PART-III
SECTION-IV

TECHNICAL SPECIFIATION

C O N T E N T S

VOLUME-II OF III

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PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

WORKING SPECIFICATION
FOR
CONSTRUCTION OF
MAINS AND DISTRIBUTION NETWORK
FOR NATURAL GAS IN CITY CONDITION

INDEX

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

SPECIFICATION
FOR
PRELIMINARY ACTIVITIES

SPECIFICATION NO.: MEC/S/05/62/101

CONTENTS

1.0 **OBJECT**

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

2.0 **EQUIPMENT**

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

3.0 **DRAWINGS**

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

3.1. **Survey**

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

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

3.2 **Construction Drawings**

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

a) The underground obstacles

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

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

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

b) The proposed pipelines routes

Public land

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

- basic grid

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

- distribution network

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

Private land

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

c) Pipeline equipment locations

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

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

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

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

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

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

4.0 PERMITS

4.1 Installation Permits

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

- stores ad workshops
- material stock yards
- backfill material yards

- earth spoil dumps
- etc.

4.2 **Circulation Permit**

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

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

4.3 **Digging Permit**

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

4.4 **Trial-Hole Permit**

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

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

5.0 STAKING OUT

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

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

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

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

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

SPECIFICATION
FOR
EXCAVATION OF THE TRENCH

SPECIFICATION NO.: MEC/S/05/62/102

CONTENTS

1.0 OBJECT

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

2.0 MATERIALS AND EQUIPMENT

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

3.0 ROUTE

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

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

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

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

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

4.0 SIZE OF THE TRENCH

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

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

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

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

5.0 CLEARING

5.1 Removal of Obstacles

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

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

5.2 Circulation

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

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

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

5.3 Modifications of Traffic

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

6.0 REMOVAL OF ROAD SURFACINGS

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

7.0 DIGGING OF THE TRENCH

The Contractor shall trench to the specified depth and width. In large and busy streets the maximum total length and duration of open trench shall be given in the special specifications or as decided by Engineer-in-charge.

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

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

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

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

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

8.0 SHEETING AND BRACING OR PROPPING

8.1 Trench

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

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

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

8.2 Existing Structures

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

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

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

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

9.0 DEWATERING

9.1 In The Trench

The Contractor shall keep the trench free from water.

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

9.2 Outside of The Trench

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

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

10.0 JOINT HOLES

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

11.0 EXCAVATED MATERIAL

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

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

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

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

12.0 SIGNALING, FENCING AND LIGHTING

12.1 Signalling

12.1.1 Site Identification

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

12.1.2 Traffic Signals

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

12.2 Fencing

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

12.3 Lighting

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

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

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

13.0 ENCLOSURE – (2 NOS. SKETCHES)

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

SPECIFICATION
FOR
TAKING OVER, HANDLING, HAULING, STOCKING AND STRINGING STEEL PIPES

SPECIFICATION NO.: MEC/S/05/62/103

CONTENTS

1.0 OBJECT

This specification refers to the taking over, handling, hauling, stocking and stringing of the pipes and equipment to be used in the construction of the distribution networks

2.0 EQUIPMENT

The Contractor shall supply the equipment which is required for the loading, hauling, unloading, stocking and protecting the pipes and pipeline equipment.

The equipment used by the Contractor shall be adapted to the condition of the roads and tracks, the relief of the land, the characteristics of the pipes and the construction schedule.

3.0 TAKING OVER PIPES AND PIPELINE ACCESSORIES

The Contractor shall check the packing lists and bill of loading and send them to the Engineer, with acceptance or reservation for shortage or damage.

Should no reservation be mentioned in these document, the Engineer may consider that the Contractor has received and accepted all pipes and pipeline accessories listed in these documents. Any missing or damaged pipe of pipeline accessory shall be replaced or repaired by the Contractor.

All demurrage charge incurred because of a delay in unloading/ loading the pipes or pipeline accessories shall be borne by the Contractor.

4.0 HANDLING AND STOCKING PIPES AND PIPELINE ACCESSORIES

The Contractor shall take all the necessary steps and precaution to ensure that the bare or coated pipes are not damaged during loading, hauling, unloading and stocking.

4.1 Bare Pipes

The pipe shall be handled with care, in order to prevent damage. The use of steel cable, of chains wound round the pipes, of steel hooks is strictly prohibited. Nevertheless, lifting hooks equipped with a bent brass copper plate, placed within each pipe end, may be used, when approved by the Engineer.

During haulage the pipes shall be wedged and protected in such a way as to prevent any distortion, flattening or damage to pipes ends and as to have no contact with the adjacent pipe.
The maximum number of layers of bare pipes, both on the vehicles used for hauling and in the ground stock yard shall be determined in order to prevent distortion and flattening.

The pipe layers shall be wedged to avoid any accidental rolling.

If not flat, the stock yard shall be levelled by the Contractor. The pipes shall be supported clear from the ground by skids.

4.2 **Coated Pipes**

In addition to the precautions here above mentioned for the bare pipes the Contractor shall handle and stock the coated pipes under the following conditions.

4.2.1 Handling

The use of claws, pliers, chains, slings and ropes for crane lifting is prohibited.

The recommended devices are: twisted hemp, plastic or leather straps, at least 100 mm wide, and a swing-bar for limiting the flexion of the pipes. The wood planks used for handling shall be perfectly smooth or coated with plastic strips on both faces.

When the water is hot the Contractor shall handle the coated pipes during the cool hours of the day. The Contractor shall avoid handling the coated pipes when the ambient temperature is 0°C and below.

4.2.2 Stocking

The Contractor shall not stock on the same pile :
- coated pipes of different diameters,
- crossed layers of coated pipes.

The pipe shall be supported clear from the ground by skids and wedges, either coated with neoprene strips, 25 to 30cm wide, having a padding approved by the Engineer.

In the stock yard the maximum number of layers of coated pipes for a pile is as follows:

Nominal pipe diameter	Number of layers
25 mm	10
32 mm	8
50 mm	6
80 mm and more	2

Between the pipe layers, the Contractor shall place neoprene strips, matting or any other flexible material approved by the Engineer.

4.3 **Pipeline Accessories**

The pipeline accessories, such as valves, insulating flanges, flanges, etc. shall be stocked under temporary shelters such as tarpaulins, nylon sheets and kept clear from the ground by wood planks or any approved isolating devices. Both ends of valves and insulating flanges shall be temporarily sealed by wooden plugs or plastic caps to prevent dust, dirt and moisture from entering.

5.0 STRINGING PIPES AND PIPELINE ACCESSORIES

The pipes shall be strung along the edge of the trench in such a way that:

- they cause no inconvenience to the road and street traffic and no damage to roads, streets and alleys,
- they are neither in danger of being damaged by Contractor's machines nor by road users vehicles.

The Contractor shall be responsible for stringing the pipes and pipeline accessories at the proper location in according with the construction drawings.

The strung coated pipes shall be kept clear from the ground by padded skids.

The valves, insulating flanges, cathodic protection and regulator equipment shall be brought from the stock yard to the site at the time of their installation.

The pipes and pipeline accessories that are to be installed in flooded areas or areas likely to be flooded shall not be supplied until the moment of assembly.

6.0 USING CROP-ENDS

The Contractor shall ensure the transport of any usable crop-ends to the locations where they can be used, taking care that there are no more than three (3) welds over a ten (10) meter straight length of pipeline.

The length of a crop-end pipe considered as usable shall be at least:

- 0.50 m for pipes having a nominal diameter of 200 mm and less:
- two diameters for pipes having a nominal diameter of 250 mm and over.

The maximal total length of unusable crop-ends (pipes rejected for reasons attributed to the Contractor and pipes used for welding process approval test and welder qualification tests) shall be fixed at three per thousands of the total length per category of pipe supplied by the Company. The surplus of unusable lengths shall be chargeable to the contractor.

7.0 INVENTORY

The Contractor shall for each category of pipe, keep a permanent inventory of the pipes and pipeline accessories he has received.

After the execution of the works, and for the pipes supplied by the Company, the Contractor shall draw-up a list of unused pipes and usable crop-ends. This document shall be part of the technical records to be given to the Engineer.

8.0 RECOVERY AND STORAGE

When the pipes have been supplied by the Company, the pipes remaining after the construction of the pipelines as well the usable crop-ends shall be marked by the Contractor, hauled end stored in a place determined by the Engineer.

The parts stored shall be classified by category according to their characteristics (diameter, thickness, grade of steel)

These operations must be finished by the date of "Completion of the Work"

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

SPECIFICATION
FOR
PREPARATION OF THE STEEL PIPES

SPECIFICATION NO.: MEC/S/05/62/104

CONTENTS

1.0 OBJECT

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

2.0 MATERIALS AND EQUIPMENT

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

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

Any machine producing defective bends shall be immediately replaced.

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

3.0 CHECKING THE PIPES

The Contractor shall examine each pipe before its preparation.

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

4.0 INTERNAL CLEANING

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

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

5.0 CLEANING THE ENDS

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

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

6.0 CUTS AND BEVELS

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

6.1 Straight Pipes

Hand cutting by torch is forbidden.

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

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

6.2 Mitered Pipes

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

The pipe shall be bevelled by grinding.

7.0 DIRECTION – DIVERSION

7.1 Flexion

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

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

7.2 Field Cold Bending

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

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

Any flattened or buckled pipe shall be rejected.

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

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

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

7.3 **Factory Elbows**

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

7.4 **Mitered Bends**

Mitered bends are not permitted on pipelines intended to operate at 30 percent or more of the specified minimum yield limit elastic strength. Deflection caused by misalignment up to 3 degrees are not considered as miters.

Mitered bends are permitted for pipelines intended to operate at less than 30 percent of the specified minimum yield strength. However, it shall be used only after due approval from Engineer-in-charge.

In that case, the Contractor may use miter bends for deflections angles equal to or less than 12.5°.

The minimum distance between miters, measured at the crotch shall not be less than one pipe diameter.

8.0 **TEES**

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

9.0 **CHECKING OF INSIDE SECTION**

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

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

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

10.0 REJECTED PIPES

The rejected pipes shall be marked ñREJECTEDòin red paint.

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

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

SPECIFICATION
FOR
LOWERING IN

SPECIFICATION NO.: MEC/S/05/62/105

CONTENTS

1.0 **OBJECT**

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

2.0 **EQUIPMENT**

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

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

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

The dimension and type shall be approved by the Engineer.

3.0 **CAPPING PIPELINE SECTIONS**

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

4.0 **LOWERING-IN**

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

- The quality and the quantity of lifting and handling machines and devices; width non-abrasive slings or bets shall be used for lowering-in the pipelines. All lowering-in devices and padded skids shall be subject to close inspection to ensure that the coating is not damaged before the pipe reaches the bottom of the trench.

- The good condition of the coating and its quality of insulation; when the pipeline is constructed with previously coated pipes, not lowered-in directly but placed on skids above or beside the trench the quality of the coating shall be systematically checked, and any necessary repairs shall be carried out in conformity with the specification.

- The good condition of the trench; when the coated pipeline is to be lowered-in the bottom shall be free of brushes, skids, piped, crops, rocks, hard lumps of earth or clay, sticks, so that the protective coating shall not be punctured nor abraded.

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

Immediately after lowering-in the pipelines, the Contractor shall place 20 cm of soft material over them.

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

5.0 FLOODED TRENCH

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

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

6.0 AIR PRESSURIZING PIPELINE SECTIONS

As soon as possible after lowering-in the pipeline sections shall be air-pressurized at 1 kg/cm^2 and the constructed portions of network shall be maintained so pressurized until tightness tests.

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

SPECIFICATION
FOR
BACKFILLING THE TRENCH

SPECIFICATION NO.: MEC/S/05/62/106

CONTENTS

1.0 **OBJECT**

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

2.0 **MATERIALS AND EQUIPMENT**

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

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

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

3.0 **BACKFILLLING**

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

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

3.1 **Soft Layer**

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

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

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

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

3.2 **Above The Soft Layer**

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

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

3.3 **Temporary Reconditioning**

3.3.1 Normal

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

3.3.2 Reinforced

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

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

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

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

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

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

4.0 PROTECTION OF BACKFILL

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

5.0 CLEANING

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

6.0 FINAL RESURFACING

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

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

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

7.0 OBSTACLES

The conditions for executing the backfilling and the reconditioning of the surface where an obstacle is involved are defined in the specification ñObstacle crossings and special passagesò

8.0 SETTLEMENT OF DAMAGES

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

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

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

9.0 ENCLOSURE (4 NOS. SKETCHES)

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

SPECIFICATION
FOR
OBSTACLES CROSSING AND SPECIAL PASSAGES

SPECIFICATION NO.: MEC/S/05/62/107

CONTENTS

1.0 OBJECT

This specification refers to the crossing of obstacles encountered during the pipelines construction.

2.0 MATERIALS AND EQUIPMENT

The Contractor shall supply the materials and equipment necessary for the execution of the works for the crossing of obstacles encountered by the pipelines, and in particular those required for :

- earthwork, boring, etc.
- construction, checking, testing and positioning the pipelines and of their accessories
- protecting and insulating the pipelines
- protection and reinforcing the obstacles crossed and the surrounding area
- backfilling
- reconditioning the ground surface.

3.0 WORK SCHEDULE

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

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

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

4.0 NOTIFICATION OF THE RELEVANT AUTHORITIES OR OWNERS

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

5.0 CROSSING OR ABOVE GROUND OBSTACLES

5.1 Crossing of Railways or Highways

The crossing shall be carried out :

- either by horizontal boring using steel casings
- or in a trench with or without casing as required

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

5.1.1 Boring and crossing with steel casing

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

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

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

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

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

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

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

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

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

Insulators shall be fit on the coated pipe so that :

- the distance between insulators takes into account the weight of the pipe filled with water and the load permissible per insulator.

- An insulator is placed as near as possible to the ends of the casing and is doubled by a second insulator at the most fifty (50) cm away.

- The portion of the anchor bolts extending beyond the insulator after being tightened shall be cut off in order to prevent any contact with the casing.

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

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

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

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

5.1.2 Crossing in open trench with steel casing

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

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

5.1.3 Crossing in open trench without steel casing

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

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

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

5.2 **Crossing of Canals**

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

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

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

The specifications for digging shall be applied.

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

The dimensions of the slab shall be :

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

The structure of the ditch or canal shall be reconditioned.

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

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

6.0 **CROSSING OF UNDERGROUND OBSTACLES**

6.1 **Cables, Pipelines and Other Utilities**

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

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

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

The minimum clearance is shown on attached typical drawings.

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

6.2 **Masonry Work**

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

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

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

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

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

7.0 **PARLLEL ROUTES**

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

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

8.0 **SPECIAL PASSAGES**

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

- on supports, with or without casing
- suspended directly or in a gutter
- fixed to the wall by collars and mechanically protected.

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

The number, dimension, shapes and distribution of the supports, shall be studied and designed, account being taken of the nature and shape of the supporting, structures

the value of climatic stresses (wind, ice, snow) of vibration phenomena (excess dynamic pressure, traffic etc.)

8.1 **Supported Pipeline**

Metallic supports shall be fixed onto the structure

The supports shall have:

- a sliding surface to enable movement in any direction in the plane of the pipeline

- side stops to prevent the pipeline from falling.

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

- the lengthwise movement of the pipeline, in order to prevent it from leaving its sliding plane.

- the sideways movement of the pipeline without it being able to rock against nor touch the support stops

- the electrical insulation of the pipeline

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

8.2 **Suspended Pipeline**

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

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

- the lengthwise movement of the pipeline

- the electrical insulation of the pipeline from the cradle

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

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

8.3 **Pipeline Fixed by Collars**

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

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

8.4 **Galleries**

In case a gas pipeline is to be placed in gallery, it shall be fixed onto the wall by means of supports, cradles or collars or any other device approved by the Engineer.

The pipeline location within the gallery shall be determined by the Contractor in accordance with this specification and in agreement with the concerned authorized requirements.

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

9.0 **ENCLOSURES (12 NOS. SKETCHES)**

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

SPECIFICATION
FOR
MARKING OUT

SPECIFICATION NO.: MEC/S/05/62/108

CONTENTS

1.0 **OBJECT**

This specification refers to the marking out of basic grid pipelines, valves, current taps, etc.

2.0 **MATERIALS AND EQUIPMENT**

The Contractor shall supply the materials and equipment necessary for placing the markers and for the indicator-plates.

The markers and indicator-plates shall conform to the attached typical drawings.

3.0 **LOCATION OF THE INDICATOR-PLATES**

3.1 **Pipelines**

If required by the engineer, indicator-plates shall be installed along the basic grid pipeline route on both side of highways, railways, canals and other main obstacle crossings.

The indicator-plates shall only show the distance between the indicator- plate and the pipeline.

3.2 **Valves Current Taps, etc.**

All the valves current taps, etc. of the basic grid and distribution network shall be marked out.

The indicator-plates shall only show the location of the sight holes on the ground

The indicator-plates shall be fixed onto natural markers such as buildings, fences etc. or onto markers, as shown on attached drawing.

The Contractor shall place the markers, if any, in such a way they cause no inconvenience to the flow of traffic and public and that they cannot be moved. The volume and shape of the foundation shall be suited to the nature of the ground in which it is implanted.

The location of each indicator-plate shall be recorded on the as built drawings.

4.0 **PAINTING**

The markers shall be painted as stipulated in the special condition of contract.

5.0 **ENCLOSURES (4 NOS. SKETCHES)**

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

SPECIFICATION
FOR
TESTING

SPECIFICATION NO.: MEC/S/05/62/109

CONTENTS

1.0 OBJECT

This specification refers to the tests to be carried out on gas pipelines before their start-up.

The special conditions indicate the regulation texts to which the tests are subjected.

2.0 NATURE OF THE TESTS

The tests consist of :

- The test to check the resistance of the pipeline after final positioning; this test shall be hydrostatic if the maximum operating pressure is greater than 5 bar gauge and pneumatic if it is lower than or equal to 5 bar gauge.
- The test to check the tightness of the pipeline, after the previous test has been carried out with satisfactory results; this test shall be hydrostatic if the maximum operating pressure is greater than 5 bar gauge, pneumatic if it is lower than or equal to 5 bar gauge.
- The inspection to check the assembly and connections.

3.0 MATERIALS AND EQUIPMENT

The Contractor shall supply all the materials, products, equipment, apparatus and tools necessary for the execution of the tests, in particular:

- Temporary connection, branching and service-line installation.
- The test and filling compressor and pumps, valves, tanks and foam pigs.
- Measuring and inspection apparatus.
- Water, air, electricity, etc.
- Inhibitor, drying products, means for injection
- Means of transport and telecommunication between places where tests and checks are being performed.
- The equipment and means for rapid intervention of an emergency repair team.

All materials, products, equipment and apparatus used in the execution of the tests shall be submitted to the Engineer for approval.

4.0 TEST SCHEDULE

The Contractor shall draw up and submit to the Engineer for approval the detailed schedule for the execution of the tests, in accordance with the specification "Documents drawn-up by the Contractor".

In addition to the schedule, the Contractor shall supply :-

- The longitudinal section and relative altitudes of the pipelines to be hydrostatically tested.
- The location and arrangement of the launching traps.
- The location of thermometer and pressure gauges.
- The characteristics of the pipes and accessories laid at each part of the longitudinal section.
- The factory test pressure of the pipes and accessories which could limit the test pressure on site.
- The maximum operating pressure envisaged.
- The nature and density of the filling product(s) used for the tests.
- The nature of the proposed inhibitor.
- The safety measures forecast.

5.0 PRESENCE OF THE ENGINEER

The tests must be performed in the presence of the Engineer who shall be notified at least forty-eight (48) hours in advance.

In addition, the representatives of the Company must be notified within the same time limit, in order that they may be present at the tests if so wished.

6.0 ORGANISATION OF THE TESTS AND CHECKS

The Contractor must, at the time of the tests, make any necessary arrangements to safeguard the public safety. The steps taken must be made known.

The Contractor shall be responsible for any damage or any accident caused either directly or indirectly by the execution of the tests.

7.0 RESISTANCE TEST

7.1 Maximum Operating Pressure Greater Than 5 bar gauge

The fluid used shall be water. In order to prevent the formation of air pockets, the line section to be tested shall be filled slowly, from the lowest point of the section as far as practical, the water pushing slowly an adequate number of foam pigs.

If purging devices are to be installed at the highest points so as to prevent air pockets, the pipeline shall be cut on both sides of each purging device after the testing operations. To replace the removed section, a new pipe section shall be welded and the welds radio graphed.

Before launching the first foam pig, the Contractor shall introduce in the line section a volume of water corresponding to the volume of ten(1) meters of pipeline.

The test pressure shall be at least equal to 1.5 times the maximum operating pressure and at the most equal, for each pipe part, fitting and accessory apparatus, to its factory test pressure.

The resistance test shall last two hours and may be performed during the stabilising time prior to the tightness test.

If the properties of the water necessitate it, the latter shall be decanted, filtered and an inhibitor product added.

That test consists, for the Contractor, to check that the pressure in the pipeline does not undergo any considerable drop.

7.2 **Maximum Operating Pressure Lower and or Equal to 5 bar gauge**

The fluid used shall be air.

The test pressure shall be at least equal to 1.5 times the maximum operating pressure.

The resistance test may not take place if, in the sections laid in the ditches, the trench is not backfilled to a height of at least 0.40m above the upper tangent of the pipeline, and if, in the sections placed on supports, the pipeline is not finally fixed on to the supports and into the anchorage blocks.

The test shall last four hours and may be performed during the stabilizing time prior to the tightness test.

That test consists, for the Contractor, to check that the pressure in the pipeline does not undergo any considerable drop.

8.0 **TIGHTNESS TEST**

8.1 **Maximum Operating Pressure Greater Than 5 bar gauge**

If the resistance test has been successfully withstood by the pipeline and accessory equipment, the Contractor shall carry out a hydrostatic tightness test at a pressure :-

- At least equal to the maximum operating pressure foreseen, measured at the highest points of the section subjected to the test.
- At the most equal to the resistance test pressure measured at the lowest points.

Before performing this test the Contractor shall ensure that the quantity of air contained in the pipelines or accessory equipment is low enough not to cause any doubt in the results of the tightness test; if need be he shall place air vent device at the most suitable points.

The test procedure is described in the Annexure-I.

8.2 **Maximum Operating Pressure Lower Than or Equal to 5 bar gauge**

If the resistance test is successfully withstood by the pipeline and accessory equipment, the Contractor shall perform a pneumatic tightness test at a pressure of 1 bar gauge (Ñ10%).

The duration of the test shall be 192 hours.

The test procedure is described in the Annexure-2.

9.0 **VALVE ASSEMBLIES**

All the valves, fittings, pipes, flanges and apparatus which constitute the valve assemblies, may be tested all together at the workshop, if prefabricated.

The test shall be performed with all the vales open.

10.0 **INSPECTION OF UNTESTED JOINTS**

After the connection of sections which have satisfied the test, the tie-in welds shall be 100% inspected by radiography and marked.

11.0 **REPAIRS**

If a test is not deemed satisfactory by the Engineer, the Contractor shall take any steps necessary for detecting defects or leaks and repairing them. After repair, the tests shall be performed again until a result considered satisfactory by the Engineer has been obtained.

12.0 **REPORTS AND STATEMENTS**

The Contractor shall draw up all the reports concerning the performance of the tests and shall carry out all the justificating calculations of pressure variations observed. These documents which shall form part of the technical records shall be progressively handed over to the Engineer as they are drawn up.

13.0 **DRAINING**

As soon as the hydrostatic tests have been deemed satisfactory, the Contractor shall proceed to empty the water contained in the pipeline and accessory apparrus he shall use foam-pigs of a suitable type.

The draining shall be considered satisfactory when the spheres arrive at the end of the pipeline section without pushing any water.

If the pipeline is not purged from air to gas just after the tests, the pipe shall be air pressurised at one (1) bar gauge.

14.0 TEST REPORT

At the end of the testing operations on a pipeline section, when the measurement results are acceptable the Contractor shall :

- draw up the test report
- make the necessary calculations
- submit the test report to the Engineer for approval.

The test report shall be harided over the Engineer before the starting-up operations.

15.0 ANNEXURES

1. Procedure for Hydrostatic Tightness Tests
2. Procedure for Pneumatic Tightness Test
3. Coating Resistance Test

ANNEXURE-1

PROCEDURE FOR HYDROSTATIC TIGHTNESS TEST

1.0 GENERAL CONDITIONS OF TIGHTNESS TEST

1.1 Duration of test

1.2 Stablizing time

1.3 Test pressure

1.4 Measuring instruments

1.5 Possible time extensions

2.0 TIGHTNESS TEST ACCURACY

2.1 General

2.2 Revelation of a minimum leakage

2.3 Minimum leakage hypotheses

3.0 PRACTICAL PROCEDURE FOR TESTS

3.1 Checking for presence of air

3.2 One hour tightness test

3.3 24 hours tightness test

3.4 Annexes

1.0 GENERAL CONDITIONS OF TIGHTNESS TEST

1.1 Duration of Test

This duration shall be in terms of the volume of the section being tested.

If $V \leq 20m^3$, duration 1 hour
If $V > 20m^3$, duration 24 hours

1.2 Stablizing Time

The tightness test may only begin after a certain stabilizing time has elapsed after the filling-up of the pipe with water and expanding it at a pressure at least equal to that of the test.

The resistance test may take place during the stabilizing time period.

The stabilizing time shall depend on the diameter and is given below :-

40 mm
$\phi \leq 400mm$: 1 days
$\phi \leq 750mm$: 2 days
$\phi \geq 800mm$: 3 days

1.3 Test Pressure

The value must be at least equal to the maximum operating pressure foreseen and at the most equal to the resistance test pressure.

1.4 Measuring Instruments

1.4.1 Temperature

The thermometers to be used must be permit the temperature to be measured with an accuracy of 0.1ÁC.

The number of thermometers to be placed shall be left to the discretion of the Engineer. There must, however, be at least 4 for a section up to 500m, long at least 6 for a section more than 500m long, and at least one every two kilometers the reading of all thermometers must be carried out in less than one hour.

1.4.2 Pressure

The pressure readings shall be carried out by means of a dead weight tester the sensitive of which, in the conditions of the test, shall be about 10 g/cm^2.

The pressure variations shall be recorded ; the accuracy of the corresponding apparatus shall be at least equal to 0.5 bar. Any manifest irregularity of the recorded curve shall lead to the rejection of the test.

1.5 **Possible Time Extensions**

The tightness test consists of at the most 3 pressure readings. If these 3 readings do not lead to a favourable conclusion, the test must be performed again after a delay of at least 3 days (except where there are abnormally fast temperature variations in which case a return to more normal conditions is required), during which time the pipeline shall be kept under pressure with a recording of the pressure. During this delay of 3 days, the Engineer may, at this discretion, carryout a certain number of additional temperature and pressure measurements to be used as estimation factors.

2.0 TIGHTNESS TEST ACCURACY

2.1 **General**

It is not generally possible to except that a tightness test will detect any leak. The visual inspection maybe able to accomplish this, but, as soon as the test is based on the verification of a formula, there are two sources of uncertainty; on the one hand, the formula used is never anything more than an approximation of the real fact, on the other hand the measuring apparatus give only approximations of the real values.

For a tightness test, it is therefore only possible to guarantee the retention of the mass of water contained in the pipeline up to a certain volume, and only possible to guarantee the tightness of the pipe upto a certain point.

It is therefore necessary to chose a prior this certain point for undetected leaks; experiments have enabled a choice to be made which is not entirely arbitrary.

2.2 **Revelation of a Minimum Leakage**

The coating of the steel pipe adheres to the pipeline, and a stress applied at a certain point cannot cause this to become unstuck unless it exceeds a certain value. It follows that, for the coating to become unstuck and cracked during testing, a hole must have a certain diameter. This minimum value defines a threshold, and the corresponding flow is about 5 litres an hour under a pressure of 70 bar.

2.3 **Minimum Leakage Hypotheses**

Minimum leakage shall be defined by a certain flow of water under a given pressure P.

This flow equals :

$$q = \frac{1}{15}(P + 5) \text{ for } P \leq 100$$

$$q = 7 \text{ for } P > 100$$

q being expressed in litres/ hour, and P in kg/cm^2

3.0 **PRACTICAL PROCEDURE FOR TESTS**

3.1 **Checking for Presence of Air**

3.1.1 Measurements to be taken

Let V be the volume of the pipeline to be tested.

A checked volume m shall be drained off : the result is a pressure drop $\Delta P1$ - measured on a dead weight tester.

3.1.2 Interpretation

The theoretical pressure drop ΔPO corresponding to m is :

$$\Delta P0 = \frac{m}{V\left(\chi + \frac{D}{Ee}\right)} \text{ (m and V being expressed with the same unit)}$$

with :

χ : compressibility factor of water
D, e : nominal outside diameter and wall thickness of the pipe
E : young's module of steel

Should the section tested include pipe of different wall thicknesses and grades, the value of D / Ee to be taken into account shall be equal to the weighted average of the different value of D / Ee relating to homogeneous sections, the weight factors being the corresponding volumes.

The ratio $\frac{\Delta P1}{\quad}$ is formed.

Δ P2

If the ratio is less than :

- 0.90 where the pipe diameter less than 400mm.

- 0.95 where the pipe diameter is more than or equal to 400mm, there is an excessive quantity of air and there is reason to refuse the test.

3.2 **One Hour Tightness Test**

Two pressure readings P1 and P2 shall be made at one hour interval, in such conditions that the temperature does not change during the test, at times t1 and t2.

3.2.1 Interpretation

Algebraically : (P1 - P2) < 0.5 kg/cm2 : test acceptable
(P1 - P2) = 0.5 kg/cm2 : short extension
(P1 - P2) > 0.5 kg/cm2 : test refused

3.2.2 Short Extension

A third reading P3 shall be taken at time t3 after an interval of time t equal to İ hour after t2.

Let ΔP'0 be the pressure drop which would have been caused by the minimum leakage during (t3 - t2). ΔP'0 is calculated from the formula of 3.1.2 in which m is replaced by the volume equal to the product of the flow of the minimum leakage by (t3 - t2).

Algebraically : (P1 - P2) < 0.5 ΔP'0 : test acceptable
(P1 - P2) > 0.5 ΔP'0 : test refused

3.3 **24 Hours Tightness Test**

3.3.1 Measurement to be taken

i) 2 tests pressure reading P1 and P2 at times t1 and t2 with an interval of 24 hours.

ii) Temperature readings along the tested pipeline, at time t1 and t2 in order to get T1 and T2, which are the average values of the ground temperatures.

iii) The air temperature Ta1 and Ta2 and the atmospheric pressure b1 and B2 at times t1 and t2.

3.3.2 Interpretation

i) Notation

f : factor of which the average value depends only on the diameter of the pipe and is given in the attached graph.

∂f / f : dispersion factor of f, given in the same graph.

μ : expansion factory of water

γ : cubic expansion factor of steel

χ : compressibility factory of water

D, e : outside diameter and thickness

E : young's module of steel

H : maximum permissible pressure variation

$\Delta P'0$: pressure drop caused by minimum leakage throughout the duration of test extension

P : difference of pressure after temperature correction.

ii) Calculations to be made

$$H = \frac{\partial f}{f} / \Delta P + 0.2\, f.K$$

$$\Delta P = f.K\,(T1 - T2) \text{ with } K = \frac{\mu - \gamma}{\chi + D/Ee}$$

$$p = P1 - \Delta P - P2$$

iii) Conclusions

The test is satisfactory if p < H

If otherwise, an extension of about one hour is made by taking, at time t3 at an interval of about one hour after t2, a pressure reading P3.

Let $\Delta P'0$ be the pressure drop which would have been caused by minimum leakage throughout the duration of the extension ($\Delta P'0$ is calculated as in the one hour tests).

The test is satisfactory, if P2 - P3 is less than 0.5 Δ P'0. If the test is not satisfactory, it shall be redone.

3.4 **Annexes**

Curves giving f and ∂f / f in terms of the pipeline diameter.

Variations of the compressibility factor of water χ in terms of its temperature.

Variation of μ - γ in terms of the temperature of the water.

HYDROSTATIC TEST

$\frac{\partial f}{f}$

Curves Giving f and ----- In terms of diameter ϕ

HYDROSTATIC TEST

HYDROSTATIC TEST

ANNEXURE-2

PROCEDURE FOR PNEUMATIC TIGHTNESS TEST

1.0 GENERAL CONDITIONS

1.1 Stablizing time

1.2 Test Duration

1.3 Test Pressure

1.4 Measuring instruments

2.0 PRACTICAL PROCEDURE FOR TESTS

2.1 Measurements to be taken

2.2 Corrections for 0ÁC

2.3 Interpretation

1.0 GENERAL CONDITIONS

1.1 Stablizing time

The stabilizing time shall be 24 hours.

1.2 Test Duration

The duration of the test shall be 192 hours after the stabilizing time.

1.3 Test Pressure

The value of the test pressure shall be 1 bar gauge (Ñ10%).

1.4 Measuring instruments

1.4.1 Temperature

The thermometers shall enable the temperature measurement to be accurate to 0.1%.

The thermometers shall be distributed on the whole tested area. Their maximum number shall be 10.

The reading of all thermometers must be carried out in less than half an hour.

1.4.2 Pressure

The pressure readings shall be taken by means of instruments the sensibility of which shall be at least equal to 1mm of mercury.

All measuring instruments shall be factory made.

2.0 PRACTICAL PROCEDURE FOR TESTS

2.1 Measurement to be taken

The measurements shall be taken in the morning before sunrise.

All measurements shall be taken with the same apparatus at the same places at the beginning of each day.

The measurements to be taken shall be :

- Atmospheric Pressure : b in mm of mercury

- Temperature of the air : Ta in ÁC

- Relative pressure in the pipeline : P in mm of mercury

- Temperature of the ground : T in ÁC
  against the pipeline

2.2 **Corrections for 0°C**

2.2.1 Atmospheric Pressure

The formula to be used shall be :

$br = b(1 - 18.1 \times 10^{-5} Ta)$

br = rectified atmospheric pressure (height at 0ÁC of the column of mercury)

b = Read atmospheric pressure

Ta = air temperature at the barometer location

2.2.2 Relative pressure in the pipeline

The formula to be used shall be :

$$Po = \frac{P}{1 + T / 273}$$

Po = rectified relative pressure at 0ÁC

P = read relative pressure in the pipeline

T = average temperature of the ground

2.2.3 Absolute pressure for 0ÁC

Pa = Po + br

2.3 **Interpretation**

The test shall be satisfactory if the difference in the absolute pressure Pa in the pipeline, corrected for 0ÁC, between two consecutive days and between first day and each day of test, is less than the maximum error due to defects in the accuracy of the measuring instruments, estimated at 10mm of mercury.

ANNEXURE-3

COATING RESISTANCE TEST

1.0 GENERAL PROCEDURE FOR THE TEST

2.0 INTERPRETATION

3.0 ACCEPTANCE

4.0 OTHER CHECKS

1.0 GENERAL PROCEDURE FOR THE TEST

i) Make sure that all insulating flanges are shunted.

ii) Measure (by means of a copper/ copper sulphate electrode) and record the pipeline potentials Uo at every cathodic test point, with no applied cathodic protection yet (static potentials). Such a measurement is not compulsory for test purposes but may give useful indications in case anomalies are detected later on.

iii) Switch on the cathodic protection. Wait a few days for stabilisation. Set the potential output of the station at 2.1 Volts Measure and record the current input (I) in the network.

iv) Measure and record the pipeline potential at every cathodic test point with cathodic protection ON (U2) and OFF (U1) by interrupting the cathodic protection input in the network on a timed cycle of 20 seconds ON, 10 seconds OFF.

2.0 INTERPRETATION

The exact value of the coating resistance of network, R, cannot be known, but in can be assumed that it is over the calculated value at the most underprivileged, point, i.e. where U2 - U1 is minimum.

Therefore :

$$R > \frac{S\,(U2 - U1)\ \text{min.}}{I}$$

Where :

R = Coating resistance of network in Ωm^2
S = Total external surface of the pipeline
U1 = potential with cathodic protection OFF, in V
U2 = potential with cathodic protection ON, in V
I = current input in the work, in A

3.0 ACCEPTANCE

For a network without service lines :

$R > 4\,000\ \Omega.m^2$
For a network with service lines (steel) :

$R > 2\,000\ \Omega.m^2$

4.0 **OTHER CHECKS**

The foregoing only concerns the coating resistance measurement.

As far as the working order of the cathodic protection system is concerned one shall take the opportunity of the coating resistance test performance to also check the followings :-

i) At the most underprivileged point, /U2/ is greater than 1 000mV.

ii) $I / S < 50\ \mu.A/m^2$ (micro amps per square meter).

iii) At no test point with other buried metallic structure, the potential variation of the structure with cathodic protection ON and OFF exceed 20mV.

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

SPECIFICATION
FOR
PURGING AND COMMISSIONING THE NETWORK

SPECIFICATION NO.: MEC/S/05/62/110

CONTENTS

1.0 OBJECT

This specification refers to the preparatory and execution operations for purging and commissioning a gas distribution network.

2.0 MATERIALS AND EQUIPMENT

The Contractor shall supply all materials and equipment necessary for:

- Purging the pipelines from air to gas.
- Supervising the purging operations.
- Checking that the performance of the accessories conform to the contract.
- Adjusting the accessories.
- Commissioning the works.

The contractor shall also supply and have ready on site:

- The replacement materials such as valve operation indicators, plastic caps for casing, etc. which may be damaged during the startup operations. If such materials are taken from the spare to be supplied by the contractor they shall be immediately replaced
- Safety equipment such as fire extinguishers, gas masks, gas analyzers etc., to ensure labour and public safety.

The company will supply the gas free of charge, at the required pressure and flow.

3.0 WORK SCHEDULE

The contractor shall draw-up and submit a purging schedule to the Engineerôs approval, in the conditions specified in the specification ñDocuments drawn-up by the contractorò.

This schedule shall specify:

- The portion of network to be purged.
- The characteristics of the works to be purged.
- The operation sequence and the description of the equipment intended to be used.
- The staff intended to be mobilized including the necessary specialist and technicians of the manufacturers of the materials if necessary.

4.0 SAFETY PRECAUTIONS

The contractor may not proceed to the purging until safeguards have been placed around the installations and works, where they are needed in application of the safety regulations.

The contractor shall be required to satisfy any public regulations. He shall, where necessary, obtain permission from the concerned Authorities before beginning any operations, and he shall take all the necessary precautions to ensure safety of persons and properties during the purging operations, these precautions must be made known to all persons concerned and if necessary shall be publicized.

5.0 PURGING

5.1 General

The purging operations include:

- Purging the pipelines from air to gas.
- Checking the performance of the accessories.
- Adjusting the accessories.

All these operations shall be performed under the supervision of the Engineer and in the presence of representatives of the company. The contractor shall give a 3(three) days notice. They shall not start unless the network is thoroughly completed and all test certificates regarding the concerned works have been signed and the purging schedule is approved by the Engineer.

5.2 Pipeline

The purging operations for pipelines include:

- Making accessible the purging devices of the portion of network to be started up.
- Installing the vent pipes and/or torches on to the purging devices.
- Purging from air to gas the network in such a way that the eventual ring mains be purged before the branch lines.
- Removing the vent pipes and/or torches, when the network is filled with gas.
- Beckfilling the eventual excavations at purging device locations.

5.3 Accessories

The contractor shall check the performance of the accessories in accordance with the manufacturerôs instruction.

These checks shall include in particular:

- The manual opening and closing of all valves.
- The electrical check that all insulating flanges are in good working conditions.
- The inspection of good working condition and adjustment of checking and safety devices.

6.0 REPAIRS

The contractor shall replace as quickly as possible any parts and devices supplied by himself and proving to be defective.

7.0 PERFORMANCE DEFECTS

If the performances of the accessories do not meet the contract requirements, the contractor shall take any necessary steps to remedy the situations as soon as possible, even by installing any additional device which might prove necessary.

8.0 CERTIFICATE OF COMPLETION

When the following are completed in accordance with the contractor provisions:

- The network is completely constructed and all accessory installations are installed and tested including telecommunication cables if any.
- The network is purged from air to gas.
- It prove to be tight.
- The accessory performances prove to conform to be contract.
- The accessories are adjusted to the operation conditions.
- All connections are made, all marker plates and signs are installed.
- The site test certificate regarding the works have been signed by the Engineer.
- The factory test certificate regarding the materials have been handed over to the Engineer by the Contractor.
- The spare parts and tools have been handed over to the company by the contractor.

- The technical records have been handed over to the Engineer by the Contractor.

The Engineer shall deliver the certificate of completion regarding the network or concerned portion of network to the contractor.

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

SPECIFICATION
FOR
TECHNICAL RECORDS

SPECIFICATION NO.: MEC/S/05/62/111

CONTENTS

1.0 OBJECT

These specification relate to the preparation drawing-up presentation by the Contractor, his sub-contractor, suppliers and handing over to the Engineer if the document which constitute the technical records of the pipelines, stations and accessory works constructed by the Contractor.

2.0 COMPOSITION OF TECHNICAL RECORDS

The technical records shall be composed of:

- The technical documents which shall be drawn-up progressively by the contractor as the execution of the works precedes, kept continually up to date, transmitted to the engineer at his request and returned to the contractor for correction or complement if any.

- The as-built documents which shall be in conformity with the construction of all the works and handed over to the Engineer at the date of issue of the certificate of completion.

3.0 TECHNICAL DOCUMENT

These document shall include:

- Construction drawings.

- The welder qualification certificates

- The reports on the weld inspections.

- The welding reports

- The sectioning of the pipeline for the testing.

The reports on tests carried out on site, in application of the regulation texts, on pipeline, stations and accessory works, as well as, if need be the report drawn-up the representation of the Authority in charge of the inspection of the these tests.

4.0 AS-BUILT DOCUMENT

These documents include in particular:

- The map of the final route of the pipelines.

- The as-built drawings at the scale mentioned in the special specification and recording or as per standard engineering practice followed as per Engineer-in-charge.

- The depth of the pipeline.
- The characteristics of the pipes and the limits for changes in characteristics.
- The position and size of pipeline equipment such as valves, casing, insulating joints, current taps, vents, telecommunication cables, etc.
- The position of the markers.
- The plans which are conform to the construction of the stations and accessory works and other equipment, bcaring the exact list of plants and diagram of the cathodic protection installations.
- The starting-up reports of the works (pipelines, stations accessory works cathodic protection) the measurements and operation tests.
- The final discharge obtained by the contractor from owner, operators, municipal authorities after the restoration of the ground surface.
- Inventory of equipment supplied by the company to the contractor for the construction of the works.
- The welding records.
- The radiographic exposures of welds.

5.0 DRAWING-UP OF TECHNICAL RECORDS.

The drawings-up of the documents of technical records with regard to the preparation, presentation, form and size, procedure for transmission and approval shall be submitted to the rules defined in the specification ñDocument drawn-up by the contractorò

6.0 HANDING OVER OF TECHNICAL RECORDS

The technical records (one reproducible and 10 copies) shall be handed over to the engineer at the date of the certificate of completion.

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

SPECIFICATION
FOR
CONSTRUCTION OF VALVE ASSEMBLY

SPECIFICATION NO.: MEC/S/05/62/112

CONTENTS

Valve assemblies location and construction will be as per contractorÕs construct drawing and technical instructions that must be submitted for EngineerÕs approval.

In all events these assemblies must comply with the general requirements given below and will be constructed in conformance with typical drawings enclosed with the tender.

1.0 GENERAL DIMENSION

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

2.0 CIVIL WORKS

2.1 Inside Dimension

The inside dimensions must allow:

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

2.2 Concrete:

As per applicable standards.

2.3 General Water Tightness

- The valve chamber has to be water proof the side walls and bottom have to withstand an outside hydrostatic pressure of at least 1 bar.
- The pipe and casing penetration sealing devices must:
  - Accept angular deflections of 5Á
  - Ensure electric insulation between metallic components and civil works.

2.4 Access

Camber Covering

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

- It includes an access cover, less than 60kg. to enable access, by a man-through a standing ladder into chamber.

- Must be able to support a maximum load of 25 tons, its design has to be such as to allow top side to be filled with the same material as the surface, roadway of pavement (concrete, asphalt, slabs etc.).

- Must be lockable and withstand external efforts.

- Must bear the mark ñGASò

2.5 **Aeration**

- The valve chambers shall be fitted with an upper aeration duct opening, at most 20 cm. from chamber access cover and a lower aeration duct opening grid at most 20 cm. from chamber floor.

- Air ducts shall be of steel of fibrous cement each with a minimum cross-section of 200 cm^2.

- Water horizontal portions of these ducts have a 2% slope, their low point shall be on valve chamber side to evacuate the water that may penetrate these ducts.

- Water tightness of ducts and their connection to valve chamber shall be as per paragraph 2.2.

- A yellow warning strip shall be placed over all horizontal portions of these ducts.

- Aeration duct will exist ground and extend for the lower duct 2m above ground level and for upper duct 2.50 m above ground level and this in an area where they do not hinder vehicular nor pedestrian traffic.

- Duct surface outlets shall be protected against the engress of water and other objects likely to clog therm.

3.0 **PROTECTION AGAINST STRAY CURRENTS AND ELECTROSTATIC LOADS.**

In order to avoids having stray currents pass through the valve assembly (cathodic protection currents, stray currents, electrostatic loads), the different metallic devices shall be electrically bonded to an earthing plate.

The earth resistance shall be less than 20 ohms.

The valve assembly shall be electrically isolated from the upstream and downstream pipes by insulating joints placed outside the valve chamber and at a maximum distance of 2 meters.

4.0 CATHODIC PROTECTION

The pipeline portions electrically isolated from valve chambers shall be interconnected by means of a removable link.

Rev. : 0
Edition : 1

SPECIFICATION

FOR

MAINLINE CONSTRUCTION (ONSHORE)

SPECIFICATION NO.: MEC/S/05/21/01

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

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 deened 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 works "Should, "May" and "Will" are non-mandatory, advisory or recommended.

3.0 REQUIREMENTS OF R.O.U. AND ACCESS THERETO

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

CONTRACTOR shall notify 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 metres 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 $35mm^{2.}$

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 kneeboots) 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 tbe 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 prevent all the time.

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

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

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

4.0 RIGHT-OF-WAY

The CONTRACTOR is required to perform his construction activities within the width of Right-of-way set aside for construction of pipeline, unless he has made other arrangements with the 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 centreline of the pipeline at distance of maximum 100 metres for straight line sections and maximum 10 metres for horizontal bends. Wherever ROW centreline has been staked on ground, CONTRACTOR shall exercise care in accurately staking the pipeline centreline, in consultation with COMPANY.

3) Stake two ROW markers at least at every 100 metres.

4) Set out a reference line with respect in pipeline centreline at a convenient location. Markers on reference line shall be at a distance of maximum 100m for straight line sections and maximum 10m for horizontal bends.

5) Install distance markers locating and indicating special points, such as but not limited to :

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

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

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

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

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 non-interference, especially in areas like grasing lands, villages etc.

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

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

4.4 **Row Clearing and Grading**

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

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 jurisdication 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 crossfall 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 recognised such restricctive features of the Right-of-Way and shall provide the necessary detoors and execute the works without any extra cost to COMPANY. Public travel shall not be inconvenienced nor shall be wholly obstructed at any point.

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

CONTRACTOR shall be responsible for moving its equipment and men across or around watercourses. This may require the construction of temporary bridges or culverts. Temporary bridging or access to fording required for Right-of-Way crossing water courses shall be constructed. CONTRACTOR shall ensure that such temporary works shall not interfere with normal water flow, avoid overflows, keep the existing morphology unchanged and shall not unduly damage the banks or water courses. No public ditches or drains shall be filled or bridged for passage of equipment until CONTRACTOR has secured written approval of the Authorities having jurisdiction over the same. CONTRACTOR shall furnish COMPANY a copy of such approval.

