misfire.

☐ Drilling near the hole that has misfired shall not be permitted until one of the two following operations have been carried out by the Supervisor:

I) The Supervisor should very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper or jet of water or compressed air (using a pipe of soft material) and withdraw the fuse with the primer and detonator attached. A fresh primer and detonator with fuse shall then be placed in this hole and fired.

II) The Supervisor shall get one foot of the tamping cleaned off and indicate the direction by placing a stick in the hole. Another hole may then be drilled at least 9" away and parallel to it, this hole should then be charged and fired. The balance of the cartridges and detonators found in the muck shall be removed.

☐ The Supervisor shall at once report to the office all cases of misfire, the cause of the misfire and the steps taken in connection therewith.

☐ If a misfire has been found to be due to defective detonator, or explosive, the whole quantity from the box from which the defective articles were taken must be returned to the manufacturer for inspection to ascertain whether the whole box contains defective materials.

☐ Re-drilling the holes that have misfired either wholly or partly shall not be permitted.

### **13.0 DISPOSAL OF DETERIORATED EXPLOSIVES**

All deteriorated explosives shall be disposed off in an approved manner. The Contractor shall prepare said disposal plan, which shall be approved by Company / Local Authorities / Controller of explosives. The quantity of the deteriorated explosives to be disposed off shall be intimated to Company prior to its disposal. All the records of such disposal shall be maintained by Contractor.