4.6 **Steep and Rocky Terrain**

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

In rough or steep terrain, CONTRACTOR may have to grade access roads and temporary bypass roads for its own use. Where such access roads do not fall on the Right-of-Way, CONTRACTOR shall obtain necessary written permission from land owners and tenants and be responsible for all damages caused by the construction and use of such roads, and at no extra cost to COMPANY, Wherever rocky terrain is encountered, grading shall be carried out in all types of solid rocks which cannot be removed until loosened by blasting, drilling, wedging or by other recognised means of quarrying solid rocks.

Where use of explosives is required in connection with Right-of-Way grading and trenching, CONTRACTOR shall comply fully with requirements of the use of explosives as provided under 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 vaccum 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 are prohibited.

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

The coated pipes at all times shall be stacked by placing them on ridges of sand free from stones and covered with a plastic film or on wooden supports provided with suitable cover. This cover can, for example, consist of dry, germ free straw with a plastic film, otherwise foam rubber may be used. The supports shall be spaced in such a manner so as to avoid permanent bending of the pipes, particularly in case of small diameter pipes with low wall thickness. The pipes shall be stacked so that the uncoated bevelled ends are in line at one end thus making differences in length clearly noticeable.

Stacks shall consist of limited number of layers so that the pressure exercised by the pipe's own weight does not cause damages to the coating. Each pipe section shall be separated by means of spacers suitably spaced for this purpose. Stacks shall be suitably secured against falling down and shall consist of pipe sections having the same diameter and wall thickness. The weld bead of pipes shall be positioned in such a manner so as not to touch the adjacent pipes.

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

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

The lorries/rail wagons shall be equipped with adequate pipe supports having as many round hollow beds as the number of pipes to be placed on the bottom of the lorry bed. Supports shall be 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 stachions of lorries/rail wagons used for transportation shall be covered by non-abrasive material like rubber belts or equivalent. Care shall be exerclsed 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 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, railwys, 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 s, 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 linepipe

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 cnaracteristics did to unsuitable storage must be strictly complied with and, if required, an adequate heat conditioning shall be provided for these materials.

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

Storage of coating materials which are susceptible to deterioration or damages especially due to humidity, exposure to high thermal cconditions 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.

Beside 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 pemit 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 categorised 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 metres 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)	Rocky Terrain	1.0
c)	Minor water crossings/ canals / drain / nala / stream	1.5
d)	River crossings for which scour depth is defined (below scour)	1.5
e)	River crossings (Bank width < 50 m) below lowest bed level)	1.5
f)	Other crossings (Bank width > 50 m) (below lowest bed level)	2.5 (for normal soil) 1.5 (for rocky strata)
g)	Water crossing by HDD (below least bed level)	2.5
h)	Uncased/ Cased Road Crossings/ Station approach	1.2
i)	Railroad Crossings	1.7
j)	Drainage, ditches at roads / railway crossings	1.0
k)	Marshy land and creek area	1.5

Notes :

In case pipeline is located within 1.5 m from any dwelling unit, the cover shall be increased by 300 mm over and above that specified.

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.

6.6 Extra Depth and Clearance

At points where the contour of the earth way require 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 aproaches to crossings. Such trenching work shall be done by CONTRACTOR at no extra cost to the COMPANY.

COMPANY intends that there will be a minmum of hand grading of the trench bottom. However, to achieve this, CONTRACTOR will have to dig as square a bottom of the trench as possible with his equipment. This in part can be obtained by adjusting and

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

6.8 Padding

In all cases where rock or gravel or hard soil is encountered in the bottom of the trench, COMPANY will decide the exact extent of trench padding, that will be required. The thickness of the compacted padding shall not be less than 150mm. In those areas that are to be padded, the trench shall be at least 150mm deeper than otherwise required, and evenly and sufficiently padded to keep the pipe, when in place, at least 150mm above bottom of excavated trench.

Acceptable padding shall be placed under the pipeline before its installation, and around after installation to establish at both sides and on top of the pipe a permanent layer of padding. The thickness of compacted padding on top of pipe corrosion coating shall be at least 150mm. Padding materials that are approved by COMPANY shall be graded soil/ sand and/ or other materials containing no gravel, rock, or lumps of hard soil. Sand used for padding shall pass through sieve size ASTM-10 or ISO-2.00.

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

6.9 Protection of Trench

CONTRACTOR shall keep the trench in good condition until the pipe is laid, and no claim is to be made to the COMPANY by reason of its caving either before or after pipe is laid.

All lumber, sheet-piling jacks or other materials, that may be necessary to shore the trench, in order to prevent caving are to be furnished and removed by CONTRACTOR.

CONTRACTOR shall dewater if necessary, using well point system or other suitable systems, shore, or do what else might be required to excavate the trench, install the pipe in it and backfill the trench in accordance with these specifications at no extra cost to COMPANY.

6.10 Protection of Underground Utilities and Special Methods

Details of some underground utilities, as far as acquired by COMPANY, shall be indicated in the Drawings. However, CONTRACTOR shall obtain plans and full details of all existing and planned underground services from the relevant Local Authorities and shall follow these plans closely at all times during the performance of work. CONTRACTOR shall be responsible for location and protection of all underground lines and structures. In special locations the use of trenching machine, backhoe may result

in damage to property and subsurface structures likely to be encountered during excavation. At such places, CONTRACTOR shall excavate the trench manually to same specification at no extra cost.

Where the pipeline crosses other underground utilities/ structures, the CONTRACTOR shall first manually excavate to a depth and in such a manner that the utilities/ structures are located.

Temporary under pinning or any other type of supports and other protective devices necessary to keep the interfering structure intact shall be provided by the CONTRACTOR at his own cost and shall be of such design as to ensure against their possible failure.

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

6.11 Encroachments and Working near other utilities

In locations, where pipeline has to be laid in the body of a road, canal, dyke or other locations under jurisdiction of Government/ Public Bodies, the CONTRACTOR shall perform such work without extra compensation, according to the requirement of concerned Authorities. When it becomes necessary that CONTRACTOR has to resort to hand digging, well point, erection of sheet piling or any other special construction methods in these areas, no extra compensation shall be paid. CONTRACTOR shall contact the Authorities concerned in order to become familiar with their requirements.

In locations, where the pipeline has to be laid more or less parallel to an existing pipeline, cable and/ or other utilities in the Right-of-way, CONTRACTOR shall perform the work to the satisfaction of the Owner/ Authority of the existing pipeline/ cable/ utility. In such locations CONTRACTOR shall perform work in such a way that even under the worst weather and flooding conditions, the existing pipeline/ utilities remain stable and shall neither become undermined nor have the tendency to slide towards the trench.

CONTRACTOR shall be liable for any damage occuring 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 suboil 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 authorise fabricated bends for installation at points where in COMPANY's judgement the use of such bends is unavoidable.
Overbends 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 Elastic Bends

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

7.2 Cold Field Bends

7.2.1 The radius of cold field bends shall not be less than 40 times the pipe nominal diameter for pipe diameter 18 inch and above and shall not be less than 30 times the pipe nominal diameter for pipe diameter less than 18 inch.

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

7.2.3 CONTRACTOR shall, before the start of the work, submit and demonstrate to COMPANY a bending procedure which shall conform with the recommendations of the manufacturer of the bending machine. The procedure shall include amongst other steps - lengths, maximum degree per pull and method and accuracy of measurement during pulling of the bend. This procedure and the equipment used shall be subject to COMPANY's approval.

7.2.4 Pipes with longitudinal welds shall be bent in such a way that the weld lies in the plane passing through the neutral axis of the bend which shall be installed positioning the longitudinal weld in the upper quadrants. If horizontal deviations are to be achieved by joining more adjacent bends, the bending of the pipe lengths shall be made by positioning the longitudinal welds alternatively 70mm above and below the plane passing through the neutral axis in such a way that the bends are welded with the longitudinal welds displaced by about 150mm and situated in the upper quadrants. In case of vertical bends formed from a number of pipe lengths, the longitudinal welds shall be positioned on the plane passing through the neutral axis of the bend to the right and left alternatively.

7.2.5 The pads, dies and rolls of the bending equipment shall have relatively soft surfaces to avoid damage to the pipe coating. Where applicable, fully retaining bending shoes shall be used. Roller type bending machines are preferred.

7.2.6 The ends of each bent length shall be straight and not involved anyway in the bending. The length of the straight section shall permit easy joining. In no event shall the end of the bend be closer than 1.5m from the end of a pipe or within one meter of a girth weld.

7.2.7 The ovalisation caused on each pipe by bending shall be less than 2.5% of the nominal diameter at any point. Ovalisation is defined as the reduction or increase in the internal diameter of the pipe compared with the nominal internal diameter. A check shall be performed on all bends in the presence of COMPANY by passing a gauge consisting of two discs with a diameter equal to 95% of the nominal internal diameter of the pipe connected rigidly together at a distance equal to 300mm.

7.2.8 The wall thickness of finished bends, taking into account wall thinning at the outer radius, should not be less than the design thickness. An indication of wall thinning as a percentage is given by the following empirical formula :

$$\text{Wall Thinning} = \frac{50}{n + 1}$$

Where 'n' is the inner bend radius divided by pipe diameter. Pipes with measured wall thickness greater than the nominal wall thickness (i.e. with +ve tolerance) shall normally be used for making cold field bends.

7.2.9 Cold bent pipes on site shall have the corrosion coating carefully checked with the aid of a holiday detector for cracks in the coating down to the pipe wall. It must also be checked whether the coating has disbonded from the pipe wall during bending by beating with a wooden mallet along the outer radius. Any defects or disbonding of the coating caused during bending (also forced ridges in the coating) shall be repaired at the CONTRACTOR's expense in accordance with COMPANY approved procedures.

7.2.10 When pipelines are laid in parallel, the horizontal bends shall be concentric.

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 AND WELDING

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

All rust and foreign matters shall be removed from the beveled ends by power operated brush. This shall be affected inside & out side and for a minimum distance of 25 mm from edge of bevel. The bevel shall be thoroughly inspected at this stage. Should laminations, spilt ends or manufacturing defects in the pipe observed, the length of the pipe containing such defects shall be removed from the line in accordance with relevant specification.

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

8.1 Pipe Defects and Repairs

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

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

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

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

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

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

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

8.2 Pipe Handling And Skid Spacing

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

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

8.2.3 Skids shall be atleast 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 atleast 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 (atleast every 10th support) with a greater number required at bends and undulation grounds.

8.3 Night Caps

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

8.4 Temporary Caps

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

9.0 LAYING OF PIPE

9.1 Lowering In Trench

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

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

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

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

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

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

9.1.7 Laying shall be carried out under safe conditions so as to avoid stresses and temporary deformations of the equipments which may cause damage to the pipeline itself and to the coating. In localised 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 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 atleast 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

Pipeline greater than 24" : 300mm

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

12.0 SPECIAL INSTALLATIONS ON THE PIPELINE.

12.1 General

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

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

Without limiting the generality thereof, the work required to complete the installations shall, where applicable, include all site surveys, site preparation, filling, grading, fencing, foundations, installation of block valves, side valves, pipework, pipe supports, pressure gauges, mechanical facilities, civil work, painting, installation of all electrical

equipments, motors, cables, conduIt, wiring and fixtures and hooking up of same; installation of all instruments, piping, valves and fittings; mount all instruments and make all piping and electronic connections, etc.

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

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

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

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

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

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

12.1.2 **Dimensional tolerances.**

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

a) General dimension such as face to face, face or end to end, face or end to center, and center to center : ± 3 mm.
b) Inclination of flange face from true in any direction: 4 mm per meter.
c) Displacement of branch connection from indicated location: ± 1.6mm. When multiple branches are involved, the displacement of the branches shall not exceed 3mm from a common point.
d) Rotation of flange bolt holes shall not exceed 1.6 mm.

12.1.3 **Flanged connections.**

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

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

12.1.4 **Threaded connections.**

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

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

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

12.1.5 **Welded connections**

Where the Ends of the piping components being welded have an internal surface misalignment exceeding 1.6mm, the wall of the component extending internally shall be trimmed by machining so that the adjoining internal surfaces will be approximately flush. All welding shall be performed in accordance with the specification " Specification for welding of pipelines and related facilities".
Tie - ins between fixed points shall be made at maximum ambient temperature.

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12.1.6 **Civil Work**

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

12.1.7 **Painting**

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

12.1.8 **Coating of buried-Installations, etc.**

All buried valves, insulating joints, flowtees, bends, other in-line fittings and appurtenances shall be coated with minimum three coats of approved quality of coal-tar epoxy or any other equivalent suitable COMPANY approved coating at no extra cost to the COMPANY. For buried pipes either heat shrink tapes conforming to COMPANY's specification or coal tar epoxy shall be used. CONTRACTOR shall submit to COMPANY

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

12.1.9 **Clean-up**

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

12.2 **Installation of Valves and Valve Stations**

12.2.1 Block and sectionalising valve stations shall be installed as shown on the approved drawings. It is CONTRACTOR's responsibility to have the units completely assembled, tested and made fully functional including all related instruments etc.

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

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

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

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

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

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

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

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

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

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

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

13.0 WORKING SPREAD LIMITATIONS

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

Between ROW grading, clearing and backfilling : 30 Kms

Between backfilling and final clean-up : 05 Kms

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

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

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

14.9 Ditches for which no instructions for restoration have been issued, or restoration cannot be done according to existing banks because of the absence of it, shall be restored as instructed by COMPANY. The bed of ditches crossed by the pipeline, shall be cleaned over the full width or the ROW, also outside the ROW if necessary. This restoration might involve the supply and installation proper materials for backfill and protection, sodding or other precautions to prevent erosion or guarantee the stability. Work has to be done after deliberation and acceptance of the authorities and COMPANY. Other field drains have to be restored by hand and/or special equipment to be used for that purpose as soon as possible and if necessary, also outside the ROW.

14.10 Any subsidence, cave-ins, wash-outs, which have been caused during the pipeline construction and maintenance, caused by whatever reason within the edge of ditches and open drains, shall be repaired by CONTRACTOR immediately or at first notice given by COMPANY.

14.11 After the clean-up, the ROW of pastures has to remain fenced and to be removed during the maintenance period. When agricultural and other traffic (requested by tenant) have to cross the ROW the cross-overs have to be fenced with the same material as the ROW. If necessary, special materials have to be used to allow traffic on the cross-over. Fencing of the right-of-way as specified shall not be removed until CONTRACTOR has obtained written permission by COMPANY. In general this has to be done during the maintenance period.

14.12 All openings in or damage to the fence or enclosures shall be repaired by installing new fencing of quality which shall be at least equal to the parts damaged or removed. Provisional gates shall be removed and replaced with new fencing. All repairs to fences and enclosures shall be carried out to the complete satisfaction of COMPANY, land owner and/or tenant.

14.13 If, in the opinion of COMPANY, the sod in pasture land has been damaged by vehicles and wheel tracks are visible, the ROW shall be tilled with a disc-harrow or rotary cultivator several times. The damaged sod shall be firmly cut up and thoroughly mixed through the top-soil. In general the ROW has also to be ripped. After this procedure no closed-in layers must be found and sufficiently loose top-soil 25 to 30cm thick must be present. The whole procedure has to be approved by COMPANY. Subsequently, the entire ROW which is part of pasture land, shall be prepared for seeding and fertilized according to the instructions of COMPANY.

14.14 In crop fields the tillage shall consist of passing over the land several times with a disc harrow, cultivating with a spading machine, or plow, to a depth of approx. 20 cm. In general the ROW has also to be ripped. After this cultivation process no closed-in layers must be found in the ROW. The equipment used and methods adopted shall require the approval of COMPANY. Ripping, has to be done with rippers with a distance of 50 cm between the ripper blades. The type to be used shall be approved by COMPANY.

14.15 A sapling of any plant/tree uprooted or cut during construction shall be planted along the route as per the direction of the COMPANY and in accordance with the Forest Preservation Act, 1981. The cost of sapling and its plantation shall be to CONTRACTOR's account.

14.16 The ROW and the backfilled trench in particular has to be finished in such a way that after settlement of the soil the fields are at their original level.

If during the maintenance period certain parts of the ROW are lower than the original level, COMPANY can order CONTRACTOR to bring these parts to the original level. If the level of the ROW for clean-up is ordered by COMPANY, risk of above mentioned additional restoration shall not be to CONTRACTOR's account.

In cases where heavy damage has occurred to the structure of the subsoil as a result of special circumstances, COMPANY reserves the right to order CONTRACTOR to carry out special work. Said special work can include:

- spading with dragline (depth 30 - 80 cm);
- spading with dragline (depth 80 - 100 cm);
- fertilizing;
- cover with sand.

If during clean-up operations, soil shortages become apparent outside the trench, CONTRACTOR shall supplement said soil shortage using suitable materials, approved by COMPANY.

If site and/or climatic conditions should render this necessary, COMPANY shall have the right to order CONTRACTOR to suspend certain parts of the WORK related to the clean-up and postpone it to a later date.

14.17 **Soil Surplus**

If on site, as a result of the work and after careful backfilling and compacting, a sub-soil surplus exists, this shall be worked up by grading and compacting below the sub-soil top layer and as a rule this shall be done in the same plot of land. It shall not be permitted to remove the surplus from the plot concerned, unless it concerns rejected soil which has to be removed. Working up surplus soil or removal of rejected soil shall be considered to pertain to the WORK.

To work a soil surplus into the ground CONTRACTOR shall remove an additional strip of top soil beside the trench. Next the upper layer of sub-soil shall also be removed. Both soil types shall be stored separately across a width depending on the size of the soil surplus. The soil surplus shall then be distributed across the trench thus widened, after which it shall be graded and compacted and subsequently the top layer of sub-soil and the top-soil shall be replaced in the correct order, in accordance with the Specifications.

In case COMPANY has given prior permission for mixed excavation of the sub-soil as well as in cases where COMPANY deems mixed excavation permissible, the above provision of separate storage of the upper layer of sub-soil shall not apply to the working up of the soil surplus.

In cases where the soil surplus can be worked up in other plots where soil shortages have arisen due to the WORK, this shall only be done after prior permission by 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.

Edition : 1

SPECIFICATION
FOR
WELDING OF ONSHORE GAS PIPELINES

SPECIFICATION NO.: MEC/S/05/21/02

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION OIL & GAS SBU, DELHI		
TITLE	WELDING OF ONSHORE GAS PIPELINES	DOCUMENT NO. MEC/S/05/21/02	Page 1 of 1 REVISION : 1 EDITION : 1

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PREPARED BY:	CHECKED BY:	APPROVED BY:	ISSUE DATE :
(Shalini Singh)	(Sunil Kumar)	(A.K. Johri)	Jan. 2009

01. SCOPE

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

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

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).
- Welding and Brazing Qualification, ASME Sec. IX.

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

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

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

The CONTRACTOR shall submit batch test certificates from the electrode manufacturers giving details of physical and chemical tests carried out by them for each batch of electrode to be used.

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, f or each batch of electrode.

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

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

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

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_2, 5% CO_2 the variation of such addition shall not exceed ± 10% of that stated. Moisture content shall correspond to a dew point of - 30°C or lower.

05. EQUIPMENT & ACCESSORIES

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

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

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

06. WELDING PROCESSES

6.1 Welding of various materials under this specification shall be carried out using following process.

6.1.1 Main line (24" ϕ & above API 5L Gr. X-70, PSL-2)

Welding shall be carried out by automatic or semi automatic welding process.

6.1.2 Main line (24" ϕ & above API 5L Gr. X-80, PSL-2)

Welding shall be carried out by automatic welding process. When welding is carried out

only from outside, copper backing shall be used at the root side.

6.2 Tie-Ins and Crossings

Shielded Metal Arc Welding and Semi-automatic Flux Cored Arc Welding shall be used for tie-ins and crossings.

6.3 Any deviation desired by the Contractor shall be obtained through the written consent of the Company.

Following agencies for Automatic Welding Systems are acceptable:

a) CRC-Evans Automatic Welding Systems, Houston
b) Pipe Welding Technology, Italy
c) RMS Welding Systems, Canada
d) Sermier Dasa, France

In case, the bidder proposes to employ any other agency, the proposed agency shall meet the qualification criteria mentioned in the following paragraph and shall submit necessary documentation meeting the criteria. The detailed system description and the procedure shall be submitted to the COMPANY for evaluation and approval

"Automatic welding systems and agencies who have proven track record of high productivity with satisfactory quality of weld and have done a single project of diameter 20" or above for a minimum length of 50 km and for a cumulative length of 500 km or above on large diameter Pipe lines in the last ten years shall only be accepted. CONTRACTOR shall engage only such automatic welding systems and agencies for the work to be covered by main line automatic welding. The track record shall be submitted to the COMPANY for approval prior to engagement".

6.4 The welding specification charts specifically developed for welding of the pipeline under this project shall be followed. The welding procedure adopted and the consumables used shall be specifically approved.

6.5 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 bevelled ends by power operated tools. This shall be effected inside and outside and for a minimum distance of 25mm from the edge of the weld bevel. The bevels shall be thoroughly inspected at this stage. If any of the ends of the pipe joints are damaged to the extent that, in the opinion of COMPANY, satisfactory weld spacing cannot be obtained and local repair by grinding cannot be successfully done, the damged 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 atleast 150mm from any other weld. The welds for fittings shall be so located that the toe of the weld shall not come within 50 mm of any other weld. Cold dressing is permissible only in cases of slight

misalignment and may only be carried out with a bronze headed hammer. Hot dressing shall not be permitted. When welding pipes of different wall thickness (as directed by COMPANY) a special transition piece shall be used. This shall have a minimum of 1:4 taper. The welds shall be subject to both ultrasonic and radiographic inspection.

The root gap shall be accurately checked and shall conform to the qualified welding procedure. The use of internal line-up clamps is mandatory for pipe diameters 10" and above. However, in some cases (tie-in welds, flanges, fittings, diameter of pipe 10" etc.) where it is impossible to use internal clamps, an external line-up clamp may be used.

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

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

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

09.0 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 (for yard double jointing) 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 oridinary line welding without misalignment or uneveness.

c) The root pass of butt joints shall be executed properly so as to achieve full penetration with complete fusion of the root edges. Weld projection inside the pipe shall not exceed 1.6 mm wherever not specified by the applicable code.

d) Any deviation desired from the recommended welding technique and electrodes indicated in the welding specification chart shall be adopted only after obtaining express approval of the COMPANY.

e) Welding shall be continuous and uninterrupted during a pass.

f) On completion of each run, craters, welding irreigularities, slag, etc., shall be removed by grinding and chiselling.

g) While the welding is in progress care shall be taken to avoid any kind of movement of the components, shocks, vibration and stresses to prevent occurance of weld cracks.

h) Fillet welds shall be made by shielded metal arc welding process irrespective of the thickness and class of piping. Electrode size shall not exceed 3.25mm diameter for socket joints. Atleast two passes shall be made on socket weld joints

i) Root pass of fillet weld for branch connection can also be made by GTAW process. However other pass shall be made by SMAW process as mentioned above (point h).

j) Peening shall not be used.

10.2 **Joint Completion**

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 (QWPS).

The pipe shall always be adequately supported and must not be pumped or shaken during welding. The clamp shall be removed, as indicated in clause 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.

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

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

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

Electrodes starting and finishing points shall be staggered from pass to pass. Arc-strikes outside the bevel on the pipe surface are not permitted. Arc - strike or arc-burn on the pipe surface outside the weld, which are caused accidentally by electrical arcs between the electrodes, electrode holder, welding cable shall be removed by grinding in accordance with a procedure approved by COMPANY and the repair checked by ultrasonic, radiographic, magnetic particle or dyepenetrant tests which the COMPANY feels necessary. The pipe wall thickness after grinding shall not be less that the minimum thickness limit permitted for the pipe. Repair of arc-strikes by welding is prohibited.

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

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

11.0 HEAT TREATMENT

11.1 Preheating

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

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 LPG flame with ring burner may be used with the permission of the COMPANY under careful supervision.

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

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

11.2 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 atleat as that specified in the relevant applicable standards/ codes.

The width of the heated band centered on the weld shall at least be equal to the width of weld plus 2" (50mm). The temperature gradient shall be such that the length of the material on each side of the weld, at a temperature exceeding half the heat treatment temperature, is atleast 2.5 rt where 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 treatment charts. The same identification numbers shall also be followed for identification on corresponding radiographic films. The chart containing the identification number and piping sketch shall be submitted to the COMPANY in suitable folders.

k) Vickers hardness/ Brinnel hardness of the heat affected zone as well as of the weld metal, after heat treatment shall be measured using a suitable hardness tester and shall not exceed the maximum hardness specified in the welding specification chart. The weld joint shall be subjected to reheat treatment, when

hardness measured exceeds the specified limit, at the CONTRACTOR's own expense.

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

12.0 INSPECTION AND TESTING

12.1 General

a) The COMPANY's Inspector shall have free access to all concerned areas, where the actual work is being performed. The CONTRACTOR shall be also provide the COMPANY's inspector all means and facilities necessary to carry out inspection.

b) The COMPANY is entitled to depute its own inspector to the shop or field where pre-fabrication and erection of pipelines are being done, with (but not limited to) the following objectives :-

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

ii. To supervise the welding procedures qualification.

iii. To supervise the welder's performance qualification.

iv. To carry out visual/NDT examination of the weldings.

v. To check whether shop/ field welding is being executed is in conformity with the relevant specification and codes of practice followed in pipe construction.

c) CONTRACTOR shall intimate sufficiently in advance the commencement of qualification tests, welding works and acceptance tests, to enable the Company's inspector to be present to supervise the same.

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 special requirements of the specification / 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 & Annexure-IV** (attached) shall be submitted to the COMPANY's Inspector for approval immediately after completing the procedure qualification test and atleast 2 weeks before the commencement of actual work. Standard tests as specified in the code shall be carried out in all cases. In addition to these, tests, other tests like radiography, macro/ micro examination, hardness tests, dye penetrant examination, charphy V-notch etc. shall be carried out on specimens. It shall be the responsibility of the CONTRACTOR to carry out all the tests required to the satisfaction of the COMPANY's Inspector. The destructive testing of welded joints shall be as per Clause 14.0.

12.3 **Welder's Qualification**

a) Welders shall be qualifed in accordance with the API 1104 and other applicable specifications by the CONTRACTOR at his expense. The butt weld test pieces of the qualification test shall meet the radiographic test requirements specified in Clause 12.5 and 16.0 of this specification. The COMPANY's Inspector shall witness the test and certify the qualification of each welder separately. Only those welders who have been approved by the COMPANY's Inspector shall be employed for welding. CONTRACTOR shall submit the welder qualification test reports in the standard format as shown in **Annexure-V** and obtain express approval, before commencement of the work. It shall be the responsibility of CONTRACTOR to carry out qualification tests of welders and obtain written approval, before commencement of works.

b) The welders shall always have in their possession the identification card as shown in **Annexure-VII** 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 unqualfiied 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**

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

The non-destructive examination shall mainly consist of examination using Automated Ultrasonic Testing (AUT) as detailed in clause no. 16.0. This shall be applicable for all welds made by automatic GMAW process with narrow gap edge preparation and welds made by semi-automatic FCAW process.

The CONTRACTOR shall make all the arrangements for the AUT of work covered by the specification at his expense. The CONTRACTOR shall furnish all the reports to the COMPANY, immediately after examination together with the corresponding interpretation reports on the approved format. The details of the AUT reports 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. The COMPANY will review all the AUT records of welds and inform the CONTRACTOR to those welds, which are unacceptable. The decision of the COMPANY shall be final and binding in this regard.

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 NDT work covered by the specification at his expense.

All requirements mentioned in the specification shall be arranged and executed by the CONTRACTOR through his own resources. In addition, Radiography examination shall be required in the following cases as per clause no. 17.0 of this specification :

a) On the first 100 welded joints corresponding to each automatic GMAW welding procedure used.
b) When welds are repaired.
c) When in the opinion of COMPANY, radiography inspection is required to confirm or clarify defects indicated by Ultrasonic examination.
d) Welding of Transition piece of pipe.

In addition, Radiography inspection may be required for certain critical welds of the pipeline, i.e. tie-ins, welding of valves, flanges, randomly selected at COMPANY discretion. All fillet and groove welds, other than those AUT examined, shall be subjected to Dye-Penetrant /MP testing followed by manual Ultrasonic testing.

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

All other welds and Tie-in joints having API bevel shall be examined by Radiography. When Radiography is used, the provisions stated in this para shall be applicable.

- For all production welds, X-ray Radiography by internal crawlers be used.

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 Radiography examination of work covered by the 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 the requirements mentioned in the specification shall be arranged and executed by the CONTRACTOR through his own resources. In addition, Ultrasonic inspection is required in the following cases as per clause no. 15.0 of this specification:

a) On the first 10 welded joints corresponding to each automatic GMAW welding procedures used.
b) When welds are repaired.
c) When in the opinion of COMPANY, Ultrasonic inspection is required to confirm or clarify defects indicated by Radiography.

In addition, Ultrasonic inspection may be required for certain critical welds of the pipeline, i.e. tie-ins, welding of valves, flanges, randomly selected at COMPANY discretion. All fillet and groove welds, other than those are subjected to Radiography, shall be subjected to Dye-Penetrant/MP inspection. The non-destructive testing system used for inspecting welds must by approved by the COMPANY.

Acceptance Criteria

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

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

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

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. A 100% ultrasonic test shall be done at the repaired area externally. Any repaired area that is wide, irregular or rough shall be rejected and a full cut out shall be done. Single pass repairs shall be subjected to 100%, Dye-Penetrant / MP testing.

Repairs are limited to a maximum of 30% of the weld length. Not more than two repairs are permitted on the same location. All repairs shall be carried out the day after initial Radiography or earlier. A report of all repairs shall be maintained by CONTRACTOR and submitted every day to the Company / Consultant.

13.2 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. Having passed the visual and the nondestructive inspection, the test weld shall be subjected to mechanical test.

Weld specimens shall be taken from the positions indicated in Fig. 1 of this specification from areas as free from defects as possible; for this reason it is necessary to take the previous non-destructive tests into account. The minimum number of tests

to be carried out is given in Table-1 of this specification.

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

14.2 **Tensile Strength**

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

The ISO test specimen are shown in Fig. 2 of this specification.

14.2.1 **Method**

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

Table-1

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

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

14.3 **Nick-Break Test**

14.3.1 **Preparation**

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

14.4 **Macroscopic Inspection**

14.4.1 **Preparation**

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

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

14.4.2 **Method**

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

14.4.3 **Requirements**

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

14.5 **Hardness Test**

14.5.1 **Preparation**

The prepared macrosection is to be used for hardness testing using the Vickers method with 10 kg load Indentations are to be made along traverses each approximately 1mm below the surface on both sides of the weld.
In the weld metal a minimum of 6 indentations equally spaced along the traverses are to be made. The HAZ indentations are to be made along the traverses for approximately 0.5mm each into unaffected materials, and starting as close to the fusion line as possible.

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

14.5.2 **Method**

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

14.5.3 **Requirements**

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

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

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

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

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

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

14.6.2 **Test Method**

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

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

14.6.3 **Requirements (Note-1)**

The impact energy shall be as follows :

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, where 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
Width of the die `C' : 50.8mm

The acceptance criterion on shall however be as per para 2.643 and 2.653 of API 1104 nineteenth edition Sept. 1999.

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 as described in para 11.4.3, API 1104; nineteenth edition. 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. The Ultrasonic inspection procedure shall be approved by the Company.

15.4 Test Procedure

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

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

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

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

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

15.6 Probes

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

15.7 **Reference Sample Pieces**

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

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

15.8 **Calibration**

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

15.9 **Regulation of Amplification During Production Testing**

Scanning sensitivity shall be as provided in API 1104 para 11.4.7.2 &11.4.7.3.

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 AUTOMATED ULTRASONIC TESTING (AUT)

- **INTRODUCTION**

The specification shall be applicable for Automated Ultrasonic Testing (AUT) system suitable for pipeline girth welds. The system shall be based on focused pulse-echo, tandem or through transmission methods enhanced with mapping image and augmented by Time Of Flight Diffraction (TOFD) technique.

- **REFERENCE DOCUMENTS**

ASTM E 1961-98 "Standard Practice for Mechanized Ultrasonic examination of Girth Welds using Zonal Discrimination with Focused Search Units". The inspection system shall meet and exceed the requirements of ASTM E 1961-98.

Appendix-E, "Automated Ultrasonic Girth Weld Testing", OS-F101, Submarine Pipeline Systems, January 2000.

API Std. 1104 – "Welding of Pipeline and Related Facilities".

- **APPROVED AGENCIES**

Following agencies for Automatic Ultrasonic Testing (AUT) are acceptable:

a) RTD Quality Services, Rotterdam, Netherlands
b) SHAW Pipeline Services, Canada
c) WELDSONIX, USA
d) UT Quality, Canada
e) SCI, Spain
f) SIEVERT India Private Ltd., India

In case bidder proposes to employ any other agency, the proposed agency shall meet

the qualification criteria listed below and shall submit necessary documentation. The detailed system description and procedure shall be submitted for COMPANY evaluation/ approval.

Automatic Ultrasonic Testing (AUT) systems and agencies who have proven track record and have done a single project of diameter 20" or above and minimum length of 50 km and also have inspected a cumulative length of 500 km or above on large diameter Pipe lines in the last ten years shall only be accepted. The agency should have been approved by the reputed inspection agencies. The track record shall be submitted to the COMPANY for approval prior to engagement.

- **AUT SYSTEM**

The system shall meet and exceed the requirements of ASTM E1961-98.

The system shall provide an adequate number of examination channels to ensure the complete volumetric examination of the weld through the thickness in one circumferential scan. The evaluation zones should be of maximum 2.0mm height. The instrument linearity should be such that the accuracy is within 5%.

Each examination channel should be selective for pulse-echo or through transmission mode gate position and length for a minimum of two gates and gain.

TOFD techniques & B-scan mapping should be available to improve characterization. Recording thresholds should be selectable to display signals between 0 and 100% of full screen height for simple amplitude and transit time recording and it should be from 0 to 100% for B-scan or mapping type recording of data. Two recordable signals output per gate should be available being either analog or digital and representative of signal height and time of flight. Measuring distance accuracy of circumferential weld shall be within 1.0 cm from zero (0) position.

Electronic noise shall be lower than acoustical noise in all channels for the probes and sensitivities to be used during inspection. The signal to noise ratio for each channel during examination shall be at least ≥ 20 dB for shear waved probes.

- **COUPLING**

The coupling shall be obtained by using a medium suitable for the purpose. It shall be suitable for the temperature used. No residue shall remain on the pipe surface. A method should be employed to determine that constant coupling is achieved during examination. An examination of the test piece with its surface wiped dry should

produce a record showing an absence of the couplant recording signal.

- **SEARCH UNITS**

The search unit shall meet all the requirements specified in Para 6.4 of ASTM E1961¬-98.

- **CALIBRATIONS**

Reference standards shall be manufactured from a section of unflawed project specific line pipe supplied by pipeline CONTRACTOR. The agency shall then submit the reference standard design to the COMPANY before manufacturing. No design changes in the reference standard shall be made without the prior approval. Annexure A3 of the standard ASTM E1961-98 provides an example for minimum requirements for reference standards.

The system shall be optimized and calibrated as stated in Para 7.0 and 8.0 of ASTM E 1961-98. Static and Dynamic calibration shall be done and the approved procedure shall clearly state the gain setting fixed for each channel.

The reference standard should be used to verify the scanning sensitivity at the start of each shift and thereafter at intervals not exceeding two (2) hours or ten (10) welds.

A re-calibration shall be carried out if :

a) The calibration of an inspection function differs more than +/- 3dB from the previous calibration
b) The gate settings need to be adjusted with more than +/- 1.5 mm with the previous calibration
c) After a weld repair
d) After equipment breakdown.

In case the calibration differs from the initial setting, outside the given tolerances, the applicable probe(s) and coupling shall be checked. If the calibration has to be changed, the welds before this calibration upto the previous calibration will be re-examined.

The reference standard design for calibration shall be approved separately. The procedure for calibration and verification shall be same as given above.

- **PROCEDURE**

A detailed AUT procedure shall be prepared and qualified for each wall thickness and joint geometry to be examined prior to the start of any NDT work. Repair procedure shall be separately qualified for each joint geometry. All the requirements of ASTM E1961-98 should be met. The procedure as a minimum shall include the following:

- Functional description of equipment
- Reference standards and guidelines controlling equipment maintenance
- Instructions for scanning device, Ultrasonic instrument, Ultrasonic electronics, Hard & Software for recording processing, Display presentation and storage of inspection data
- Transducer configuration(s), characteristics types coverage.
- Number of examination zones for each wall thickness to be examined.
- Gate settings
- Equipment settings -Description of calibration blocks including type, size and location of calibration reflectors, a) calibration intervals, b) calibration records - Static and dynamic calibration procedure
- Identification of inspection starting point scanning direction and indication of length inspected
- Method for scanner alignment and maintenance of alignment
- Allowed temperature range
- Couplant coupling and coupling control and channels provided to indicate lack of coupling and method to ensure constant coupling
- Transducer and over all functional checks
- Height and length sizing methodology
- Surface condition and preparation
- Description of inspection work
- Acceptance criteria and instructions for reporting including example of recorder chart and form to be used.
- A table indicating corresponding channel no., probe, type, location of reflector, probe coupling etc.

- **Setting of Inspection Gates**

Pulse-echo and Tandem Channels

With each transducer positioned for the peak signal response from the calibration

reflector the detection gates are to be set. The gate shall start 2-6mm (allowance for width of heat affected zone) before the theoretical weld bevel preparation. The gate ends shall be after the theoretical weld centerline. All gates will be programmed to record amplitude and/or transit distance information. The length of the transit distance in the root channel will be extended to enable root penetration registration.

Mapping Channels

The mapping gates in the body of the weld shall start 2-6mm (allowance for width of heat affected zone) before the theoretical weld bevel preparation. The gate length will be extended to enable cap reinforcement registration. The mapping gates in the root will be set identical to the pulse-echo transit distance channels to enable the registration of the root penetration.

TOFD Channel

The TOFD gate start will be set 1 µSec before the arrival of the lateral wave and should extend up to the first back wall echo to achieve full cover of wall thickness.

Note: The gate settings may be altered if geometry indications dictate.

Sensitivity Settings

With each transducer positioned for the peak signal response from the calibration reflector (flat bottom holes), the detection gates are to be set. In this position, the probe holder is fixed to the probe frame. The equipment sensitivity (echo amplitude) for all inspection channels shall be set at 80% Full Screen Height (FSH).

Mapping channels in the body of the weld will be used to detect the presence of porosity and in addition to identify the position of the weld cap reinforcement for pattern recognition purpose. The sensitivity as a minimum is equal to the related pulse- echo channels, increased with additional gain to ensure proper detection.

Mapping channels in the root will be used to identify the position of the root penetration for pattern recognition purpose. The sensitivity as a minimum shall be equal to the related pulse-echo channels, increased with additional gain to ensure proper detection.

The lateral wave of the TOFD channel sensitivity is set at 80% FSH.

- **TRAINING AND QUALIFICATION**

1. All Inspectors' of the COMPANY (Owner) shall be imparted training at the CONTRACTOR's cost. The inspector shall be provided complete awareness and knowledge regarding the equipment, limitations, capabilities complete range, method of operation, calibration, scanning, including development of suitable procedure, training on variables effecting the system performance and interpretation of results.

2. The Ultrasonic lead operator performing the examination shall be qualified in accordance with the COMPANY's written practice and in accordance with ASNT Practice SNT-TC-1A and EN 473 Level II. He should have experience in multichannel UT equipment and be trained in using mechanized UT manipulators.

- **FIELD EXAMINATIONS AND REPORTING**

All the requirements stated in Para 9 and 10 of ASTM E1961-98 shall be followed a minimum.

- **INTERPRETATION OF RESULTS**

General

With the transit distance measurements and with the information from the mapping and TOFD channels visible on the result presentation, indications shall be judged whether they are from the weld geometry or from the defects. The coupling channels will check for coupling loss; in case of coupling loss, a re-scan shall be carried out.

Inspection Result

The inspection result should be evaluated and/or reported as follows:

Welds shall be evaluated using both the pulse-echo and TOFD criteria shown below.

This shall be performed in parallel and rejection against either of these criteria shall be cause for rejection of the weld. The exceptions to this are described in the following notes:

1. All indications in the pulse echo channels should be evaluated which exceed the threshold level of 20% FSH.
2. Defect length shall be measured for the pulse-echo channels from the point where the signal exceeds 20% FSH to the point the signal falls below. The largest height assessed with TOFD or the greatest measured amplitude with pulse-echo shall be assumed to apply over the whole defect length.
3. If the indication cannot be resolved by TOFD i.e. the upper and lower flaw diffraction tips cannot be separately distinguished, no measurement can be made to determine the defect height. In this case, the signal from the pulse-echo channels will be solely used to determine that particular area of the scan.
4. Defects shall be assessed for interaction as follows:

   a) Horizontal interaction

   If the distance between two adjacent defects is less than the length of the smaller of the two defects, then the defect shall be treated as a single defect.

   b) Vertical interaction

   Vertical interaction of defects shall be assessed using TOFD. If the distance between the two adjacent defects is less then the height of the shorter of the two defects, than the defect shall be treated as a single defect. Where the individual defects cannot be resolved by TOFD for the vertical interaction, then the defects are assumed to interact and shall be treated as a single defect.

5. The maximum allowable accumulated defect length shall be as per the criteria given in welding specification.

- **ACCEPTANCE CRITERIA**

Weld quality shall be judged on the basis of the acceptability criteria mentioned in welding specification.

17.0 RADIOGRAPHY

17.1 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

17.2 **Applicable Standards**

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

i. API 1104, Standard for welding Piplines 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.

17.3 **Procedure**

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

17.3.2 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.

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

17.3.4 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.

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

17.3.6 When the radiation source and the film are both on the outside of the weld and located diametrically opposite each other, the maximum acceptable length of film for each exposure shall not exceed the values given in Table-4 of API 1104. The minimum film overlap, in such cases, shall be 40mm. The ellipse exposure technique may be used on nominal pipe sizes of 2 inch and smaller provided that the source of film distance used is a minimum of 12 inch.

17.3.7 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.

17.3.8 Three copies of the exposure charts relating to material thickness, kilo voltage, source of film distance and exposure time shall also be made available to COMPANY by the CONTRACTOR.

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

back to a particular butt weld and welder on piping drawing and pipe line alignment drawing.

17.3.10 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.

17.3.11 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.

17.3.12 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.

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

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

17.4 **Radiation Source**

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

17.4.2 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.

17.5 **Level of Quality**

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

17.6 **Penetrameters**

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

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

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

17.7 **Film Identification Markers**

All films shall be clearly identified by lead numbers, letters, and/or markers. The image of the markers shall appear on the films, without interfering with the interpretation. These markers positions shall also be marked on the part to be radiographed and shall be maintained during radiography.

17.8 **Protection and care of film**

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

17.8.2 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.

17.9 **Re-radiography**

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

17.9.2 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.

17.9.3 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.

17.9.4 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.

17.10 **Qualification of Radiographers**

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

17.10.2 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

17.10.3 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.

17.11 **Preservation of Radiographs**

17.11.1 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.

17.11.2 All radiographs shall become property of the COMPANY.

17.12 **Equipment and Accessories**

17.12.1 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.

17.12.2 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.

17.13 **Radiation Protection**

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

17.13.2 The protection and monitoring shall comply with local regulations.

17.13.3 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.

17.14 **Display of Safety Instructions**

17.14.1 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.

17.15 **Enforcement of Safety Regulations**

17.15.1 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.

17.16 **First Aid and Industrial Injuries**

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

17.16.2 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.

17.16.3 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.

17.17 **No Exemption**

17.17.1 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

ELECTRODE QUALIFICATION TEST RECORD

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

Manufacturer's Name :

Brand Name :

Batch Number & Size Tested :

Classification & Code :

Intended for Welding in Position :

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 temp. :

Postweld Heat Treatment Details :

Visual Examination :

Radiographic Examination Results :

Tensile Test Results :

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

ANNEXURE-I
Sheet 2 of 3

C. **Impact Test Results**

Test Temperature : Notch in :

Type of Specimens (Charpy) : Size of Specimens :

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

d

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)
3)

Macro Test results :

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

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

FORMAT FOR WELDING PROCEDURE SPECIFICATION (WPS)

Company Name _____ By _____
Welding Procedure Specification No. _____ Date _____ Supporting PQR No. (S) _____ Revision No. _____ Date _____
Welding Process (es) _____ Type (s) _____
(Automatic, Manual, Machines or Semi Auto)

JOINTS

Joint Design _____
Backing (Yes) _____(No) _____
Backing Material (Type) _____
Sketches Production Drawings. Weld Symbols Written
Description should show the general arrangement of the parts to be welded. Where applicable, the root specing and the details of weld groove may be specified.

(At the option of the Manufacturer sketches may be attached to illustrate joint design weld layers and bead sequence e.g. for notch toughness procedures, for multiple process procedures, etc.)

BASE METALS

P.No. _____ Group No. _____ to P. No. _____ Group No. _____
OR
Specification type and grade _____
to Specification type and grade _____
OR
Chern. Analysis and Mech. Prop. _____
to Chern. Analysis and Mech. Prop. _____
Thickness Range :
Base Metal: Groove _____ Fillet _____
Deposited Weld Metal: Groove _____ Fillet _____
Pipe Dia Range : Groove : _____ Fillet _____
Other _____

ANNEXURE-III
Sheet 2 of 3

FILLER METALS

F.No. _____ Other _____
A.No. _____ Other _____
Spec. No. (SFA) _____
A WS No. (Class) _____
Size of filler metals _____
_____
(Electrodes, Cold Wire, Hot Wire etc.)
Electrode-Flux (Class) _____
Flux Trade Name _____
Consumable Inset _____
Each base metal/filler metal combination should be recorded individually.

WPS NO. _____ Rev. _____

POSITIONS :	**POSTWELD ED HEAT TREATMENT**
Position (s) of Groove _____ Welding Progression: UP _____ Down ____ Position (s) of Fillet _____	Temperature Range _____ Time Range _____
PREHEAT Preheat Temp. Min. _____ Interpass Temp. Max. _____ Preheat Maintenance _____	**GAS** Shielding Gas (es) _____ Percent Composition (mixtures) _____ _____ Flow Rate _____ Gas Backing _____ Trailing Shielding Gas Composition _____

ELECTRICAL CHARACTERISTICS

Current AC or DC_____ Polarity _____
Amps (Range) _____ Volts (Range) _____
(Amps and volts range should be recorded for each electrode size, position, and thickness, etc. This information may be listed in a tabular form similar to that shown below).
Tungsten Electrode Size and Type _____
(Pure Tungsten, 2% Ceriated, etc)

Mode of Metal Transfer for GMAW _____
(Spray arc, short circuiting arc, etc.)

ANNEXURE-III
Sheet 3 of 3

Electrode Wire feed speed range _____
_____

TECHNIQUE

String or Weave Bead _____
Orifice or Gas Cup Size_____
Initial and Interpass Cleaning (Brushing, Grinding, etc.) _____
_____

Method of Back Gouging _____
Oscillation _____

Contact Tube to Work Distance _____
Multiple or Single Pass (per side) _____
Multiple or Single Electrodes _____
Travel Speed (Range) _____

Peening _____
Other _____
_____

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Others
		Class	Dia	Type Polarity	Amp. Range			
								e.g. Remarks, comments, Hot wire Addition, Technique Torch Angle, etc.

ANNEXURE-IV

Sheet 1 of 3

FORMAT FOR PROCEDURE QUALIFICATION RECORD (PQR)
RECORD ACTUAL CONDITIONS USED TO WELD TEST COUPON

Company Name _____

Procedure Qualification Record No. _____ Date _____

WPS No. _____

Welding Process (es) _____

Types (Manual, Automatic, Semi-Auto) _____

JOINTS

Groove Design of Test Coupon

(For combination qualification the deposited weld metal thickness shall be recorded for each Filler metal or process weld)

BASE METALS Material Sepc. _____ Type of Grade _____ P.No. _____ to P.No. _____ Thickness of Test Coupon _____ Diameter of Test Coupon _____ Other _____ _____	**POSTWELD HEAT TREATMENT** Temperature _____ Time _____ Other _____ _____ _____ _____
FILLER METALS Weld Metal Analysis A No. _____ Size of Filler Metal _____ Filler Metal E.No. _____ SF A Specification _____ A WS Classification _____ Other _____ _____	**GAS** Type of Gas on Gases _____ Composition of Gas Mixture _____ Other _____ _____ _____ _____
POSITION Position of Groove _____ Weld Progression (Uphill, Downhill) _____ Other _____ _____	**ELECTRICAL CHARACTERISTICS** Current _____ Polarity _____ Amps. _____ Tungsten Electrode Size _____ Other _____

ANNEXURE-IV
Sheet 2 of 3

PREHEAT	TECHNIQUE
Phreheat Temp. _____ Interpass Temp. _____	Travel Speed _____ String or Weave Bead _____ Oscillation _____ Multipass or Single Pass (per side) _____ Single or Multiple Electrodes _____ Other _____

GUIDED BEND TESTS

Type of Figure No.	Result

TOUGHNESS TESTS

Specimen No.	Notch Location	Notch Type	Test Temp.	Impact Value	Lateral Exp.		Drop Weight	
					% Shear	Mils	Break	No Break

FILLET WELD TEST

Result - Satisfactory: Yes _____ No _____ Penetration into Parent Metal: Yes _____ No. _____

Marco – Results _____

OTHER TESTS

Type of Test _____

Deposit Analysis _____

Other _____

_____

Welder's Name _____ Clock No. _____ Stamp No. _____

ANNEXURE-IV
Sheet 3 of 3

Test Conducted by _____ Laboratory Test No. _____

We certified that the statements in this record are correct and test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Date : _____ Manufacturer : _____

By : _____

(Detail of record of tests are illustrative only and may be moulded to conform to the type and number of tests required by codes and specifications).

ANNEXURE-V

FORMAT FOR MANUFACTURER'S RECORD FOR WELDER OR WELDING OPERATOR QUALIFICATION TESTS

Welder Name _____ Check No. _____ Stamp. No. _____

Using WPS No. _____ Rev. _____

The above welder is qualified for the following ranges

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

ANNEXURE-V
Sheet 2 of 2

Guided Bend Test Results

Type and Fig. No.	Result

Radiographic Test Results
For alternative qualification of groove welds by radiography

Radiographic Results _____

Fillet Weld Test Results

Fracture Test (Describe the location, nature and size of any crack of tearing of the specimen _____
Length and Per Cent of Defects _____ inches _____%
Macro Test – Fusion _____
Appearance - Fillet Size (ing) _____x_____ Convexity or Concavity _____

Test Conducted by _____ Laboratory - Test No. _____

We certify that the statements in this record are correct and that the test welds were prepared. Welded and tested in accordance with the requirements of Section IX of the ASME Code.

Date _____ Organization _____
By _____

(Details of record tests are illustrative only and may be modified to conformation to the type & number of tests required by the Code).

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

ANNEXURE-VI

Sheet 1 of 1

RADIOGRAPHIC PROCEDURE QUALIFICATION RECORD FOR PIPE WELDING

1. Location
2. Date of Testing
3. Name of the Contractor / Agency
4. Material : Carbon steel / Alloy Steel / Stainless Steel

4.A Technique: DWSI / SWSI / DWDI

5. Diameter & Thickness:
6. Type of Weld Joint:
7. Radiation Source:
8. Intensifying Screens/Lead Screens:
9. Geometric Relationship:
10. Limit of Film Coverage:
11. Film Type and Make:
12. Exposure Time:
13. Processing:
14. Density:
15. Sensitivity:

16.* Type of penetrameter:
(Source side)

17.* Type of penetrameter:
(Film side)

Signature of Contractor / Agency with Seal

Approval of MECON's Inspector

* Ref. Para regarding recommended practice on placement of penetrameters Article 22, SE 142, ASME Sec. V.

* For "Random Radiography" lines placement of penetrameters as per Article 2, ASME, Sec. V is permitted.

ANNEXURE-VII

Sheet 1 of 1

WELDERS IDENTIFICATION CARD

Name :

Identification :

Date of Testing :

Process :

Diameter and Thickness :

Thickness Range Qualified :

Diameter Range Qualified :

WPS No. :

Welding Position & Progression :

Type of welding consumables used :

Valid Till :

Photograph

Approved by :

Employer's Signature with seal

ANNEXURE-VIII

Sheet 1 of 1

Type of Source and Films to be used for RADIOGRAPHY

NOMINAL WALL THICKNESS (T) IN mm		SHOP WELDED JOINTS		IN-SITU WELDS	
		SOURCE	FILM : CEN Class	SOURCE	FILM : CEN Class
T> 19	All Materials	Gamma Ray	C5	Gamma Ray	C5
8T< 19	Carbon Steel	Gamma Ray	C4	Gamma Ray	C4
	All other materials	Gamma Ray	C3	Gamma Ray	C3
<8	Carbon Steel Other than Inspection Class IV *	Gamma Ray	C3	Gamma Ray	C3/C1
	All other materials and Carbon Steel of Inspection Class IV *	X-Ray	C4	X-ray with C4 or Equivalent to be used. Gamma Ray (Se 75 Source only) with C3/C2 Equivalent may be allowed only if in the assessment of the owner's inspector, Joints are inaccessible for X-ray equipment and radiographic sensitivity is achieved.	

Note: Integral to above table

1) Films slower than the above may have to be used, if required radiographic sensitivity is not achieved consistently.

* Piping classes where 100% RT is specified. Refer Std. Spec. No. _____.

COMPARISON OF FILMS FROM DIFFERENT MANUFACTURERS

CEN Classification	KODAK	AGFA	FUJI
---	CX	D8	---
C5	AA400	D7	IX 100
C4	T200	D5	IX80
C3	MX125	D4	IX50
C2	M100	D3	---
CI	DR50	D2	IX25
---	SR**	---	---

* * *Special films, extremely fine grain* & *very high resolution*

WELDING SPECIFICATION CHART

Dia.- 8ò,6ò,4ò THK. RANGE : 6.4 mm				
MATERIAL SPECIFICATIONS	PIPES	**For 8ò, 6ò, 4ò - API 5L Gr X-42 PSL 2**		
		-		
	FITTINGS	-		
	FLANGES	-		
	OTHERS	-		
BASE METAL 'P' NO	**1**			
WELDING PROCESS	**GROOVE JOINTS**			
	BUTT		FILLER PASS : **SMAW**	
	ROOT PASS : **SMAW**	FILLER PASS : **SMAW**	ROOT PASS : **N.A.**	FILLER PASS : **N.A.**
	FILLET JOINTS / SOCKET JOINTS : **N.A.**			
WELDING MATERIAL	**GROOVE JOINTS**			
	BUTT		HOT, FILLER & CAP PASS : **E-7010**	
	ROOT PASS : **E-6010**	HOT, FILLER & CAP PASS : **E-7010**	ROOT PASS : **N.A.**	FILLER PASS : **N.A.**
	FILLET JOINTS / SOCKET JOINTS : **N.A.**			
	BACKING RING : N.A.		**CONSUMABLE INSERT : N.A.**	
JOINT PREPARATION	**AS PER ASME B31.8 / ASME SEC. ïIX, Latest Edition**			
GASES	PURGING :		SHIELDING :	
GAS COMPOSITION	PURGING :		POST HEATING :	
PREHEATING	PREHEAT TEMP: **As Applicable**		POST HEATING :	
CONTINUITY OF WELDING AND PREHEAT : REFER TO SPECIFICATION				
POST WELD HEAT TREATMENT	HOLDING TEMP : N.A.		MIN. HOLDING TIME :	
	RATE OF HEATING: N.A.		RATE OF COOLING :	
	METHOD OF COOLING : N.A.		RATE OF COOLING :	
MECHANICAL PROPERTY REQUIREMENTS	CHARPY 'V' NOTCH VALUE :		0°C	AVERAGE : **27 J**
	AT TEMPERATURE :			
	HARDNESS :			
CODE OF FABRICATION :	**ASME B31.8 / API 1104**			

WELDING SPECIFICATION CHART

PIPING CLASS:	**A1A, B1A,D1A**			
MATERIAL SPECIFICATIONS	PIPES	ASTM A106 GR.B, API 5L GR B PSL-2,API 5L X42 PSL2 **ASSORTED PIPES**		
	FITTINGS	ASTM A105, ASTM A234 GR.WPB, MSS SP-75 GR. WPHY-52, MSS SP-75 GR. WPHY-65		
	FLANGES	ASTM A105, ASTM A694 GR.F-52, ASTM A694 GR. F-65, ASTM A694 GR.-70		
	OTHERS	-		
BASE METAL 'P' NO	**1**			
WELDING PROCESS	**GROOVE JOINTS SINGLE SIDE BEVEL**			
	BUTT		**OTHER THAN BUTT**	
	ROOT PASS : **GTAW / SMAW**	FILLER PASS : **GTAW/SMAW**	ROOT PASS : **SMAW**	FILLER PASS : **SMAW**
	FILLET JOINTS / SOCKET JOINTS : **SMAW**			
WELDING MATERIAL	**GROOVE JOINTS**			
	BUTT		**OTHER THAN BUTT**	
	ROOT PASS : **ER70S-2 / E6010**	FILLER & CAP PASS **ER70S-2/ E7018-1**	ROOT PASS : **ER70S-2/ E6010**	FILLER PASS : **ER70S-2/ E7018-1**
	FILLET JOINTS / SOCKET JOINTS : **E7018-1**			
	BACKING RING : N.A.		**CONSUMABLE INSERT : N.A.**	
JOINT PREPARATION	**AS PER ASME B31.8 / ASME SEC. ïIX, Latest Edition**			
GASES	PURGING :		SHIELDING **: Argon**	
GAS COMPOSITION	PURGING :		SHIELDING : **99.995**%	
PREHEATING / INTER PASS	PREHEAT TEMP **10 -100 Deg** **INTERPASS : Max 200 Deg**		POST HEATING : NA	
CONTINUITY OF WELDING AND PREHEAT : REFER TO SPECIFICATION				
POST WELD HEAT TREATMENT	HOLDING TEMP :		HOLDING TIME :	
	RATE OF HEATING:		MIN. HOLDING TIME :	
	METHOD OF COOLING :		RATE OF COOLING :	
MECHANICAL PROPERTY REQUIREMENTS	CHARPY 'V' NOTCH VALUE :		MIN: **22 J**	AVERAGE : **27 J**
	AT TEMPERATURE :		0°C	
	HARDNESS :			
CODE OF FABRICATION :	**ASME B31.8 / ASME SEC. ïIX, Latest Edition**			
TECHNICAL NOTES :				

Rev. : 0
Edition : 1

SPECIFICATION
FOR
HYDROSTATIC TESTING OF ONSHORE PIPELINE

SPECIFICATION NO.: MEC/S/05/21/03

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

1.0 SCOPE

1.1 This specification covers the minimum requirements of supply, works and operations to be performed by CONTRACTOR for hydrostatic testing of cross-country 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 226	Natural Gas Transmission Pipelines and City Gas Distribution Networks

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 50 kms.

3.2 For pipeline sections which in COMPANY's opinion, once installed would require an inordinate amount of effort for repair in case of a leak, a provisional pre-test shall be conducted. However, after installation, such pretested sections shall be tested again alongwith the entire pipeline.

3.3 Hydrostatic test shall commence only after mechanical and civil works completion, i.e., all welds have been accepted and the pipeline has been laid and backfilled according to the specifications. Hydrostatic test shall include those sections which have been previously tested, viz. Rail/ road crossing, major water crossings including test on banks and in place after installation, and scraper traps at the terminals. CONTRACTOR shall perform all works required for hydrostatic testing after obtaining prior written approval from the COMPANY.

3.4 The pipeline shall be tested in accordance with the requirements of the latest edition of ANSI B 31.8 or ANSI B 31.4, OISD 226 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 hydrostatic test pressure shall be as follows :

For pipeline handling hydrocarbon in gaseous phase :

a) 1.25 times the design pressure for pipeline located in Class-1 and Class-2 locations as per ASME B 31.8.

b) 1.4 times the design pressure for pipeline located in Class-3 and Class-4 locations as per ASME B 31.8.

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^3 / hr. min. ; 1000m^3 / hr. max.
If a single pump is used, a standby unit must be available.

c) Variable speed positive displacement pumps equipped with a stroke counter to pressurise the line with a known stroke and capable of exceeding the maximum test pressure by at least 20 bar.

d) Two positive displacement meters to measure the volume of water used for filling the line. These meters shall be provided with a callibration certificate not older than one month.

e) Portable tanks of sufficient size to provide a continuous supply of water to the pump during pressurizing.

f) Bourdon pressure gauges of suitable pressure range and accuracy.

g) Dead weight testers with an accuracy of 0.01 bar measuring in increments of 0.05 bar provided with a calibration certificate not older than one month.

h) Two 48 hours recording pressure gauges tested with charts and ink gauges tested with dead weight tester prior to use. These shall be installed atp the test heads.

i) Pressure recording charts.

j) Two temperature recorders for fill water.

k) Thermocouples for measuring the pipe wall temperature.

l) Two laboratory thermometers 0°C to 60°C range, accuracy ± 0.1 degree to be used in thermowells.

m) Means to measure the volume of water necessary to drop the line pressure by 0.5 bar (container on scales or graduated cylinder).

n) Injection facilities to inject additives into the test medium in the required proportions.

o) Communication equipment suitable for a continuous connection between the beginning and the end of the test section and with the inspection team along the line, in accordance with the requirements of local Authorities.

p) The temporary scraper traps shall be installed according to the testing sections fixed in the test procedure manual. Proper piping and valuing arrangements shall be available to allow launching and receiving of each pig independently.

The test heads shall be sized in conformity with ASME specification Section VIII, Division 2 with particular reference to Appendices 4 and 5.

q) Thermocouples for assuring the temperature of the pipe wall shall be installed on the pipeline to be tested:

- 1 thermocouple at about 500m distance from the pumping head.
- 1 thermocouple every 2500m of the pipe the spacing may be increased to maximum 5000m depending on the terrain and nature of sub-soil along the alignment of section.
- 1 thermocouple at about 500m distance from the terminal head.

The spacing may be increased to maximum 5000 metre depending on the terrain and nature of sub soil along the alignment of test section.

Thermocouples shall be attached on the external surface of the pipe after removal of external coating and shall be adequately protected and COMPANY's coating instructions shall be followed.

7.0 **PROCEDURES**

7.1 Equipment and/or parts which need not or must not be subjected to the test pressures, must be disconnected or separated from the pipeline to be tested.

7.2 If the difference of minimum and maximum atmosphere temperature should cause thermal instability on the pipe section directly exposed to atmospheric condition, the scraper traps and above ground pipeline shall be properly protected.

The pipeline test shall exclude long segments of line exposed to atmospheric conditions, viz. Aerial lengths on piers, suspension bridges, etc., which shall be tested separately.

7.3 The test medium shall be soft non-aggressive water furnished by the CONTRACTOR. The water to be used shall be filtered, shall not be contaminated, and free from sand or silt. CONTRACTOR shall submit laboratory test reports of water used for testing. The possible use of sea water shall be subject to its degree of cleanliness, the possibility of obtaining a pre determined salinity neutralization and the use of corrosion inhibitors, this at the sole discretion of COMPANY. CONTRACTOR shall provide COMPANY approved corrosion inhibitors, oxygen scavengers and bactericides to be added to the test water. The CONTRACTOR shall furnish and install all temporary piping which may be necessary to connect from source of water to its pumps and manifolds/ tankage.

7.4 Before filling operation the CONTRACTOR shall clean the pipeline by air driven pigs provided with spring loaded bushes and chisels to remove all mill scale rust/ sand from the inside of pipe section. For this purpose temporary headers for air cleaning shall be attached to the pipeline. The number of pig runs is depending upon the cleaning results and shall be determined by the COMPANY at site.

7.5 “After cleaning the pipeline by using air and acceptance by Company, gauging shall be carried out by using gauging pig. The gauge plate diameter shall be equal to 95% of inside diameter of the heaviest wall pipe in the test section. While computing the ID of heaviest wall pipe, pipe manufacturing tolerance shall not be considered. A 10mm thick aluminium plate shall be used for making gauge plate.

After receipt of gauging pig at the other end, the gauge plate shall be inspected in the presence of Company representative. A deformed, bent or severally nicked plate or damaged pig shall be evidence of gauging pig run failure and the same is not acceptable to company. In such cases the Contractor shall repair and rectify the line and repeat the gauging pig run to the satisfaction and approval of the Company Representative. Any obstruction and/ or faults such as dents, buckles, flat spots, etc. analysed and noted during gauging pig run shall be located and any necessary repair work shall be performed to rectify the same to the satisfaction of the Company. A written approval shall be obtained from Company regarding successful completion of gauging pig run.

After acceptance of gauging operation, air header shall be cut and removed. Pre-tested test headers loaded with three numbers of four cup batching pig shall be welded to test Section. Un-inhibited water equal to 10% of the volume of test section shall be introduced in front of the first pig. The first pig shall be launched by introducing about 1.5 km un-inhibited water.

Then the second pig shall be launched by pumping the inhibited water till the second pig is received at the other end. The thermal stablisation and pressurisation can now the started".

7.6 Thermal Stabilization

After a check has been made to confirm if the pressure has attained at least 1 bar (g) on the highest section, thermal stabilization can be started.

Thermal equilibrium between the pipeline and environment shall be checked through the thermocouples installed on the pipeline.

Temperature readings shall be made at 2 hours-intervals. Thermal stabilization shall be considered to have been achieved when a difference not higher than 1°C is attained between the average values of the last two readings. Thermal stabilization completion shall be approved by COMPANY.

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 0.5 bar increment between 90% of test pressure to full test pressure as recorded by the dead weight tester.

The pressurizing shall be cycled according to the following sequence:

a) Pressurize to 50% of test pressure, hold pressure for 1 hour.

b) Drop pressure to static head of test section at test head.

c) Pressurize to 75% of test pressure, hold pressure for 1 hour.

d) Drop pressure to static head of test section at the test head.

e) Pressurize to test pressure.

During the pressurization to each test pressure, two tests shall be carried out for the calculation of air volume in the pipeline under test.

In case, during the hold pressure periods indicated above, a decrease in pressure is observed, the operations shall not be repeated more than twice, after which the line shall not be considered capable of test, until the CONTRACTOR has isolated and eliminated the cause for the lack of water tightness.

7.8 Air Volume Calculation

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

For calculation of air in the pipeline the second pressure lowering shall be used, and the relevant drained water shall be accurately measured (V_1). This amount measured shall be compared to the theoretical amount (V_p) corresponding to the pressure lowering that has been carried out, by using the procedure outlined in clause 12.1 of this specification.

If no air is present in the length under test:

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

In order that the above ratio is acceptable, it shall not differ from 1 by more than 6% (i.e. 1.06).

If the air found in the pipeline is within the above established tolerance, then the pressurizing can continue. If the ratio V_1 / V_p exceeds 1.06, the hydrostatic testing cannot go on and additional pig passages shall be performed to remove the air pockets.

The test shall be repeated as per the above procedure until above estimated tolerances are satisfied. The pressurizing can then continue, to reach the value of test pressure.

7.9 Testing

After the section has been pressurized and the air volume test has given acceptable results the test pressure shall be held for a minimum of 24 hours after stabilization. After temperature and pressure has stabilized, the injection pump shall be disconnected and all connections at the test heads shall be checked for leakage. The pressure recorders shall then be started with the charts in a real time orientation for continuous recording throughout the test.

During the testing period the following measurements shall be recorded :

- every one hour pressure measurements form dead weight testers.
- every two hours the ambient temperature and the pipe temperature at the thermocouples.

All data shall be recorded on appropriate forms attached to the hydrostatic test procedure manual. Care shall be taken that the maximum test pressures are not exceeded.

Bleed-off water shall be accurately measured and recorded.

8.0 **ACCEPTANCE**

8.1 The hydrostatic test shall be considered as passed if pressure has kept a constant value throughout the test duration, except for change due to temperature effects. Such change shall be evaluated as described under clause 12.2 of this specification.

The pressure change value as a function of temperature change shall be algebraically added to the pressure value as read on the meters. The pressure value thus adjusted shall be compared with the initial value and the test shall be considered as acceptable if the difference is less than or equal to 0.3 bar. In case of doubt the testing period shall be extended by 24 hours.

8.2 If test section fails to maintain the specified test pressure after isolation, CONTRACTOR shall determine by search the location of leakage or failure. All leaks and failures within the pipe wall or weld seam shall be repaired by replacement of entire joint or joints in which leakage or failure occurs. In circumferential welds the method of repair shall be determined by the COMPANY. CONTRACTOR shall comply with instructions of the COMPANY whether to replace a section of the line pipe that includes the line leak or whether to repair the circumferential weld. This repair should however meet the requirements of 'Specification for Welding Pipelines and Related Facilities'. Where failure occur in pipeline field bends, bends shall be replaced with same degree of bends. After completion of repairs, the hydrostatic test shall be repeated in full, as per this specification.

8.3 The cost of repairs or replacements, followed by refilling and repressurizing the line, due to poor workmanship, shall be borne by the CONTRACTOR. In the event of leaks or failures resulting form faulty COMPANY furnished materials, CONTRACTOR shall be reimbursed for furnishing all labour, equipment, materials, except those materials furnished by the COMPANY, and transportation necessary to repair and repressurize the section of the pipeline to the pressure at the time of recognition of leak or line failure. CONTRACTOR shall be entitled for compensation as per the provisions of the CONTRACT. All work of reinstalling line pipe, to replace pipe failures shall be done in accordance with the relevant specification included in the CONTRACT.

8.4 CONTRACTOR shall haul and stockpile all damaged and defective pipes to storage locations designated by the COMPANY. All cracks and splice resulting from failures shall be coated with an application of grease to preserve the characteristics of failures from corrosion. Joint of failed pipes shall be marked with paint, with a tag indicating failure details, date and location of failure and pressure at which failure occurred.

9.0 **TERMINATION**

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

9.1 CONTRACTOR shall dewater the tested line as per the following requirement after test acceptance.

The dewatering shall be carried out by using four cup pigs and foam pigs driven by compressed air. The detailed dewatering procedure shall be developed by the CONTRACTOR

in such a way as to provide adequate control of pigs during dewatering. Pigs and equipment required for dewatering the line shall be furnished by CONTRACTOR and shall be approved in advance by the COMPANY. Four cup pigs shall first be passed through the line to displace the water. Foam pigs shall then be passed in order to complete the line dewatering. CONTRACTOR shall use a number of foam pigs, each in different colors/ numbered for this purpose. The line shall be considered dewatered when a negligible amount of water is flushed out by the last foam pig and approval is given by the COMPANY.

9.2 During dewatering, care shall be taken to properly dispose the discharging water in order to avoid pollution, damages to fields under cultivation and/or existing structures and interference with the traffic. Before start of dewatering and disposal of hydrotest water, a procedure for treatment of inhibited water to prevent pollution shall be submitted by contractor to owner/ consultant for review and approval.

9.3 Upon completion of the testing and dewatering operation, any provisional traps for pigs and all other temporary installation relating to the test shall be removed. Subsequently the individual sections of the line already tested shall be joined in accordance with the requirements of relevant specifications issued for the purpose.

10.0 TEST REPORT

A complete report signed by CONTRACTOR and the COMPANY shall be submitted upon completion of the hydrostatic test for each test section.
This report shall contain as a minimum:

- the cleaning, flushing, filling and testing procedures used;
- schematic layout of cleaning, filling and testing facilities;
- instruments calibration certificates;
- a profile of the pipeline that shows the test sites, all instrument and injection connections;
- pipe filling logs and records;
- additive specification, required concentration and additive injection records;
- pig specifications;
- pig inspection records including photographs of the damages;
- records of gauging pig survey and photographs;
- pressurization and stabilization records;
- pressure and temperature recording charts with appropriate information inscribed thereon;

- temperature data along the pipeline;
- dead weight tester logs and recording;
- air volume calculations;
- pressure change due to temperature change calculations;
- environmental data;
- depressurization logs and records;
- dewatering procedure and schematic layout of relevant facilities;
- dewatering logs and records;
- records and photograph of all leaks.

11.0 MEASUREMENTS

11.1 Water Amount Measurement

The water volume added to the section to be tested shall be measured during the filling stage through a positive displacement meter (a turbine meter may also be used). In the calculation, as per clause 12.1 of this specification, use shall be made of the geometrical volume of the section in question.

11.2 Pressure Measurement

Pressure shall be measured with a dead weight tester with an accuracy of 0.01 bar that shall permit readings of at least 0.05 bar.

During the test the pressure shall be recorded by means of a pressure recorder featuring the following specifications:

Accuracy	:	± 0.1% of the full-scale value
Recording	:	continuous on tape or disk, graph width 100mm
Feed	:	20mm/h for tape diagrams, 7.5°/h for disk diagrams
Recording	:	to be such as to record pressure between 50% and 90% of the diagram width.

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

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

11.3 **Temperature Measurements**

Water temperature shall be taken at every 2 hours through the thermocouple that have been installed on the pipe wall along the section under test on the pipe wall.
Further the temperature measurement shall be taken :

- during the filling operation
- during the thermal stabilization stage
- during the hydrostatic test

The thermocouple's sensitivity shall enable temperature readings with an accuracy of ±0.2°C.

b) Water temperature shall also be measured on the pump delivery by means of a recording thermometer (temperature recorder) throughout the filling stage.

The recording thermometer shall have the following features :

Accuracy ± 1% of the scale range

Scale - 10° to + 40° C

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

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

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

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

Accuracy ± 1% of the scale range

Scale - 0° to + 60° C

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

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

12.0 **CALCULATIONS**

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

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

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

Where:

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

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

Δ P = Pressure rise (bar)

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

t = nominal pipe thickness(mm)

A = isothermal compressibility value for water at the pressurization temperature in the P range (bar_{-1}) x 10^6.

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

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

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

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

Where,

ΔP = pressure change resulting from a temperature change (bar)

ΔT algaebrical difference between water temperature at the beginning of the test and water temperature as measured at the end of the test (°C).

B = value of the difference between the thermal expansion of water at the pressure and temperature as measured at the end of the test and that of steel ($°C^{-1}$) x 10^6

(Refer table – A)

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

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

t = nominal thickness of pipe (mm).

13.0 PRECAUTIONS DURING THE TEST

In addition to all that has been expressly described in the procedures for carrying out the tests, the following additional requirements shall be complied with:

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

13.2 Signs stating "PIPE UNDER TEST-KEEP OFF" with local language translation shall be placed where the pipeline is uncovered, and particularly where the provisional traps and stations are located. Such areas shall be suitably fenced in such a way as to prevent access of unauthorized personnel. No unauthorized personnel shall be closer than 40 m to the pipeline or equipment under test.

13.3 Provisional scraper traps shall be installed in compliance with methods and suitable locations so that their rupture cannot cause any injuries to the personnel or third parties.

13.4 The test station shall be placed in such a location as to prevent it from being affected by a catastrophic failure in the test head.

13.5 Once dewatering is over, the sectionalizing valves and other valve assemblies tested previously, shall be installed at locations shown in the drawings and in accordance with the procedures contained in the relevant specifications. All thermocouple installed in the pipeline shall be removed and damaged corrosion coating shall be repaired using COMPANY approved materials and procedure.

14.0 PRESERVATION OF PIPELINE

When so stated in the CONTRACT, to preserve/conserve the pipeline for a specified duration, CONTRACTOR shall completely fill the pipeline with water, with sufficient quantity of corrosion inhibitors depending upon quality of water and the period of conservation, at a pressure to be agreed upon with the COMPANY at a later stage. CONTRACTOR shall obtain necessary approval from the COMPANY of the procedure and the type and quantity of the inhibitors used before commencement of the works.

TABLE - A

^{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

DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL THERMAL EXPANSION FACTOR (^{0}C $^{-1}$) (10^{-6})

TABLE - A

^{0}C Bar	9	10	11	12	13	14	15
0.981	+34.82	+4922	+63.20	+76.78	+89.99	+102.83	+115.34
10	+36.97	+51.26	+65.15	+78.64	+91.75	+104.51	+116.93
20	+39.36	+53.55	+67.33	+80.71	+93.72	+106.39	+118.71
30	+41.76	+55.84	+69.51	+82.79	+95.70	+108.26	+120.49
40	+44.18	+58.14	+71.70	+84.87	+97.68	+110.14	+122.28
50	+46.60	+60.45	+73.90	+86.96	+99.68	+112.04	+124.07
60	+49.02	+62.76	+76.10	+89.07	+102.67	+113.93	+125.88
70	+51.44	+65.08	+78.32	+91.17	+103.68	+115.84	+127.69
80	+53.88	+67.40	+80.53	+93.29	+105.69	+117.76	+129.50
90	+56.32	+69.73	+82.75	+95.41	+107.70	+119.67	+131.32
100	+58.77	+72.07	+84.98	+97.53	+109.73	+121.59	+133.15
110	+61.21	+74.41	+87.22	+99.66	+111.75	+123.52	+134.98
120	+63.67	+76.74	+89.45	+101.79	+113.79	+125.46	+136.82
130	+66.12	+79.09	+91.69	+103.93	+115.83	+127.39	+138.67
140	+68.58	+81.45	+93.93	+106.07	+117.67	+129.34	+140.51
150	+71.05	+83.80	+96.18	+108.21	+119.90	+131.20	+142.37
160	+73.51	+86.15	+18.43	+110.36	+121.96	+133.74	+144.22
170	+75.97	+88.51	+100.68	+112.51	+124.01	+135.19	+146.08
180	+78.44	+90.87	+102.94	+114.66	+126.06	+137.15	+147.94
190	+80.91	+93.23	+105.19	+116.82	+128.12	+139.11	+149.81
200	+83.37	+95.59	+107.45	+118.97	+130.17	+141.07	+151.68
210	+85.84	+97.95	+109.71	+121.13	+132.24	+143.03	+153.55
220	+88.30	+100.31	+111.97	+123.29	+134.29	+144.99	+155.42
230	+90.67	+102.67	+114.23	+125.45	+136.36	+146.96	+157.30
240	+93.22	+105.03	+116.48	+127.60	+138.42	+148.93	+159.18
250	+95.69	+107.39	+118.74	+129.76	+140.48	+150.90	161.05
260	+98.14	+109.74	+121.00	+131.92	+142.54	+152.87	+162.93
270	+100.60	+112.10	+123.25	+134.08	+144.61	+154.84	+164.81
280	+103.05	+114.44	+125.50	+136.24	+146.67	+156.84	+166.69
290	+105.50	+116.79	+127.75	+138.39	+148.73	+158.78	+168.57
300	+107.94	+119.13	+130.00	+140.54	+150.79	+160.75	+170.45

DIFFERENCE BETWEEN THE THERMAL EXPANSION FACTOR THE STEEL THERMAL EXPANSION FACTOR (^{0}C $^{-1}$) (10^{-6})

TABLE - A

^{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

DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL THERMAL EXPANSION FACTOR ($^0C^{-1}$) (10^{-6})

TABLE -A

^{0}C Bar	24	25	26	27	28	29	30
0.981	+215.22	+215.14	+234.88	+244.41	+253.79	+263.00	+272.03
10	+216.13	+225.99	+235.66	+245.13	+254.44	+264.59	+272.57
20	+217.15	+226.94	+236.53	+245.94	+255.18	+264.27	+273.18
30	+218.18	+227.88	+237.41	+246.75	+255.93	+264.95	+273.80
40	+219.21	+228.85	+238.30	+247.58	+256.69	+265.64	+274.42
50	+220.25	+229.82	+239.20	+248.40	+257.45	+266.33	+275.07
60	+221.30	+230.79	+240.11	+249.24	+258.22	+267.04	+275.70
70	+222.35	+231.78	+241.02	+250.08	+258.99	+267.75	+276.35
80	+223.42	+232.77	+241.94	+250.93	+259.78	+248.47	+277.01
90	+224.48	+233.76	+242.87	+251.79	+260.57	+269.19	+277.66
100	+225.56	+234.76	+243.79	+252.66	+261.36	+269.92	+278.33
110	+226.64	+235.78	+244.73	+253.53	+262.17	+270.77	+279.01
120	+227.73	+236.79	+245.68	+254.40	+262.98	+271.41	+279.69
130	+228.82	+237.81	+246.63	+255.28	+263.69	+272.16	+280.38
140	+229.92	+238.84	+247.59	+25618	+264.62	+272.92	+281.08
150	+231.03	+239.87	+248.55	+257.07	+265.44	+273.69	+281.78
160	+232.14	+240.91	+249.52	+257.97	+266.28	+274.46	+282.49
170	+233.26	+241.96	+250.49	+258.88	+267.12	+275.23	+283.20
180	+234.38	+243.01	+251.47	+259.79	+267.97	+276.01	+283.92
190	+235.51	+244.06	+252.46	+260.71	+268.82	+276.80	+284.64
200	+236.64	+245.12	+253.45	+261.63	+269.67	+277.59	+285.37
210	+237.77	+246.18	+254.45	+262.50	+270.54	+278.39	+286.11
220	+238.91	+247.26	+255.45	+263.49	+271.40	+279.19	+286.85
230	+240.06	+248.33	+256.46	+264.43	+272.28	+280.00	+287.59
240	+241.21	+249.41	+257.46	+265.37	+273.16	+280.82	+288.35
250	+242.36	+250.49	+258.48	+266.31	+274.04	+281.63	+289.11
260	+243.52	+251.58	+259.49	+267.27	+274.92	+282.46	+289.86
270	+244.68	+252.66	+260.52	+268.23	+275.82	+283.29	+290.64
280	+245.84	+253.76	+261.54	+269.18	+276.71	+284.12	+291.40
290	+247.01	+254.86	+262.57	+270.15	+277.61	+284.95	+292.18
300	+248.18	+255.96	+263.60	+271.11	+278.51	+285.79	+292.95

DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL THERMAL EXPANSION FACTOR (^{0}C $^{-1}$) (10 $^{-6}$)

Rev. : 0
Edition : 1

SPECIFICATION
FOR
MAJOR WATER CROSSINGS
(CONVENTIONAL)

SPECIFICATION NO.: MEC/S/05/21/04

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

00 **DEFINITION**

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

1.0 **SCOPE**

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

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

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

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

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

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

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

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

- the words `Shall' and `Must' are mandatory

- the words `Should', `May' and `Will' are non-mandatory, advisory, or recommended.

2.0 GENERAL

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

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

i) installation method

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

iii) required work area along with layout and location

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

v) manpower deployment during construction

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

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

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

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

c) Buoyancy studies

d) Preparation of fabrication yard and launching areas.

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

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

g) Procedure for corrosion coating of field joint

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

i) Pulling or other installation method and related calculations.

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

k) Trench correction before launching.

l) Method of positioning and sinking of pipeline.

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

n) Method of backfilling, bank protection and survey.

o) Final test procedure after backfilling.

p) Safety systems during launching, rope tests.

q) Communication.

r) Abandonment and recovery procedures concurred.

s) Necessary permission from concerned authorities for crossing.

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

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

2.3 CONTRACTOR shall comply with all the conditions and requirements issued by authorities having jurisdiction in the area where the work is to be performed. CONTRACTOR shall, at his own responsibility, obtain necessary permits from the authorities having jurisdiction, for performing his work.
If no public roads exist, CONTRACTOR shall arrange on his own for access to his work area at no extra cost to COMPANY.

2.4 **Pre-construction Surveys**

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

3.0 **TRENCHING**

3.1 **Dredging/ Excavating**

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

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

3.1.3 Navigational traffic shall not be obstructed, unless permission has been given thereto. CONTRACTOR shall issue all necessary publications according to the local regulations. Instructions given by authorities shall be followed accurately and immediately, so that there in no hindrance to traffic. For stoppage of navigational traffic public notification, PA system, signal/ sign etc. shall be provided.

CONTRACTOR cannot request a compensation if his work is hampered or delayed due to weather conditions, any obstacles/ or by any traffic on the spot, where work is executed.

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

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

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

All measurements shall be witnessed by COMPANY. The resulting profile, corrected to the elevation of the undisturbed water-course, shall then be the reference profile. Said profile shall be plotted on a 1:200 vertical and horizontal scale.

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

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

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

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

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

3.2 Pumping Line

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

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

3.3 **Spoil**

Spoil which is not dumped on and including spoil acquired after cleaning the water crossing trench, shall be transported and dumped in places, designated thereto by agreement between CONTRACTOR and authorities and approved of by COMPANY. Spoil shall be transported in (split) barges; only those barges shall be used that avoid spilling during transportation due to incorrect closing of the flaps, etc. Spoil which is dumped outside the designated places shall be removed by CONTRACTOR at first notice by COMPANY.

3.4 **Dykes, Dams and Weirs**

CONTRACTOR shall install temporary provisions in the existing dykes, dams, etc. to prevent flooding of low areas.

Therefore in general, in existing dykes, dams, etc a double substituting weir must be installed before start of excavation in the existing dyke or dam. Such a double substituting weir can be a closed wall of sheet piling, supported by soil. The provisions shall be such that the underwater profile of the dredged trench, the water movement caused by ships, etc. cause no slides/ cave-ins of the dyke or dam.

4.0 **CONTINUOUS CONCRETE COATING**

CONTRACTOR shall provide concrete coating over the pipeline including the bends in accordance with the specification issued for the purpose (refer specification no. MEC/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 (24) 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^2 and with a minimum elongation at failure of 12%. The minimum zinc coating of 275 gm^{-2} shall be applied on single/ double twisted wire. After the trench has been backfilled and during the clean up works, the water crossing shall be cleaned across the whole width of ROW. The existing bed profile shall be maintained after restorations.

7.2.2 Unless stipulated otherwise by the authorities or by COMPANY, CONTRACTOR shall protect the banks of the major water crossings by using gravel and boulders filled embankment mattresses of galvanized iron wire (of specification as in 7.2.1 above) to be laid over the backfilled, compacted and graded banks. In case slope of the banks is 1:1 or more, bank protection shall be carried out using gabions. Bank protection works shall be carried out by CONTRACTOR in accordance with the drawings included in the CONTRACT. All materials required for such works shall be supplied by CONTRACTOR and all works carried out in accordance with specifications, approved drawings, instructions of COMPANY and to the complete satisfaction of authorities having jurisdiction at no extra cost to COMPANY.

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

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

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

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

8.0 FINAL HYDROSTATIC TEST

The complete water crossing must be tested immediately after the approved backfilling of the trench. The test procedure shall result in a hoop stress in pipe corresponding to 90% SMYS of the pipe material. After temperature stabilisation pressure shall be retained in the pipeline for a minimum of twenty four (24) 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

Rev. : 0
Edition : 1

SPECIFICATION
FOR
PIPELINES CROSSING ROADS, RAILROADS, MINOR WATER AND OTHER CROSSINGS

SPECIFICATION NO.: MEC/S/05/21/05

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

1.0 SCOPE

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

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

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

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

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

2.0 REFERENCE CODES, STANDARDS AND SPECIFICATIONS

2.1 Reference has been made in this specification to the latest edition (edition enforce at the time of floating the enquiry) of the following codes, standards and specifications.

a) ASME B 31.4 - Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids.

b) ASME B 31.8 - Gas Transmission and Distribution Piping Pipelines Crossing Railroads and Highways.

c) API RP 102 - Recommended practice for Liquid Petroleum Pipelines Crossings Railroads and Highways.

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

e) Part 192, Title 49 - Transportation of Natural and Other Gases by Pipeline.

f) Part 195 - Transportation of liquids by Pipeline.

2.2 In case of conflict between the requirements of above mentioned codes, standards, specifications and practices, the most stringent requirement shall govern.

3.0 GENERAL

3.1 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 unnecesarilly hamper the users of the roads, railroads, buried services and/ or water courses. The water flow shall not be obstructed in any way.

3.2 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.
- Approval letter from Competent Authority.

Such works shall be without any extra cost to COMPANY.

3.3 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 jurisdication 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 4 hours. Test section shall be visually examined for leaks/ defects, etc.

4.0 ROAD AND RAILROAD CROSSINGS

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

The work shall be carried out in accordance with the approved drawings and job standards, as directed by COMPANY and to the satisfaction of COMPANY and the authorities having jurisdication over th 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 jurisdication 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.

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

4.3 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.

4.4 The diameter of the hole for a bored section shall have a hole diameter as close as practicable to the outside diameter of the carrier or casing pipe. If excessive void or too large hole results, or if it is necessary, in the opinion of COMPANY, to abandon the bored hole, prompt remedial measures such as filling the hole with suitable material shall be taken to the entire satisfaction of the COMPANY and Authorities having jurisdication thereof at no extra cost to COMPANY. Equipment used for installation of casing pipe shall be of the type approved by COMPANY.

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

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

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

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

shall be removed than the volume of the pipe. The auger drive shall be provided with a clutch.

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

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

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

4.5 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.

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

4.7 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.

4.8 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.

4.9 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.

4.10 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.

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

5.0 CROSSINGS OF BURIED SERVICES

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

5.2 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.

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

6.0 MINOR WATER COURSE CROSSINGS

6.1 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.

6.2 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.

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

6.4 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.

6.5 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.

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

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

6.9 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.

6.10 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.

6.11 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 jurisdication 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^2 and with a minimum elongation at failure of 10%. The minimum zinc coating of 200 gm^{-2} shall be applied on single/ double twisted wire.

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

- 2m plus the highest water level (recoverable) or 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.

6.12 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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Edition : 1

SPECIFICATION

FOR

PIPING FABRICATION AND ERECTION

SPECIFICATION NO.: MEC/S/05/21/06

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

1.0 GENERAL

This specification covers general requirements of fabrication and erection of aboveground and trench piping systems at site. The specification covers the scope of work of contractor, basis of work to be carried out by contractor and standards, specifications and normal practice to be followed during fabrication and erection by the contractor.

2.0 SCOPE

Generally the scope of work of contractor shall include the following :

2.1 Transportation of required piping materials, pipe support and all other necessary piping materials from Owner's storage point or contractor's storage point (in case of contractor's scope of supply) to work site / shop including raising store requisitions for issue of materials in the prescribed format & maintaining an account of the materials received from Owner's stores.

2.1.1 Piping materials include the following but not limited to the same.

a. Pipes (All sizes and schedule)

b. Flanges (All sizes, types & Pressure ratings).

c. Fittings (All sizes, types and schedule)

d. Valves (All sizes, types and Ratings)

e. Gaskets (All sizes, types & Ratings)

f. Bolts, Nuts or M/C Bolts (All types)

g. Expansion Joint / Bellows (All types)

h. Specialty items like online filters, ejectors, sample coolers, steam traps, strainers, air traps etc.

i. Online instruments like control valve, orifice flange, rotameter, safety valves etc.

2.2 Shop & field fabrication and erection of piping in accordance with documents listed under Cl. 3.0 i.e. 'BASIS OF WORK' including erection of all piping materials enumerated above.

2.3 Fabrication and erection of pipe supports like shoe, saddle, guide, stops, anchors, clips, cradles, hangers, turn buckles, supporting fixtures, bracket cantilevers, struts, teeposts including erection of spring supports and sway braces.

2.4 Fabrication

2.4.1 Fabrication of piping specials like special radius bends, reducers, mitres etc.

2.4.2 Fabrication of plain and threaded nipples from pipes as required during erection.

2.4.3 Fabrication of swage nipples as and when required.

2.4.4 Fabrication of odd angle elbow like 60°, 30° or any other angle from 90/45° elbows as and when required.

2.4.5 Fabrication of flange, reducing flange, blind flange, spectacle blinds as and when required.

2.4.6 Fabrication of stub-in connection with or without reinforcement.

2.4.7 Grinding of edges of pipes, fittings, flanges etc. to match mating edges of uneven / different thickness wherever required.

2.5 Modifications like providing additional cleats, extension of stem of valve, locking arrangement of valves etc. as and when required.

2.6 Preparation of Isometrics, bill of materials, supporting details of all NON-IBR lines upto 2-1/2" within the unit battery limit and get subsequent approval from Engineer-in-Charge as and when called for.

2.7 Obtaining approval for drawings prepared by contractor from statutory authority, if required.

2.8 Spun concrete lining of the inside of pipes 3" NB & above including fittings and flanges as required in accordance with specification.

2.9 Rubber lining inside pipes, fittings, flanges as and when required, in accordance with specification.

2.10 Radiography, stress relieving, dye penetration, magnetic particle test etc. as required in specification.

2.11 Performing PMI using alloy analysers as per 'Standard Specification for Positive Material Identification at Construction Sites, 6-82-0002'.

2.12 Casting of concrete pedestals and fabrication & erection of small structures for pipe supports including supply of necessary materials.

2.13 Providing insert plates from concrete structures and repair of platform gratings around pipe openings.

2.14 Making material reconciliation statement and return of Owner's supply left over materials to Owner's storage.

2.15 Flushing and testing of all piping systems as per standard specification for inspection, flushing and testing of piping systems (Specification No. MEC/S/05/21/11).

3.0 BASIS FOR WORK

3.1 The complete piping work shall be carried out in accordance with the following

3.1.1 "Approved for Construction" drawings and sketches issued by MECON to the Contractor - Plans and/or Isometrics.

3.1.2 "Approved for Construction" drawings and sketches issued by Turn-key bidders to the Contractor - Plans and/or Isometrics.

3.1.3 Approved Process licensor's standards and specifications.

3.1.4 Drawings, sketches and documents prepared by contractor duly approved by Engineer-in-Charge' (such as isometrics and offsite piping etc.)

3.1.5 Approved construction job procedures prepared by Contractor as stipulated in 2.16

3.1.6 MECON specifications/documents as below :

a. Process and Instrument Diagram.

b. Piping Materials Specification

c. Piping support standards.

d. Line list / Number

e. Piping support index.

f. Standard specification of NDT Requirement of Piping

g. Welding specification charts for piping classes.

h. Standard specification for Pressure Testing of Erected Piping System.

i. Welding specification for fabrication of piping

j. Any other MECON or OTHER specifications attached with Piping Material Specification or special condition of contract.

k. Procedure for storage, preservation and positive identification of materials Contractors works / stores.

3.1.7 Following codes, standards and regulations

a. ASME B 31.3 : Process Piping
b. ASME Sec. VIII : Code for unfired pressure vessel.
c. IBR Regulations

d.	IS:823	:	Code for procedure for Manual Metal Are Welding of Mild Steel (for structural steel).
e.	NACE Std.	:	Code for Sour Services material requirements MR.

Note : All codes referred shall be latest edition.

3.2 Deviations

Where a deviation from the "Basis of Work" and approved job procedure described above is required or where the basis of work does not cover a particular situation, the matter shall be brought to the notice of Engineer - in - Charge and the work carried out only after obtaining written approval from him in each case.

4.0 FABRICATION

4.1 Piping Material

Pipe, pipe fittings, flanges, valves, gaskets, studs bolts etc. used in a given piping system shall be strictly as per the "Piping Material Specification" for the "Pipe Class" specified for that system. To ensure the above requirement, all piping material supplied by the Owner / Contractor shall have proper identification marks as per relevant standards / MECON's specifications / Licensors specification. Contractor shall provide identification marks on left over pipe lengths wherever marked up pipe lengths have been fabricated / erected. Material traceability is to be maintained for AS., S.S., NACE, LTCS, material for Hydrogen service and other exotic materials by way of transferring heat number, etc. (hard punching) as per approved procedure. This shall be in addition to colour coding for all piping materials to avoid mix-up.

4.2 Fabrication

4.2.1 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.

4.2.2 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".

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

4.2.4 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.

4.2.5 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.

4.2.6 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.

4.2.7 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.

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

4.2.9 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.

4.2.10 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.

For the purpose of common understanding the construction job procedure, to be submitted by the contractor, shall include proposal for

- Maximizing prefabrication, inspection and testing at fabrication shop with minimum field joints.
- Positive material identification, handling, storage & preservation.

4.3 Dimensional Tolerances

Dimensional tolerances for piping fabrication shall be as per MECON Standard Specification. The Contractor shall be responsible for working to the dimensions shown on the drawings. However, the Contractor shall bear in mind that there may be variations between the dimensions shown in the drawing and those actually existing at site due to minor variations in the location of equipments, inserts, structures etc. To take care of these variations "Field Welds" shall be provided during piping fabrication. An extra pipe length of 100 mm over and above the dimensions indicated in the drawing may be left on one side of the pipe at each of the field welds. During erection, the pipe end with extra length at each field weld, shall be cut to obtain the actual dimension occurring at site. Isometrics, if supplied may have the field welds marked on them. However, it is the responsibility of the Contractor to provide adequate number of field welds. In any case no extra claims will be entertained from the Contractor on this account. Wherever errors / omissions occur in drawings and Bills of Materials it shall be the Contractor's responsibility to notify the Engineer-in-Charge prior to fabrication or erection.

4.4 IBR Piping

4.4.1 Contractor shall be supplied generally with all drawings for steam piping falling under the purview of Indian Boiler Regulations duly approved by Boiler Inspectorate. The Contractor shall carry out the fabrications, erection and testing of this piping as per requirements of Indian Boiler Regulations and to the entire satisfaction of the local Boiler Inspector. The Contractor shall also get the approval of IBR inspector for all fabrication and testing done by him at his own cost. All certificates of approval shall be in proper IBR forms. . .

4.4.2 Approval of boiler inspector on the drawings prepared by the contractor shall be obtained by the contractor at his own cost.

4.5 Pipe Joints

The piping class of each line specifies the type of pipe joints to be adopted. In general, joining of lines 2" and above in process and utility piping shall be accomplished by butt welds. Joining of lines 1-1/2" and below shall be by socket welding / butt welding / threaded joints as specified in "Piping Material Specifications". However, in piping 1-1/2" and below where socket welding/ threaded joints are specified butt - welds may be used with the approval of Engineer-in-Charge for pipe to pipe joining in long runs of piping. This is only applicable for non-galvanized piping without lining.

Flange joints shall be used at connections to Vessels, Equipment's, Valves and where required for ease of erection and maintenance as indicated in drawings.

4.6 Butt Welded and Socket Welded Piping

End preparation, alignment and fit-up of pipe pieces to be welded, welding, pre-heat, post-heating and heat treatment shall be as described in the welding specification and NDT specification.

4.7 Screwed Piping

In general, Galvanized piping shall have threads as per IS:554 or ANSI B 2.1 NPT as required to match threads on fittings, valves etc. All other piping shall have threads as per ANSI B 2.1, tapered unless specified otherwise.

Threads shall be clean cut, without any burrs or stripping and the ends shall be reamed. Threading of pipes shall be done preferably after bending, forging or heat treating operations. If this is not possible, threads shall be gauge checked and chased after welding heat treatment etc.

During assembly of threaded joints, all threads of pipes and fittings shall be thoroughly cleaned of cuttings, dirt, oil or any other foreign matter. The male threads shall be coated with thread sealant and the joint tightened sufficiently for the threads to seize and give a leakproof joint.

Threaded joints to be seal-welded shall be cleaned of all foreign matter, including sealant and made up to full thread engagement before seal welding.

4.8 Flange Connections

All flange facings shall be true and perpendicular to the axis of pipe to which they are attached. Flanged bolt holes shall straddle the normal centerlines unless different orientation is shown in the drawing.

Wherever a spectacle blind is to be provided, drilling and tapping for the jack screws in the flange, shall be done before welding it to the pipe.

4.9 Branch Connections

Branch connections shall be as indicated in the piping material specifications. For end preparation, alignment, spacing, fit-up and welding of branch connections refer welding specifications. Templates shall be used wherever required to ensure accurate cutting and proper fit-up.

For all branch connections accomplished either by pipe to pipe connections or by using forged tees the rates quoted for piping shall be inclusive of this work.

Reinforcement pads shall be provided wherever indicated in drawings/ specifications etc.

4.10 Bending

Bending shall be as per ASME B31.3 except that corrugated or creased bends shall not be used.

Cold bends for lines 1-1/2" and below, with a bend radius of 5 times the nominal diameter shall be used as required in place of elbows wherever allowed by piping specifications. Bending of pipes 2" and above may be required in some cases like that for headers around heaters, reactors etc.

The completed bend shall have a smooth surface, free from cracks, buckles, wrinkles, bulges, flat spots and other serious defects. They shall be true to dimensions. The flattening of a bend, as measured by the difference between the maximum and minimum diameters at any cross-section, shall not exceed 8% and 3% of the nominal outside diameter, for internal and external pressure respectively.

4.11 Forging and forming

Forging and forming of small bore fittings, like reducing nipples for piping 1-1/2" and below, shall be as per ASME B 31.3.

4.12 Mitre Bends and Fabricated Reducers

The specific application of welded mitre bends and fabrication reducers shall be governed by the Piping Material Specifications. Generally all 90 deg. mitres shall be 4-piece 3-weld type and 45 deg. mitres shall be 3-piece 2-weld type as per MECON Standard unless otherwise specified. Reducers shall be fabricated as per directions of Engineer-in-Charge. The radiographic requirements shall be as per Material Specifications for process and utility systems and NDT Specification for steam piping under IBR, radiographic requirements of IBR shall be complied with.

4.13 Cutting and Trimming of Standard Fittings & Pipes

Components like pipes, elbows, couplings, half-couplings etc. shall be cut / trimmed / edge prepared wherever required to meet fabrication and erection requirements, as per drawings and instructions of Engineer-in-Charge. Nipples as required shall be prepared from straight length piping.

4.14 Galvanised Piping

Galvanised carbon steel piping shall be completely cold worked, so as not to damage galvanised surfaces. This piping involves only threaded joints and additional external threading on pipes may be required to be done as per requirement.

4.15 Jacketed Piping

The Jacketing shall be done in accordance with MECON Specification or Licensors specification as suggested in material specification or special condition of contract.

Pre-assembly of jacketed elements to the maximum extent possible shall be accomplished at shop by Contractor. Position of jumpover and nozzles on the jacket pipes, fittings etc. shall be marked according to pipe disposition and those shall be prefabricated to avoid damaging of inner pipe and obstruction of jacket space. However, valves, flow glasses, in line instruments or even fittings shall be supplied as jacketed.

4.16 Shop Fabrication / Prefabrication

The purpose of shop fabrication or pre-fabrication is to minimise work during erection to the extent possible. Piping spool, after fabrication, shall be stacked with proper identification marks, so as facilitate their withdrawal at any time during erection. During this period all flange (gasket contact faces) and threads shall be adequately fabricated by coating with a removable rust preventive. Care shall also be taken to avoid any physical damage to flange faces and threads.

4.17 Miscellaneous

4.17.1 Contractor shall fabricate miscellaneous elements like flash pot, seal pot, sample cooler, supporting elements like turn buckles, extension of spindles and interlocking arrangement of valves, operating platforms as required by Engineer-in-Charge.

4.17.2 Spun Concrete Lining

The work of inside spun concrete lining of pipes and specials of diameter 3" and above shall be done as per material specifications and special condition contract.

4.17.3 Fabrication of pipes from plate

Pipes shall be fabricated at site as and when required as per the specifications attached and the actual Piping Material Specification.

5.0 ERECTION

5.1 Cleaning of Piping before Erection

Before erection all pre-fabricated spool pieces, pipes, fittings etc. shall be cleaned inside and outside by suitable means. The cleaning process shall include removal of all foreign matter such as scale, sand, weld spatter chips etc. by wire brushes, cleaning tools etc. and blowing with compressed air/or flushing out with water. Special cleaning requirements for some services, if any shall be as specified in the piping material specification or isometric or line list. S.S jacketed piping requiring pickling shall be pickled to remove oxidation and discolouring due to welding.

5.2 Piping Routing

No deviations from the piping route indicated in drawings shall be permitted without the consent of Engineer- in-Charge.

Pipe to pipe, pipe to structure / equipments distances / clearances as shown in the drawings shall be strictly followed as these clearances may be required for the free expansion of piping / equipment. No deviations from these clearances shall be permissible without the approval of Engineer-in-Charge.

In case of fouling of a line with other piping, structure, equipment etc. the matter shall be brought to the notice of Engineer-in-Charge and corrective action shall be taken as per his instructions.

5.3 Cold Pull

Wherever cold pull is specified, the Contractor shall maintain the necessary gap, as indicated in the drawing. Confirmation in writing shall be obtained by the Contractor from the Engineer-in-Charge, certifying that the gap between the pipes is as indicated in the drawing, before drawing the cold pull. Stress relieving shall be performed before removing the gadgets for cold pulling.

5.4 Slopes

Slopes specified for various lines in the drawings / P&ID shall be maintained by the Contractor. Corrective action shall be taken by the Contractor in consultation with Engineer-in-Charge wherever the Contractor is not able to maintain the specified slope.

5.5 Expansion Joints / Bellows

Installation of Expansion Joints/Bellows shall be as follows:

- All Expansion joints / Bellows shall be installed in accordance with the specification and installation drawings, supplied to the Contractor.
- Upon receipt, the Contractor shall remove the Expansion Joints/ Bellows from the case(s) and check for any damage occurred during transit.
- The Contractor shall bring to the notice of the Engineer-in-Charge any damage done to the bellows / corrugations, hinges, tie-rods, flanges / weld ends etc.
- Each Expansion Joint / Bellow shall be blown free of dust / foreign matter with compressed air or cleaned with a piece of cloth.
- For handling and installation of Expansion Joints, great care shall be taken while aligning. An Expansion Joints shall never be slinged from bellows corrugations / external shrouds, tie / rods, angles.
- An Expansion Joints / Bellow shall preferably be slinged from the end pipes / flanges or on the middle pipe.
- All Expansion Joints shall be delivered to the Contractor at "Installation length", maintained by means of shipping rods, angles welded to the flanges or weld ends or by wooden or metallic stops.
- Expansion Joints stop blocks shall be carefully removed after hydrostatic testing. Angles welded to the flanges or weld ends shall be trimmed by saw as per manufacturer's instructions and the flanges or weld ends shall be ground smooth.
- The pipe ends in which the Expansion Joint is to be installed shall be perfectly aligned or shall have specified lateral deflection as noted on the relevant drawings.
- The pipe ends / flanges shall be spaced at a distance specified in the drawings.
- The Expansion Joint shall be placed between the mating pipe ends / flanges and shall be tack welded/bolted. The mating pipes shall again be checked for correct alignment.
- Butt-welding shall be carried out at each end of the expansion joint. For flanged Expansion Joint, the mating flanges shall be bolted.

- After the Expansion Joint is installed the Contractor shall ensure that the mating pipes and Expansion Joints are in correct alignment and that the pipes are well supported and guided.

- The Expansion Joint shall not have any lateral deflection. The Contractor shall maintain parallelism of restraining rings or bellows convolutions.

- Precautions

  - For carrying out welding, earthing lead shall not be attached with the Expansion Joint.

  - The Expansion bellow shall be protected from arc weld spot and welding spatter.

  - Hydrostatic Testing of the system having Expansion Joint shall be performed with shipping lugs in position. These lugs shall be removed after testing and certification is over.

5.6 Flange Connections

While fitting up mating flanges, care shall be exercised to properly align the pipes and to check the flanges for trueness, so that faces of the flanges can be pulled together, without inducing any stresses in the pipes and the equipment nozzles. Extra care shall be taken for flange connections to pumps, turbines, compressors, cold boxes, air coolers etc. The flange connections to these equipments shall be checked for misalignment, excessive gap etc. after the final alignment of the equipment is over. The joint shall be made up after obtaining approval of Engineer-in-Charge.

Temporary protective covers shall be retained on all flange connections of pumps, turbines, compressors and other similar equipments, until the piping is finally connected, so as to avoid any foreign material from entering these equipments.

The assembly of a flange joint shall be done in such a way that the gasket between these flange faces is uniformly compressed. To achieve this the bolts shall be tightened in a proper sequence. All bolts shall extend completely through their nuts but not more than 1/4".

Steel to C.I. flange joints shall be made up with extreme care, tightening the bolts uniformly after bringing flange flush with gaskets with accurate pattern and lateral alignment.

5.7 Vents and Drains

High point vents and low point drains shall be provided as per the instructions of Engineer-in-Charge, even if these are not shown in the drawings. The details of vents and drains shall be as per piping material specifications / job standards.

5.8 Valves

Valves shall be installed with spindle / actuator orientation / position as shown in the layout drawings. In case of any difficulty in doing this or if the spindle orientation / position is not shown in the drawings, the Engineer-in-Charge shall be consulted and work done as per his instructions. Care shall be exercised to ensure that globe valves, check valves, and other uni-directional valves are installed with the "Flow direction arrow "on the valve body pointing in the correct direction. If the direction of the arrow is not marked on such valves, this shall be done in the presence of Engineer-in-Charge before installation.

Fabrication of stem extensions, locking arrangements and interlocking arrangements of valves (if called for), shall be carried out as per drawings / instructions of Engineer-in-Charge.

5.9 Instruments

Installation of in-line instruments such as restriction orifices, control valves, safety valves, relief valves, rotameters, orifice flange assembly, venturimeters, flowmeters etc. shall form a part of piping erection work.

Fabrication and erection of piping upto first block valve / nozzle / flange for installation of offline Instruments for measurement of level, pressure, temperature, flow etc. shall also form part of piping construction work. The limits of piping and instrumentation work will be shown in drawings / standards / specifications. Orientations / locations of take-offs for temperature, pressure, flow, level connections etc. shown in drawings shall be maintained.

Flushing and testing of piping systems which include instruments mentioned above and the precautions to be taken are covered in flushing, testing and inspection of piping. Care shall be exercised and adequate precautions taken to avoid damage and entry foreign matter into instruments during transportation, installation, testing etc.

5.10 Line Mounted Eqipments / Items

Installation of line mounted items like filters, strainers, steam traps, air traps, desuperheaters, ejectors, samples coolers, mixers, flame arrestors, sight glasses etc. including their supporting arrangements shall form part of piping erection work.

5.11 Bolts and Nuts

The Contractor shall apply molycoat grease mixed with graphite powder (unless otherwise specified in piping classes) all bolts and nuts during storage, after erection and wherever flange connections are broken and made-up for any purpose whatsoever. The grease and graphite powder shall be supplied by the Contractor within the rates for piping work.

5.12 Pipe Supports

Pipe supports are designed and located to effectively sustain the weight and thermal effects of the piping system and to prevent its vibrations. Location and design pipe supports will be shown in drawing for lines 2” NB. However, any extra supports desired by Engineer-in-Charge

shall also be installed.

No pipe shoe / cradle shall be offset unless specifically shown in the drawings.

Hanger rods shall be installed inclined in a direction opposite to the direction in which the pipe move during expansion.

Preset pins of all spring supports shall be removed only after hydrostatic testing and insulation is over. Springs shall be checked for the range of movement and adjusted if necessary to obtain the correct positioning in cold condition. These shall be subsequently adjusted to hot setting in operating condition. The following points shall be checked after installation, with the Engineer-in-Charge and necessary confirmation in writing obtained certifying that :

- All restraints have been installed correctly.
- Clearances have been maintained as per support drawings.
- Insulation does not restrict thermal expansion.
- All temporary tack welds provided during erection have been fully removed.
- All welded supports have been fully welded.

6.0 WELDING

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

7.0 ERECTION

7.1 Pre-fabrication and Field Assembly

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

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

7.1.2 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.

7.2 Supporting

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

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

7.2.2 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.

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

7.3 **Equipment hook-up**

7.3.1 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.

8.0 **INSPECTION**

8.1

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

8.3 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.

9.0 **PROTECTIVE COATING**

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

9.2 All under ground portion of piping system shall be coated with three layer P.E. coating. CONTRACTOR shall prepared procedure for epoxy painting of burried 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.

9.3 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.

10.0 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.

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

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

10.3 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.

10.4 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

11.0 HYDROSTATIC TESTING

11.1 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.

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

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

11.4 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.

11.5 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.

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

11.7 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 pressurising pump. Pressure gauge used for hydrostatic testing shall be calibrated with dead weight tester in the presence of Engineer-in-charge. Range of pressure gauge shall generally be 1.5 times the test pressure.

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

11.9 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.

11.10 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.

11.11 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.

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

11.13 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.

11.14 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.

11.15 **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
d) Test results
e) Signature of CONTRACTOR
f) Approval signature by COMPANY.

ANNEXURE-1

WELDING SPECIFICATION

1.0 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 obligation 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.

1.3A **Filler Materials**

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

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

c) The electrode shall be suitable for the welding process recommended and base metal used. Unless otherwise specified physical properties of the welds produced by a electrode recommended for the welding of a particular base metal shall not be lower than the minimum valves specified for the base metal and shall correspond to the physical properties of the class of electrode adopted. The choice of electrode shall be made after conducting the required tests on the electrodes as per relevant standards, and shall be the sole prerogative of the Engineer-in-charge.

d) Tungsten electrodes used shall conform to ASME Sec. II C SFA 5.12 specification. Thoriated Tungsten electrodes shall not be permitted due to possible radiation hazard. Instead, ceriated Tungsten Electrodes (EWCe-2 or equivalent) shall be used for GTA Welding.

e) 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.

f) 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.

g) 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.

h) 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.

i) 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.

1.3B **SHIELDING & PURGING GAS**

a) Argon gas used in GTA welding for shielding purposes shall be 99.995% pure. The purity of the gas shall be certified by the manufacturer. The rate of flow for shielding purposes shall be established through procedure qualification tests. Normally this rate may be 12-20 CFH.

b) Argon gas with a purity level of 99.995% shall be used for purging.

c) When GTAW process alone or a combination of GTA Wand SMAW processes is recommended for the production of a particular joint, the purging shall be maintained during the root pass and for the first filling pass to minimize oxidation on the inner side of the pipe, unless otherwise specified in Welding Specification Chart.

d) Initial purging shall be maintained for sufficient period of time so that at least 4-5 times the volume between the dams is displaced, in order to completely remove the entrapped air. In no case should the initial purging period be less than 10 minutes. High gas pressure should be avoided.

e) After initial purging, the flow of the backing gas should be reduced to a point where only a slight positive pressure prevails. For systems, which have a small volume (up to 1/2 cubic foot) to be purged, a gas flow rate of 6-CFH is usually adequate. Systems of larger volume may require higher flow rates and these should be established during procedure qualification tests.

f) Gas backing (purging) is not required for socket type of welded joints.

g) Dams, used for conserving inert gas during purging, shall be removed after completion of the welding, and shall be accounted for. Wherever, removal of dams is not possible after welding, use of water-soluble dams should be made.

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**

a) 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.

b) On completion of each run, craters, welding irregularities, slag etc., shall be removed by grinding and chiseling. Wire brushes used for cleaning stainless steel joints shall have stainless steel wires and the grinding wheels used for grinding stainless steel shall be of a suitable type. Separate grinding wheels and wire brushes should be used for carbon steels and stainless steels.

1.8 **Alignment and Spacing**

a) Prior to alignment, the contractor shall inspect the pipe ends inside and outside for damage, dents, laminations etc. Pipe for welding shall be set up correctly spaced. Temporary attachment of any kind shall not be welded. Every effort shall be made to reduce misalignment by the use of clamp and rotation of pipes to the best fit. For pipes of same nominal wall thickness, the off set should not exceed 1.6mm. Any branch connections sleeve shall be at least 150mm from any other weld. The welds for fitting 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.

b) Tack welds, for maintaining the alignment, of pipe joints shall be made only by qualified welders using approved WPS. Since the tack welds become part of the final weldment they shall be executed carefully and shall be free from defects. Defective tack welds must be removed prior to the actual welding of the joints.

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.

1.9.2 During field welding using GTAW process, particular care shall be exercised to prevent any air current affecting the welding process.

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

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

e) Welding shall be continuous & uninterrupted during a pass.

f) On completion of each run, craters, welding irregularities, slag etc., shall be removed by grinding and chiselling.

g) While the welding is in progress care should be taken to avoid any kind of movement of components, to prevent occurrence of weld cracks.

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

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

1.10.2 **Joint Completion**

a) Joint shall be completed using the class of filler wires/ electrodes, recommended in the welding specification chart. Size of the electrode shall not exceed 4 mm in diameter for stainless steels and alloy steels used for low temperature applications.

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

b) 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.

1.10.3 **Dissimilar Welds**

Where welds are to be produced between carbon steels and alloy steels, preheat and post weld heat treatment requirements shall be those specified for corresponding alloy steels and filler wire / electrodes shall correspond to ER 70 S-G or AWS E-7016/7018 type. For welds between two dissimilar Cr-Mo low alloy steels, preheat and post weld

heat treatments shall be those specified for higher alloy steel and electrodes used shall correspond to those specified for steel of lower alloy content. For carbon steel or alloy steel to stainless welds, use of filler wire / electrodes E/ER-309/E-310/E NiCr Fe-3 shall be made. The welding procedure, electrodes / filler wires to be used shall be approved by the Engineer-in-Charge.

1.11 Heat Treatment

1.11.1 Preheating

a) Preheating requirements for the various materials shall be as per the welding specification chart attached. No welding shall be carried out without preheating the joint to 10°C (50°F) when the ambient temperature is below 10 degree.

b) Preheating shall be performed using resistance or induction heating methods. Preheating by gas burners, utilising any acetylene or oxy-propane 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 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.

e) Preheating temperature shall be maintained over the whole length of the joint during welding. Temperature recorders shall be provided by the Contractor to record the temperature.

1.11.2 Post Heating

In case of alloy steel materials such as Cr-Mo steels, if the post weld heat treatment is not performed immediately after welding, the weld joint and adjacent portion of pipe, at least 50 mm on either side of weld, shall be uniformly heated to 300°c. This temperature shall be maintained for half an hour minimum, and then wrapped with mineral wool before allowing it to cool to room temperature. If the Post Heating temperature specified in the Welding Specification Charts exceeds 300°C, the same shall be followed. Similarly, if the welding specification chart specifies post-heat time, the same shall be applicable. Post weld heat treatment as specified in the Welding Specification Chart shall be carried out later on.

1.11.3 Postweld 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. In this regard procedure qualification to be done before carrying out

PWHT in production welds.

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

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

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

e) While carrying out local post weld heat treatment, technique of application of heat must ensure uniform temperature attainment at all points of the portion being heat treated. Care shall be taken to ensure that width of treated band over which specified post weld heat treatment is carried out, the temperature attained is atleast as that specified in the relevant applicable standards/ codes.

f) Throughout the cycle of heat treatment, the portion outside the heated band shall be suitably wrapped under insulation so as to avoid any harmful temperature gradient at the exposed surface of pipe. For this purpose temperature at the exposed surface of the pipes should not be allowed to exceed 400°C.

g) The temperature attained by the portion under heat treatment shall be recorded by means of thermocouple pyrometers. Adequate number of thermocouples should be attached to the pipe directly at the equally spaced location along the periphery of the pipe joint. The minimum number of thermocouples attached per joint shall be 1 upto 6" dia, 2 upto 10" dia and 3 upto 12" and above. However the Engineer-in-charge can increase the required minimum number of thermocouples to be attached if found necessary.

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

i) Immediately on completion of the heat treatment, the post weld heat treatment charts/ records alongwith the hardness test results on the weld joints (whenever required as per the welding specification chart), shall be submitted to Engineer-in-charge for his approval.

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

numbers and piping sketch shall be submitted to the Engineer-in-charge in suitable folders.

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

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

1.12 Cleaning of the Weld Joints

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

1.13 Inspection & Testing

1.13.1 General

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

b) The owner is entitled to depute his own inspector to the shop or field where pre-fabrication and erection of pipelines are being done with (but not limited to) the following objectives :-

i. To check the conformance to relevant standards and suitability of various welding equipments and the welding performance.
ii. To supervise the welding procedure qualification.
iii. To supervise the welder performance qualifications.

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

1.13.2 Welding Procedure Qualifications

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

b) COMPANY's inspector will review, check and approve the welding procedure submitted and shall release the procedure for procedure qualification tests. The procedure qualification test shall be carried out by the Contractor under field conditions at this own expense. A complete set of test results in format as per **Exhibit-D** (attached) shall be submitted to the COMPANY's inspector for approval immediately after completing the procedure qualification test and atleast 2 weeks before the commencement of actual work. Standard tests as specified in the code shall be carried out in all cases. In addition to these tests, other tests like radiography, macro/ micro examination, hardness testers, dye penetrant examination, Charpy V-notch etc. shall be carried out on specimens. It shall be the responsibility of the contractor to carry out all the tests required to the satisfaction of the COMPANY's Inspector. The destructive testing of welded joints shall be as per **Annexure-2** and 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. No welder shall be permitted to work without the possession of the identify card. It shall be the responsibility of contractor to carry out Qualification tests of welders.

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

1.13.4 **Visual Inspection**

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

1.13.5 **Non-destructive Examination**

The non destructive examination shall mainly consist of examination using x-ray radiography as detailed in **Annexure-4.**

Radiographic examination of one hundred percent (100%) girth welds will be required by the COMPANY. Welds shall meet the standards of acceptability as set forth in API 1104 and as per the requirements laid in subsequent paragraphs.

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

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

All requirements mentioned in the specification shall be arranged and executed by the CONTRACTOR through his own resources. In addition, for pipes with wall thickness 9.5mm and above, ultrasonic inspection is required in the following cases as per **Annexure-3** of this specification.

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

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

c) When welds are repaired.

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

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

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

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

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

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

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

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

iii. Unrepaired burn through areas are unacceptable.

Contractor shall appoint agency for carrying out the radiography works at site from the list of agency (ies) enclosed in the bid document.

- The Radiographic Examination procedures to be adopted shall be submitted by the contractor as per **Exhibit-F** and shall be got approved from the Owner's Inspector prior to employment. A person qualified to ASNT Level-II or ASNT Level-III in Radiographic testing shall prepare the procedure. The Radiography Procedure shall be established to demonstrate that the required sensitivity can be consistently achieved under the most unfavorable parameters (e.g. source to film distance, geometric unsharpness, thickness etc.). The radiographic technique and procedure adopted shall conform of the requirements mentioned in Article 2 as well as Article 22 of ASME Sec.V. The IQI sensitivity obtained shall be equal to or better than the requirements mentioned in Article 2 of ASME Sec.V. Source side penetrameter shall be used in establishing radiographic procedure / technique. The acceptance criteria shall be as per the relevant codes of Fabrication and over riding requirements if mentioned else where in the technical specifications of the contract. The Contractor shall be responsible for carrying out Radiography; rectification of defects and re-radiography of welds repaired/rectified at his cost.

- 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 the more stringent of the two recommended for the materials being welded. Wherever random Radiography is called for, in a particular piping class, the dissimilar materials weld joints shall essentially be included.

- Type of Radiation source and film to be used shall be as per **Exhibit-H** for carrying out radiographic examination. However if specifications (as given else where in the contract) for some critical material require usage of X-Radiation, then Radiography shall be done using X-Rays only.

- The Contractor shall fulfill all the statutory and owner's safety requirements while handling X-ray and Gamma-ray equipments.

- In case of random radiography, the joints for Radiography shall be selected by the Owner's Inspector and the Radiography shall be performed in his presence, if he instructs the contractor to do so. The contractor shall furnish all the radiographs, to the Owner's Inspector immediately after processing along with evaluation by a person qualified to ASNT Level-II in Radiographic testing, inline with Article 2 of ASME Sec.V. The certificate of ASNT / ISNT Level II qualification of the NDT personnel shall be submitted to owner's inspector for his approval prior to start of job.

- The Contractor shall provide the Owner's Inspector, all the necessary facilities at site such as a dark room with controlled temperature, illuminator (viewer) suitable for varying densities, a duly calibrated electronic densitometer with batteries, magnifying glass, tracing papers, ruler, marking pencils etc. to enable him to review the radiographs.

- Where random radiography is specified, the first weld of each welder shall be completely radiographed. In the case of pipe of size 6" and below, the first two welds shall be completely radiographed.

- For each weld performed by a welder found unacceptable, two additional checks shall be carried out on welds performed by the same welder. This operation is iterative and the of two additional welds for each weld deemed unsatisfactory shall be continued till such time that two consecutive welds of satisfactory quality are found for every defective weld.

- The Contractor shall carry out these additional radiographic testing at his own expense. To avoid the possibility of too many defective welds by a single welder remaining undetected for a long period to time, the Contractor shall promptly arrange for Radiographic Examination so that there is no accumulation of defective joints.

- Contractor shall quote rates for X-ray as well as Gamma Ray for joints indicated to be radiographed by X-ray in Table of **Exhibit-H.**

1.13.6 **Check shots**

(a) Owner / Engineer- in- charge or his representative shall select 5% of the total joints radiographed on a day for check shots. Contractor shall carry out check shots as directed.

(b) Weld profiles of check shots shall be compared with weld profile observed in the earlier Radiographs. In the event of anyone variation in the check shots and earlier Radiographs, contractor shall re-shoot the entire lot of joints radiographed by particular Radiography agency on the particular date. All the re-shot films shall be compared with the originally submitted films.

1.13.7 **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, as per ASME Section V article 6 and 7 respectively. The tests are to be performed by a person possessing a valid ASNT / ISNT Level-II qualification in the method being used.

(b) For austenitic stainless steels and other nonmagnetic materials, liquid (dye) penetrant test shall be carried out. For carrying out this test, the materials shall be brought within a temperature limit of 15° to 50°C.

1.13.8 **Hardness Test**

Hardness requirements for welds shall be as per the Welding Specification Chart / Non Destructive Examination Specification attached elsewhere in the contract. Hardness testing shall be carried out by Vickers Hardness Tester during welding procedure qualification and shall be cross sectional. For production welds, hardness testing shall be carried out by portable digital hardness testers. Poldi hardness tester shall not be permitted. Contractor shall produce documentary evidence/calibration certificate to the Owner's Inspector and obtain approval of the hardness testing equipment.

1.13.9 **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 CONTRACTOR (4 COPIES EACH)

a) Electrode and Welding Consumable Qualification Records as per **Exhibit-A, f**or the Welding Consumables tested and approved for the work.
b) Batch Test Certificates, for the Electrodes used, obtained from the Electrode Manufacturers.
c) Proposed Heat Treatment Procedure as per **Exhibit-B.**
d) Heat Treatment Charts.
e) Weld joint hardness test results.
f) Welding Procedure Specifications as per **Exhibit-C** immediately after receipt of the order.
g) Welding Procedure Qualification records as per **Exhibit-D.**
h) Welder Performance Qualification records as per **Exhibit-E** immediately after conducting Welder Qualification Tests.
i) Radiography Procedure as per **Exhibit-F** and other NDT procedures.
j) Radiographic test Report along with Radiographs and other NDT reports.
k) Piping Sketch (Isometric) giving all the details regarding the pipe specifications, welded joints, joints radiographed magnetic particle, tested, ultrasonic tested, penetrant tested, joints heat treated, WPS used, welders identification number, etc.

EXHIBIT-A

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 :

Tensile Test Results :

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

C : **Impact Test Results**

Test Temperature : Notch in :

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

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

D : **Chemical Analysis Result**

Electrode size used :

Batch No.

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

E : **Fillet Weld Test Results**

Welding Positions :

Base Materials :

Size of electrode used :

Visual Inspection Results : 1)
2)
3)

Micro Test Results

Fracture Test Results :

Remarks :

F : **Other Test Results**

i) Transverse Tensile Test :

In Combination with :

Base Material used :

Position of Welding :

Preheat Temperature :

Postweld Heat Treatment :

Radiography :

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

2. **Guide Bend Test**

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

3. **Any other tests**

Conclusions

Approved By :

EXHIBIT-B
Sheet 1 of 2

STRESS RELIEF HEAT TREATMENT PROCEDURE SPECIFICATION

Name of the Heat - Treatment :.....
Name of the Project :.....Specification
Reference No. .....

1. **General Details**

Name of the Equipment : .....

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

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

Material : .....

2. **Furnace Details**

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

Capacity (size) : .....
Maximum Temp. (°C)

Method of temp. measurement : .....

Atmosphere Control : .....

3. **Heat Treatment Cycle Details**

Charging Temp. °C : .....

Rate of Heating, °C/Hr : .....

Soaking Temp., °C : .....

Soaking Time, Hrs. : .....

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

COUPON TEST RECORD

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

---

1 2 3 4 5 6 7

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

---

1 2 3 4 5 6 7

Coupon Stenciled ..... Original
Dimension of Plate ..... Original area of plate ($inch^2$) ..... Maximum Load
..... Tensile S/ in. plate area
..... Fracture Location
.....

Procedure — Qualifying Test — Qualified
Welder — Line Test — Disqualified

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 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 (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
with seal

WELDING SPECIFICATION CHART

EXHIBIT-G
Sheet 1 of 2

Class :

Material Specification :

Pipes : API 5L Gr. X 60, API 5L Gr. B API 5L Gr. X 42

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

Flanges : A 105, 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

Post weld heat treatment :

Holding temp. : 595-650 C Holding Time : 1 Hr. per inch thk
Rate of heating : 200 C/hr max. Min holding time : 1 hr.
Method of cooling : Controlled Rate of cooling : 200°C/hr max.

Mechanical property requirements :

Charpy `V' notch impact test valve :

Normal	:	22 J
Average	:	27 J
At temperature	:	0 °C
Hardness	:	300 HV10 (for weld & HAZ)

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

TECHNICAL NOTES

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

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

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

API 5L Gr. B	:	Thickness upto and inclusive of 12mm	100 °F min.
A 105	:		
MSS-SP-44 Gr. F60	:	Thickness beyond	200 °F
A 234 Gr. 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^2	20 ft. lb. at 0°C
E7018-I	52.7 kg/mm^2	-
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	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 4½ incl.	0	0	2	2	0	0	0	0	0	4
Over 4½ less than 12 3/4	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)										
4½ and smaller	0	2	0	0	0	2	0	0	0	4
Over 4½ 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 are to be made in the adjacent region as well as on the opposite side of the macrosection along the specified traverses.

1.5.2 **Method**

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

1.5.3 **Requirements**

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

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

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

1.6 **Charpy-V-notch Impact Test**

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

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

Nominal wall thickness in mm	Test Specimens width in mm
> 12	12
> 9.5 and ≤ 12	7.5

≥ 7 and ≤ 9.5	5
< 7	2.5

1.6.2 **Test Method**

The test shall be carried out as indicated in ISO R 148 "Beam Impact Test V-notch.

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

1.6.3 **Requirements**

The impact energy shall be greater or equal to :-

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

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

1.7 **Bend Test Requirements**

The bend test specimens shall be made and tested as per the requirements of API-1104 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 atleast wide enough to allow full skip examination.

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

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

- Ultrasonic equipment and coupling medium
- Sample sections for calibration of instruments.
- Equipment for cleaning of surface to be examined.
- Rulers calibrated in centimeters for exact location of the position of defects.

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

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

b) continuous operation

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

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

1.5 **Ultrasonic Instruments**

The ultrasonic instruments :

- Shall be each pulse type, able to generate, receive and display, on the screen a cathode ray tube (CRT) pulse, at frequencies between 1 and 6 mhz. The useful part of the CRT screen shall be at least 70m wide and at least 50mm high.

- Shall have various amplification, with steps of 1 or 2 dB over a range of a least 60 dB.

- The regulation control shall be accurate to within 1 dB and this accuracy shall be certified by the instrument manufacturer.

- May be powered by a battery or an electric generator. In the first case, the autonomy of operation (endurance) of the instrument shall be sufficient to carry on working without frequent interruptions, and the instrument shall be equipped with an automatic switch which switches it off when the battery runs down, in the second case, there must be a voltage 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_1 and V_2 sample block, IIW type or the calibration block ASTM E-428.

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

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

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

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

1.6 **Calibration**

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

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

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

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

1.9 **Regulation of Amplification during Production Testing**

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

1.10 **Qualification of Ultrasonic Testing Operators**

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

1.11 **Evaluation of Indications given by Ultrasonic Tests**

Each time that echoes from the weld bead appear during production testing, the instrument amplification shall be altered to coincide with the reference amplifications and the probe shall be moved until maximum respond is obtained paying attention all the time to the probetube coupling.

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

1.12 **Other Equipment**

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

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

ANNEXURE-4

RADIOGRAPHY

1.0 **SCOPE**

This annexure covers the radiographic inspection of all types of welded joints of the main pipeline. The welded joints shall include the following :

i) Full girth welds on the mainline construction including double jointing of pipe, if adopted.

ii) Welds for installation of block valves, insulating joints and other appurtenances and tie-ins.

iii) Welds at scraper launching and receiving barrels

iv) Terminal Piping.

2.0 **APPLICABLE STANDARDS**

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

i) API 1104, Standard for welding pipelines and related facilities.

ii) ANSI B31.8, code for Gas Transmission and Distribution Piping Systems.

iii) ANSI B31.4, Code for Liquid Petroleum Transportation Piping System.

iv) ASTM E94, Recommended practice for Radiographic Testing.

v) ASTM, E 142, Standard Method for Controlling Quality of Radiographic Testing.

vi) The American Society for non-destructive Testing. Recommended Practice No. SNT-TC-1A Supplement-A.

3.0 **PROCEDURE**

3.1 The radiographic examination procedure to be adopted shall be submitted by the CONTRACTOR as per **Exhibit-F.**

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

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

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

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

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

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

3.4 The procedure of radiographic examination shall produce radiographs of sufficient density, clarity and contrast so that defects in the weld or in the pipe adjacent to the weld, and the outline and holes of the pentrameter are clearly discernible.

3.5 All the girth welds of mainline shall be subjected to 100% radiographic examination. The CONTRACTOR shall furnish all the radiographs to the COMPANY, immediately after processing them, together with the corresponding interpretation reports on approved format. The details of the radiographs 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. MEC/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 aCOMPANY 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 Not withstanding the above there is nothing in these clauses to exempt the CONTRACTOR from the operation of any other act or rules in force.

Rev. : 0
Edition : 1

SPECIFICATION
FOR
SHOP & FIELD PAINTING

SPECIFICATION NO.: MEC/S/05/21/07

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

1.0 **GENERAL**

1.1 These technical specifications shall be applicable for the work covered by the contract, and without prejudice to the various codes of practice, standard specifications etc. it is understood that contractor shall complete the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of Engineer-in-charge.

1.2 Wherever it is stated in the specification that a specific material is to be supplied or a specific work is to be done it shall be deemed that the same shall be supplied or carried out by the contractor.

Any deviation from this standard without within deviation permit from appropriate authority will result in rejection to job.

2.0 **SCOPE**

Scope of work covered in the specification shall include, but not limited to the following.

2.1 This specification defines the requirements for surface preparation, selection and application of paint on external surfaces of equipment, vessels, machinery, piping, ducts, steels structures, external & internal protection of storage tanks for all services RCC Chimney & MS Chimney with or without refractory lining and flare lines etc.

2.2 **Extent of Works**

2.2.1 The following surface and materials shall require shop, pre-erection and field painting.

a. All uninsulated C. S. & A.S. equipment like columns, vessels, drums, storage tanks, heat exchangers, pumps, compressors, electrical panels and motors etc.

b. All uninsulated carbon and low alloy piping fitting and valves (including painting of identification marks), furnace, ducts and stacks.

c. All items contained in a package unit as necessary.

d. All structural steel work, pipe, structural steel supports, walkways, handrails, ladders, platforms etc.

e. RCC/ MS chimneys with or without refractory lining & Flare lines.

f. Identification colour bands on all piping as required including insulated aluminium clad, galvanised, SS and non-ferrous piping.

g. Identification lettering/ numbering on all painted surface of equipment/ piping insulated aluminium clad, galvanised, SS and non-ferrous piping.

h. Marking/ identification signs on painted surfaces of equipment/ piping for hazardous service.

i. Supply of all primers, paints and all other materials required for painting other than ownerôs 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 ñpipingò, ñgratingsò and ñhandrailsòetc. 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 MECON 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 ï Colour code.
ASTM Vol. 6.01 and 6.03	:	American standard test methods for Paints and coatings.
ANSI 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 manufacturerôs instructions shall be followed as far as practicable at all times. Particular attention shall be paid to the following:

a. Instructions for storage to avoid exposure as well as extremes of temperature.

b. Surface preparations prior to painting.

c. Mixing and thinning.

d. Application of paints and the recommended limit on time intervals between coats.

4.0 EQUIPMENT

4.1 All tools, brushes, rollers, spray guns, abrasive materials hand/ power tools for leaning and all equipments, scaffolding materials, shot/ wet abrassive blasting, water blasting equipments & air compressors etc. required to be used shall be suitable for the work and all in good order and shall be arranged by the contractor at site and in sufficient quantity.

Mechanical mixing shall be used for paint mixing operations in case of 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 achieve 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 2İ or equivalent as per Swedish Standard SIS-055900-1967/ ISO-8501-1-1988. Where highly corrosive condition exits, then blast cleaning shall be Sa3 as per Swedish Standard.

Remove all other contaminants, oil, grease etc. by use of an aromatic solvent prior to surface cleaning.

5.1.3 Blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceeding 85%.

5.1.4 Irrespective of the method of surface preparation, the first coat of primer must be applied on dry surface. This should be done immediately and in any case within 4 hours of cleaning of surface. However, at times of unfavourable weather conditions, the Engineer-in-Charge shall have the liberty to control the time period, at his sole discretion and / or to insist on recleaning, as may be required, before primer application is taken up. In general, during unfavourable weather conditions, blasting and painting shall be avoided as far as practicable.

5.1.5 The external surface of R.C.C. chimney to be painted be dry and clean. Any loose particle of stand, cement, aggregate etc. shall be removed by rubbing with soft wire brush if necessary, acid etching with 10-15% HCL solution about 15 minutes shall be carried out and surface must be thorought washed with water to remove acid & loose particles then dry completely before application of paint.

5.2 Procedure of Surface Preparation.

5.2.1 Blast Cleaning

5.2.1.1 Air Blast Cleaning

The surface shall be blast cleaned using one of the abrasives: AL_20_2 particles chilled casts iron or malleable iron and steel at pressure of 7kg. Cm^2 at appropriate distance and angle depending on nozzle size maintaining constant velocity and pressure. Chilled cast iron, malleable iron and steel shall be in the form of shot or grit of size not greater than 0.055ò maximum in case of steel and malleable iron and 0.04ò maximum in case of chilled iron. Compressed air shall be free form moisture and oil. The blasting nozzles should be venturei style with tungsten carbide or boron carbide as the material for liners. Nozzles orifice may vary from 3/16ò to IJò On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey white metallic lusture. Primer or first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall bot be done outdoors in bad weather without adequate protection or when there is dew on the metal which is to be cleaned, surface profile shall be uniform to provide good key to the paint adhesion (i.e.35to 50µ). If possible vacuum collector shall be installed for collecting the abrasive and recycling.

5.2.1.2 Water Blast cleaning

Environmental, health and safety problems associated with abrassive blast cleaning limit the application of air blast cleaning in many installations. In such case water blast cleaning is resorted to.

Water blast cleaning can be applied with or without abrassive and 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 abrassives are used. The most commonly used pressure for high pressure water blast cleaning for maintenance surface preparation is 3000 to 6000 psi at 35-45 liters/ minute water volume and pressure upto 10000 psi and water volume of 45 liters/ minute provide maximum cleaning.

The wate blast cleaned surface shall be comparable to SSPC-SP-12/ NACE No. 5. The operation shall be carried out as per SSPC guidelines for water blast cleaning. The indicative values for sand injection is

Air : 300 to 400 Cu.ft/ min.

Water	:	5-10 liter/ min. with corrosion inhibitor
Sand	:	200-400 lbs/ hr.
Nozzle	:	0.5 to 1òdia

Special equipments for water blast cleaning with abrasives now available shall be used.

5.2.2 Mechanical of Power tool cleaning

Power tool cleaning shall be done mechanical striking tools, chipping hammers, griding wheels or 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 dones not appear in the specifications of paint systems.

Hand tool cleaning normally consists of the following:

a. Hand descaling and/ or hammering
b. Hand scraping
c. Hand wire brushing

Rust, mill scale spatters, old coating and other foreign matter, shall be removed by hammering, scrapping tools, emery paper cleaning, wire brushing or combination of the above methods. On completion of cleaning, loose materials shall be removed from the surface by clean rags and the surface shall be brushed, swept, deducted and blown off with compressed air/ steam to remove all loose matter. Finally the surface may be washed with water and dried for effective cleaning.

5.3 **Non compatible shop coat primer**

The compatibility of finishing coat should be confirmed from the paint manufacturer. In the event of use of primer such as zinc rich epoxy, inorganic zinc silicate etc. as shop coat the pant system shall depend on condition of shop coat, if shop coat is in satisfactory condition showing no major defects, the shop

coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer-in-Charge.

5.4 Shop coated (coated with primer & finishing coat) equipment should not be repainted unless paint is damaged.

5.5 Shop primed equipment and surface will only be óspot cleanedô 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, manufacturerôs standard can be followed after review.

5.7 **Coating Procedure and Application:**

5.7.1 Surface shall not be coated in rain, wind or in environment where injurious airbone elements exists, when the steel surface temperature is less than 5ÁF above dew point when the relative humidity is greater then 85% or when the temperature is below 40ÁF.

5.7.2 Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hrs. the same day.

5.7.3 To the maximum extent practicable, each coat of material shall be applied as a continuous film uniform thickness free of probes. Any spots or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

5.7.4 Each coat shall be proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can applied without the development of any detrimental film irregularities such as lifting or loose of adhesion of the under coat. Manufacturer instruction shall be followed for intercoat interval.

5.7.5 When the successive coat of the same colour have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life.

5.7.6 Air spray application shall be in accordance with the following:

a. The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied, and shall be equipped with suitable pressure regulators and gauges. The air caps, nozzles, and needles shall be those recommended by the manufacturer of the equipment for the material beign sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.

b. Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. The air from the spray gun impinging against the surface shall show condensed water or oil.

c. Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous mechanical agitation.

d. The pressure on the material in the pot and of the air at the gun shall be adjusted for optimum spraying effectiveness. The pressure on the material in the pot shall be adjusted when necessary for change in elevation of the gun above the pot. The atomizing air pressure at the gun shall be high enough to properly atomize the paint but not so high as to cause excessive fogging of paint, excessive evaporation of solvent, or less by overspray.

e. Spray equipment shall be kept sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film.

Any solvents left in the equipment shall be completely removed before applying paint to the surface begin painted.

f. Paint shall be applied in a uniform layer, with overlapping at the edge of the spray pattern. The spray patterns shall be adjusted so that the paint is deposited uniformly. During application the gun shall be held perpendicular to the surface and at a distance which will ensure that a wet layer of paint is deposited on the surface. The trigger of the gun should be released at the end of each stroke.

g. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface repainted.

h. Areas inaccessible to the spray gun shall be painted by brush: if not accessible by brush, daubers or sheepking shall be used.

i. All nameplates, manufacturerôs identification tags, machined surface instrument glass, finished flange faces, control valve items and similar items shall be masked to prohibit coating disposition. If these surface are coated, the component shall be cleaned and restored to its original condition.

j. Edges of structural shapes and irregular coated surface shall be coated first and an extra pass made later.

k. If spray gun shown choking, immediately dechoking procedure shall be followed.

5.7.7 Airless spray application shall be in accordance with the following procedure: as per steel structure paint manual vol. 1 & vol. 2. By SSPC, U.S.A., Air less spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor is used to operate a pump to produce pressures of 1,000 to 6.000 psi. Paint is delivered to the spray gun at this pressure through a single hose within the gun, a single paint stream is divided into separate streams, which are forced through a small orifice resulting in atomization of paint without the use of air. This result in more repaid coverage with less overspray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional airspray.

Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have in built agitator that keep the paint uniformly mixed during the spraying. The unit shall consists of in built strainer. Usually very small quantities of thinning is required before spray. Incase of High Build epoxy coating (two pack), 30:1 pump ratios and 0.020-0.023ò tip size will provide a good spray pattern. Ideally fluid hoses should no be less than 3/8ò 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 of brush marks left in the applied paint

f. Surface not accessible to brushes shall be painted by spray, duubers, or sheepkin.

5.7.9 Manual application by sling (where 6 Oô clock position of pipe is not approachable)

A canvas strip (alternatively a tinplate strip) about 450mm wide and 1.5m longs is hold under the pipe by two men. Liquid coating poured on the sling at each side of the pipe. The men holding this sling move it up and down and walk slowly forward while fresh coating is poured on the pipe and they manipulate the sling so that an even coating is ontained all round the bottom. This work shall be done vey carefully and by experienced personnel. There shall bot be any formation of ñWhiskersò 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 unit the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exced 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 manufacturerôs 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/ weldding:

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 90ÁC to 500ÁC.

- Surface preparation shall be done as per procedure 5.9.2

- One coat of F-9 shall be applied wherever damaged was observed on pre-erection/ pre-fabrication/ shop primer of inorganic zinc silicate coating (F-9) shall not be applied if damaged area is not more than 5 x 5 cm.

5.10 **PAINT APPLICATION**

5.10.1 Shop priming/ pre-erection priming with F9 of F12 shall be done only on blasted surface.

5.10.2 Shop priming/ pre-erection priming with F-9 or F-12 shall be done only with airless spray.

5.10.3 For large flat surface field painting shall be done by airless spray otherwise brush can be used.

5.11 **Assessment of Painting Requirement**

The paint system to be applied for a specific job shall be arrived as sequentially as given below :

- Identify the environment from area classification details and chose the appropriate table.

- Identify the design temperature from the technical documents.

- Identify the specific field paint system and surface preparation requirement from the above identified table and temperature range.

- Identify the shop priming requirement from Table 7.1 based on compatibility of the above paint system.

- Identify the need of repair of shop primer and execute as per Table 7.2.

5.12 **Documentation.**

A written quality plan with procedure for qualification trials and for the actual work.
Daily progress report with dedtails of weather condition, particular of application no of coats and type of materials applied, anomolies, progress of work versus programme.
Result of measurement of temperature relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.
Particular of surface preparation and paint application during trials and during the work.
Details of non-compliance, rejects and repairs.
Type of testing equipments and calibration.
Code and batch numbers of paint material used.

TABLE-I (for clause 5.0)
SURFACE PREPARATION STANDARDS

S. NO.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)				REMARK
		SWEDISH STANDARD SIS-05-5900 1967	SSPC-SP USA	NACE USA	BRITISH STANDARD BS-4232: 1967	
1.	MANUAL OR HAND TOOL CLEANING REMOVAL OF LOOSE RUST LOOSE MILL SCALE AND LOOSE PAINT, CHIPPING, SCRAPING, SANDING AND WIRE BRUSHING, SURFACE SHOULD HAVE A FAINT METALLIC SHEEN.	ST.2	SSPC-SP-2	-	-	THIS METHOD IS APPLIED WHEN THE SURFACE IS EXPOSED TO NORMAL ATMOSPHERIC CONDITION WHEN OTHER METHODS CANNOT BE ADOPTED AND ALSO FOR SPOT CLEANING DURING MAINTENANCE PAINTING.
2.	MECHANICAL OR 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 GRINDIN, AFTER REMOVAL OF DUST, SURFACE SHOULD HAVE A PRONOUNCED METALLIC SHEEN.	ST.3	SSPC-SP-3	-	-	-DO-

TABLE-I (for clause 5.0)
SURFACE PREPARATION STANDARDS

S. NO.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)				REMARKS
		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 İ	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)				REMARKS
		SWEDISH STANDARD SIS-05-5900 1967	SSPC-SP USA	NACE USA	BRITISH STANDARD BS-4232: 1967	
3.3	COMMERCIAL BLAST BLAST CLEANING UNIT AT LEAST TWOð THIRD OF EACH ELEMENT OF SURFACE AREA IS FREE OF ALL VISIBLE RESIDUES WITH DESIRED SURFACE PROFILE.	SA-2	SSPC-SP-6	No. 3	THIRD QUALITY	FOR STEEL REQUIRED TO BE PAINTED WITH CONVENTIONAL PAINTS FOR EXPOSURE TO MILDLY CORROSIVE ATMOSPHERE FOR LONGER LIFE OF THE PAINT SYSTEMS.
3.4	BRUSH-OFF BLAST BLAST CLEANING TO WHITE METAL CLEANLINESS, REMOVAL OF ALL VISIBLE RUST, MILL SCALE , PAINT & FOREIGN MATTER, SURFACE PROFILE IS NOT SO IMPORTANT.	SA-1	SSPC-SP-7	No. 4		

6.0 PAINT MATERIALS

Paint manufacturers shall furnish all the characteristics of paint material on printed literature, alongwith the test certificate for all the specified characteristics given in this specifications. All the paint materials shall be of first quality and conform to the following general characteristics as per the table 6.1, 6.2 and 6.3.

PAINT MATERIALS
TABLE NO.: 6.1 PRIMERS

S. No.	DESCRIPTION	P-2	P-4	P-6
1.	Technical Name	Chlorinated rubber Zinc Phosphpate primer	Etch primer/ wash primer	Epoxy zinc phosphate primer
2.	Type and composition	Single pack, air drying chlorinated rubber based medium plasticised with unsaponlfiable plasticizer, plgmented with Zic phosphate.	Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pogmented 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 dilm thickness) per coat (approx)	40-50µ	8-10µ	40-50µ
5.	Theoretical covering capacity in M2/ coat/ litre (approx)	8-10	8-10	8-10
6.	Welght per litre in kgs/ litre (approx)	1.3	1.2	1.4
7.	Touch dry at 30ÁC (approx)	30 minutes	2 hrs.	After 30 mins.
8.	Hard dry at 30ÁC (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 30ÁC for two component paints (approx).	Not applicable	Not applicable	8 hrs.
11.	Temperature Resistance	60ÁC	Not applicable	80ÁC

PAINT MATERIALS
TABLE NO.: 6.2FINISH PAINT

S. No	DESCRIPTION	F-2	F-3	F-6	F-7
1.	Technical Name	Acrylic polyurethane finish paint	Chlorinated rubber based finish paint	Epoxy-High build finish paint	High build coaltar epoxy coating.
2.	Type and composition	Two-pack aliphatic isocynate cured acrylic finish paint	Single pack plasticised chlorinated rubber based medium with chemical and weather resistant pigments.	Tow- pack polyamide/ 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 M2/ coat/ litre (approx)	10-13	8-10	5-6	5-2-6.5
6.	Welght per litre in kgs/ litre (approx)	1.3	1.2	1.4	1.5
7.	Touch dry at 30ÁC (approx)	1 hrs.	30 minutes	3 hrs.	4 hrs.
8.	Hard dry at 30ÁC (approx)	Overnight	8 hrs.	Overnight	48 hrs.
9.	Overcoating 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 at 30ÁC for two component paints (approx).	6-8 hrs.	Not applicable	4-6 hrs.	4-6 hrs.
11.	Temperature Resistance	80ÁC	60ÁC	80ÁC	125ÁC

PAINT MATERIALS
TABLE NO.: 6.3 FINISH PAINTS

S. No	DESCRIPTION	F-8	F-9	F-11	F-12
1.	Technical Name	Self priming type surface tolerant high build epoxy coating (Complete rust control coating)	Inorganic Zinc Slicate coating	Heat resistant synthetic medium based two pack aluminum paint suitable upto 250ÁC dry temperature	Heat resistant silicone aluminum paint suitable upto 500Á 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 zinc silicate coating.	Heat resistant synthetic medium based two pack aluminum paint suitable upto 250ÁC	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	6.0-7.2	8-9	10-12	8-10
6.	Welght per litre in kgs/ litre (approx)	1.4	2.3	1.2	1.1
7.	Touch dry at 30ÁC (approx)	3 hrs.	30 min.	3 hrs.	30 min.
8.	Hard dry at 30ÁC (approx)	24 hrs.	12 hrs.	12 hrs.	24 hrs.
9.	Overcoating interval (approx)	Min.: 10 hrs. Max.: 6 months	Min.: 8 hrs. at 20ÁC and 50% RH. Max.: Unlimited	Min.: 16 hrs. Max.: Unlimited	Min.: 16 hrs. Max.: Unlimited

S. No	DESCRIPTION	F-8	F-9	F-11	F-12
10.	Pot life (approx) at 30ÁC for two component paints (approx).	90 min.	4-6 hrs.	Not applicable	Not applicable
11.	Temperature resistance	80ÁC	400ÁC	250ÁC	500ÁC

F-14: Specially for mulated polyamine cured coal tal epoxy suitable for-45ÁC to 125ÁC for application under insulation
F-15: Two pack cold curved epoxy phenolic coating suitable for 45ÁC to 125ÁC for application under insulation
F-16: Eoxy siloxane anser coat 738

PAINT MATERIALS
TABLE NO. 6.4 FINISH PAINTS

Sl. No.	Description	F-14	F-15	F-16	F-17
1.	Technical name	Polyamine cured coal tar epoxy	Two-component Epoxy phenolic coating cured with polyamine adduct hardner system (primer + intermediate coat + finish paint)	Ambient temperature curing Poly Siloxane coating / High build cold applied inorganic copolymer based aluminum coating suitable for under insulation coating of CS and SS piping for high temperature service.	Two component solvent free type high build epoxy phenolic / novalac epoxy phenolic coating cured with Polyamine adduct hardner system.
2.	Type & composition	Specially formulated polyamine cured coal tar epoxy suitable for application under insulation	Two pack ambient temperature curing epoxy phenolic coating system suitable for application under insulation of CS / SS piping.	Amercoat 738 from Ameron Products, USA / Berger 938 from Berger Paints Ltd., or Intertherm 751 CSA from Akzo Nobel coating. Note : 6	Two component solvent free type high build epoxy phenolic / novalac epoxy phenolic coating cured with Polyamine adduct hardner system.
3.	Volume Solids (minimum)	70%	65%	60%	98-100%
4.	DFT (Dry Film thickness) per coat (minimum)	125 μm	75 - 100 μm	75 - 100 μm	125- 150 μm
5.	Theoretical covering capacity in M^2 / coat / litre (minimum)	5.5	6.5-8.5	6.0-8.0	6.5-8.0
6.	Weight per liter in kgs/litre (max paint) (minimum)	1.5	1.7	1.3	1.7
7.	Touch dry at 30ÁC (maximum)	4 hrs.	2 hrs.	1 hr.	2 hrs.

Sl. No.	Description	F-14	F-15	F-16	F-17
8.	Hard dry at 30ÁC (maximum) Full cure 30ÁC (for immersion / high temp. service)	24 hrs. 168 hrs.(7 days)	24 hrs. 168 hrs.(7 days)	16 hrs. -	24 hrs. 168 hrs.(7 days)
9.	Over-coating interval	Min. 6 hrs. Max. 5 days	Min. 36 hrs. Max. 21 days	Min. 16 hrs. Max. Not applicable	Min. 16 hrs. Max. 21 days.
10.	Pot life at 30ÁC for two component paints (minimum)	4 hrs.	1.5 hrs.	1 hr.	1 hr.
11.	Temperature Resistance (min.)	-45ÁC to 125ÁC under insulation	-45ÁC to 125ÁC under insulation (Note : 5)	Up to 400ÁC for CS & SS under insulation	-45ÁC to 150ÁC for immersion service

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 manufacturerôs 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
F-17	:	Two component solvent free type high built epoxy phenolic / novalac epoxy phenolic coating cured with polyamine.

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 400	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
7.1.3	-40 to 150 for Structures, hand rails and Grating only	SSPC-SP-3	1 COAT OF F-9 OR 2 COATS OF P-7 @ 40μ DFT / COAT	65-75 OF F-9 OR 80 (P-7)	For Damaged Area of more than 5 x 5 Cm2.

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	401 TO 550	SSPC-SP-3	1 COAT OF F-12	20	FOR DAMAGED AREA OF MORE THAN 5X5 CM.

TABLE 8.0: FIELD PAINT SYSTEM FOR NORMAL CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL)

ALL NORMAL CORROSIVE AREAS SUCH AS OFF SITES EXTERNAL SURFACE OF UNINSULATED COLUMNS, VESSELS, HEAT EXCHANGERS, BLOWERS, PIPING, PUMPS, TOWERS, COMPRESSORS, STRUCTURAL STEEL WORKS, RCC CHIMNEY WITH OR WITHOUT REFRACTORY LINE INSIDE CHIMNEY (ALL ENVIRONMENTS), EXCLUDING TANK TOPS, FLARE LINES, D.M. PLANTS, INTERIOR OF TANKS ETC. FLARE LINES FOR NORMAL CORROSIVE ENVIRONMENT ALSO TO NE PAINTED AS PER TABLE 9.0

S. NO.	DESIGN TEMPERATURE IN C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			FIELD PRIMER	FINISH PAINT		
8.1	-90 TO ï 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 pre-erection/ 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	

S. NO.	DESIGN TEMPERATURE IN C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			FIELD PRIMER	FINISH PAINT		
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 14ÁC TO 80ÁC AND S.NO. 8.2 WILL BE DELETED.

TABLE 9.0: FIELD PAINT SYSTEM FOR CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL)

FOR ALL CORROSIVE AREAS ABOVE GROUND WHERE H_2S, SO_2 FUMES OR SPILLAGES 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 ï 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/ 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 pre-erection/ fabrication primer
9.3	81 TO 400	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75µ DFT/ COAT	2 COATS OF F-12 @ 20 µ DFT/ COAT 2 X 20 = 40	105	
9.4	401 TO 500	SSPC-SP-10	REPAIR 2S PER 7.2.2	2 COATS OF F-12 @ 20 µ DFT/ COAT	80	

TABLE 10.0: FIELD PAINT SYSTEM FOR HIGHLY CORROSIVE (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL) EXTERNAL SURFACES OF UNINSULATED COLUMNS, VESSELS, HEAT EXCHANGERS, BLOWERS, PIPING PUMPS, TOWERS, COMPRESSORS, FLARE LINES, STRUCTURE STEEL ETC.

EXPOSED TO SPILLAGE OR FUMES OF HCL H_2S0_4, SALTY WATER IMPINGEMENT, CHLORIDE ETC.

S. NO.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			FIELD PRIMER	FINISH PAINT		
10.1	-90 TO ï 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
			FILED 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.						
11.2	-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
			FILED 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	

S. NO.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			FILED PRIMER	FINISH PAINT		
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
			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 PRIMER TYPE-B AS PER AWWA-C-203 (1991)	2 LAYERS OF COALTAR BASED TAPE COATING AS PER AWWA-C-203.	4 mm	
13.2	CARBON STEEL PLANT PIPING (UNDERGROUND)					
13.2.1	61 TO 400	SSPC-SP-10	1 COAT OF F-9 @ 65-75µ DFT/ COAT	NONE	65-75	
13.3	EXTERNAL SIDE OF UNINSULATED UNDERGROUND STORAGE TANKS:					
13.3.1	40 TO 80	SSPC-SP-10	1 COAT OF F-9 @ 65-75µ DFT/ COAT	3 COATS OF F-7 @ 100µ DFT/ COAT 3 X 100 = 300	365	
13.3.2	-90 TO ï 41 81 TO 400Ác	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
			PRIMER	FINISH PINTS		
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 PRE-FABRICATION 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 temprature ranges no painting is required under insulation.
14.1.2	OPERATING TEMPERATURE ï 45 TO 125Á C BUT DESIGN TEMPERATURE 126-400Á C	SSPC-SP-10	REPAIR OF PRE-FABRICATION 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 0Á C TO ALL MINUS TEMPRATURE	ALUMINUM SHEETING WITH ALUMINUM FOIL AND CHLORIDE FREE MINERAL SEALANT CONTAINING BARIUM CHROMATE SHALL BE APPLIED				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
14.2.2	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	

S. NO.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			PRIMER	FINISH PINTS		
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.
14.2.5	CYCLIC SERVICE-196 TO 480 EXCEPTING ï 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
			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
			FILED PAINT	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 ñPAINT STORAGE NO NAKED LIGHT-HIGHLY INFLAMMABLEòshall be clearly displayed outside.

18.0 COLOUR CODE FOR PIPING

For identification of pipeline, the colour code as per Table 18.1 shall be used. Paint material for color-coding shall be as specified in this standard in clause- 6.0.

18.1 Colour coding scheme for pipe, equipment, machinery & structure:

SR. NO.	DESCRIPTION	GROUND COLOUR	FIRST COLOUR BAND	SECOND COLOUR BAND
18.1.1	ALL KINDS OF WATER			
	DRINKING WATER	Sea Gree	French Blue	Signal Red
	DE-MINERALISED WATER	-do-	Gulf Red	-
	COOLING WATER	-do-	French Blue	-
	BOILER FEED WATER	-do-	Gulf Red	-
	CONDENSATE	-do-	Light Brown	Signal Red
	QUENCH WATER	-do-	Dark Grey	-
	WASH WATER	-do-	Ganary Yellow	-
	PROCESS WATER	-do-	Oxide Red	-
	PROCESS WATER	-do-	Crimson Red	-
	FIRE WATER	Fire red	White	-
	SEA WATER	Sea Green		-
18.1.2	STEAM			
	VERY HIGH PRESSURE STEAM (VHP)	Aluminiumto IS2339	Signal Red	-
	HIGH PRESSURE STEAM (SH)	-do-	French Blue	-
	MEDIUM PRESSURE STEAM (SH)	-do-	Gulf Red	
	LOW PRESSURE STEAM (SL)	-do-	Canary Yellow	Canary Yellow
	DILUTION STEAM/ PURGE STEAM	-do-	Grey	

SR. NO.	DESCRIPTION	GROUND COLOUR	FIRST COLOUR BAND	SECOND COLOUR BAND
18.1.3	COMPRESSED AIR PLANT AIR INSTRUMENT AIR NITROGEN OXYGEN CO_2	Sky Blue -do- -do- Canary Yello -do- -do-	Signal Red Silver Grey French Blue Black White Light Grey	- - - - - -
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- -do- smoke 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-	 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 zong stretch/ xard piping at 50M interval.

e. At start and terminating points.

18.4 **Identification Sign**

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

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

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

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

18.5 **Colour Bands**

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

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

Note: For insulated pipes, nominal pipe size means the outside diameter of insulation.
Nominal pipe size figures are to be inches.

18.5.2 Colour band(s) shall be arranged in the sequence shown in Table 18.1 and the sequence follows the direction of flow. The relative proportional width of the first colour band to the subsequent bands shall be 4:1, minimum width of any band shall be as per Clause 18.5.1.

18.5.3 Whenever it is required by the Engineer-in-charge to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal strips of black and golden yellow as epr IS:2379 shall be painted on the ground colour.

18.6 Wherever it is required by the Engineer-in-charge to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal strips of black and golden yellow as per IS:2379 shall be painted on the ground colour.

19.0 IDENTIFICATION OF VESSELS, PIPING ETC.

19.1 Equipment number shall be stencilled in black or white on each vessel, column, equipment & machinery (insulated or uninsulated) after painting. Line number n black or white shall be stencilled on all the pipelines of more than one location as directed by Engineer-in-charge, size of letters printed shall be as below :

Column & Vessels	-	150mm(high)
Pump, Compressor and other machinery	-	50mm (high)
Piping	-	40-150mm

19.2 **Identification of storage tanks**

The storage tanks shall be marked as detailed in the drawing.

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 ne 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 inculde 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 intermidiate stages of work. Contractor shall be responsible for making good any defects found during final inspection/ guarantee period/ defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra cost to owner, the extra cost should have prior approval of Engineer-in-Charge.

21.4 **Primer Application**

After surface preparation the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-in-Charge.

21.5 The shades of successive coats should be slightly different in colour in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer-in-Charge before application of successive coats.

21.6 The contractor shall provide standard thickness measurement instrument with appropriate ranges(s) for measuring.

Dry film thickness of each coat, surface profile guage for checking of surface profile in case of blast cleaning. Holiday directors and pinhole detector and positector whenever required for checking in case of immersion conditions.

21.7 Prior to application of paints on surface of chimneys the thickness of the individual coat shall be checked by application of each coat of same paint on M. S test panel. The thickness of paint on test panel shall be determined by using guage such as "Elkomere". This thickness of each coat shall be checked as per provision of this specification. This shall be approved by Engineer-in-Charge before application of paints on surface of chimney.

21.8 At the discretion of Engineer-in-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations.

21.9 Final inspection shall include measurement of paint dry film thickness. Adhesion Holiday detection check of finish and workmanship. The thickness should be measured at as many points/ locations as decided by Engineer-in-Charge and shall be within + 10% of the dry thickness, specified in the specifications.

21.10 The contractor shall arrange for spot checking of paint materials for Sp. Gr., flow time (ford cup) and spreading rate.

22.0 GUARANTEE

22.1 The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/ to be provided during execution of work.

22.2 The contractor shall produce test report from manufacturer regarding the quality of the particular batch of paint supplied. The Engineer-in-Charge shall have the right the test wet samples of paint at random, for quality of same as stipulated in clause 11 above. Batch test report of manufacturerôs 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 MECON, 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 MECON 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 manufacturerôs 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 manufacturerôs 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 Companyôs 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 MECON.

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

S. No.	MANUFACTURER NAME	P2 CHLORINATED RUBBER Zp PRIMER	P4 ETCH PRIMER/ WASH PRIMER	P6 EPOXY ZINC PH. PRIMER	F9 INORGANIC ZINC SILICATE PRIMER/ COATING
1.	ASIAN PAINTS (I) LTD.	ASIOCHL OR HB. ZN.PH PRIMER RO PC 168	APCONYL WP 636 (PC 335)	APCODUR HB. RO.ZP-PC433	APCOCIL 605
2.	BARGER PAINT LTD.	LINSOL HIGH BUILD ZP PRIMER	BISON WASH PRIMER	EPILUX 610	ZINC ANODE 304
3.	AMERON/ GODDLASS NEROLAC PAINTS LTD.	-	AMERCOAT 187	AMERCOAT 71	DIMET COTE-9
4.	JENSON & NICHOSON PAINTS LTD. AND CHOKUGU JENSON NICHOLSON	JENSOLAC CHLORINATED RUBBER HB ZN.PH. PRIMER	J & N ETCH PRIMER	EPILAC ZINC PHOSPHATE PRIMER	-
5.	SHALIMAR PAINTS LTD.	CHIOROKOTE ZINC PHOSPHATE PRIMER GREY	TUFFKOTE ETC PRIMER	EPIGUARD 4 ZINC PHOSPHATE PRIMER GREY	TUFFKOTE ZILICATE TL
6.	SIGMA COATING	SIGMA NUCOL UNICOAT 7321	SIGMA COVER PRIMER (7413)	COLTURE CM PRIMER 7412	SIGMASIL MC (7568)
7.	CDC CARBOLINE LTD.	-	-	CARBOLINE 893	CARBOZINC 11
8.	PRIMER PRODUCTS LTD.	-	-	P-15/3A U-16/92	U17/ 92 ETHYL SILICATE INORGANIC ZINC
9.	CORAMANDEL PAINTS CHEMICALS LTD.	COROCLORE CR HB. ZN. PH. PRIMER	CPC WASH PRIMER	COROPEX EPOXY ZH. PH. HIGH BILD PRIMER	-

S. No.	MANUFACTURER NAME	P2 CHLORINATED RUBBER Zp PRIMER	P4 ETCH PRIMER/ WASH PRIMER	P6 EPOXY ZINC PH. PRIMER	F9 INORGANIC ZINC SILICATE PRIMER/ COATING
10.	ANUPAM ENTERPRISES	ANUCHLOR ZP PRIMER	ANUPRIME 291	ANUPAM ANILICOR A-EZP-500	-
11.	GRAND POLYCOATS	GP CHILOROPRIME 601	GP PPRIME 401	-	-
12.	BOMBAY PAINTS LTD. THEMPEL MAKINE PAINTS	HEMPA TEX HIGHBUILD 4633	PENTOLITE WASH PRIMER 8520	HEMPELõS 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	JOTACOTE ï 2

S. No.	MANUFACTURER NAME	P2 CHLORINATED RUBBER Zp PRIMER	P4 ETCH PRIMER/ WASH PRIMER	P6 EPOXY ZINC PH. PRIMER	F9 INORGANIC ZINC SILICATE PRIMER/ COATING
				SPECIAL ZINC PHOSPHATE PRIMER	
19.	KCC PRODUCTS (KOREA)				EZ 180(N)

LIST OF RECOMMENDED MANUFACTURER'S PRODUCTS (Contd….)

S. No.	MANUFACTURER NAME	F2 ACRYLIC-POLY YURETHANE FINISH PAINT	F3 CHLORINATED RUBBER FINISH PAINT	F6 HIGH BUILD FINISH PAINT	F7 HIGH BUILD COAL TAR EPOXY COATING
1.	ASIAN PAINTS (I) LTD.	APCOTHANE CF76 (PC 1109)	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	J & N 993 HB POLYURETHANE	JENSON HB CHLORINATED	EPILAC 981 ENAMEL	EPILAC SOLVENTLESS COAT

S. No.	MANUFACTURER NAME	F2 ACRYLIC-POLY YURETHANE FINISH PAINT	F3 CHLORINATED RUBBER FINISH PAINT	F6 HIGH BUILD FINISH PAINT	F7 HIGH BUILD COAL TAR EPOXY COATING
	LTD. AND CHOKUGU JENSON NICHOLSON	FINISH PAINT.	RUBBER FINISH PAINT		TAR EPOXY COATING
5.	SHALIMAR PAINTS LTD.	SHALITHANE FINISH	CHLORKOTE FINISH	EPIGARD KL FINISH	BIPIGARD 6 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	-	COROCLORE CR FINISHING	COROPEX EPOXY HB COATING	COROPEX EPOXY COAL TAR COATING
10.	ANUPAM ENTERPRISES	ANUTHANE ENAMEL	ANUCHLOR HB ENAMEL	DURACOAT-6000	COROGUARD
11.	GRAND POLYCOATS	GP COAT 131, 132 GP BOND 141	GP CHILOROGAURD 631	GP GUARD HP 234	POLYGUARD GE

LIST OF RECOMMENDED MANUFACTURER'S PRODUCTS

S. NO.	MANUFACTURER'S NAME	F2	F3	F6	F7
12.	BOMBAY PAINTS LTD./ 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 PHOSPHATE PAINTS ONLY)				
17.	VCM POLYURETHANE PAINTS (FOR POLY EURETHANE PAINTS ONLY)	PIPCOTHANE ALIPHATIC POLYURETHANE FINISH PAINT			
18.	JOTUN PAINTS	HARDTOP AS		PENGUARD	JOTAGUARD 85
19.	KCC PRODUCTS (KOREA)			KOPOX TOPCOAT HB ET 5740	EH 173

LIST OF RECOMMENDED MANUFACTURER'S PRODUCTS

S. NO.	MANUFACTURER'S NAME	F-8 EPOXY MASTIC COATING SURFACE TOLERANT	F-11 HEAT RESISTANCE SYNTHETIC MEDIUM ALUMINUM PAINT	F-12 HEAT RESISTANCE SILICON AL. PAINT
1.	ASIAN PAINTS (I) LTD.	APCODOR CF 640	ASIAN HR ALUMINUM PAINT (PC 300)	HR SILICON ALUMINUM PAINT (PC 189)
2.	BARGER PAINT LTD.	PROTECTOMASTIC	FERROLOT HR ALUMINUM PANT	BARGER HEAT RISISTANT SILICON ALUMINUM PAINT
3.	AMERON/ GODDLASS NEROLAC PAINTS LTD.	AMERLOCK 400		AMERCOAT 878
4.	JENSON & NICHOSON PAINTS LTD. AND CHOKUGU JENSON NICHOLSON	-	FERROTECT SYNTHETIC RUBBER H/R ALUMINUM PAINT 4000	FERRLOTECT SILICON HEAT RESISTANCE 1000
5.	SHALIMAR PAINTS LTD.	EPIPLUS 56	HEAT RESISTING LUSTROL ALUMINUM	LUSTOTHERM HIGH TEMP ALUMINUM PAINT
6.	SIGMA COATING	SIGMA ETPC ALUMINUM	HIGH TEMPERATURE RESISTANT EPOXY SUSTEM UPTO 200ÁC 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	-	SILVOTOL HR ALUMINUM PAINT	CPC SILICONE HR ALUMINUM PAINT
10.	ANUPAM ENTERPRISES	ANUMASTIC-102	-	ANUPAM HEAT GUARD

LIST OF RECOMMENDED MANUFACTURER'S PRODUCTS

S. NO.	MANUFACTURER'S NAME	F8	F11	F12
11.	GRAND POLYCOATS	GP PRIME GUARD 235		-
12.	BOMBAY PAINTS LTD./ HEMPEL MARINE PAINTS	HEMPADUR 1708	KANGAROO HHR ALUMINUM 4950	HEMPADUR HIGH BUILD 5520
13.	VANAPRABHA ESTERS & GLYCERIDES,	VEGEPOX MASTIC 2255	VEG HR AL PAINT TO IS211339	VEG HHR AL PAINT TO 600ÁC
14.	SUNIL PAINTS AND VARNISHED PVT. LTD.	LPOXY HIGHBUILD P.S.901	-	-
15.	COURTAULDS COATING LTD.	INTERPLUX	-	INTERTHERM 50
16.	MARK-CHEM INCOPORATED, (FOR PHOSPHATE PAINTS ONLY)			
17.	VCM POLYURETHANE PAINTS (FOR POLY EURETHANE PAINTS ONLY)	-		
18.	JOTUN PAINTS	JOTUMATIC 87		SOLVELITT HEAT RESISTANT SILICON PAINT
19.	KCC PRODUCTS (KOREA)	EH 4158H		QT 606

Rev. : 0
Edition : 1

SPECIFICATION

FOR

REPAIR OF PIPELINE CORROSION COATING

SPECIFICATION NO.: MEC/S/05/21/08

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

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 crosslinked Polyolefin backing, coated on the inside with semi-crystalline thermoplastic Adhesive and filler mastic

1.2 The repair patch shall have thermal indicators to ensure correct heat is being applied during application.

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 80 patch make of Covalence Raychem or equivalent).
- Filler mastic : PERPFILLER of make Covalence Raychem or equivalent.
- PERP melt stick of make Covalence Raychem or equivalent.
- Certified by DIN to meet the requirement of EN12068 stress class CHT 80.

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**

The application procedure to be followed for Holiday type of damage shall be in accordance with manufacturer's instructions and minimum requirements specified below whichever is more stringent.

Preparation : Remove coating from damaged area with knife, scraper or power brush. Scrap off the damaged area and adjacent coating to remove oil, grease, ruse dirt and moisture.

Preheating : Preheat the exposed bare metal surface to about 80°C and adjacent pipe coating to about 60°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.

- Procedure qualification shall be carried out for repair patch. The value for peel strength to pipe surface and to factory coating carried out as per EN 12068 shall be 0.5 N/mm minimum at 60°C.

6.0 DOCUMENTATION

6.1 Prior to procurement of coating repair materials, Contractor shall furnish four copies of, but not limited to, the following for qualification of the Manufacturer and material :

i) Complete descriptive technical catalogs describing the materials offered alongwith samples of repair coating materials, its properties and installation instruction as applicable specifically to the project.

ii) Test certificate and results of previously conducted tests from independent inspection agency.

iii) Reference list of previous supplies of the similar material indicating the project details such as diameter, quantity, service conditions, 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.

6.2 Prior to shipment of materials from the Manufacturer's works. Contractor shall furnish six copies of the following :

i) Test Certificates for each batch of materials.
ii) Specific installation instruction with pictorial illustrations.
iii) Specific storage and handling instructions.

6.3 All documents shall be in English Language only.

Rev. : 0
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SPECIFICATION
FOR
PIPELINE MARKERS

SPECIFICATION NO.: MEC/S/05/21/10

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

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REFERENCE DRAWINGS

MECON STANDARD DRAWINGS

MEC/TYP/05/21/10/001	:	TYPICAL ROW BOUNDARY MARKER
MEC/TYP/05/21/10/002	:	K.M. POST
MEC/TYP/05/21/10/003	:	PIPELINE WARNING SIGN
MEC/TYP/05/21/10/004	:	NAVIGABLE WATERWAY PIPELINE CROSSING WARNING SIGN
MEC/TYP/05/21/10/005	:	AERIAL MARKER
MEC/TYP/05/21/10/006	:	DIRECTION MARKER

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, painted (Painting shall be in accordance with the MECON Standard Specification for Shop & Field Painting) and installed in accordance with the MECON 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 MECON Standard Drawing No. MEC/TYP/05/21/10/005 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 MECON Standard Drawing No. MEC/TYP/05/21/10/002 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 MECON Standard Drawing No. MEC/TYP/05/21/10/003 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 MECON Standard Drawing No. MEC/TYP/05/21/10/001 for details.

8.0 DIRECTION MARKERS

Direction markers as shown in MECON Standard Drawing No. MEC/TYP/05/21/10/006 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 SPECIAL MARKERS

As directed by Company, Special Marker shall be installed at Location where the following changes takes place :

- Change in pipeline diameter and wall thickness.
- Change in type of pipe.
- Change in class locations for pipeline conveying gas.

The above data may be provided on other types of marker (except RoU boundary marker), if the relative distance between the two does not exceed 100 m.

10.0 NAVIGABLE WATERWAY PIPELINE CROSSING WARNING SIGN

The Navigable Waterway Pipeline Crossing Warning Sign shall be fabricated in accordance with MECON Standard Drawing No. MEC/TYP/05/21/10/004. 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.

Rev. : 0
Edition : 1

SPECIFICATION
FOR
FLUSHING AND TESTING OF
PIPING SYSTEMS

SPECIFICATION NO.: MEC/S/05/21/11

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

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 Consultant Representative / Engineer-in- Charge.

2.0 REFERENCE

ASME B31.3-2004 : Process Piping

IBR : Indian Boiler Regulations

3.0 INSPECTION

During various stage and after completion fabrication and erection, the piping system shall be inspected by the Consultant Representative / 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.

4.0 FLUSHING

Flushing of all lines shall be done before pressure testing.

Flushing shall be done by ófresh potable waterô or ódry compressed air, wherever water flushing is not desirableôto clean the pipe of all dirt, debris or loose foreign materials.

Required pressure of water, flushing shall meet the fire hydrant pressure or utility water pressure. For air flushing the line, system will be pressurised by compressed air at the required pressure which shall be 50 psi maximum. The pressure shall then be released by quick opening of a valve, already in the line for this purpose. This procedure shall be repeated as many times as required till the inside of the pipe is fully cleaned.

In line instruments like control valves, orifice plates, rotameters, safety valves and other instruments like thermowells which may interfere with flushing shall not be included i m the flushing circuit.

From all permanent strainers the screens/meshes shall be removed before flushing. Screens/meshes shall be re- installed after flushing but before testing.

During flushing temporary strainers shall be retained. These shall be removed, cleaned and reinstalled 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 comprss4ed air, after flushing is completed.

During flushing discharged water/air shall be drained at the place directed the Engineer- in - Charge. If necessary, proper temporary drainage shall be provided by the contractor.

Care shall be taken during flushing so as not to damage/spoil work of other agencies. Precautions shall also be taken to prevent entry of water/foreign matter into equipment, electric motors, instruments, electrical installations etc. in the vicinity of lines being flushed.

The contractor shall carry out all the activities required before, during and after the flushing operation, arising because of flushing requirements, such as but not limited to the following.

Dropping of valves, specials, distance pieces, online instruments and any other piping part before flushing. The flanges to disengaged for this purpose shall be envisaged by the contractor and approved by the Engineer-in-Charge. These flanges shall be provided with temporary gaskets at the time of flushing.

After flushing is completed and approved, the valve, distance pieces, piping specials etc. shall be re-installed by the contractor with permanent gaskets. However, flanges of equipment nozzles and other places where isolation is required during testing, only temporary gaskets shall be provided.

Records in triplicate shall be prepared and submitted by the Contractor for each piping system for the flushing done in the proforma provided / approved by EIC.

5.0 TESTING

Pressure testing, in general shall be as per clause 345 of ASME B31.3, unless otherwise specified, herein. Lines carrying highly hazardous / poisonous fluids must have a sensitive leak test. For IBR lines, ôIBR Regulationsôshall also be followed.

5.1 Extent of testing

With the exclusion of instrumentation. piping system fabricated or assembled in the field shall be tested irrespective of whether or not they have been pressure tested prior to site welding of fabrication.

To facilitate the testing of piping systems, vessels and other equipments may be included in the system with the prior approval of Engineer-in-charge, if the test pressure specified is equal to or less than that for the vessels and other equipments.

Pumps, compressors and other votary equipments shall not be subjected to field test pressures.

Lines which are directly open to atmosphere such as vents, drains, safety valves, discharge need not be tested, but all joints shall be visually inspected wherever necessary such lines shall be tested by continuous flow of fluid to eliminate the possibility of blockage. However, such lines if provided with block valve shall be pressure tested upto the first block valve.

Seats of all vales shall not be subjected to a pressure in excess of the maximum cold welding pressure of the valve. Test pressure applied to vales shall not be grater than the manufacturer is recommendation nor less than that required by the applicable code. Where desirable set pressure is less than test pressure, test shall be made through an open valve.

Instruments in the system to be tested, shall be excluded from the test by isolation or removal, unless approved otherwise by the Engineer-in-charge. Restrictions which interfere with filling, venting and drawing such as orifice plates etc. shall not be installed unless testing is complete.

Control valves shall not be included in the test system. Where by-passes are provided test shall be performed through the by-pass end/or necessary spool shall be used in place of the control valve.

Pressure gauges which are part of the finished system, but cannot withstand test pressure shall not be installed until the system has been tested. Where piping systems to be tested are directly connected at the battery limits to piping for which the responsibility tests with other agencies, the piping to be tested shall be isolated from such piping by physical disconnection such as valves or blinds.

5.2 General Requirement/Test preparation for Testing

Test shall be carried out with permanent gaskets installed unless specified otherwise or instructed by the Engineer-in- charge.

No pressure test shall be carried out against close valve unless approved by the Engineer-in-charge.

The Engineer-in-charge shall be notified in advance by the contractor, of the testing sequence and programme, to enable him to be present for witnessing the test. The contractor shall be fully responsible for making arrangements with the local boiler inspector to witness the tests for steam lines falling under IBR. IBR certificates for these tests shall be obtained in the relevant IBR forms and furnished to the Engineer-in-charge. Before testing, all piping shall be cleaned by flushing to make it free from dist loose scale, debris and other loose foreign materials.

All piping systems to be hydrostatically tested shall be vented at the high points and the systems purged of air before the test pressure is applied.

Wherever in the line any void is existing due to any reasons, for absence of control valve, safety valve, check valves etc. it shall be filled with temporary spools.

All joints welded, screwed or flanged shall be left exposed for examination during the test. Before pressuring the lines, each weld joint shall be cleaned by wire brush to free it from rest and any other foreign matter.

Where a system is to be isolated of a pair of companion flanges, a blank shall be inserted between the companion flanges. Minimum thickness of the blank shall be designed in accordance with applicable design code.

Open ends of piping system where blanks cannot be used, such as pumps, compressors, turbines or wherever equipment or pipe spool have been receivered or disconnected prior to hydrostatic testing, shall be blinded ï 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 pressurise 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 ï weight supported shall be temporarily supported, where the weight of the fluid would overload the support. Retaining pins for spring supports shall be removed only after testing is completed and test fluid is completely drained.

When testing any piping system, air or steam of approximately 2 kg/cm^2 (g) may be used as preliminary test to detect missing gaskets etc. as this avoids the necessity of purging the gas to make repairs. However, this method may not be used for this purpose, if the steam temperature is more than the design temp. of the line.

For jacketed pipes testing of core pipes shall be done on individual pieces where the pipe is continuously packed, before it is jacketed. The outer jacket shall be tested separately as a system for piping with discontinuous jacketing, the core pipe and the jacket shall be tested as separate system.

5.3 Testing Modes, Test pressure and Test Pressure Gauges

5.3.1 Testing Modes

In general all pressure test shall be hydrostatic using iron free water, which is clean and free of silt. Maximum clorine content in water for hydrostatic testing for MS piping shall be 15-20 ppm. Air shall be used for testing only if water would cause corrosion of the system or overloading of supports etc. in special cases as directed by Engineer-in-charge.

If operating fluid in the line is much lighter than testing fluid, the additional weight of testing fluid may render piping supports (as designed) inadequate. This will call for additional temporary supports. The typical examples are flare and vapor lines. It is preferable that hydrostatic testing is avoided in such systems and instead pneumatic testing may be specified.

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.

5.3.2 Test Pressure

The hydrostatic/pneumatic test pressure shall be as indicated in the line list or as per the instruction of Engineer-in-charge.

The selection of the piping system for one individual test shall be based on the following :-

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.

5.3.3 Test Pressure Gauge

All gauge used for field testing shall have suitable range so that the test pressure of the various system falls in 35% to 65% of gauge scale range. Pressure gage shall be minimum of 150 mm. Size of Bourdon shall not be less than 75% of nominal diameter of dial range. Gauge shall be of a good quality and in first class working condition.

Prior to the start of any test or periodically during the field test programmes, all test gauges shall be calibrated using a standard dead weight gauge tester or other suitable approved testing apparatus. Any gauge having an incorrect zero reading or error of more than Ñ 2% of full scale range shall be discarded. The Engineer-in-charge shall check the accuracy of master pressure gauge used for calibration.

5.4 Testing Pressure

5.4.1 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 depressurising 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 four hours.

The pump and the piping system to be tested are to be provided with separate pressure indicating test gauges. There gauges are to be checked by the standard test gauge before each pressure test.

Care shall be taken to avoid increase in the pressure due to atmospheric variation during the test.

5.4.2 Air Test

When testing with air, pressure shall be supplied by means of a compressor. The compressor shall be portable type with a receiver after cooler & 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).

5.5 Completion of Testing

After the hydrostatic test has been completed, pressure shall be released in a manner and at a rate so as not to endanger personnel or damage equipments.

All vents and drains shall be opened before the system is to be drained and shall remain open till all draining is complete, so as to prevent formation of vacuum in the system. After draining lines/systems shall be dried by air.

After testing is completed the test blinds shall be removed and equipment/piping isolated during testing shall be connected using the specified gaskets, bolts and nuts. These connections shall be checked for tightness in subsequent pneumatic tests to be carried out by the contractor for complete loop/circuit including equipments (except rotary equipments).

Pressure 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.

5.6 Test Records

Records in triplicate shall be prepared and submitted by the contractor for each piping system, for the pressure test done in the proforma provided / approved by the Engineer-in-charge.

SPECIFICATION
FOR
CASING INSULATORS
AND END SEALS

SPECIFICATION NO. MEC/S/05/62/12

(PROCESS & PIPING DESIGN SECTION)

MECON LIMITED

DELHI - 110 092

CONTENTS

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 12ò (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.

$$\frac{\text{Casing internal dia-carrier outer dia}}{2}$$

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:

Property	Value	ASTM Test Method
Dielectric strength	450-500 Volts/Mil	D-149
Compresssive strength	3200 psi	D-695i
Tensile strength	3100-5000	D-638, D-651
Impact strength	4.Oft. 1b./inch of notch	D-256
Water Absorption	0.01%	D-570

5.0 INSPECTION AND TESTING

Manufacturer shall furnish material test certificates of the components used in the assembly of casing insulations as per the requirements of clause 4.0 of this specification.

PART-B CASING END-SEALS

1.0 SCOPE

This specification covers the minimum requirements of design, material, fabrication and supply of casing end-seals intended to be used for pipeline cased crossings.

2.0 FUNCTION

Casing end seals are intended to be used for sealing the annular space between casing pipe and carrier pipe at casing ends so as to prevent ingress of moisture and water.

3.0 DESIGN

The scale shall be suitable for the casing and carrier pipe diameters as applicable for each case.

The casing end-seal shall be flexible to cater for the expansion and contraction of carrier and casing pipes and shall be able to tolerate both angular and concentric misalignment of casing pipe without loss of sealing efficiency.

The design of the casing end-scale shall permit easy installation of the seal to the cased pipeline crossing.

It shall provide moisture-proof seals when installed for the entire anticipated life of the buried pipeline.

Manufacturer shall obtain prior approval from COMPANY on casing end seals design/drawings.

4.0 MATERIAL

The casing end-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:

Property	Minimum Value	Test Method
a) Backing (Sleeve and closure patch)		
Tensile strength	2200 psi	ASTM D-638
Ultimate Elongation	400%	ASTM D-638
Heat Shock	No visual cracks, flow or drips (at 225ÁC, 4 hours)	ASTM D-2671
b) Adhesive		
Ring and Ball softening point	90ÁC	ASTM E-28
Lap Shear	60ÁC - 25 psi 23ÁC - 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 replaces, 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.

Rev. : 0
Edition : 1

SPECIFICATION

FOR

FIELD JOINT COATING (ONSHORE PIPELINES)

SPECIFICATION NO.: MEC/S/05/21/13

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

1.0 SCOPE

This specification covers the minimum requirements of materials, equipment and installation of field joint anti-corrosion coating of underground onshore factory coated pipelines with either three layer polyethylene or fusion bonded epoxy (FBE) coating by heat shrink wraparound sleeves conforming to DIN EN 12068 ï ñCathodic Protection ï External Organic Coatings for the Corrosion Protection of Buried or Immersed Steel Pipelines used in Conjunction with Cathodic Protection ï Tapes and Shrinkable Materialsò and the requirements of this specification. Unless modified / replaced by this specification, all requirements of DIN EN 12068 shall remain fully applicable and complied with.

This specification shall be read in conjunction with the conditions of all specifications and documents included in the Contract between Company and Contractor. Unless specified otherwise, all sections of this specification shall apply to all specifications referred in this specification.

2.0 REFERENCE DOCUMENTS

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

a) ASTM D-149 : Standard Test Methods of Dielectric Breakdown voltage and Dielectric Strength of solid electrical insulating materials at commercial frequencies.

b) ASTM D-257 : Standard Test Methods for D-C Resistance or conductance of insulating materials.

c) ASTM D-570 : Standard Method of Test for Water Absorption of Plastics.

d) ISO 8502-3 : Preparation of Steel Stubstrates before Application of Paints and Related Products ï Part-3 ï 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 ï 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 Contractor shall supply joint coating materials, all equipment and manpower required for a skillful and adequate application of coating in the field in accordance with the specifications.

Contractor shall submit and demonstrate to Company proposed materials and works procedures for applying field coating and repair procedures for same. These proposed procedures and all materials, equipment and tools used in the work shall be subject to Company's approval.

3.2 Field Joint Corrosion Coating Material

Field joint anti-corrosion coating material shall be either heat shtrinktable wraparound sleeve or cold applied tape suitable for a maximum operating temperature of (+) 65ÁC (T_{max}) and shall conform to designation EN 12068 ï C HT 60 UV. In addition the field joint anti-corrosion coating shall comply the requirements specified in para 3.3 of this specification.

3.2.1 Heat Shrinkable Wraparound Sleeve

Heat shrinkable wrap around sleeve shall consist of radiation cross-linked thermally stabilised, ultraviolet resistant semi-rigid polyolefin backing with a uniform thickness of high shear strength thermoplastic/copolymer hot melt adhesive. The joint coating system may consist of a solvent free epoxy primer applied to the pipe surface prior to sleeve application. The backing shall be coated with 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 (Min.)	On Weld Bead (Min.)
4ò(114.3 mm) to 10ò(273.0 mm)	2.0 mm	1.6 mm
12ò(323.9 mm) to 18ò(457.2 mm)	2.2 mm	1.8 mm
20ò(508.0 mm) to 30ò(762.0 mm)	2.5 mm	2.0 mm
≥ 32ò(812.8 mm)	3.0 mm	2.5 mm

The heat shrink wraparound sleeve shall have the required adhesive properties when applied on various commercial pipe-coating materials. The pre-heat and application temperatures required for the application of the shrink sleeve shall not cause loss of functional properties of the pipe coating.

Heat shrinkable wraparound field joint coating system manufactured by M/s Covalence and M/s Canusa are acceptable for the supply of field joint coating materials. The Contractor shall propose the specific grade of field joint coating system meeting the requirements of this specification from these manufacturers. In case the Contractor proposes to supply heat shrinkable wraparound sleeve from any other manufacturer, then the Contractor shall propose only those coating systems that have been previously used for pipelines of size same or higher than the size indicated in tender, for a length of 50 km and above in a single project for similar operating conditions.

3.2.2 **Cold Applied Tapes**

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

The Contractor shall propose only those cold applied tape coating systems that have been previously used in pipelines of size 16" and above and a length of 50 km and above in a single project for similar operating conditions.

3.3 **Functional Requirements of Field Joint Coating**

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

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

3.3.2 **Functional Properties of Joint Coating System (As applied)**

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

a) Cathodic Disbondment Resistance at T_{max} i.e. 60ÁCshall be 20mm when tested as per Annexure K of DIN EN 12068. Test shall be carried out at (+) 60ÁC.

b) Peel Strength shall be as follows :

Peel Strength		Unit	Requirement for Mech Resistance Class C (Minimum)	Test Method as per DIN EN 12068
Inner to Inner + Outer to Inner	@23ÁC	N/mm	1.5	Annexure-B
	@T_{max}	N/mm	0.3	
Outer to Outer	@23ÁC	N/mm	1.5	
	@T_{max}	N/mm	0.3	
To Pipe Surface	@23ÁC	N/mm	3.5	Annexure-C
	@T_{max}	N/mm	0.3	
To Factory Coating	@23ÁC	N/mm	3.5	
	@T_{max}	N/mm	0.3	

Notes

(T_{max} shall be (+) 60ÁC)

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 :

- Manufacturerôs 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 manufacturerôs 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 manufacturerôs original packing and away from direct sunlight and in accordance with manufacturerôs 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 (Digital Pyrometer with flat probe type contact).
d) Roughness profile measuring (Stylus) instrument

4.0 APPLICATION PROCEDURE

4.1 General

4.1.1 The application procedure shall be in accordance with manufacturerôs instruction and the minimum requirements specified below whichever are the most stringent and shall be demonstrated to and approved by the Company. Manufacturerôs expert shall supervise the application and shall be available at site upon request during qualification of application procedure and during construction at Contractorôs 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 until the requirements stated in sections ñInspectionò and ñTestingòof this specification are met.

4.1.3 Oil, grease and salt shall be removed from steel surface by wiping with rags soaked with suitable solvents such as naphtha or benzene. Kerosene shall not be used for this purpose. Solvent cleaning procedure according to SSPC-SP1 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 (in case the authority having jurisdiction have no objection, the contractor may adopt sand blasting instead of garnet material). During blast cleaning the pipe surface temperature shall be simultaneously more than 5Áand more than 3ÁC 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 2İ in accordance with Swedish Standard SIS-055900 with a roughness profile of 50-70 microns. Surface roughness profile shall be measured using an approved profile comparator in accordance with ISO 8503-1 and shall be calibrated prior to the start of the work in accordance with ISO:8503-3 or ISO:8503-4. The blast cleanliness shall be checked on every joint and the roughness profile shall be checked 1 every 10 joints.

Dust grit or foreign matter shall be removed from the cleaned surface by an industrial vacuum cleaner. The dust contamination allowed shall be of a rating max 2 as per ISO:8502-3. The frequency of checking for dust contamination shall be 1 every 10 joints.

Blast cleaned field joint shall be coated within 2-4 hours according to the conditions below :

- Relative Humidity (RH) > 80% - 2 Hours
- Relative Humidity (RH) 70-80% - 3 Hours
- Relative Humidity (RH) < 70% - 4 Hours

Pipes delayed beyond this point or pipes showing any visible rust stain shall be blast cleaned again.

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 surface are free of soil, grease, rust, mud, earth or any other foreign matter. All these substances shall be removed before coating, to the procedures herein described.

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 sleeves shall be of a size such that a minimum overlap of 50mm is ensured (after shrinking) on both sides of yard applied corrosion coating of the pipes.

In cases where carrier pipe is installed by direct boring/jacking, the overlap on the mill coating for the leading edges of the joints shall be minimum 200mm. When this extra overlap is achieved by providing an additional patch of heat shrink tape/wraparound, it shall be applied in such a manner that the square edge of the patch on the joint coating is in the direction opposite to the direction of boring/jacking.

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 (Digital Pyrometer with flat probe type contract) to check this, approved temperature indicates shall be used. Temperature indicating crayons shall not be used. Pre-heat temperature shall be checked on every joint. Care shall be taken to ensure that the entire circumference of the pipe is heated evenly. Temperature measuring instruments shall be calibrated immediately before the start of the works and thereafter at intervals recommended by the manufacturer of the instrument.

4.2.3 Upon pre-heating the pipe surface shall be applied with two pack epoxy primer of wet film thickness 150 microns or as per manufacturerôs recommendation whichever is higher, to cover the exposed bare metal of the welded field joint and 10mm min. onto the adjacent pipe coating if recommended by the manufacturer. The wet film thickness of the primer shall be checked or every joint with a wet film thickness gauge prior to installation of sleeve. Thickness gauge shall be calibrated once per shift.

4.2.4 Immediately after application of epoxy primer, the wraparound sleeve shall be entirely wrapped around the pipe within the stipulated time recommended by the manufacturer. Sleeve shall be positioned such that the closure patch is located to one side of the pipe in 10 or 2 Oôclock 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.

The coatings mentioned are for undergrounds installations.

For HDD Joint Coating fiber glass reinforced heat shrinkable sleeve certified to Stress class C60 type CANUSA-TBK or COVALENCE / DIRAX shall be used. Directional drilling kit, multilayer sleeve system or equivalent to be approved by Owner / Engineer.

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

For the buried valve station (moulded piece, valves, elbows etc) Thermoset plastic coatings may be used. They will be of type S50 certified as per DIN 30671 & DIN 30677.

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

At the point of transition from the aboveground pipe to underground pipe special coating material FIBAROLL or equivalent to be used over the coated part of U.G. pipe and painted part of A.G. Pipe end over lapping shall be at least 500 mm inside the ground and 500 mm on painted AG line. Minimum thickness shall be 1.5 mm. The application of the material will be as per supplier's specification.

Wherever Thrust Boring (Jacking) method is carried out, for mechanical protection of coating of carrier pipe extra layer of hard cold applied tapes C-70 class as per DIN 30675-1 or solvent free PUR (1000 microns) as per DIN 3067712 Ep-50 types shall be applied. Surface preparation (sand blasting) of PE layer shall be appropriate as per applicator's recommendations. The type & thickness of coating must got approved by Owner / Engineer prior to coating.

4.3 Application of Cold Applied Tapes

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

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 150 microns or as per manufacturerôs 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 also be applied in similar method.

In the cases where carrier pipe is installed by direct boring/jacking, the overlap on the mill coating for the leading edges of the joints shall be minimum 200mm. The direction of spiral wrapping in these cases shall be such that the square edge of the wrapping with the joint coating is in the direction opposite to the direction of boring/jacking.

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 :

i) Surface preparation cleanliness, roughness profile and dust contamination
ii) Pre-heat temperature (as applicable)
iii) Primer thickness
iv) As applied coating thickness
v) Holiday detection
vi) Peel test at (+) 23ÁC & (+) 60ÁC on pipe surface & factory applied coating and at over laps (as applicable). If required to achieve the temperature of (+) 60ÁC, suitable thermal blanket may be used.
vii) Visual appearance and void after installation on the body, area adjoining the weld and area adjoining the factory applied coating. (To establish voids adjoining the weld and factory coating a strip of 50 mm wide and 200 mm long shall be stripped and examined).

Company Representative shall witness the tests and inspection. Regular application of field joint coating shall commence only upon successful completion of the pre-qualification testing.

After successful completion of the pre-qualification testing as above, the entire field joint coating shall be removed, the pipe surface re-blasted and field joint coating re-applied as per the requirements of this specification.

5.0 **INSPECTION**

5.1 A visual inspection shall be carried out for the following :

- Mastic extrusion on either ends of the sleeve shall be examined. (applicable for heat shrink wraparounds).
- There shall be no sign of punctures or pinholes or bend failure. The external appearance of the sleeve shall be smooth, free of dimples, air entrapment or void formation.
- Weld bead profile shall be visible through the sleeve.
- The entire closure patch shall have changed colour uniformly (applicable for heat shrink wraparounds).

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 of at least 25 kV. Inspection of the sleeves shall be conducted only after the joint has cooled below 50°C. (applicable for heat shrink wraparounds).

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

5.4 **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.

6.0 **TESTING**

6.1 Company reserves the right to remove and test one out of every 50 joint coatings or one joint coating out of every day's production whichever is stringent. Contractor shall provide all assistance in removing and testing of field joint coatings.

6.2 From each test sleeve, one or more strips of size 25mm x 200 shall be cut perpendicular to the pipe axis and slowly peeled off.

The required peel strength shall meet the requirements of clause 3.2.4.2 (ii) 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 on 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.

6.3 If the sleeve taken away for test does not meet the requirements of clause 6.2 the adjacent two sleeves shall also be removed and inspected.

If the adjacent two sleeves are acceptable the test rate shall be increased to one sleeve in every twenty five until Company's Representative is satisfied. The test rate can then be reduced as per clause 6.1.

If either or both of the adjacent two sleeves do not meet the requirements of clause 6.2, the field coating shall be stopped. (Refer clause 7.0).

6.4 Company Representative reserve the right of 100% removal of sleeves if he is not convinced that the requirements of clause 6.2 are achieved.

6.5 Coating thickness shall be checked by non-destructive methods for each fields joints.

7.0 **REPAIRS**

7.1 If a field joint is detected to be unacceptable after testing as per section 6.0 of this specification the Contractor shall, at his own cost :

- determine the cause of the faulty results of the field coating.
- mobilise the expert of manufacturer, if required.
- test to the complete satisfaction of the 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.

7.2 Contractor shall replace all joint coating found or expected to be unacceptable a per section 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 Company.

7.4 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.

7.5 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 Coating defects are establish, the Contractor shall be responsible for excavations at such points, repairing the coating, spark testing and backfilling the excavation without extra charge.

8.0 DOCUMENTATION

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

i. 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.

ii. Test certificates and results of previously conducted tests, for all properties listed in clause 3.2.4 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, years of supply, project name, contact person and feed back on performance.

Once the Companyôs 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.

8.2 Prior to shipment of materials from the Manufacturerôs Works Contractor shall furnish the following documents :

i. Test certificates/ results as per Manufacturerôs Quality Control Procedure for each batch of materials.
ii. Specific application instructions with pictorial illustrations.
iii. Specific storage and handling instructions.

8.3 All documents shall be in English Language only.

Rev. : 0
Edition : 1

SPECIFICATION
FOR
VENTS, DRAINS AND WELLS

SPECIFICATION NO.: MEC/S/05/21/15

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

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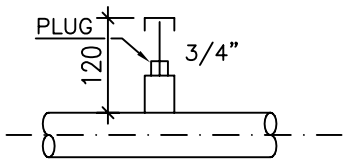
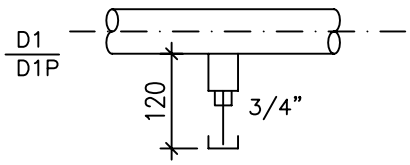
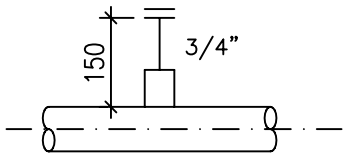
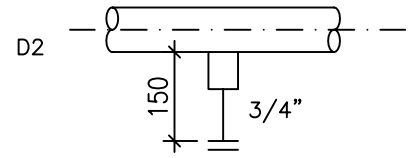
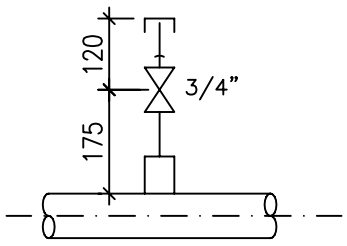
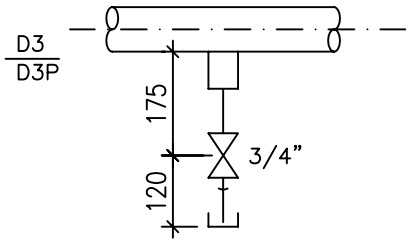
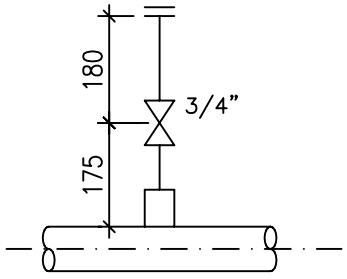
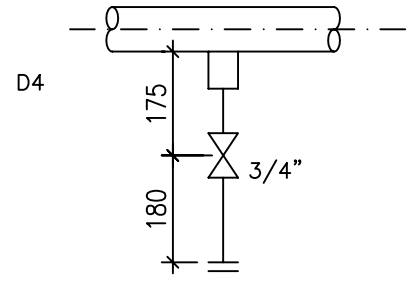
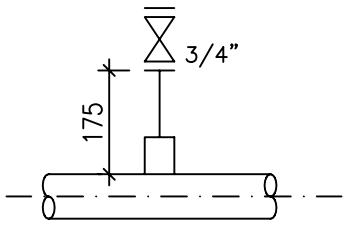
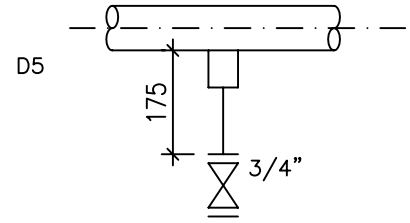
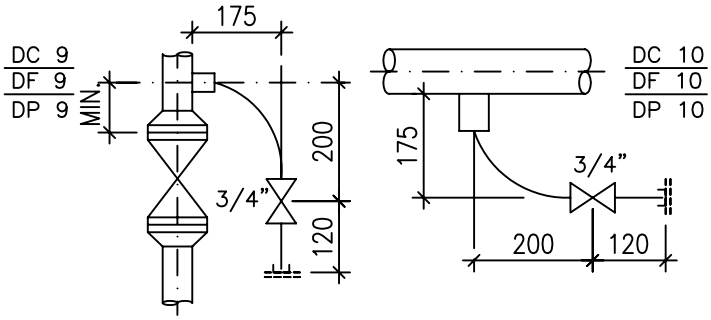
V1 / V1P		D1 / D1P 
V2		D2 
V3 / V3P		D3 / D3P 
V4		D4 
V5		D5 

NOTES:–

1. DIMENSIONS ARE VALID FOR 75mm (MAX.) THICKNESS INSULATION FOR HIGHER INSULATION THICKNES INCASE DIMENSIONS AS REQUIRED.
2. VENTS & DRAINS SHALL BE PROVIDED WITH GATE, GLOBE OR PLUG VALVE WITH HALF COUPLING OR STUB IN WITH CAP OR FLANGE, BLIND FLANGE, AS PER PIPING SPECIFICATIONS.
3. VENTS/DRAINS CAN BE PROVIDED ON FLAT SIDE OF ECCENTRIC REDUCERS ON SIZES 4" & ABOVE.
4. LEGEND V=VENT, D=DRAIN, C=CAP, F=FLANGE, P=PLUG
5. PLUGGED END OF VALVE OR FITTING SHALL BE THREADED.



REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.

REVISIONS

SECTION: P&PD	NAME	DATE	CHKD	DATE
DSGN				
DRWN				
APPROVED				

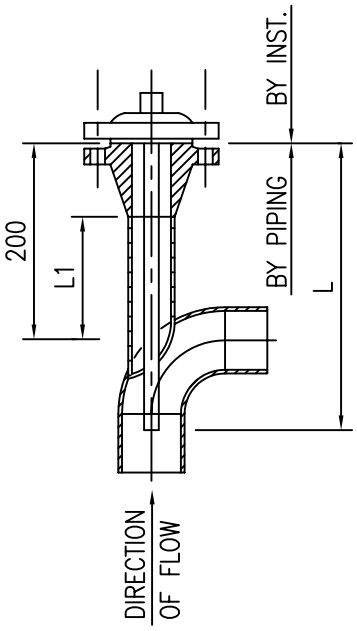
VENT & DRAIN
FOR LINES 2" & ABOVE

MECON LIMITED

SCALE : N.T.S.

DRG.NO MEC/SD/05/21/15/01

REV 0



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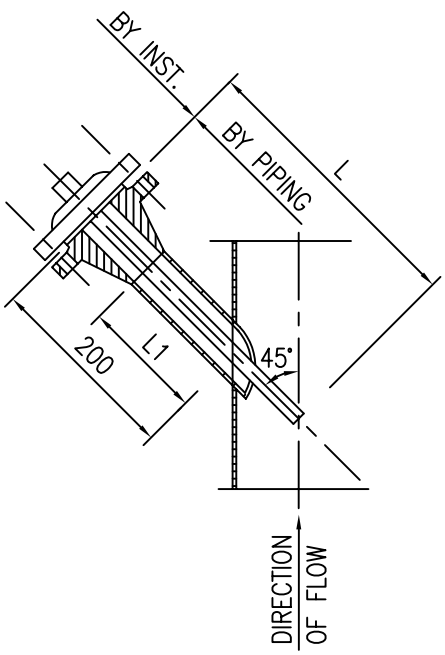

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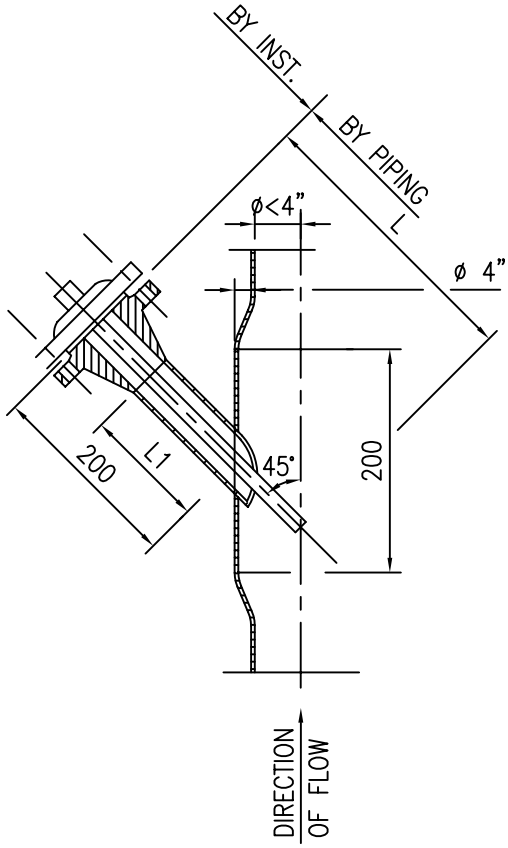

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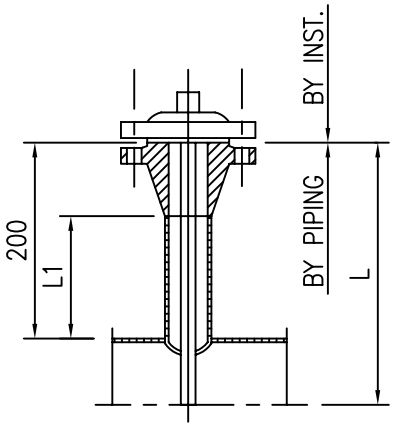

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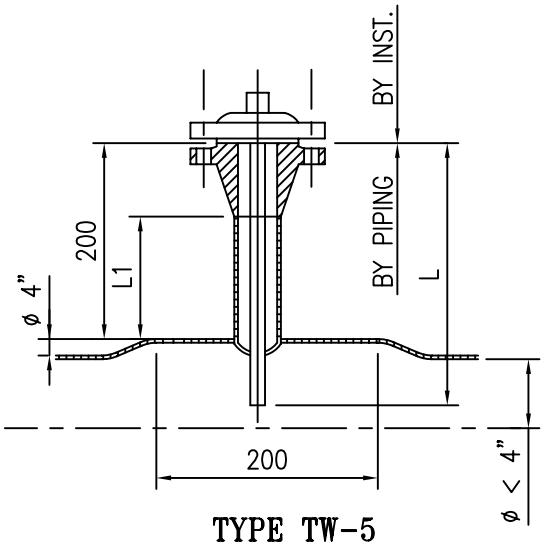


TYPE TW-5

LINE DIA	L 1.5" FLANGED WELL
4"	200
6"	300
8"	300
10"	300
12"	300
14"	300
16"	400
18"	400
20" & LARGER	500
VESSELS	AS REQUIRED

1. ELBOW MIN. 4" ø OR LARGER
2. VERTICAL LINE 4" ø OR LARGER
3. HORIZONTAL LINE 4" ø OR LARGER
4. VERTICAL LINE DIA LESS THAN 4"
5. HORIZONTAL LINE DIA LESS THAN 4"

NOTES:

1. BOLTS, NUTS AND GASCKETS BY PIPING.
2. MIN. CLEARANCE FOR REMOVAL L+550
3. L1 DIMENSIONS ARE CALCULATED FOR WN, RF FLG. ONLY.
4. IN CASE ANY DEVIATION IS REQUIRED FOR INSTALATION TAPS FROM THIS STD. INST. DEPTT. TO BE CONSULTED.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
			REVISIONS				

SECTION: P&PD	NAME	DATE	CHKD	DATE
DSGN				
DRWN				
APPROVED				

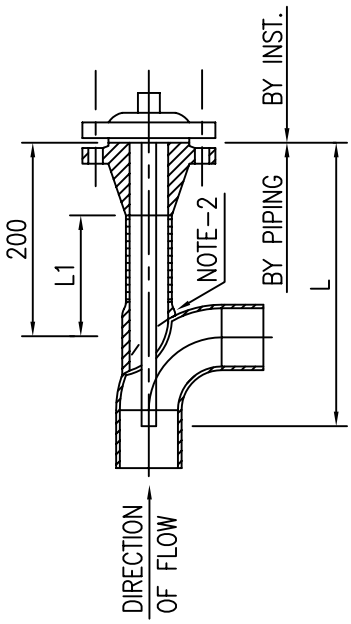
WELLS INSTALLATION
1½" DIA TAPS

MECON LIMITED

SCALE : N.T.S.

DRG.NO MEC/SD/05/21/15/02 (SH. 1 OF 2)

REV 0



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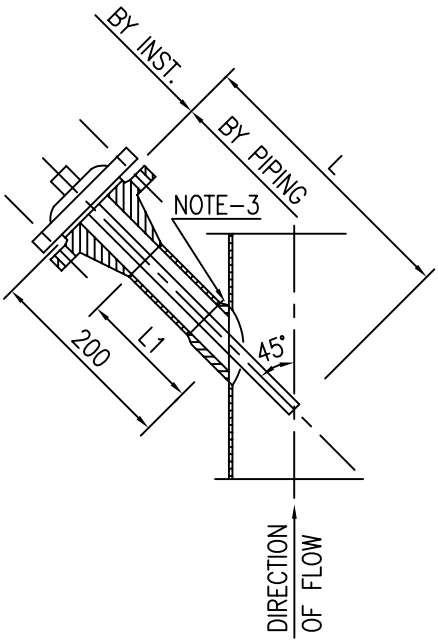

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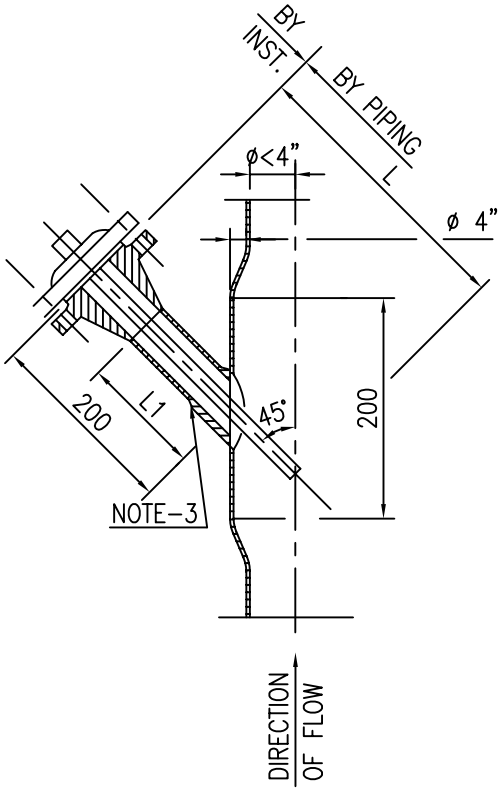

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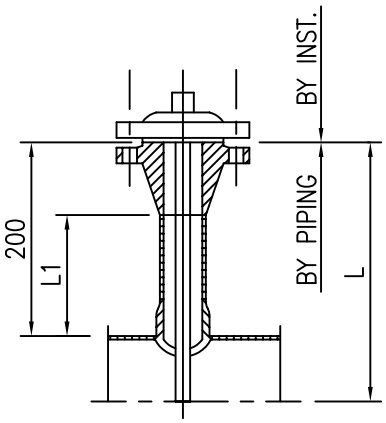

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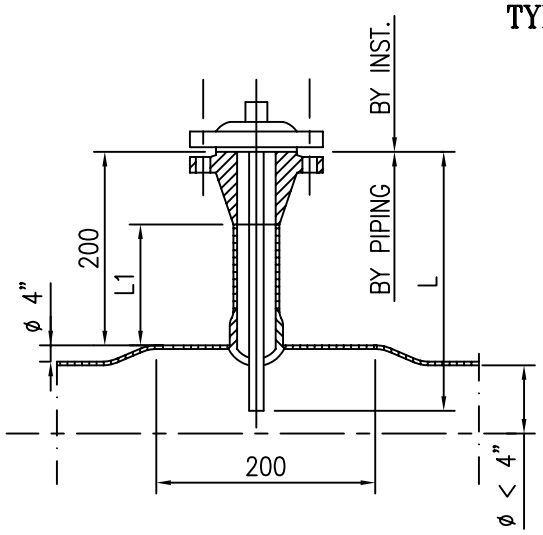


TYPE TW-10

LINE DIA	L 1.5" FLANGED WELD
4"	200
6"	300
8"	300
10"	300
12"	300
14"	300
16"	400
18"	400
20" & LARGER	500
VESSELS	AS REQUIRED

6. ELBOW MIN. 4" ø OR LARGER
7. VERTICAL LINE 4" ø OR LARGER
8. HORIZONTAL LINE 4" ø OR LARGER
9. VERTICAL LINE DIA LESS THAN 4"
10. HORIZONTAL LINE DIA LESS THAN 4"

NOTES:

1. BOLTS, NUTS AND GASCKETS BY PIPING.
2. MIN. CLEARANCE FOR REMOVAL L+350.
3. COUPLING TO BE SPECIAL LENGTH.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
			REVISIONS				

SECTION: P&PD

	NAME	DATE	CHKD	DATE
DSGN				
DRWN				

APPROVED

WELLS INSTALLATION
1 1/2" DIA TAPS

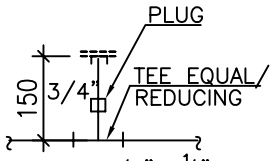
MECON LIMITED

SCALE : N.T.S.

DRG.NO MEC/SD/05/21/15/02 (SH. 2 OF 2)

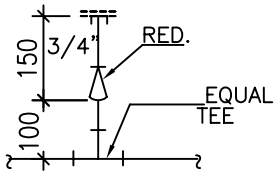
REV 0

VC 2
VF 2
VP 2



VENT ON LINE 3/4"–1½"

VC 2
VF 2
VP 2



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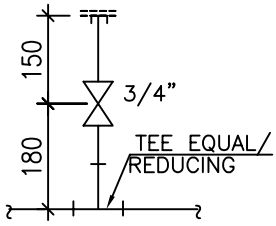
VF 3
VP 3



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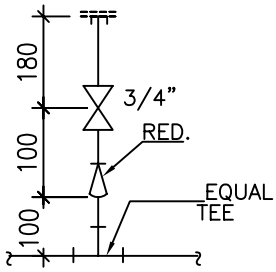
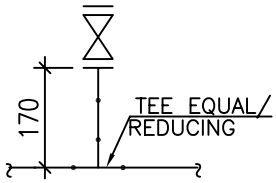
VF 4
VP 4



VENT ON LINE 1"–1½"

VC 5
VF 5



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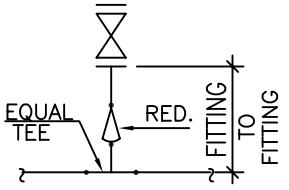
VC 6
VF 6



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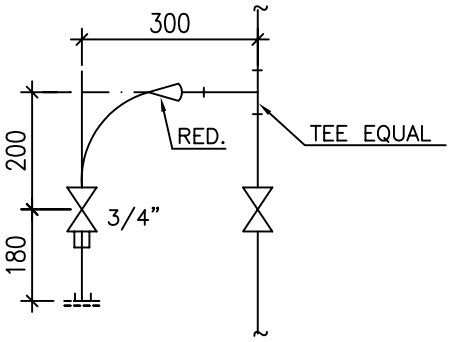
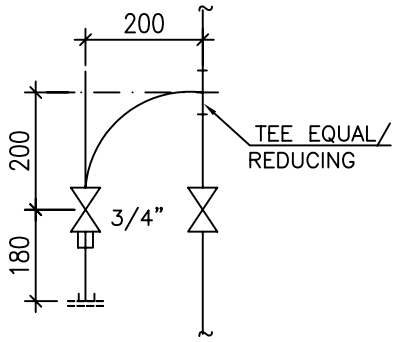


DRAIN ON LINE 1"–1½"

DC 7
DF 7
DP 7



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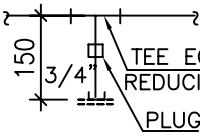
DP 8



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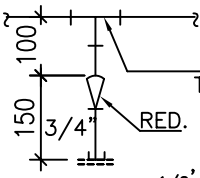
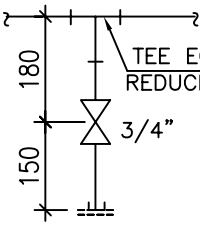
DP 2

DRAIN ON LINE 3/4"–1½"



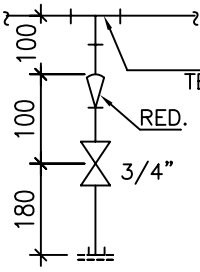
DC 2
DF 2
DP 2

DRAIN ON LINE 1'–1$^{1/2}$'



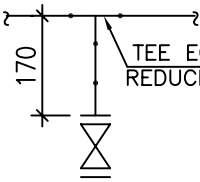
DC 3
DF 3
DP 3

DRAIN ON LINE 3/4"–1½"



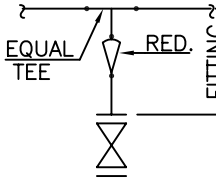
DC 4
DF 4
DP 4

DRAIN ON LINE 1"–1½"



DC 5
DF 5

DRAIN ON LINE 3/4"–1½"



DC 6
DF 6

DRAIN ON LINE 1"–1½"

NOTES:–

1. DIMENSIONS ARE VALID FOR 50mm (MAX.) THICKNESS INSULATION. FOR HIGHER INSULATION THICKNES INCASE DIMENSIONS AS REQUIRED.
2. VENTS & DRAINS SHALL BE PROVIDED WITH GATE, GLOBE OR PLUG VALVE
3. LEGEND V=VENT, D=DRAIN, C=CAP, F=FLANGE, R=REDUCER, COUPLING OR SWAGE, P=PLUG
4. PLUGGED END OF VALVE OR FITTING SHALL BE THREADED.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
			REVISIONS				

SECTION: P&PD

	NAME	DATE	CHKD	DATE
DSGN				
DRWN				

APPROVED

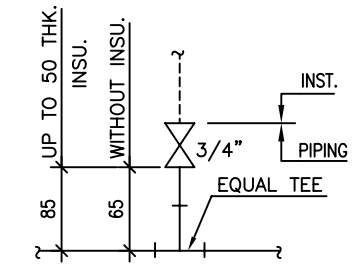
VENT & DRAIN ON LINES 1½" & BELOW

MECON LIMITED

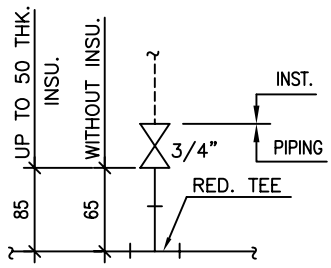
SCALE : N.T.S.

DRG.NO MEC/SD/05/21/15/03

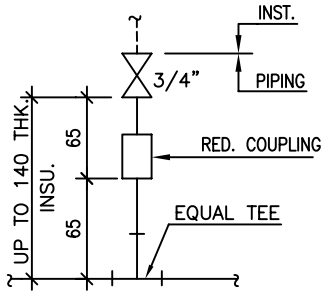
REV 0



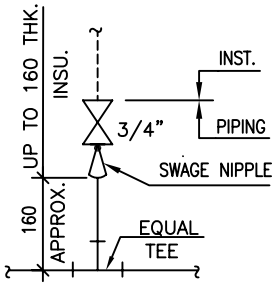
PC-1 ON LINE 3/4"



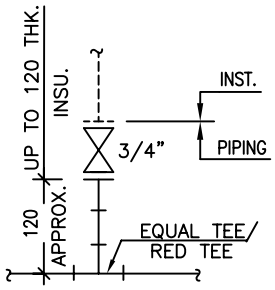
PC-2 ON LINE 1"-1 1/2"



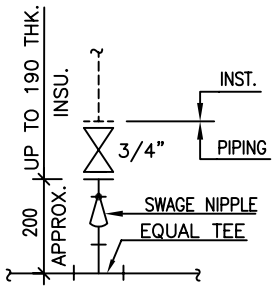
PC-3 ON LINE 1"-1 1/2"



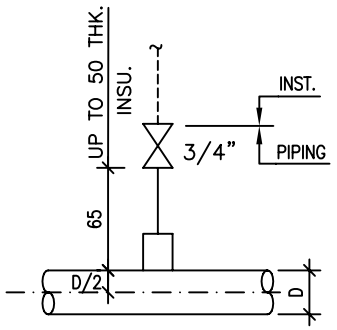
PC-4 ON LINE 1"-1 1/2"



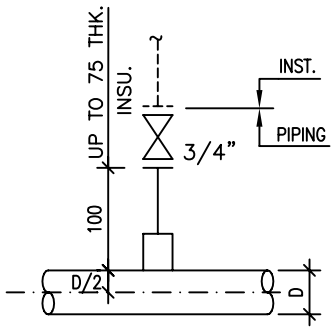
PC-5 ON LINE 3/4"-1 1/2"



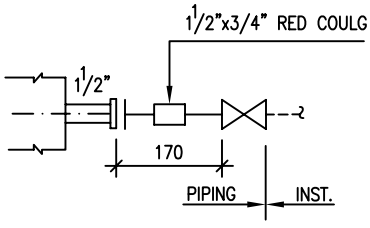
PC-6 ON LINE 1"-1 1/2"



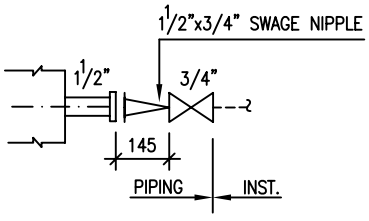
PC-10 ON LINE 2" & ABOVE



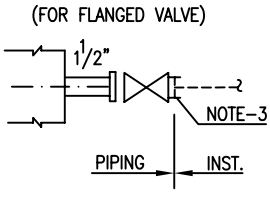
PC-11 ON LINE 2" & ABOVE



PC-12



PC-13



PC-14

PC-15 WITH 2" VALVE

ON VESSELS/ COLUMNS

NOTES:-

1. THE INDICATED DIMENSIONS ARE IN MINIMUM WHICH ALSO COVER INSULATION TO THE EXTENT SHOWN ABOVE. IN HIGHER THICKNESS OF INSULATION THAN INDICATED, THE DIFFERENCE SHALL BE ADDED IN THE DIMENSIONS SHOWN ABOVE ACCORDINGLY.
2. PRESSURE TAPPING SHALL BE PROVIDED WITH GATE, GLOBE OR PLUG VALVE WITH TEE, HALF COUPLING OR STUB-IN, AS PER PIPING SPECIFICATION.
3. IN CASE OF FLGD. VALVES BOLTING & GASKET ON BOTH SIDES OF VALVE SHALL BE IN PIPING SCOPE.
4. IN CASE OF TAPPINGS PROVIDED OTHER THAN INDICATED IN THIS STD FOR LAYOUT REASONS DETAILED DIMENSIONS WILL BE CALLED OUT.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD		
REVISIONS						REFERENCES	DRG. NO.

SECTION: P&PD	NAME	DATE	CHKD	DATE
DSGN				
DRWN				
APPROVED				

PRESSURE TAPPING

MECON LIMITED

SCALE : N.T.S.

DRG.NO MEC/ SD/05/21/15/05

REV 0

Rev. : 0
Edition : 1

STANDARD SPECIFICATION

FOR

BLASTING

SPECIFICATION NO.: MEC/S/05/21/18

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

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 be 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 of2 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 centreline

- 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 of 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.

Rev. : 0
Edition : 1

SPECIFICATION
FOR
GASKETS, BOLTS & NUTS

SPECIFICATION NO.: MEC/S/05/21/19

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

TECHNICAL NOTES FOR GASKETS

1.0 All gaskets shall conform to the codes/standards and specifications given in the requisition. Vendor shall strictly comply with MR / PR stipulations and no deviations shall be permitted.

2.0 Process of manufacture, dimensions and tolerances not specified in requisition shall be in accordance with the requirements of the manufacturer's standards.

3.0 Test reports shall be supplied for all mandatory tests for gaskets as per the standards specified in the requisition.

4.0 Chemical composition and hardness of RTJ gaskets shall also be furnished in the form of test reports on samples.

5.0 For Spiral wound material following shall be furnished:

a. Manufacturer's test certificate for filler material and spiral material as per the relevant material specifications.

b. Manufacturer's test certificate for raw materials and tests for compressibility / seal-ability & recovery as per the relevant material specifications.

6.0 Full face gaskets shall have bolt holes punched out.

7.0 Filler material for spiral wound gaskets shall not have any colour or dye.

8.0 All spiral wound gaskets shall be supplied with Outer ring. Material of the outer ring shall be CS unless other wise specified in the MR.

9.0 For spiral wound gaskets, material of Inner Compression ring shall be same as Spiral Strip material. In addition to the requirements as per code and as specified in the MR, inner rings shall be provided for the following:

a. Sizes 26" and above.

b. Class 900 and above.

10.0 Hardness of metallic RTJ gaskets shall not exceed the values specified below unless otherwise specified in MR :

Ring Gasket Material	**Maximum Hardness (BHN)**
Soft Iron	90
Carbon steel	120
5 Cr. ½ Mo	130
Type 304, 316, 321, 347	140
Type 304L, 316L	120

11.0 Face finish of metallic RTJ gaskets shall be 32 to 63 AARH.

12.0 Gaskets of different types and sizes shall be placed in separate shipping containers and each container clearly marked with the size, rating, material specification and item code.

13.0 All items shall be inspected and approved by MECON Inspector or any other agency authorized by MECON.

14.0 Any additional requirements specified in the requisition, shall be fully complied with.

15.0 Non-metallic ring gaskets as per ASME B16.21 shall match flanges to ASME B16.5 upto 24" (except 22" size) and to ASME B16.47B above 24" unless specified otherwise. For 22" size, the matching flange standard shall be MSS-SP44 unless specified otherwise.

16.0 Spiral wound gasket as per ASME B16.20 shall match flanges to ASME B16.5 upto 24" (except 22" size) and to ASME B16.47B above 24" unless specifically mentioned otherwise. For 22" size, the matching flange standard shall be MSS-SP44 unless specified otherwise.

17.0 The following abbreviations have been used in the Material Requisition for Spiral Wound Gaskets :

(I)	:	Inner Ring
(O)	:	Outer Ring
CAF	:	Compressed Asbestos Fibre
GRAFIL	:	Grafoil Filler

TECHNICAL NOTES FOR BOLTS & NUTS

1.0 The process of manufacture, heat treatment, chemical & mechanical requirements and marking for all stud bolts, m/c bolts, jack screws & nuts shall be in accordance with the codes / standards and specification given in the requisition. The applicable identification symbol in accordance with the material specification shall be stamped on each bolt and nut. Vendor shall strictly comply with MR / PR stipulations and no deviations shall be permitted.

2.0 Test reports shall be supplied for all mandatory tests as per the relevant material specifications.

3.0 Material test certificate shall also be furnished. (Heat Analysis, Product Analysis and Mechanical Requirement)

4.0 Stress Rupture Test as detailed in ASTM A453 shall be carried out for all ASTM A453 bolting material irrespective of the temperature.

5.0 All bolting shall be as per ANSI B 18.2.1 for studs. M/c bolts and jackscrews and ANSI BI8.2.2 for nuts.

6.0 Threads shall be unified (UNC for 1" dia and BUN for> 1" dia) as per ANSI B.1.1 with class 2A fit for studs, M/c bolts and jackscrews and class 2B fit for nuts.

7.0 Stud bolts shall be threaded full length with two heavy hexagonal nuts. Length tolerance shall be in accordance with the requirement as per ANSI B 16.5.

8.0 The nuts shall be double chamfered, semi-finished, heavy hexagonal type and shall be made by the hot forged process and stamped as per respective material specification.

9.0 Heads of jackscrews and m/c bolts shall be heavy hexagonal type. Jackscrew end shall be rounded.

10.0 Each size of studs & m/c bolts with nuts and jackscrews shall be supplied in separate containers marked with size and material specifications. 'CRYO' shall be marked additionally in case 'CRYO' is specified in the requisition.

11.0 All items shall be inspected and approved (stagewise) by MECON inspector or any other agency authorized by MECON.

12.0 The heat treatment for stud bolts & nuts shall be as per code unless mentioned otherwise.

13.0 All austenitic stainless steel bolts, nuts, screws shall be supplied in solution annealed condition unless specified otherwise in the material specification.

14.0 Any additional requirements specified in the requisition shall be fully complied with.

15.0 Stud bolts, nuts & jackscrews shall be impact tested wherever specified in the material specification and also where the material specification is indicated as "CRYO". For" S.S. nuts and bolts minimum impact energy absorption shall be 27 Joules and test temperature shall be -196°C unless mentioned otherwise. For other materials impact energy and test shall be as per respective code.

16.0 Bolts / nuts of material of construction B7M / 2HM shall be 100% Hardness tested as per supplementary requirement S3 of ASTM A 193.

17.0 When specified as galvanized, the studs, m/c bolts and nuts shall be 'hot dip zinc coated' in accordance with requirements of 'class C' of 'ASTM A 153'. As an alternative, electro-galvanizing as per IS 1573, 'Service Grade Number 2' is also acceptable.

18.0 All Stud Bolts of Bolt diameter size 1" and above shall be provided with three nuts irrespective of whatever has been specified elsewhere in the MR.

PIPING MATERIAL SPECIFICATION

LAYING & CONSTRUCTION OF 8'', 6" & 4" NB U/G STEEL P/L NETWORK & ASSOCIATED WORKS

DOC. NO.- MEC/S/05/25/1092, R0

(PROCESS & PIPELINE DESIGN SECTION)
MECON LIMITED
DELHI - 110 092

TABLE OF CONTENTS

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 & Distribution Piping System - Latest edition and OISD Standard 226-Natural Gas Transmission Pipeline and City Gas Distribution Networks.

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, MECON 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:

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 line pipe shall be as per the requirements of specification as indicated in Table-1.

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.

7.6 Butt welding ends shall conform to ANSI B 16.25/ API 5L. In case of difference in thickness of matching ends, requirements of ASME B 31.8 shall apply.

7.7 Integrally reinforced forged branch fittings such as sockolet, threadolet, weldolet, nippolet etc. shall be as per MSS-SP-97. Fittings not covered in ASME B 16.9 and MSS-SP-97 shall conform to manufacturer's standard.

7.8 Fittings thickness tolerances shall match pipe thickness tolerance.

8.0 **BENDS**

8.1 Unless otherwise specified for terminal piping, the elbow of radius R = 1.5 D shall only be used.

8.2 The radius of cold field bends shall not be less than 30 times the nominal diameter for pipes upto nominal diameter of 16" and shall not be less than 40 times the nominal diameter for pipes of nominal diameter of 18" and above. Limited use of long radius bends (R =3D) may be permitted for reason of space constraints in city / city like conditions.

9.0 **FLANGES**

9.1 Flange rating shall be same as ANSI B 16.5/MSS-SP-44/ B 16.47 Series A as specified.

9.2 Dimensions of flanges shall be in accordance with ANSI B 16.5/ B 16.47 Series A, as applicable.

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.

9.9 Spectacle blind/ spacer & blinds shall be in accordance with ASME B 16.48 / Manufacturer's Standard. Spectacle blind shall be used for sizes up to 8" NB and spacer & blind for 10" & above 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 MECON's standard.

10.0 GASKETS

10.1 Spiral wound metallic gaskets shall conform to B 16.20 and API 601 shall be provided with graphite filler. All spiral wound gaskets shall be provided with stainless steel centering ring.

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/ ASME B 16.47 with full threading.

11.3 Threads for nuts shall be as per ANSI B 1.1, as follows:

Nuts for stud dia ¼" to 1"	:	UNC-2B
Nuts for stud bolts dia 1 $^{1/8}$" to 3 ¼"	:	8UN-2B

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

Studs bolts dia ¼" to 1"	:	UNC-2A
Stud bolts dia 1$^{1/8}$" to 3 ¼"	:	8UN-2A

11.5 Heads of jack screws shall be heavy hexagonal type. Jack screw end shall be rounded. Stud bolts shall be fully threaded with two hexagonal nuts.

12.0 THREAD SEALANT

12.1 Threaded joints shall be made with 1" wide PTFE Jointing tape.

13.0 QUICK OPENING END CLOSURE

Quick opening end closure to be installed on scrapper traps shall be equipped with safety locking devices in compliance with section VIII, division 1, UG-35.2 of ASME Boiler and Pressure Vessel code.

14.0 HYDRO TESTING VENTS AND DRAINS

High point vents and low point drains required for the purpose of hydro testing shall be of size 1" and consist of sockolet , Plug & Ball valve for vent, Globe & Ball Valve for drain, flange & blind flange.

15.0 PIPELINE SPECIALITY ITEMS

Pipeline Specialty items viz., Scrapper Traps, Barred Tee, Insulating Joints, LR bends shall be as per respective data sheets, specifications

Sl. No.	Pipe Material Description	Size (NB)	Thickness (mm)	Length
1.	API 5L Gr. X-42, PSL-2	8"	6.4	As per SOR Quantity
2.	API 5L Gr. X-42, PSL-2	6"	6.4	As per SOR Quantity
3.	API 5L Gr. X-42, PSL-2	4"	6.4	As per SOR Quantity

TABLE-2

INDEX OF PIPING MATERIAL SPECIFICATIONS

Class	Service	C.A. (mm)	Basic Material	Design Code	Enclosed as
A1A	Natural Gas	1.5	ASTM A 106 Gr. B /API 5L Gr. B	ANSI B31.8	Appendix-I
B1A	Natural Gas	1.5	ASTM A 106 Gr. B /API 5L Gr. B	ANSI B31.8	Appendix-II
D1A	Natural Gas	1.5	ASTM A 106 Gr. B /API 5L Gr. B	ANSI B31.8	Appendix-III

VALVES

TYPE	SIZE	RATING	ENDS	MANUF. STD.	BODY MATERIAL	TRIM MATERIAL	SPECIAL REQUIRMENT
BALL	BELOW 2"	800 #	SW	BS 5351	A 105	SEAT – RPTFE	3000, B–16.11
	2" TO 24"	300 #	RF	API 6D	A 216 GR WCC/A 234 GR WPC	AISI4140+0.003" ENP/AISI410	125 AARH, B–16.5
	2" TO 24"	300 #	BW	API 6D	A 216 GR WCC/A 234 GR WPC	AISI4140+0.003" ENP/AISI410	B–16.25
PLUG	BELOW 2"	800 #	SW	BS 5353	A 105	PLUG A–105+0.003" ENP	3000, B–16.11
	2" TO 24"	300 #	RF	API 6D	A 216 GR WCB.	PLUG A–216 Gr.WCB+0.003" ENP	125 AARH, B–16.5
	2" TO 24"	300 #	BW	API 6D	A 216 GR WCB.	PLUG A–216 Gr.WCB+0.003" ENP	B–16.25
CHECK	BELOW 2"	800 #	SW	BS 5352	A 105	TRIM–STELLITED	3000, B–16.11
	2" TO 24"	300 #	RF	API 6D	A 216 GR WCB.	TRIM–STELLITED+13% CR STEEL	125 AARH, B–16.5
GLOBE	BELOW 2"	800 #	SW	BS 5352	A 105	TRIM–STELLITED, STEM–13 % CR STEEL/AISI410	3000, B–16.11
	2" TO 12"	300 #	RF	BS 1873	A 216 GR WCB.	13% CR OVERLAY	125 AARH, B–16.5
GATE	BELOW 2"	800 #	SW	API 602	A 105	TRIM–STELLITED, STEM–13 % CR STEEL/AISI410	3000, B–16.11
	2" TO 24"	300 #	RF	API 6D	A 216 GR WCB.	13% CR OVERLAY	125 AARH, B–16.5

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS				REFERENCES	DRG. NO.

SECTION: OIL & GAS				
	NAME	DATE	CHKD	DATE
DSGN	P.S.		S.K.	
DRWN	SUNIL			
APPROVED	A.K.SARKAR			

CITY GAS DISTRIBUTION NETWORK

PIPING MATERIAL SPECIFICATIONS 300# (B1A)

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MECON LIMITED

SCALE : N.T.S. (SH. 3 OF 3)

APPENDIX–III

REV 0

PIPELINE/PIPING DESIGN CODE		ASME B 31.8/ OISD 226									DESIGN FACTOR – 0.5						
ITEM	NOMINAL DIAMETER (INCHES)	0.50	0.75	1.00	1.50	2.00	3.00	4.00	6.00	8.00	10.0	12.0	14.0	16.0	18.0	20.0	
PIPE	WALL THICKNESS (MM/SCH)	S160	S160	XS	XS	XS	STD	S40	S40	7.9	STD	S40	S40	S40	S40	15.9	
	MATERIAL	ASTM A106 GR.B				ASTM A106 GR.B (CHARPY)					API 5L GR.B PSL2						
	DIMENSION STD.	B36.10									API 5L						
	METHOD OF MANUFACTURE, ENDS	SEAMLESS PE				SEAMLESS BE								BE SAW			
FLANGE	MATERIAL AND GRADE	ASTM A 105				ASTM A 105 (CHARPY)											
	TYPE, FLANGE FACING	SW. RF 125AARH				WN. THICKNESS TO MATCH PIPE THICKNESS,RF 125AARH											
	DIMENSION STD.	B16.5															
BLIND FLANGE	MATERIAL AND GRADE	ASTM A 105				ASTM A 105 (CHARPY)											
	FLANGE FACING	RF 125AARH															
	DIMENSION STD.	B16.5															
BLANK	MATERIAL AND GRADE	ASTM A 105				ASTM A 105 (CHARPY)											
	FLANGE FACING	FF 125AARH															
	DIMENSION STD.	B16.48															
	TYPE	FIG.8 FLANGE									SPACER & BLIND						
BOLTING	STUD BOLTS (FULLY THREADED)	A 193 GR B7, B–18.2															
	NUTS (HEAVY HEXAGONAL)	A 194 GR 2H, B–18.2															
GASKET	TYPE ,MATERIAL AND Dmn. STD.	SPIRAL 300# , SP.WND SS316+CAF, B–16.20–ANSI B16.5,															
ELBOW–90 ELBOW–45	MATERIAL	ASTM A 105				ASTM A 234 GR.WPB (CHARPY)											
	END DETAIL	SW,6000#		SW,3000#		BW, 1.5D											
	DIMENSION STD.	B–16.11				B–16.9											
T–EQUAL T–RED	MATERIAL	ASTM A 105				ASTM A 234 GR.WPB (CHARPY)											
	END DETAIL	SW,6000#		SW,3000#		BW, THICKNESS TO MATCH PIPE THICKNESS											
	DIMENSION STD.	B–16.11				B–16.9											
CAP	MATERIAL	ASTM A 105				ASTM A 234 GR.WPB (CHARPY)											
	END DETAIL	SCRF6000#		SCRF3000#		BW,THICKNESS TO MATCH PIPE THICKNESS											
	DIMENSION STD.	B–16.11				B–16.9											
FITTING	MATERIAL	ASTM A 105				ASTM A 234 GR.WPB (CHARPY)											
	END DETAIL	SW,6000#		SW,3000#		BW,THICKNESS TO MATCH PIPE THICKNESS											
	DIMENSION STD.	B–16.11				B–16.9											
	TYPE	COUPLING FULL,HALF LH.,RED.				RED. CON. RED. ECC.											
O'LET	MATERIAL	ASTM A 105				ASTM A 105 (CHARPY)											
	END DETAIL	SW,6000#		SW,3000#		BW											
	DIMENSION STD.	MSS–SP97				MSS–SP97											
	TYPE	SOCKOLET				WELDOLET											

SECTION: OIL & GAS

REV NO | DATE | ZONE | DESCRIPTIONS REVISIONS | BY | APPRD

REFERENCES

DRG. NO.

APPROVED A.K.SARKAR

DRWN SUNIL | DSGN P.S. | NAME | DATE | CHKD S.K. | DATE

CITY GAS DISTRIBUTION NETWORK

PIPING MATERIAL SPECIFICATIONS 300# (B1A)

SCALE : N.T.S.

APPENDIX–III

(SH. 2 OF 3)

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ANSI CLASS: 300 #	CORROSION ALLOWANCE: 1.5 MM	TEMP °C	−29.0	38.0	50	100	150	200
		PRESS. KG/CM^{2}g	52.1	52.1	51.10	47.52	45.98	44.60
SERVICE : NATURAL GAS		BASE MATERIAL: CARBON STEEL (MATERIAL GROUP 1.1)						

NOTES: −

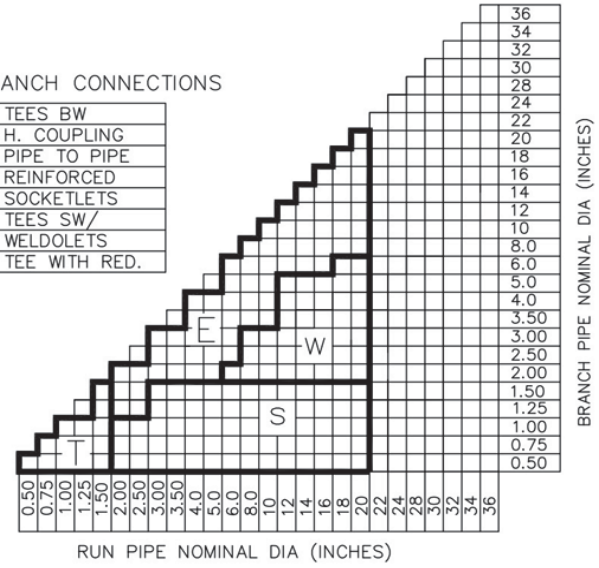
1. ALL VENTS & DRAIN SHALL BE PROVIDED WITH PLUG VALVE UNLESS MENTIONED OTHERWISE IN P&IDs.
2. FITTINGS SHALL BE OF SEAMLESS CONSTRUCTION UP TO 16" AND SHALL BE OF WELDED CONSTRUCTION 18" AND ABOVE.
3. WALL THICKNESS FOR LINEPIPE USED IN VARIOUS SECTIONS SHALL BE AS PER TABLE−1 OF PMS.
4. BALL VALVE TO BE USED IN MAINLINE SHALL HAVE BUTT WELDED ENDS EXCEPT FOR THE VALVES USED FOR HOT TAPPING WHICH SHALL BE ONE SIDE BUTT WELDED AND OTHER SIDE FLANGED.
5. PROCUREMENT OF MATERIALS SHALL BE AS PER DETAILED RELEVANT SPECIFICATIONS.
6. DESIGN PRESSURE & TEMP. FOR PIPELINE AND RELATED FACILITIES ARE 49 BAR (49.97 Kg/Cm^{2}g) & (−29° TO +65°C) RESPECTIVELY.
7. PRESSURE−TEMPERATURE RATING INDICATED ARE FOR FLANGES ONLY IN ACCORDANCE WITH ANSI B 16.5
8. FOR VALVES,STEELPIPE AND ASSOCIATED STEEL COMPONENTS OF 2" AND LARGER NOTCH TOUGHNESS PROPERTIES SHALL BE AS SPECIFIED IN RELEVANT SPECIFICATIONS/CODES, MECON'S STANDARD TECHNICAL SPECIFICATIONS AND DATA SHEETS ETC.
9. AT STATIONS, BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE BELOW
10. ALL BUTT WELDS SHALL BE 100% RADIOGRAPHED.
11. 100% OF SOCKET WELD SHALL BE SUBJECTED TO MPI/DPT.
12. PRESSURE−TEMPERATURE RATING OF VALVE BODY SHALL BE AS PER API 6D.
13. PIPELINE DESIGN CODE − ASME B 31.8 & OISD 226.
14. FOR PIPELINE SPECIALITY ITEMS (SCRAPPER TRAP, FLOW TEE, IJ, LR BENDS ETC.) AND THEIR MATERIAL DESCRIPTIONS REFER DATA SHEET OF RESPECTIVE ITEMS.

STATION PIPING MATERIAL SPECIFICATION

ITEM	SIZE	DESCRIPTION
MAINTENANCE JOINTS	ALL	FLGD., BUT TO BE KEPT MINIMUM
PIPE JOINTS	1.5" & BELOW	SOCKET WELD
	2" & ABOVE	BUTT WELDED
DRAINS	ON LINES ≤ 1.5"	3/4", AS PER MEC/SD/05/21/15/03
	ON LINES ≥ 2"	3/4" OR AS PER P&ID, MEC/SD/05/21/15/01
VENTS	ON LINES ≤ 1.5"	3/4", AS PER MEC/SD/05/21/15/03
	ON LINES ≥ 2"	3/4" OR AS PER P&ID, MEC/SD/05/21/15/01
TEMP. CONN.	1.5"	FLGD. INSTL. AS PER MEC/SD/05/21/15/02
PRESS CONN.	3/4"	SCH. 160 NIPPLE WITH BALL VALVE TO SPEC. INSTALLATION AS PER MEC/SD/05/21/15/05

BRANCH CONNECTIONS

E	TEES BW
H	H. COUPLING
P	PIPE TO PIPE
R	REINFORCED
S	SOCKETLETS
T	TEES SW/
W	WELDOLETS
D	TEE WITH RED.



APPROVED A.K.SARKAR | DRWN SUNIL | DSGN P.S. | S.K. | NAME | DATE | CHKD | DATE

SECTION: OIL & GAS

CITY GAS DISTRIBUTION NETWORK

PIPING MATERIAL SPECIFICATIONS 300# (B1A)

APPENDIX−III

SCALE : N.T.S.

(SH. 1 OF 3)

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MECON LIMITED

REVISIONS | REV NO | DATE | ZONE | DESCRIPTIONS | BY | APPRD | REFERENCES | DRG. NO.

SPECIFICATION
FOR
PIPELINE PRE-COMMISSIONING AND COMMISSIONING
OF
PIPELINE PROJECT

SPECIFICATION NO. MEC/S/05/62/61, R-1

(PROCESS & PIPELINE DESIGN SECTION)

MECON LIMITED

DELHI - 110 092

CONTENTS

1.0 INTRODUCTION

This specification covers the minimum technical requirements for pre-commissioning and commissioning of gas pipeline, including pre-commissioning 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 companyÕs 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 companyÕs 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&IDôs 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&IDôs and other design specification codes.

ii) Checking of Field Instruments

All the field instruments like control valves, sectionalising valves, transmitters, solenoid valves, shut down switches, alarms etc. shall be checked physically and also for their intended application by simulating the operating conditions. It will also include checking of different meters, gauges action of shutdown valves etc. as applicable.

iii) Survey of the Pipelines

This shall be performed to confirm that proper fittings/ supports, route markets, fencing around SV Stations etc. have been intalled along the pipeline.

iv) Checking of Communications System

This is to check that there is proper 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 if finished and shall obtain approval of the company before proceeding to the next inertisation phase.

4.3 **Swabbing**

4.3.1 **General**

The swabbing operation is meant to reduce the remaining water in the pipeline to bring the pipeline into touch dry condition.

Swabbing operation shall be carried out to ensure that there is no free water left inside the pipeline. This is done by driving number of swabbing pigs so that the weight increase in pig before and after the swabbing operation is not more then 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 companyôs 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.: MEC/S/05/21/65

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

1.0 SCOPE

This specification establishes the Healthy, Safety and Environment (HSE) management requirement to be compiled with by the Contractors during construction.

This specification is not intended to replace the necessary professional judgement needed to design & implement an effective HSE system for construction activities and the contractor is expected to exceed requirements given in this specification.

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)
- Building and other construction workers (regulation of employment and condition of service) Act, 1996
- Job Specifications
- Relevant IS Codes (refer Annexure-A)
- Reporting Formats (refer Annexure-B)
- Statutory requirements

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 weekly once.

Above 250 & upto 500	-	Deploy one qualified and experienced safety Engineer/ Officer who will guide the workers from time to time as well as impart basic guideline & training at least weekly once. He / She shall possess a recognized Degree in any branch of engineering or technology or architecture and had a post qualification construction experience of minimum two years or possess a recognized Diploma in any branch of engineering or technology or Graduate in Science stream and had a post qualification construction experience of minimum five years.
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/ MECON & their representatives from any and all liabilities arising out of non fulfillment of HSE requirements.

Above is the minimum requirement and the Contractor shall ensure physical presence of a safety personnel at each place where Hot work permit is required. No work shall be started at site until above safety personnel are physically present at site. The contractor shall submit a safety organogram clearly indicating the lines of responsibility and reporting system. He shall furnish Bio-Data/Resume/Curriculum Vitae of the safety personnel he intends to mobilize, at least 1 month before the intended mobilization, for MECON/Owner's approval.

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 Health, 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/ MECON. In case the number of workers exceeds 500, the Contractor shall position an ambulance /vehicle on full time basis very close to the worksite.

3.1.7 The Contractor shall evolve a comprehensive planned and documented system for implementation and monitoring of the HSE requirements. This shall submitted to

OWNER & MECON 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 sub-contractor (s) work site/ Office. However, compliance of HSE requirement shall be the sole responsibility of the Contractor. Any review/ approval by OWNER/ MECON 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 Sub-contractors) as brought out during review/ audit by MECON/ OWNER representative shall be resolved forthwith by Contractor. Compliance report shall be possibility submitted to MECON/ 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/ MECON. The compliance of any observation shall be arranged urgently. Contractor shall assist OWNER/MECON to achieve the targets set by them on HSE during the project implementation.

The contractor shall ensure that his staff members & workers (permanent as well casual) shall not be in a state of intoxication during working hours and shall abide by any law relating to consumption & possession of intoxicating drinks or drugs in force. Awareness about local laws on this issue shall form part of the Induction Training.

The contractor shall ensure that all personnel working for him comply with No-smoking requirements of the owner as notified from time to time. Cigarettes, lighters, auto ignition tools or appliances shall not be allowed inside the plant complex. Smoking shall be permitted only inside smoking booths expressly designated & authorized by the Owner/MECON.

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/ MECON 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.

0.2% (Zero decimal two percent) of the contract value for LSTK, EPC, EPCC or Package contracts with an overall ceiling of Rs. 1,00,00,000/- (Rupees one crore).

S. No.	Violation or HSE norms	Penalty Amount
1.	For not using personal protective equipment (Helmet, Shoes, Goggles, Gloves, Full body harness, Face shield, Boiler suit, etc.)	Rs. 250/- per day / item / person
2.	Working without Work Permit / Clearance	Rs.5,000/- per occasion

S. No.	Violation or HSE norms	Penalty Amount
3.	Unsafe electrical practices (not installing ELCB, using poor joints of cables, using naked wire without top plug into socket, laying wire / cables on the roads, electrical jobs by incompetent person, etc.)	Rs.3,000/- per item per day.
4.	Working at height without full body harness, using non-standard / rejected scaffolding and not arranging fall protection arrangement as required like Safety Nets.	Rs.1,000/ per case per day.
5.	Unsafe handling of compressed gas cylinders (No trolley, jubilee clips double gauge regulator, improper storage / handling).	Rs. 100/- per item per day
6.	Use of domestic LPG for cutting purpose.	Rs.1,000/- per occasion
7.	No fencing / barricading of excavated areas.	Rs.1,000/- per occasion
8.	Not providing shoring / strutting / proper slope and not keeping the excavated earth at least 1.5 M away from excavated area.	Rs.5,000/- per occasion
9.	Non display of caution boards, list of hospitals, emergency services available at work locations.	Rs.500/- per occasion
10.	Traffic rules violations like over speeding of vehicles, rash driving, wrong parking, not using seat belts, vehicles not fitted with reverse warning alarms.	Rs.1,000/- per occasion
11.	Absence of Contractor's top most executive at site in the safety meetings whenever called by MECON / Owner	Rs.1,000/- per occasion
12.	Failure to maintain safety records by Contractor Safety personnel.	Rs.1,000/- per month.
13.	Failure to conduct daily safety site inspection, HSE meeting and HSE audit at predefined frequencies.	Rs.1,000/- per occasion
14.	Failure to submit the monthly HSE report by 5th of subsequent month to Engineer-in-Charge.	Rs. 1,000/- per occasion and Rs. 100/- per day for further delay.
15.	Poor House Keeping	Rs.1,000/- per occasion
16.	Failure to report & follow up accident (including Near Miss) reporting system.	Rs. 10,000/- per occasion

S. No.	Violation or HSE norms	Penalty Amount
17.	Degradation of environment (not confining toxic spills oil / lubricants onto ground)	Rs.1,000/- per occasion
18.	Not medically examining the workers before allowing them to work at height, not providing ear muffs while allowing them to work in noise polluted areas, made them to work in air polluted areas without respiratory protective devices, etc.	Rs.1,000/- per occasion
19.	Violation of any other safety condition as per job HSE plan, work permit and HSE conditions of contract (using crowbar on cable trenches, improper welding booth, not keeping fire extinguisher ready at hot work site, unsafe rigging practices, non-availability of First-Aid box, etc.)	Rs.1,000/- per occasion
20.	Any violation not covered above.	To be decided by MECON / Owner

This penalty shall be in addition to all other penalties specified else where in the contract. The decision of imposing stoppage of work, its extent & monitory penalty shall rest with MECON/OWNER & binding on the Contractor.

3.1.11 All fatal accidents and other personnel accidents shall be investigated by a team of Contractorôs 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 / MECON. OWNER / MECON shall have the liberty to independently investigate such occurrences and Contractor shall extend all necessary help and co-operation in this regard. MECON / Owner shall have to right to share the content of this report with the outside world.

3.2 **House Keeping**

3.2.1 Contractor shall ensure that a high degree of house keeping is maintained and shall ensure the followings:

a. All surplus earth and debris are removed/disposed off from the working site to identified location (s).

b. Unused/Surplus Cables Steel items and steel scrap lying scattered at different places within the working areas are removed to identified location (s).

c. All wooden scrap, empty wooden cable drums and other combustible packing materials shall be removed from work place to identified location(s).

d. Roads shall be kept clear and materials like pipes, steel, sand, boulders, concrete chips and bricks, etc. shall not be allowed in the roads to obstructs free movement of men & machineries.

e. Fabricated steel structurals, pipes & piping materials shall be stacked properly for erection.

f. Water logging on rods shall not be allowed.

g. No parking of trucks/ trolleys, cranes and trailors etc. shall be allowed on of roads, which may obstruct the traffic movements.

h. Utmost care shall be taken to ensure over all cleanliness and proper up keep of the working areas.

i. Trucks carrying sand, earth and pulverized materials etc. shall be covered while moving within the plant areas.

j. The contractor shall ensure that the atmosphere in plant area and on roads is free from particulate matter like dust, sand, etc. by keeping the top surface wet for ease in breathing.

k. At least two exits for any unit area shall be assured at all times.

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/ MECON. Contractor shall ensure deployment of appropriate equipment and appliances for adequate safety and healthy of the workmen and protection of surrounding areas.

Contractor shall ensure identification of all Occupational Health, Safety & Environmental hazards in the type of work he is going to undertake and enlist mitigation measures. Contractor shall carry out Job Safety Analysis (JSA) specifically for high risk jobs like working at height & in confined space, deep excavations, radiography jobs, electrical installations, blasting operations, demolishing / dismantling activities, welding / gas cutting jobs and submit the findings to MECON / Owner. The necessary HSE measures devised shall be in place prior to start of an activity by the contractor.

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.

The Contractor shall ensure that all their staff, workers and visitors including their sub-contractor(s) have been issued (records to be kept) & wear appropriate PPEs like nape strap type safety helmets preferably with head & sweat band with IJ" cotton chin strap (made of industrial HDPE), safety shoes with steel toe cap and antiskid sole, full body harness (C∈ marked and conforming to EN361), protective goggles, gloves, ear muffs, respiratory protective devices, etc. All these gadgets shall conform to applicable IS Specifications / C∈ or other applicable international standards.

Owner may issue a comprehensive color scheme for helmets to be used by various agencies. The Contractor shall follow the scheme issued by the owner. All Safety / Fire personnel shall preferably wear red colour helmet so that workmen can approach them for guidance during emergencies.

For shot blasting, the usage of protective face shield and helmets, gauntlet and protective clothing is mandatory.

For offshore jobs/contracts, contractor shall provide PPEs (new) to MECON & Owner's personnel, at his (contractor's) cost. All personnel shall wear life jacket at all time.

An indicative list of HSE standards/codes is given under Appendix-A.

The contractor shall issue height permit for working at height after verifying and certifying the checkpoints as specified in the attached permit (Format No. HSE-6). He shall also undertake to ensure compliance to the conditions of the permit during the currency of the permit including adherence to personal protective equipments.

The permit shall be issued initially for one week or expected duration of an activity and extended further for the balance duration. This permit shall be applicable in areas where specific clearance from Owner's operation Deptt. / Safety Deptt. is not required. MECON field Engineers / Safety Officers / Area Coordinators may verify and counter sign this permit (as an evidence of verification) during the execution of the job.

In case work is undertaken without taking sufficient precautions as given in the permit, MECON Engineers may cancel the permit and stop the work till satisfactory compliance is arranged. Contractors are expected to maintain a register for issuance of permit and extensions thereof including preserving the used permits for verification during audits etc.

Contractor shall arrange (at his cost) and ensure use of Fall Arrester Systems by his workers. Fall arresters are to be used while climbing / descending tall structures. These arresters should lock automatically against the anchorage line, restricting free fall of the user. The device is to be provided with a double security opening system to ensure safe attachment or release of the user at

any point of rope. In order to avoid shock, the system should be capable of keeping the person in vertical position in case of a fall.

Contractor shall ensure that Full body harnesses conforming EN361 and having authorized CC marking is used by all personnel while working at height. The lanyards and life lines should have enough tensile strength to take the load of the worker in case of a fall. One end of the lanyard shall be firmly tied with the harnesses and the other end with life line. The harness should be capable of keeping the workman vertical in case of a fall, enabling him to rescue himself.

Contractor shall provide Roof Top Walk Ladders for carrying out activities on sloping roofs in order to reduce the chances of slippages and falls.

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 arrestors conforming to BS:6158 or equivalent are installed on all gas cylinders as well as at the torch end of the gas hose, while in use. All cylinders shall be mounted on trolleys and provided with a closing key. The burner and the hose placed downstream of pressure reducer shall be equipped with Flash Back Arrester / Non Return Valve device. The hoses for acetylene and oxygen cylinders must be of different colours. Their connections to cylinders and burners shall be made with a safety collar. At end of work, the cylinders in use shall be closed and hoses depressurized. All welding machines shall have effective earthing. In order to help maintain good housekeeping, and to reduce fire hazard, live electrode bits shall be contained safely and shall not be thrown directly on the ground.

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 equipments. 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.

Contractor shall ensure installation of Safe Load Indicator (SLI) on all cranes (while in use) to minimize overloading risk. SLI shall have capability to continuously monitor and display the load on the hook, and automatically compare it with the rated crane capacity at the operating condition of the crane. The system shall also provide visual and audible warnings at set capacity levels to alert the operator in case of violations.

The contractor shall be responsible for safe operations of different equipments mobilized and used by him at the workplace like transport

vehicles, engines, cranes, mobile ladders, scaffoldings, work tools, etc.

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.

The work place shall be checked prior to start of activities to identify the location, type and condition of any asbestos materials which could be disturbed during the work. In case asbestos material is detected, usage of appropriate PPEs by all personnel shall be ensured and the matter shall be reported immediately to MECON / Owner.

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 non-ionizing radiation ultraviolet rays or similar other physical agents shall be provided with adequate shielding or protection commensurate with type of exposure involved. For ionizing radiation, requirements of Bhabha Atomic Research Centre (BARC)/ Atomic Energy Regulatory Board (AERB) shall be followed.

k) Where contract or exposure of hazardous materials could exceed limits or could otherwise have harmful affects, appropriate personal protective equipments 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 Cr¯che 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.

Emphasize on recycling of waste materials such as metals, plastics, glass, paper, oil & solvents. The waste that can not be minimized, reused or

recovered shall be stored and disposed of safely. In no way, toxic spills shall be allowed to percolate into the ground. The contractor shall not use the empty areas for dumping the wastes.

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/ MECON.

Suitable scaffoldings shall be provided to workmen for all works that cannot be safely done from the ground or from solid construction except such short period work that can be safely done using ladders. When a ladder is used, an extra workman shall be engaged for holding the ladder.

The contractor shall ensure that the scaffolds used during construction activities shall be strong enough to take the designed load. Owner / MECON reserves the right to ask the contractor to submit certification and or design calculations from his Engineering regarding load carrying capacity of the scaffoldings.

All scaffolds shall be inspected by a Scaffolding Inspector of the contractor. He shall paste a GREEN tag on each scaffold found safe and a RED tag on each scaffold found unsafe. Scaffolds with GREEN tag only shall be permitted to be used and RED ones shall immediately be removed from the site.

All electrical installations / connections shall be carried out as per the provisions of latest revision of following codes/standards, in addition to the requirements of Statutory Authorities and IE / applicable international rules & regulations:

- OISO SID 173 : Fire prevention & protection system for electrical installations
- SP 30 (BIS) : National Electric Code

All electrical installations shall be approved by the concerned statutory authorities.

- The contractor shall meet the following requirements:

i) Ensure that electrical systems and equipment including tools & tackles used during construction phase are properly selected, installed, used and maintained as per provisions of the latest revision of the Indian Electrical / applicable international regulations.

ii) Shall deploy qualified & licensed electricians for proper & safe installation and for regular inspection of construction power

distribution system / points including their earthing. A copy of the license shall be submitted to MECON / Owner for records. Availability of at least one competent licensed electrician shall be ensured at site round the clock to attend to the normal / emergency jobs.

iii) All switchboards / welding machines shall be kept in well-ventilated & covered shed. The shed shall be elevated to avoid water logging. No flammable materials shall be used for constructing the shed. Also flammable materials shall not be stored in and around electrical equipment / switchboard. Adequate clearances and operational space shall be provided around the equipment.

iv) Fire extinguishers and insulating mats shall be provided in all power distribution centers.

v) Temporary electrical equipment shall not be employed in hazardous area without obtaining safety permit.

vi) Proper house keeping shall be done around the electrical installations.

vii) All temporary installations shall be tested before energising, to ensure proper earthing, bonding, suitability of protection system, adequacy of feeders/cables etc.

viii) All welders shall use hand gloves irrespective of holder voltage.

ix) Multilingual (Hindi, English and local language) caution boards, shock treatment charts and instruction plate containing location of isolation point for incoming supply, name & telephone No. of contact person in emergency shall be provided in substations and near all distribution boards / local panels.

x) Operation of earth leakage device shall be checked regularly by temporarily connecting series test lamp (2 bulbs of equal rating connected in series) between phase and earth.

xi) Regular inspection of all installations (at least once in a month)

- The following features shall also be ensured for all electrical installations during construction phase by the contractor:

i) Each installation shall have a main switch with a protective device, installed in an enclosure adjacent to the metering point. The operating height of the main switch shall not exceed 1.5 M. The main switch shall be connected to the point of supply by means of armoured cable.

ii) The outgoing feeders shall be double or triple pole switches with fuses / MCBs. Loads in a three phase circuit shall be balanced as far as

possible and load on neutral should not exceed 20% of load in the phase.

iii) The installation shall be adequately protected against overload, short circuit and earth leakage by the use of suitable protective devices. Fuses wherever used shall be HRC type. Use of rewirable fuses shall be strictly prohibited. The earth leakage device shall have an operating current not exceeding 30 mA.

iv) All connections to the hand tools / welding receptacles shall be taken through proper switches, sockets and plugs.

v) All single phase sockets shall be minimum 3 pin type only. All unused sockets shall be provided with socket caps.

vi) Only 3 core (P+N+E) overall sheathed flexible cables with minimum conductor size of 1.5 mm^2 copper shall be used for all single phase hand tools.

vii) Only metallic distribution boxes with double earthing shall be used at site. No wooden boxes shall be used.

viii) All power cables shall be terminated with compression type cable glands. Tinned copper lugs shall be used for multistrand wires / cables.

ix) Cables shall be free from any insulation damage.

x) Minimum depth of cable trench shall be 750 mm for MV & control cables and 900 mm for HV cables. These cables shall be laid over a sand layer and covered with sand, brick & soil for ensuring mechanical protection. Cables shall not be laid in waterlogged area as far as practicable. Cable route markers shall be provided at every 25 M of buried trench route. When laid above ground, cables shall be properly cleated or supported on rigid poles of atleast 2 M high. Minimum head clearance of 6 meters shall be provided at road crossings.

xi) Under ground road crossings for cables shall be avoided to the extent feasible. In any case no under ground power cable shall be allowed to cross the roads without pipe sleeve.

xii) All cable joints shall be done with proper jointing kit. No taped / temporary joints shall be used.

xiii) An independent earthing facility should preferably be established within the temporary installation premises. All appliances and

equipment shall be adequately earthed. In case of armoured cables, the armour shall be bonded to the earthing system.

xiv) All cables and wire rope used for earth connections shall be terminated through tinned copper lugs.

xv) In case of local earthing, earth electrodes shall be buried near the supply point and earth continuity wire shall be connected to local earth plate for further distribution to various appliances. All insulated wires for earth connection shall have insulation of green colour.

xvi) Separate core shall be provided for neutral. Earth / Structures shall not be used as a neutral in any case.

xvii) ON/OFF position of all switches shall be clearly designated / painted for easy isolation in emergency.

The contractor shall identify all operations that can adversely affect the health of its workers and issue & implement mitigation measures.

For surface cleaning operations, sand blasting shall not be permitted even if not explicitly stated elsewhere in the contract.

To eliminate radiation hazard, Tungsten electrodes used for Gas Tungsten Arc Welding shall not contain Thorium.

Appropriate respiratory protective devices shall be used to protect workmen from inhalation of air borne contaminants like silica, asbestos, gases, fumes, etc.

Workmen shall be made aware of correct methods for lifting, carrying, pushing & pulling of heavy loads. Wherever possible, manual handling shall be replaced by mechanical lifting equipments.

For jobs like drilling / demolishing / dismantling where noise pollution exceeds the specified limit of 85 decibels, ear muffs shall be provided to the workers.

To avoid upper limb disorders and backaches, Display Screen Equipments' workplace stations shall be carefully designed & used with proper sitting postures. Power driven hand-held tools shall be maintained in good working condition to minimize their vibrating effects and personnel using these tools shall be taught how to operate them safely & how to maintain good circulation in hands.

The contractor shall arrange health check up for all the workers at the time of induction. Health check may have to be repeated if the nature of duty assigned to him is changed necessitating health check or doubt arises about his wellness. MECON / Owner reserve the right to ask the contractor to submit test reports.

Weather Protection

Contractor shall take appropriate measures to protect workers from severe storms, solar radiations, poisonous gases, dust, etc. by ensuring proper usage of PPEs like Sun glasses, Sun screen lotions, respirators, dust masks, etc. and rearranging / planning the construction activities to suit the weather conditions.

Communication

All persons deployed at the work site shall have access to effective means of communication so that any untoward incident can be reported immediately and assistance sought by them.

All health & safety information shall be communicated in a simple & clear language easily understood by the local workforce.

Unsuitable Land Conditions

Contractor shall take appropriate measures and necessary work permits / clearances if work is to be done in or around marshy areas, river crossings, mountains, monuments, etc.

Under Water Inspection

Contractor shall ensure that boats and other means used for transportation, surveying & investigation works shall be certified seaworthy by a recognized classification society. It shall be equipped with all life saving devices like life jackets, adequate fire protection arrangements and shall posses communication facilities like cellular phones, wireless, walkie-talkie. All divers used for seabed surveys, underwater inspections shall have required authorized license, suitable life saving kit. Number of hours of work by divers shall be limited as per regulations. MECON / Owner shall have the right to inspect the boat and scrutinize documents in this regard.

TOOL BOX MEETING (TBM)

Contractor shall conduct daily TBM with workers prior to start of work and shall maintain proper record of the meeting. A suggested format is given below. The TBM is to be conducted by the immediate supervisor of the workers.

TOOLBOX MEETING RECORDING SHEET

Date & Time		
Subject		
Presenter		
Hazards involved		
Precautions to be taken		
Workerôs Name	Signature	Section
Remarks, if any		

The topics during TBM shall include

- Hazards related to work assigned on that day and precautions to be taken.
- Any forthcoming HSE hazards / events / instruction / orders, etc.

The above record can be kept in local language, which workers can read. These records shall be made available to MECON / Owner whenever demanded.

TRAINING

Contractor shall ensure that all his personnel possess appropriate training to carry out the assigned job safely. The training should be imparted in a language understood by them and should specifically be trained about

- Potential hazards to which they may be exposed at their workplace
- Measures available for prevention and elimination of these hazards

The topics during training shall cover, at the minimum;

- Education about hazards and precautions required
- Emergency and evacuation plan
- HSE requirements
- Fire fighting and First-Aid
- Use of PPEs
- Local laws on intoxicating drinks, drugs, smoking in force

Records of the training shall be kept and submitted to MECON / Owner whenever demanded.

For offshore and jetty jobs, contractor shall ensure that all personnel deployed have undergone a structured sea survival training including use of lifeboats, basket landing, use of radio communication etc. from an agency acceptable to Owner / MECON.

INSPECTION

The contractor shall carryout daily HSE inspection and record observations at a central location. These inspection records shall be freely accessible to Owner / MECON representatives. The contractor shall also assist Owner / MECON representatives during the HSE inspections conducted by them.

ADDITIONAL SAFETY REQUIREMENTS FOR WORKING INSIDE A RUNNING PLANT

As a minimum, the contractor shall ensure adherence to following safety requirements while working in or in the close vicinity of an operating plant :

a) Contractor shall obtain permits for Hot work, Cold work, Excavation and Confined Space from Owner in the prescribed format.

b) The contractor shall monitor, record and compile list of his workers entering the operational plant/unit each day and ensure & record their return after completing the job.

c) Contractor's workers and staff members shall use designated entrances and proceed by designated routes to work areas only assigned to them. The workers shall not be allowed to enter units' area, tanks area, pump rooms, etc. without work authorization permit.

d) Work activities shall be planned in such a way so as to minimize the disruption of other activities being carried out in an operational plant / unit and activities of other contractors.

e) The contractor shall submit a list of all chemicals / toxic substances that are intended to be used at site and shall take prior approval of the Owner.

f) Specific training on working in a hydrocarbon plant shall be imparted to the work force and mock drills shall be carried out for Rescue operations / First-Aid measures.

g) Proper barricading / cordoning of the operational units / plants shall be done before starting the construction activities. No unauthorized person shall be allowed to trespass. The height and overall design of the barricading structure shall be finalized in consultation with the Owner and shall be got approved from the Owner.

h) Care shall be taken to prevent hitting underground facilities such as electrical cables, hydrocarbon piping during execution of work.

i) Barricading with water curtain shall be arranged in specific/critical areas where hydrocarbon vapors are likely to be present such as near horton spheres or tanks. Positioning of fire tenders (from owner) shall also be ensured during execution of critical activities.

j) Emergency evacuation plan shall be worked out and all workmen shall be apprised about evacuation routes. Mock drill operations may also be conducted.

k) Flammable gas test shall be conducted prior to any hot work using appropriate measuring instruments. Sewers, drains, vents or any other gas escaping points shall be covered with flame retardant tarpaulin.

l) Respiratory devices shall be kept handy while working in confined zones where there is a danger of inhalation of poisonous gases. Constant monitoring of presence of Gas / Hydrocarbon shall be done.

m) Clearance shall be obtained from all parties before starting hot tapping, patchwork on live lines and work on corroded tank roof.

n) Positive isolation of line/equipment by blinding for welding/cutting/grinding shall be done. Closing of valve will not be considered sufficient for isolation.

o) Welding spatters shall be contained properly and in no case shall be allowed to fall on the ground containing oil. Similar care shall be taken during cutting operations.

p) The vehicles, cranes, engines, etc. shall be fitted with spark arresters on the exhaust pipe and got it approved from Safety Department of the Owner.

q) Plant air should not be used to clean any part of the body or clothing or use to blow off dirt on the floor.

r) Gas detectors should be installed in gas leakage prone areas as per requirement of Owner's plant operation personnel.

s) An experienced full time safety personnel shall be exclusively deployed to monitor safety aspects in running plants.

HSE PROMOTION

The contractor shall encourage his workforce to promote HSE efforts at workplace by way of organizing workshops / seminars / training programmes, celebrating HSE awareness weeks & National Safety Day, conducting quizzes & essay competitions, distributing pamphlets, posters & material on HSE, providing incentives for maintaining good HSE practices and granting bonus for completing the job without any lost time accident.

4.0 DETAILS OF HSE MANAGEMENT SYSTEM BY CONTRACTOR

4.1 On Award 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/MECON. The Contractor shall participate in the pre-start meeting with OWNER/MECON to finalize HSE plans including the following.

- Job procedure to be followed by Contractor for activities covering Handling of equipments, 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 our under para 3.0. Contractor shall also ensure to:

- Arrange workmen compensation insurance, registration under ESI Act, third party liability insurance etc. as applicable.

- Arrange all HSE permits before start of activities (as applicable) like her work, confined space, work at heights, storage of Chemicals/explosives materials and its use and implement all precautions mentioned therein

- Submit timely the completed check list on HSE activities, Monthly HSE report, accident report, investigation report, etc. as per OWNER/MECON requirements. Compliance of instructions on HSE shall be done by Contractor and informed urgently to OWNER/MECON.

- Ensure that resident Engineers/Site-In-Charge of the Contractor shall amend all the Safety Committee/HSE meeting arranged by OWNER/ MECON only in case of his absence from site, a seconds senior most person shall be nominated by him in advance and communicated to OWNER/MECON.

- 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/MECON review.

- Assist in HSE audits by OWNER/ MECON and submit compliance report.

- Generate & submit HSE records/ reports as per HSE Plan.

- Appraise OWNER/MECON on HSE activities at site.

5.0 RECORDS

At the minimum, the contractor shall maintain/ submit HSE records in the following reporting formats:

1.	Monthly HSE Checklist cum compliance report	HSE-1
2.	Accident / Incident Report	HSE-2
3.	Supplementary Accident / Incident Investigation report	HSE-3
4.	Near Miss Incident Report	HSE-4
5.	Monthly HSE Report	HSE-5
6.	Permit for working at height	HSE-6
7.	Permit for working in confined space	HSE-7
8.	Permit for radiation work	HSE-8
9.	Permit for demolishing / dismantling	HSE-9

ANNEXURE-A

A. I.S. CODES ON HSE

SP:53	Safety code for the use, Care and protection of hand operated tools.
IS: 818	Code of practice for safety and health requirements in electric and gas welding and cutting operations
IS: 1179	Eye and Face precautions during welding, equipment etc.
IS: 1860	Safety requirements for use, care and protection of abrasive grinding wheels.
IS: 1989(Part-I & II)	Leather safety boots and shoes
IS: 2925	Industrial Safety Helmets
IS: 3016	Code of practice for fire safety precautions in welding and cutting operations.
IS: 3043	Code of practice for earthing.
IS: 3764	Code of safety for excavation work
IS: 3786	Methods for computation of frequency and severity rates for industrial injuries and classification of industrial accidents.
IS: 3996	Safety Code of scaffolds and ladders.
IS: 4082	Recommendation on stacking and storage of construction materials and components at site.
IS: 4770	Rubber gloves for electrical purposes
IS: 5121	Safety code for piling and other deep foundations
IS: 5216 (Part-I)	Recommendations on Safety procedures and practices in electrical works
IS: 5557	Industrial and Safety rubber lined boots.
IS: 5983	Eye protectors
IS:6519	Selection, care and repair of Safety footwear
IS: 6994 (Part-I)	Industrial Safety Gloves (Leather & Cotton Gloves)
IS: 7293	Safety Code for working with construction Machinery

IS: 8519	Guide for selection of industrial safety equipment for body protection
IS: 9167	Ear protectors
IS: 11006	Flash back arrestor (Flame arrestor)
IS:11016	General and safety requirements for machine tools and their operation
IS: 11057	Specification for Industrial safety nets
IS: 11226	Leather safety footwear having direct moulded rubber sole
IS: 11972	Code of practice for safety precaution to be taken when entering a sewerage system
IS: 13367	Code of practice-safe use of cranes
IS: 13416	Recommendations for preventive measures against hazards at working place

B. INTERNATIONAL STANDARDS ON HSE

Safety Glasses	:	ANSI Z 87.1, ANSI ZZ 87.1, AS 1337, BS 2092, BS 1542, BS 679, DIN 4646 / 58211
Safety Shoes	:	ANSI Z 41.1, AS 2210, EN 345
Hand Gloves	:	BS 1651
Ear Muffs	:	BS 6344, ANSI S 31.9
Hard Hat	:	ANSI Z 89.1 / 89.2, AS 1808, BS 5240, DIN 4840
Goggles	:	ANSI Z 87.1
Face Shield	:	ANSI Z 89.1
Breathing Apparatus	:	BS 4667, NIOSH
Welding & Cutting	:	ANSI Z 49.1
Safe handling of compressed Gases in cylinders	:	P-1 (Compressed Gas Association 1235 Jefferson Davis Highway, Arlington VA 22202 ï USA)

ANNEXURE-B

DETAILS OF FIRST AID BOX

SL. NO	DESCRIPTION	*QUANTITY*
1.	Small size Roller Bandages, 1 inch wide (Finger Dressing small)	6 Pcs.
2.	Medium size Roller Bandages, 2 inch wide (Hand and Foot Dressing)	6 Pcs.
3.	Large size Roller Bandages, 4 inch wide (Body Dressing Large)	6 Pcs.
4.	Large size Burn Dressing (Burn Dressing Large)	4 Pkts.
5.	Cotton wool (20 gms packing)	4 Pkts.
6.	Antiseptic Solution Dettol (100 ml.) or Savlon	1 Bottle
7.	Mercurochrome Solution (100 ml.) 2% in water	1 Bottle
8.	Ammonia Solution (20 ml.)	1 Bottle
9.	A Pair of Scrissors	1 Piece
10.	Adhesive Plaster (1.25 cm x 5 m)	1Spool
11.	Eye pads in Separate Sealed Packet	4 Pcs.
12.	Tourniqut	1 No.
13.	Safety Pins	1 Dozen
14.	Tinc. Iodine / Betadin (100 ml.)	1 Bottles
15.	Ointment for burns (Burnol 20 gms.)	1 Bottole
16.	Polythene Wash cup for washing eyes	1 No.
17.	Potassium Permanganate (20 gms.)	1 Pkt.
18.	Tinc. Benzoine (100 ml.)	1 Bottole
19.	Triangular Bandages	2 Nos.
20.	Band Aid Dressing	5 Pcs.
21.	Iodex / Moov (25 gms.)	1 Bottole
22.	Tongue Depressor	1 No.
23.	Boric Acid Powder (20 gms.)	2 Pkt.
24.	Sodium Bicarbonate (20 gms.)	1 Pkt.
25.	Dressing Powder (Nebasulf) (10 gms.)	1 Bottole
26.	Medicinal Glass	1 No.
27.	Duster	1 No.
28.	Booklet (English & Local Language)	1 No. each
29.	Soap	1 No.
30.	Toothache Solution	1 No.
31.	Eye Ointment	1 Bottle
32.	Vicks (22 gms.)	1 Bottle
33.	Forceps	1 No.
34.	Cotton Buds (5 nos.)	1 Pkt.
35.	Note Book	1 No.
36.	Splints	4 Nos.
37.	Lock	1 Piece
38.	Life Saving/Emergency/Over-the Counter Drugs	As decided at site
	Box size : 14ò x 12ò x 4ò	

Note : The medicines prescribed above are only indicative. Equivalent medicines can also be used. A prescription, in this regard, shall be required from a qualified Physician.

ANNEXURE – C

TYPE OF FIRES VIS-À-VIS FIRE EXTINGUISHERS

Fire	Fire Extinguishers				
	Water	**Foam**	**CO_2**	**Dry Powder**	**Multi Purpose (ABC)**
Originated from paper, clothes, wood	√	√	Can control minor surface fires	Can control minor surface fires	√
Inflammable liquids like alcohol, diesel, petrol, edible oils, bitumen	x	√	√	√	√
Originated from gases like LPG, CNG, H_2	x	x	√	√	√
Electrical Fires	x	x	√	√	√

Legend : √ Can be used
x Not to be used

Note : Fire extinguishing equipment must be checked atleast once a year and after every use by an authorized person. The equipment must have an inspection label on which the next inspection date is giver:. Type of extinguisher shall clearly be marked on it.

ANNEXURE – D

Indicative List of Statutory Acts & Rules Relating to HSE

- The Indian Explosives Act and Rules
- The Motor Vehicle Act and Central Motor Vehicle Rules
- The Factories Act and concerned Factory Rules
- The Petroleum Act and Petroleum Rules
- The Workmen Compensation Act
- The Gas Cylinder Rules and the Static & Mobile Pressure Vessels Rules.
- The Indian Electricity Act and Rules
- The Indian Boiler Act and Regulations
- The Water (Prevention & Control & Pollution) Act
- The Water (Prevention & Control of Pollution) Cess Act
- The Mines & Minerals (Regulation & Development) Act
- The Air (Prevention & Control of Pollution) Act
- The Atomic Energy Act
- The Radiation Protection Rules
- The Indian Fisheries Act
- The Indian Forest Act
- The Wild Life (Protection) Act
- The Environment (Protection) Act and Rules
- The Hazardous Wastes (Management & Handling) Rules
- The Manufacturing, Storage & import of Hazardous Chemicals Rules
- The Public Liability Act
- The Building and Other Construction Workers (Regulation of Employment and Condition of service) Act
- Other statutory acts Like EPF, ESIS, Minimum Wage Act.

ANNEXURE – E

CONSTRUCTION HAZARDS, THEIR EFFECTS & PREVENTIVE MEASURES

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
(A) EXCAVATION Pit Excavation up to 3.0m	➢ Falling into pit	➢ Personal injury	➢ Provide guard rails/barricade with warning signal. ➢ Provide at least two entries/exits. ➢ Provide escape ladders.
	➢ Earth Collapse	➢ Suffocation / Breathlessness ➢ Buried	➢ Provide suitable size of shoring and strutting, if required. ➢ Keep soil heaps away from the edge equivalent to 1.5m or depth of pit whichever is more. ➢ Dond allow vehicles to operate too close to excavated areas. Maintain at least 2m distance from edge of cut. ➢ Maintain sufficient angle of repose. Provide slope not less than 1:1 and suitable bench of 0.5m width at every 1.5m depth of excavation in all soils except hard rock. ➢ Battering/benching the sides.
	➢ Contact with buried electric cables ➢ Gas/ Oil Pipelines	➢ Electrocution ➢ Explosion	➢ Obtain permission from competent authorities, prior to excavation, if required. ➢ Locate the position of buried utilities by referring to plant drawings. ➢ Start digging manually to locate the exact position of buried utilities and thereafter use

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
			mechanical means.
Pit Excavation beyond 3.0m	➢ Same as above plus ➢ Flooding due to excessive rain/ underground water	➢ Can cause drowning situation	➢ Prevent ingress of water ➢ Provide ring buoys ➢ Identify and provide suitable size dewatering pump or well point system
	➢ Digging in the vicinity of existing Building/ Structure	➢ Building/ Structure may collapse ➢ Loss of health & wealth	➢ Obtain prior approval of excavation method from local authorities ➢ Use under-pining method ➢ Construct retaining wall side by side
	➢ Movement of vehicles / equipments close to the edge of cut.	➢ May cause cave-in or slides ➢ Persons may get buried	➢ Barricade the excavated area with proper lighting arrangements ➢ Maintain at least 2m distance from edge of cut and use stop block to prevent over-run. ➢ Strengthen shoring and strutting
Narrow deep excavations for pipelines, etc.	➢ Same as above plus ➢ Frequent cave-in or slides	➢ May cause severe injuries or prove fatal	➢ Battering/benching of sides ➢ Provide escape ladders
	➢ Flooding due to Hydrostatic testing	➢ May arise drowning situation	➢ Same as above plus ➢ Bail out accumulated water ➢ Maintain adequate ventilation
Rock excavation by blasting	➢ Improper handling of explosives	➢ May prove fatal	➢ Ensure proper storage, handling & carrying of explosives by trained personnel. ➢ Comply with the applicable explosive acts & rules.
	➢ Uncontrolled explosion	➢ May cause severe injuries or prove fatal	➢ Allow only authorized persons to perform blasting operations. ➢ Smoking and open

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
			flames are to be strictly prohibited.
	➢ Scattering of stone pieces in atmosphere	➢ Can hurt people	➢ Use PPE like goggles, face mask, helmets etc.
Rock excavating by blasting (Contd)	➢ Entrapping of persons/ animals.	➢ May cause severe injuries or prove fatal	➢ Barricade the area with red flags and blow siren before blasting.
	➢ Misfire	➢ May explode suddenly	➢ Do not return to site for at least 20 minutes or unless announced safe by designated person.
Piling Work	➢ Failure of pile-driving equipment	➢ Can hurt people	➢ Inspect Piling rigs and pulley blocks before the beginning of each shift.
	➢ Noise pollution	➢ Can cause deafness ➢ and psychological imbalance	➢ Use personal protective equipments like ear plugs, muffs, etc.
	➢ Extruding rods / casing	➢ Can hurt people	➢ Barricade the area an install sign boards ➢ Provide first-aid
	➢ Working in the vicinity of ñLive-Electricityô	➢ Can cause electrocution / asphyxiation	➢ Keep sufficient distance from Live-Electricity as per IS code. ➢ Shut off the supply, if possible ➢ Provide artificial/rescue breathing to he injured.
(B) CONCRETING	➢ Air pollution by cement	➢ May affect Respiratory System	➢ Wear respirators or cover mouth and nose with wet cloth.
	➢ Handling of ingredients	➢ Hand s may get injured	➢ Use gloves and other PPE.
	➢ Protruding reinforcement rods.	➢ Feet may get injured	➢ Use Safety shoes. ➢ Provide platform above reinforcement for movement of workers.
	➢ Earthing of electrical mixers,	➢ Can cause electrocution / asphyxiation	➢ Ensure earthing of equipments and proper functioning of

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
	vibrators, etc. not done		electrical circuit before commencement of work.
	➢ Falling of materials from height	➢ Persons may get injured	➢ Use hard hats ➢ Remove surplus material immediately from work place ➢ Ensure lighting arrangements during night hours.
	➢ Continuous pouring by same gang	➢ Cause tiredness of workers and may lead to accident.	➢ Insist on shift pattern ➢ Provide adequate rest to workers between subsequent pours.
	➢ Revolving or concrete mixer/ vibrators	➢ Parts of body or clothes may get entrapped.	➢ Allow only mixers with hopper ➢ Provide safety cages around moving motors ➢ Ensure proper mechanical locking of vibrator
Super-structure	➢ Same as above plus ➢ Deflection in props or shuttering material	➢ Shuttering / props may collapse and prove fatal	➢ Avoid excessive stacking on shuttering material ➢ Check the design and strength of shuttering material before commencement of work ➢ Rectify immediately the deflection noted during concreting
	➢ Passage to work place	➢ Improperly tied and designed props / planks may collapse	➢ Ensure the stability and strength of passage before commencement of work ➢ Do not overload and under the passage.
(C) REINFORCEMENT	➢ Curtailment and binding of rods	➢ Persons may get injured	➢ Use PPE like gloves, shoes, helmets, etc. ➢ Avoid usage of shift tools
	➢ Carrying of rods for short distance/ at	➢ Workers may injure their hands and shoulders	➢ Provide suitable pads on shoulders and use safety

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
	heights		gloves. ➢ Tie up rods in easily liftable bundles ➢ Ensure proper staging.
	➢ Checking of clear distance/ cover with hands	➢ Rods may cut or injure the finger	➢ Use measuring devices tape, measuring rods, etc.
	➢ Hitting projected rods and standing on cantilever rods	➢ Persons may get injured and fall down	➢ Use safety shoes and avoid standing unnecessarily on cantilever rods ➢ Avoid wearing loose clothes
	➢ Falling of material from height	➢ May prove fatal	➢ Use helmets ➢ Provide safety nets
	➢ Transportation of rods by trucks / trailers	➢ Protruded rods may hit the persons	➢ Use red flags/lights at the ends ➢ Do not protrude the rods in front of or by the side of driverôs cabin. ➢ Do not extend the rods 1/3rd of deck length or 1.5 m which is less
(D) WELDING AND GAS CUTTING	➢ Welding radiates invisible ultraviolet and infrared says	➢ Radiation can damage eyes and skin.	➢ Use specified shielding devices and other PPE of correct specifications ➢ Avoid throated tungsten electrodes for GTAW.
	➢ Improper placement of oxygen and acetylene cylinders	➢ Explosion may occur	➢ Move out any leaking cylinder ➢ Keep cylinder in vertical position ➢ Use trolley for transportation of cylinders and chain them ➢ Use flash back arrestors
	➢ Leakage / cuts in hoses	➢ May cause fire	➢ Purge regulators immediately and then turn off ➢ Never use grease or

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
			oil on oxygen line connections and copper fittings on acetylene lines ➢ Inspect regularly gas carrying hoses ➢ Always use red hose for acetylene & other fuel gases and black for oxygen.
	➢ Opening-up of cylinder	➢ Cylinder may burst	➢ Always stand back from the regulator while opening the cylinder ➢ Turn valve slowly to avoid bursting ➢ Cover the lug terminals to prevent short circuiting.
	➢ Welding of tanks, container or pipes storing flammable liquids	➢ Explosion may occur	➢ Empty & purge them before welding ➢ Never attach the ground cable to tanks, container or pipe storing flammable liquids ➢ Never use LPG for gas cutting
(E) RADIOGRAPHY	➢ Ionizing Radiation	➢ Radiations may react with the skin and can cause cancer, skin irritation, dermatitis, etc.	➢ Ensure safety regulations as per BARC/AERB before commencement of job. ➢ Cordon off the area and install Radiation warning symbols ➢ Restrict the entry of unauthorized persons ➢ Wear appropriate PPE and film badges issued by BARC/AERB
	➢ Transportation and Storage of Radiography source	➢ Same as above	➢ Never touch or handle radiography source with hands ➢ Store radiography source inside a pit in an exclusive isolated

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
			storage room with lock and key arrangement. The pit should be approved by BARC/AERB ➢ Radiography source should never be carried either in passenger bus or in a passenger compartment of trains. ➢ BARC/AERB have to be informed before source movement. ➢ Permission from Director General of Civil Aviation is required for booking radio isotopes with airlines.
	➢ Loss of Radio isotope	➢ Same as above	➢ Try to locate with the help of Survey Meter. ➢ Inform BARC/AERB(*) (*) Atomic Energy Regulatory Board (AERB), Bhabha Atomic Research Centre (BARC) Anushaktinagar, Mumbai ï 400 094
(F) ELECTRICAL INSTALLATION AND USAGE	➢ Short circuiting	➢ Can cause Electrocution or Fire	➢ Use rubberized hand gloves and other PPE ➢ Donô lay wires under carpets, mats or door ways. ➢ Allow only licensed electricians to perform on electrical facilities ➢ Use one socket for one appliance ➢ Ensure usage of only fully insulated wires or cables ➢ Donô place bare wire ends in a socket

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
			➢ Ensure earthing of machineries and equipments ➢ Do not use damaged cords and avoid temporary connections ➢ Use spark-proof/flame proof type field distribution boxes. ➢ Do not allow open/bare connections ➢ Provide all connections through ELCB ➢ Protect electrical cables / equipments from water and naked flames ➢ Check all connections before energizing.
	➢ Overloading of Electrical System	➢ Bursting of system can occur which leads to fire	➢ Display voltage and current ratings prominently with Danger signs. ➢ Ensure approved cable size, voltage grade and type. ➢ Switch off the electrical utilities when not in use. ➢ Do not allow unauthorized connections. ➢ Ensure proper grid wise distribution of Power.
	➢ Improper laying of overhead and underground transmission lines / cables	➢ Can cause electrocution and prove fatal	➢ Do not lay unarmored cable directly on ground, wall, roof of trees ➢ Maintain at least 3m distance from HT cables ➢ All temporary cables should be laid at least 750 mm below ground on 100 mm

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
			fine sand overlying by brick soling ➢ Provide proper sleeves at crossings/ intersections ➢ Provide cable route markers indicating the type and depth of cables at intervals not exceeding 30m and at the diversions / termination.
(G) FIRE PREVENTION AND PROTECTION	➢ Small fires can become big ones and may spread to the surrounding areas	➢ Cause burn injuries and may prove fatal.	➢ In case a fire breaks out, press fire alarm system and shout ñFire, Fireò ➢ Keep buckets full of sand & water/fire extinguishing equipment near hazardous locations ➢ Confine smoking to ôSmoking Zonesô only ➢ Train people for using specific type of fire equipments under different classes of fire ➢ Keep fire doors/ shutters, passages and exit doors unobstructed ➢ Maintain good house keeping and first-aid boxes (for detail refer Annex-2) ➢ Donôt obstruct assess to Fire extinguishers ➢ Do not use elevators for evacuation during fire ➢ Maintain lightening arrestors for elevated structures ➢ Stop all electrical motors with internal combustion. ➢ Move the vehicles from dangerous

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
			locations. ➢ Remove the load hanging from the crane booms. ➢ Remain out of the danger areas.
	➢ Improper selection of Fire Extinguisher	➢ It may not extinguish the fire	➢ Ensure usage of correct fire extinguisher meant for the specified fire (for details refer Appendix-C) ➢ Do not attempt to extinguish Oil and electric fires with water. Use foam cylinders/CO_2/sand or earth.
	➢ Improper storage of highly inflammable substances	➢ Same as above	➢ Maintain safe distance of flammable substances from source of ignition ➢ Restrict the distribution of flammable materials to only min. necessary amount ➢ Construct specifically designed fuel storage facilities ➢ Keep chemicals in cool and dry place away from hat. Ensure adequate ventilation ➢ Before welding operation, remove or shield the flammable material properly ➢ Store flammable materials in stable racks, correctly labeled preferably with catchments trays. ➢ Wipe off the spills immediately

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
	➢ Short circuiting of electrical system	➢ Same as above ➢ Can cause Electrocution	➢ Dond lay wires under carpets, mats or door ways ➢ Use one socket for one appliance ➢ Use only fully insulated wires or cables ➢ Do not allow open/bare connections ➢ Provide all connections through ELCB ➢ Ensure earthing of machineries and equipments
(H) VEHICULAR MOVEMENT	➢ Crossing the Speed Limits (Rash driving)	➢ Personal injury	➢ Obey speed limits and traffic rules strictly ➢ Always expect the unexpected and be a defensive drive ➢ Use sat belts/helmets ➢ Blow horn at intersections and during overtaking operations. ➢ Maintain the vehicle in good condition ➢ Do not overtake on curves, bridges and slopes
	➢ Adverse weather condition	➢ Same as above	➢ Read the road ahead and ride to the left ➢ Keep the wind screen and lights clean ➢ Do not turn at speed ➢ Recognize the hazard, understand the defense and act correctly in time.
	➢ Consuming alcohol before and during he	➢ Same as above	➢ Alcohol and driving do not mix well. Either choose

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
	driving operation		alcohol or driving. ➢ If you have a choice between hitting a fixed object or an oncoming vehicle, hit the fixed object ➢ Quit the steering at once and become a passenger. Otherwise take sufficient rest and then drive. ➢ Do not force the driver to drive fast and round the clock ➢ Do not day dram while driving
	➢ Falling objects / Mechanical failure	➢ May prove fatal	➢ Ensure effective braking system, adequate visibility for the drives, reverse warning alarm. ➢ Proper maintenance of the vehicle as per manufacturer instructions
(I) PROOF TESTING (HYDROSTATIC/ PNEUMATIC TESTING	➢ Bursting of piping ➢ Collapse of tanks ➢ Tanks flying off	➢ May cause injury and prove fatal	➢ Prepare test procedure & obtain CONSULTANT/ Ownerôs approval ➢ Provide separate gauge for pressurizing pump and piping/equipment ➢ Check the calibration status of all pressure gauges, dead weight testers and temperature recorders ➢ Take dial readings at suitable defined intervals and ensure most of them fall between 40-60% of the gauge scale range ➢ Provide safety relief valve (set at

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
			pressure slightly higher than test pressure) while testing with air/nitrogen ➢ Ensure necessary precautions, stepwise increase in pressure, tightening of bolts/ nuts, grouting, etc. before and during testing ➢ Keep the vents open before opening any valve while draining out of water used for hydro testing of tanks ➢ Pneumatic testing involves the hazard of released energy shored in compressed gas. Specific care must therefore be taken to minimize the chance of brittle failure during a pneumatic leak test. Test temperature is important in this regard and must be considered when the designer chooses the material of construction ➢ A pressure relief device shall be provided, having a set pressure not higher than the test pressure plus the lesser of 345 KPa (50 psi) or 10% of he test pressure. The gas used as test fluid, if not air, shall be nonflammable and nontoxic.
(J) WORKING AT HEIGHTS	➢ Person can fall down	➢ May sustain severe injuries or	➢ Provide guard rails/barricade at the

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
		prove fatal	work place ➢ Use PPE like safety belts, full body harness, life line, helmets, safety shoes, etc. ➢ Obtain a permit before starting the work at height above 3 meters ➢ Fall arrest systems like safety nets, etc. must be installed ➢ Provide adequate working space (min. 0.6 m) ➢ Tie/weld working platform with fixed support ➢ Use roof top walk ladder while working on a slopping roofs ➢ Avoid movement on beams
		➢ May hit the scrap / material stacked at the ground or in between	➢ Keep the work place neat and clean ➢ Remove the scrap immediately
	➢ Material can fall down	➢ May hit the workers working at lower levels and prove fatal.	➢ Same as above plus ➢ Do not throw or drop material or equipment from height ➢ All tools to be carried in a toolkit bags or on working uniform ➢ Remove scrap from the planks ➢ Ensure wearing of helmet by the workers at low level
(K) CONFINED SPACES	➢ Suffocation / drowning	➢ Unconsciousness, death	➢ Use respiratory devices, if required ➢ Avoid over crowding inside a confined space ➢ Provide Exhaust Fans for ventilation ➢ Do not wear loose clothes, neck ties,

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
			etc. ➢ Fulfill conditions of the permit. ➢ Check for presence of hydrocarbons, O_2 level ➢ Obtain work permit before entering a confined space ➢ Ensure that the connected piping of the equipment which is to be opened is pressure free, fluid has been drained, vents are open and piping is positively isolated by a blind flange
	➢ Presence of foul smell and toxic substances	➢ Inhalation can pose threat to life.	➢ Same as above plus ➢ Check for hydrocarbon and Aromatic compounds before entering a confined space ➢ Depute one person outside the confined space for continuous monitoring and for extending help in case of an emergency
	➢ Ignition / flame can cause fire	➢ Person may sustain burn injuries or explosion may occur	➢ Keep fire extinguishers at a hand distance ➢ Remove surplus material and scrap immediately ➢ Do not smoke inside a confined space ➢ Do not allow gas cylinders inside a confined space ➢ Use low voltage (24V) lamps for lighting ➢ Use tools with air motors or electric tools with max.

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
			voltage of 24V ➢ Remove all equipments at the end of the day
(L) HANDLING AND LIFTING EQUPMENTS	➢ Failure of load lifting and moving equipments	➢ Can cause accident and prove fatal	➢ Avoid standing under the lifted load and within the operating radius of cranes ➢ Check periodically oil, brakes, gears, horns and tyre pressure of all moving machinery ➢ Check quality, size and condition of all chain pulley blocks, slings, U-clamps, D-shackles, wire ropes, etc. ➢ Allow crane to move only on hard, firm and leveled ground ➢ Allow lifting slings as short as possible and check gunny packings at the friction points ➢ Do not allow crane to tilt its boom while moving ➢ Install Safe Load Indicator ➢ Ensure certification by applicable authority.
	➢ Overloading of lifting equipments	➢ Can cause electrocution and fire	➢ Safe lifting capacity of derricks and winches written on them shall be got verified. ➢ The max safe working load shall be marked on all lifting equipments ➢ Check the weight of columns and other heavy items painted on them and accordingly decide about the crane

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
			capacity, boom and angle of erection ➢ Allow only trained operators and riggers during crane operation
	➢ Overhead electrical wires	➢ Can cause electrocution and fire	➢ Do not allow boom or other parts of crane to come within 3 m reach of overhead HT cables ➢ Hook and load being lifted shall preferably remain in full visibility of crane operator.
(M) SCAFFOLDING, FORMWORK AND LADDERS	➢ Person can fall down	➢ Person may sustain severe injuries and prove fatal	➢ Provide guard rails for working at height ➢ Face ladder while climbing and use both hands ➢ Ladders shall extend about 1m above landing for easy access and tying up purpose ➢ Do not place ladders against movable objects and maintain base at ı unit of the working length of the ladder ➢ Suspended scaffolds shall not be less than 500 mm wide and tied properly with ropes ➢ No loose planks shall be allowed ➢ Use PPE, like helmets, safety shoes, etc.
	➢ Failure of scaffolding material	➢ Same as above	➢ Inspect visually all scaffolding materials for stability and anchoring with permanent structures. ➢ Design scaffolding

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
			for max. load carrying capacity ➢ Scaffolding planks shall not be less than 50x250 mm full thickness lumber or equivalent. These shall be cleared or secured and must extend over the end supports by at least 150mm and not more that 300 mm ➢ Donot overload the scaffolds ➢ Do not splice short ladders to make a longer one. Vertical ladders shall not exceed 6m.
	➢ Material can fall down	➢ Persons working at lower level gets injured.	➢ Remove excess material and scrap immediately ➢ Carry the tools in a tool-kit bag only ➢ Provide safety nets
(N) STRUCTURAL WORKS	➢ Personal negligence and danger of fall	➢ Can cause injury or casualty	➢ Do not take rest inside rooms built for welding machines or electrical distribution system ➢ Avoid walking on beams at height ➢ Wear helmet with chin strap and safety belts when working at height ➢ Use hand gloves and goggles during grinding operations ➢ Cover or mark the sharp and projected edges ➢ Do not stand within the operating radius of cranes
	➢ Lifting / slipping of	➢ Same as above	➢ Do not stand under the lifted load

ACTIVITY	*TYPE OF HAZARD*	EFFECT OF HAZARD	PREVENTIVE MEASURES
	material		➢ Stack properly all the materials. Avoid slippage during handling ➢ Control longer pieces lifted up by cranes from both ends ➢ Remove loose materials from height ➢ Ensure tightening of all nuts and bolts
(O) PIPELINE WORKS	➢ Erection / lowering failure	➢ Can cause injury	➢ Do not stand under the lifted Load ➢ Do not allow any person to come within the radii of the side boom handling pipes ➢ Check the load carrying capacity of the lifting tools and tackles ➢ Use safe Load Indicators ➢ Use appropriate PPEs
	➢ Other	➢ Same as above	➢ Wear gum boots in marshy areas ➢ Allow only one person to perform signaling operations while lowering of pipes ➢ Provide night caps on pipes ➢ Provide end covers on pipes for stoppage of pigs while testing/cleaning operations.

FORMAT NO. : HSE-1, REV. 0

HSE CHECKLIST CUM COMPLIANCE REPORT (1/6)

Project: _____ Contractor :_____
Date: _____ Owner :_____
Inspection By:_____ Report No. :_____
Frequency : Fortnightly Job No :_____

Note: write õNAö wherever the item is not applicable

SL. NO.	ITEM	YES	NO	REMARKS	ACTION
1	**HOUSEKEEPING**				
a)	Waste containers provided and used				
b)	Sanitary facilities adequate and clean				
c)	Passageways and Walkways clear				
d)	General neatness of working areas				
e)	Others				
2	**PERSONNEL PROTECTIVE EQUIPMENT**				
a)	Goggles; Shields				
b)	Face protection				
c)	Hearing protection				
d)	Safety shoes				
e)	Hand protection				
f)	Respiratory Masks etc.				
g)	Safety Belts				
h)	Safety Helmet/Hard Hat				
I)	Others				
3	**EXCAVATIONS/OPENINGS**				
a)	Openings properly covered or barricaded				
b)	Excavations shored				
c)	Excavations barricaded				
d)	Overnight lighting provided				
e)	Others				
4	**WELDING & GAS CUTTING**				
a)	Gas cylinders chained upright				
b)	Cables and hoses not obstructing				
c)	Screens or shields used				
d)	Flammable materials protected				
e)	Fire extinguisher(s) accessible				
f)	Others				
5	**SCAFFOLDING**				
a)	Fully decked platforms				
b)	Guard and intermediate rails in place				

SL. NO.	ITEM	YES	NO	REMARKS	ACTION
c)	Toe boards in place				
d)	Adequate shoring				
e)	Adequate access				
f)	Others				
6	**LADDERS**				
a)	Extension side rails 1m above				
b)	Top of landing				
c)	Properly secured				
d)	Angle + 70 from horizontal				
e)	Others				
7	**HOISTS, CRANES AND DERRICKS**				
a)	Condition of cables and sheaves OK				
b)	Condition of slings, chains, hooks and eyes OK				
c)	Inspection and maintenance logs maintained				
d)	Outriggers used				
e)	Signs/barricades provided				
f)	Signals observed and understood				
g)	Qualified operators				
h)	Others				
8	**MACHINERY, TOOLS AND EQUIPMENT**				
a)	Proper instruction				
b)	Safety devices				
c)	Proper cords				
d)	Inspection and maintenance				
e)	Others				
9	**VEHICLE AND TRAFFIC**				
a)	Rules and regulations observed				
b)	Inspection and maintenance				
c)	Licensed drivers				
d)	Others				
10	**TEMPORARY FACILITIES**				
a)	Emergency instructions posted				
b)	Fire extinguishers provided				
c)	Fire-aid equipment available				
d)	Secured against storm damage				
e)	General neatness				
f)	In accordance with electrical requirements				
g)	Others				
11	**FIRE PREVENTION**				
a)	Personnel instructed				
b)	Fire extinguishers checked				
c)	No smoking in Prohibited Areas				
d)	Hydrants Clear				

SL. NO.	ITEM	YES	NO	REMARKS	ACTION
e)	Others				
12	**ELECTRICAL**				
a)	Use of 3-core armoured cables				
b)	Usage of 'All insulated' or 'double insulated' electrical tools				
c)	All electrical connection are routed through ELCB				
d)	Natural Earthing at the source of power (main DB)				
e)	Continuity and tightness of earth conductor				
f)	Covering of junction boxes, panels and other energized wiring places				
g)	Ground fault circuit interrupters provided				
h)	Prevention of tripping hazards				
i)	Others				
13	**HANDLING AND STORAGE OF MATERIALS**				
a)	Properly stored or stacked				
b)	Passageways clear				
c)	Others				
14	**FLAMMABLE GASES AND LIQUIDS**				
a)	Containers clearly identified				
b)	Proper storage				
c)	Fire extinguishers nearby				
d)	Others				
15	**WORKING AT HEIGHT**				
a)	Erection plan and work permit obtained				
b)	Safety nets				
c)	Full body harness and lanyards; chute lines				
d)	Health Check record available for workers going up?				
e)	Others				
16	**CONFINED SPACE**				
a)	Work permit obtained				
b)	Test for toxic gas and sufficient availability of oxygen conducted				
c)	At least one person outside the confined space for monitoring deputed				
d)	Availability of sufficient means of entry, exit and ventilation				
e)	Fire extinguishers and first-aid facility ensured				
f)	Lighting provision made by using 24V lamps				
g)	Proper usage of PPEs ensured				
17	**RADIOGRAPHY**				
a)	Proper storage and handling of source as per BARC / AREB guidelines				
b)	Working permit obtained				
c)	Cordoning of the area done				

SL. NO.	ITEM	YES	NO	REMARKS	ACTION
d)	Use of appropriate PPE's ensured				
e)	Proper training to workers/supervisors imparted				
f)	Minimum occupancy of workplace ensured				
18	**HEALTH CHECKS**				
a)	Workers medically examined and found to fit for working : i) At heights ii) In confined space.				
b)	Availability of First-aid facilities				
c)	Proper sanitation at site, office and labour camps				
d)	Arrangement of medical facilities				
e)	Measures for dealing with illness				
f)	Availability of Portable drinking water for workmen & staff				
g)	Provision of cr¯ches for children				
h)	Stand by vehicle available for evacuation of injured.				
19	**ENVIRONMENT**				
a)	Chemical and other effluents properly disposed				
b)	Cleaning liquid of pipes disposed off properly				
c)	Seawater used for hydro-testing disposed off as per agreed procedure				
d)	Lubricant Waste/Engine oils properly disposed				
e)	Waste from Canteen, offices, sanitation etc. disposed properly				
f)	Disposal of surplus earth, stripping materials, oily rags and combustible materials done properly				
g)	Green belt protection				

_____

Signature of Resident
Engineer with Seal

FORMAT NO. : HSE-2, REV. 0

ACCIDENT / INCIDENT REPORT

(To be submitted by Contractor after every Accident / Incident within 24 hours)

Report No:_____
Date: _____

Name of Site:-_____
CONTRACTOR_____

Type of Accident / Incident : ☐ Fatal ☐ Other Lost Time ☐ Non Loss Time ☐ First-Aid case

NAME OF THE INJUREDé é
AGE é .
FATHER'S NAMEé ..
SUB-CONTRACTOR M/Sé ..
DATE & TIME OF ACCIDENTé .
LOCATION é

BRIEF DESCRIPTION OF ACCIDENT

CAUSE OF ACCIDENT

NATURE OF INJURY/DAMAGE

MEDICAL AID PROVIDED/ACTIONS TAKEN

INTIMATION TO LOCAL AUTHORITIES (IF APPLICABLE)

DATE: SIGNATURE OF CONTRACTOR
WITH SEAL

To : OWNERé é é é é é é é é .. 1 COPY
: RCM/SITE-IN-CHARGE, MECON 3 COPIES

→ Divisional Head (Constn.) through RCM
→ Project Manager MECON, through RCM

FORMAT NO. : HSE-3, REV. 0

SUPPLEMENTARY ACCIDENT / INCIDENT INVESTIGATION REPORT

Supplementary to Report No: _____(Copy enclosed)

Project:_____ Site:_____
Name of Work :_____ Date:_____
Contractor:_____ Work Order / LOI No. :_____

NAME OF THE INJURED é .
AGE : é ...
SUB-CONTRACTOR M/Sé ...
DATE & TIME OF ACCIDENT / INCIDENT é
LOCATIONé é

BRIEF DESCRIPTION & CAUSE OF A ACCIDENT/ INCIDENT

NATURAL 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

ANY OTHER COMMENT BY SAFETY OFFICER.

DATE: SIGNATURE OF CONTRACTOR
WITH SEAL

To : OWNERé é é é é é é é é .. 1 COPY
: RCM/SITE-IN-CHARGE, MECON 3 COPIES

→ Divisional Head (Constn.) through RCM
→ Project Manager MECON, through RCM

FORMAT NO. : HSE-4, REV. 0

NEAR MISS INCIDENT – SUGGESTED PROFORMA

Report No: _____

Name of Site :_____ Date :_____

Name of Work :_____ Contractor :_____

INCIDENT REPORTED BY :

DATE & TIME OF INCIDENT :

LOCATION :

BRIEF DESCRIPTION OF INCIDENT

PROBABLE CAUSE OF INCIDENT

SUGGESTED CORRECTIVE ACTION

STEPS TAKEN TO AVOID RECURRENCE YES ☐ NO ☐

DATE: SIGNATURE OF CONTRACTOR WITH SEAL

To : OWNERé é é é é é é é é .. 1 COPY
: RCM/SITE-IN-CHARGE, MECON 3 COPIES

→ Divisional Head (Constn.) through RCM
→ Project Manager MECON, through RCM

FORMAT NO. : HSE-5, REV. 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			UPTO PREVIOUS MONTH	THIS MONTH	CUMU-LATIVE
a)	Average number of Staff & Workmen (average daily headcount, not man days)				
b)	Manhours Worked				
c)	Number of HSE meeting organized at site				
d)	Number of HSE awareness programmes conducted at site				
e)	Number of Lost Time Accidents (LTA)	Fatal			
		Other LTA			
f)	Number of Loss time Injuries (LTI)	Fatalities			
		Other LTI			
g)	Number of Loss Time Accidents				
h)	Number of First Aid Cases				
i)	Number of Near Miss Incidents				
j)	Man-days lost due to accidents				
k)	LTA Free Manhours i.e. Number of LTA free manhours from the Lst LTA				
l)	Compensation cases raised with Insurance				
m)	Compensation case resolved and paid to workmen				
n)	Whether workmen compensation policy taken		Y/N		
o)	Whether workmen compensation policy valid		Y/N		
p)	Whether workmen registered under ESI Act		Y/N		
Remark					

DATE:

Safety Officer /Resident Engineer
(Signature and Name)

To : OWNER
: RCM/, MECON (2 COPIES)

FORMAT NO. : HSE-6, REV. 0

PERMIT FOR WORKING AT HEIGHT (ABOVE 2 METER)

Project Site : é é é é é é é é é é é é é é Sr. No.: é é é é é é é é é
Name of the work: é é é é é é é é é é é é . Date: é é é é é é é é é é
Name of Contractor : é é é é é é é é é é é .. Nature of Work : é é é é é
Total No.of Workers: é é é é é é é é é é é .. Exact location of work : é é
Duration of work: from ..é é é . to é é é é

The following items have been checked and compliance shall be ensured during the currency of the permit:

Sl.	ITEM	DONE	NOT REQD.
1.	Equipment/Work Area inspected	☐	☐
2.	Considered hazard from other routine/non-routine operations and concerned person alerted	☐	☐
3.	ELCB provided	☐	☐
4.	Proper lighting provided	☐	☐
5.	Area cordoned off.	☐	☐
6.	Precautions against public traffic taken	☐	☐
7.	Sound Scaffolding provided	☐	☐
8.	Adequate protected Platform provided	☐	☐
9.	Acces and Exit to the area (Ladder properly fixed)	☐	☐
10.	Floor Openings covered	☐	☐
11.	Safety Net provided	☐	☐
12.	Heath check of personnel	☐	☐

A. Following personal protective equipment are provided (mark) and used as relevant Safety helmet/Gloves/Goggles/Shoes/Face Shield/Life Line/Safety Belt/Safety Harness.

B. This permit shall be available at the work site at all times.

C. Permit shall be issued for maximum one week only (Monday to Sunday).

D. This permit shall be applicable in non-operational areas.

E. After completion of the work, used permits shall be preserved for record purposes.

F. Additional precautions, if any é .

Permission is granted to work (See overleaf) = Yes/No

Name of Contractorûs Supervisor
(Initiator)

Name of Contractorûs Safety Officer
(Issuing Authority)

GRANT OF PERMIT AND EXTENSIONS

Sl. No.	Validity Period From …… To ……	Work time From …..Hrs. To …….Hrs.	Initiator (Supervisor of Contractor)	Issuing Authority (Safety Officer) of Contractor	Verification by CONSULTANT with date

Additional safety instructions, if any.

FORMAT NO. : HSE-7, REV. 0

CONFINED SPACE ENTRY PERMIT

Project Site : é é é é é é é é é é é é é é é
Name of the work: é é é é é é é é é é é é .
Name of Contractor : é é é é é é é é é é é ..
Exact location of work : é é é é é é é é é é .

Sr. No.: é é é é é é é é é
Date: é é é é é é é é é é
Nature of Work : é é é é é

Safety Requirements : POSITIVE ISOLATION OF THE VESSEL IS MANDATORY

(A) Has the equipment been ?

Y	NR		Y	NR		Y	NR	
☐	☐	isolated from power / steam / air	☐	☐	water flushed &/or steamed	☐	☐	radiation sources removed
☐	☐	isolated from liquid or gases	☐	☐	Manways open & ventilated	☐	☐	Proper lighting provided
☐	☐	depressurized &/or drained	☐	☐	cont. inset gas flow arranged	☐	☐	
☐	☐	blanked / blinded / disconnected	☐	☐	adequately cooled	☐	☐	

(B) Expected Residual Hazards

Y	NR		Y	NR		Y	NR	
☐	☐	lack of O_2	☐	☐	combustible gas / liquid	☐	☐	H_2S / toxic gases
☐	☐	corrosive chemicals	☐	☐	pyrophoric iron / scales	☐	☐	electricity / static
☐	☐	Heat / stream / frost	☐	☐	high humidity	☐	☐	ionizing radiation
☐	☐		☐	☐		☐	☐	

(C) Protective Measures

Y	NR		Y	NR		Y	NR	
☐	☐	gloves	☐	☐	ear plug / muff	☐	☐	goggles / face shield
☐	☐	protective clothing	☐	☐	dust / gas / air line mask	☐	☐	personal gas alarm
☐	☐	Grounded air educater / blower / AC	☐	☐	attendant with SCBA / air mask	☐	☐	rescue equipment / team
☐	☐	Fire fighting arrangements	☐	☐	safety harness & lifeline	☐	☐	communication equipment
☐	☐		☐	☐		☐	☐	

Authorization / Renewal (It is safe to enter the confirmed space)

Date	No. of Persons Allowed	Name of Persons allowed	Signature		Time		Signature
			Contractor's Supervisor	Contractor's Safety Officer	From	To	Workman

Permit Closure :

(A) Entry □ was closed □ stopped □ will continue on

(B) □ Site left in a safe condition
□ Housekeeping done

(C) Multi lock □ removed □ key transferred
□ Ensured all men have come out □ Manways barricaded

Remarks, if any :

FORMAT NO. : HSE-8, REV. 0

RADIATION WORK PERMIT

Project : Sr. No.:

Name of the work : Date:

Name of Contractor : Job No. :

Location of work :

Source Strength :

Cordoned distance (m) :

Name of Radiographing agency : Approved by Owner / MECON ☐

The following items have been checked & compliance shall be ensured during currency of the permit :

S. No.	Item Description	Done
1.	Safety regulations as per BARC/AERB ensured while source in use/ in transit & during storage.	☐
2.	Area cordoned off.	☐
3.	Lighting arrangements for working during nights ensured.	☐
4.	Warning signs / flash lights installed.	☐
5.	Cold work permit taken (if applicable)	☐
6.	PPEs like film badges, dosimeters used.	☐

Additional precautions, if any _____

(Radiography Agencyûs BARC / AREB authorized Supervisor) (Contractorûs Safety Officer)

Permission is granted.

Permit is valid from _____ AM/PM _____ Date to _____ AM/PM _____ Date

(Signature of permit issuing authority)

Name : Designation : Date :

Permit renewal :

Permit extended upto		Additional precautions required, if any.	Sign of issuing authority with date
Date	Time		

Work completed / stopped / area cleared at _____ Hrs. of Date _____

(Sign of permit issuing authority)
Name :

FORMAT NO. : HSE-9, REV. 0

RADIATION WORK PERMIT

Project : Sr. No.:

Name of the work : Date:

Name of Contractor : Job No. :

Name of Contractor :

Line No. / Equipment No. /Structure to be dismantled :

Location details of dismantling / demolition with sketch : (Clearly indicate the area)

The following items have been checked & compliance shall be ensured during currency of the permit :

S. No.	Item Description	Done	Not Applicable
1.	Services like power, gas supply, water, etc. disconnected.	☐	☐
2.	Dismantling / Demolishing method reviewed & approved.	☐	☐
3.	Usage of appropriate PPEs ensured.	☐	☐
4.	Precautions taken for neighboring structures	☐	☐
5.	First-Aid arrangements made	☐	☐
6.	Fire fighting arrangements ensured	☐	☐
7.	Precautions taken for blasting	☐	☐

(Contractorûs Supervisor) (Contractorûs Safety Officer)

Permission is granted.

(Permit issuing authority)
Name :
Date :

Completion Report :

Dismantling / Demolishing is completed on _____ Date at _____ Hrs.

Materials / debris transported to identified location ☐

Tagging completed (as applicable) ☐

Services like power, gas supply, water, etc. restored ☐

(Permit issuing authority)

SPECIFICATION
FOR
QUALITY ASSURANCE SYSTEMS
REQUIREMENTS

SPECIFICATION NO. MEC/S/05/62/66

मेकॉन

(PROCESS & PIPELINE DESIGN SECTION)

MECON LIMITED

DELHI - 110 092

CONTENTS

ATTACHMENTS

1.0 INTRODUCTION

This specification establishes the Quality Assurance Requirements to be met by the sub-contractors (including turnkey Contractors) and their sub-vendors.

In case of any conflict between this specification and other provisions of the contract/ purchase order, the same shall be brought to the notice of MECON, at the stage of bidding and shall be resolved with MECON, 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 MECON/ 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.
- Job procedures as required by MECON/ 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 MECON. 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 MECON 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 MECON/ 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 MECON 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 MECON/ 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 sub-contracted.

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 MECON including all subsequent changes, if any. MECON 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 MECON/ 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 MECON/ 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 MECON 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 MECON shall be duly informed.

4.7 Bidder shall establish adequate methodology such that the materials supplied by the Owner/ MECON 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 MECON/ 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 MECON/ 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 MECON/ 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 MECON/ 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 MECON/ Owner for review.

4.18 For all special processes, bidder shall deploy only qualified performers. Wherever MECON/ 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 : M/s		No. : Date :	
Location of Work : Item of Work :			
Details of Observation(Deficiency)	Recommended Course of Action Time Allowed for Correction :		
Issued by : _____ Name of Signature of RCM, MECON Site			
Corrective Action taken report by Contractor/ Vendor : Date : Name and Signature			
Distribution (before resolution) : Project Manager Owner	Chief Business Executive MECON	MECON Inspection New Delhi	Resident Construction Manager, MECON Site
Verification of Resolution by MECON : Date : Name of Signature			
Distribution (before resolution) : Project Manager Owner	Chief Business Executive MECON	MECON Inspection New Delhi	Resident Construction Manager, MECON Site

FORMAT ï 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/ MECON Review/ Audit Requirement

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

Rev. : 0
Edition : 1

SPECIFICATION
FOR
DOCUMENTATION FOR PIPELINE CONSTRUCTION

SPECIFICATION NO.: MEC/S/05/21/69

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

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 Companyôs 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 Companyôs documentation purpose during and immediately after the construction. This shall as minimum include, but not limited to the following :

2.1 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 overô
- Material defects and repairs
- Outstanding activities of Company

- List of installed markers, chainage
- Required approval from Company
- Progress planned
- Reports of manning of all crews, equipment and plant
- Report of equipment and plant
- Report of accidents
- Report of damages
- Report of acquired release, permits
- Priced variations
- Required materials for next month

2.3 **Monthly**

- Progress report for payment, safety report, report of accidents, security report, health and environment report, material balance, approved deviations.

2.4 Further, Contractor shall supply (for approval if required to the Company with document such as but not limited :

- Organogram for construction work.
- Bio-data of key personnel (including foremen).
- (Revised) list of address of personnel in particular of medical staff, safety and security offers.
- (Revised) list of approved coaters.
- (Revised) list of approved sub-contractors.
- Time schedule.
- Acquired permits and/ or approvals from Authorities, if any.
- Minutes of meeting with Company with comments, if any.
- Material certificates, material receipt.
- Guarantee from vendors and sub-contractor.
- Calculations, temporary works, bouyance, blasting.
- Drawings issued by Contractor.
- Vendors drawings.
- As-built of route maps, alignment sheets, details drawings and isometric drawings.
- Procedures such as surveying, stacking, fencing.
- Welding procedure qualification records, radiographic procedure qualification, welder qualification.
- Coating procedure.
- Installation of crossings.
- Hydrostatic testing.
- Blasting.

- Radiographic report alongwith original radiographs
- Pipe and welding book.
- Reports

  - Material tests (coating, welding, painting)
  - Computerised Potential Logging Test
  - Water Samples
  - Cleaning, Pigging Report before Hydrostatic Test
  - Hydrostatic Test
  - Calibration Test
  - Blasting Trials
  - Equipment certificate (dead weight tester, instruments, vessels, equipment)
  - Manuals
  - Major water crossings
  - Waste disposal
  - Disposal of water after hydrostatic test.

2.5 Contractor shall submit to company colour photographs of various construction activities/ operations at regular intervals. Size, number and frequency of the photographs shall be mutually agreed upon at a later stage. Also Contractor shall make video recordings of all operations right from the start of construction till the completion of the work, covering to the extent as instructed by Company and submit to Company. Upon completion of the work, Contractor and submit edited master tape plus six copies of video recording in VHS formats or any format ordered by the Company. The duration of video recording shall be of ½ hour and shall cover all aspects of the job.

3.0 AS-BUILT DRAWINGS AND PIPE BOOK

3.1 General

Contractor shall prepare "as-built" drawings of all by or on behalf of Company issued drawings and of all Contractor work drawings including vendor drawing, such as but not limited to :

For Pipeline Section :

- Route Maps
- Alignment Sheets
- Detail Drawings (road, railway, minor water crossings, major water crossings, valley crossings)

- Isometric drawings of installations
- Special installation

Further Contractor shall prepare a pipe Weld Book.

If required by the Company, Contractor shall update the diskettes for drawings issued for construction of the job.

3.2 **"As-Built" Drawings**

Contractor shall prepare a complete set of ñas-builtò 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 ñas-builtò drawings based on these data. On completion of the work, one revised film transparency of all drawing made ñas-builtò by Contractor containing the ñas-builtò 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 Companyøs approval.

The required measurement for ñas-builtò drawing shall be executed by Contractor by experienced, qualified surveyors.

The surveyors shall daily take care of all measurement required such as but not limited to:

- Horizontal location of pipeline with regard to deviations and Permanent Grid Pillars.
- Vertical Level with regard to Mean Sea Level of pipeline and grade.
- Location and type of bends, fittings etc. and grades, points of intersection.
- Change of wall thickness, materials.
- Location and details of valves, insulating flanges, fencing.
- Location and details of crossing pipes, vents.
- Location and type of coating.
- Location and type of weighting, anchoring.
- Location and type of markers.
- Location of further appurtenance (Pig-Signallers)
- Location of ROU and of pipeline with respect to ROU.
- Type of soil.

- Type of rock
- Type of blasting and ripping.
- Sand padding.
- Type of road pavement.
- Details of bank protection, number of insulators, seals.

Contractor shall also prepare isometric drawings of all installation (facilitates) etc. for which the data as mentioned in or required for the Pipe and Welding Book can be identified and these drawings can also be used for material accounting.

3.3 Nameplates of Equipment

All permanent equipment supplied and installed by Contractor shall be provided with plates by Contractor. All texts shall be submitted to Company for approval before plates may be manufactured.

3.4 Pipe Book

Every page of the pipe and Welding Book shall mention:

- Data relevant to the project and section there of.
- Sequential number.
- Length brought forward (for pipes and other materials).
- Length to bring forward (for pipes and other materials).

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

Further,

- Diameter of pipeline
- Length of each pipe
- Wall thickness
- Pipe number
- Heat number, certificate number
- Cut and re-numbered pipe ends
- Coating type
- Date of stringing
- Date of welding
- Weld number
- Welder number
- Direction of working

- Type of welding, electrodes, diameter of electrode etc.
- 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 hard copies, softcopies of final documents shall also be submitted in electronic media i.e. CD / DVD format.

Software used for the preparation of these documents shall be as follows:

Type document		Software
a)	Reports/ Documents	MS Office
b)	Drawings	Auto CAD

For the purpose of preparation of as-built drawings, Contractor shall update the ñIssued for constructionò drawings issued by the Company. It shall be the Contractorôs 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.

Rev. : 0
Edition : 1

SPECIFICATION
FOR
FIELD JOINT COATINGS OF PIPELINE
FOR HDD CROSSING

SPECIFICATION NO.: MEC/S/05/21/074

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

1.0 **SCOPE**

1.1 **General**

This specification covers the minimum requirement for application of anti-corrosion 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 Ñ 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 Contractorôs 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 ï 30672 : Corrosion protection tapes and Heat Shrinkable Sleeves.

b) SIS ï 055900 : Pictorial surface preparation standard for painting steel surfaces.

c) SSPC ï SP1 : Steel structure painting council ï 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 60ÁC continuously.

3.1.1 Each Joint Coating System shall consist of :

a) For HDD Joint Coating fiber glass reinforced heat shrinkable sleeve certified to Stress class C60 type CANUSA-TBK or COVALENCE / DIRAX shall be used. Directional drilling kit, multilayer sleeve system or equivalent to be approved by Owner / Engineer.

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

c) A solvent-free, two component liquid epoxy primer

d) A specifically designed wear cone

e) A clamping belt

3.1.2 **Sleeve Backing**

The heat shrinkable sleeves shall be manufactured from minimum 1.0 mm thick radiation cross linked, thermally stabilized, UV -resistant heat-shrinkable fabric, composed of a 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 40ÁC
Chemical resistance	ISO 175	168 hrs. immersion on either 0.1 N NaCl @ 23ÁC, 0.1N H_2 SO_4 @ 23ÁC, 0.1 N NaOH @ 23ÁC, Fuel oil @ 23ÁC. Petroleum jelly @ 70ÁC	
Followed by test for bursting strength	ISO 3303	23ÁC	1100 N Min.
Thermal ageing Followed by test for bursting strength	ISO 188 ISO 3303	150ÁC 168 hrs. 23ÁC	1700 N Min.

3.2.2 Adhesive material

Property	**Test Method**	**Condition**	**Requirement**
Softening point	ASTM E28		85ÁC minimum
Peel Strength	DIN 30672	23ÁC. CHS* 100 mm/ min. 60ÁC	200 N/cm minimum 60 N/ cm
Peel Strength After immersion for 4 weeks at 23ÁC~NaOH pH12 H_2SO_4 pH2 ground water solution:- 1.2% H_3PO_4 1.6% KOH	DIN 30672	23ÁC. CHS* 100 mm/ min.	200 N/cm minimum

Property	Test Method	Condition	Requirement
1.2NaCl 1.0% Fe_2O_3			
Peel Strength after conditioning for 30 cycles from -30ÁC to 60ÁC	DIN 30672	23ÁC. CHS* 100 mm/ min.	60 N/cm minimum
Shear strength	ISO 4587	23ÁC. CHS* 50 mm/ min.	200 N/cm^2 minimum
Corrosive effect	ASTM D 2671	120ÁC. 16 hrs.	No corrosion

3.2.3 **Primer Material**

Property	Test Method	Condition	Requirement
Density	ASTM D1084	23 +/- 0.5^0 C Part A: 2 rpm, spindle #6 Part B: 20rpm, spindle #3	Part A: 60+/- 30 Pas Part B: 1.55+/-0.55 Pas
Mixing ratio	By weight By volume	23ÁC	100:40 100:60
Shear strength	ISO 4587	23ÁC. CHS* 50 mm/ min.	1000 N/cm^2 minimum

*** CHS = Cross Head Speed**

3.2.4 **Functional Properties**

Sl. No.	Property	Test Method	Condition	Requirement
a)	Impact resistance	DIN 30672	23ÁC. Class C	No holidays when tested at 20 KV
b)	Penetration resistance	DIN 30672	60ÁC. Class C	Minimum 70% of original resistance thickness left; no holidays when tested at 20 KV
c)	Specific coating resistance	DIN 30672	23ÁC.	10^8 Ohm sq. m minimum; no oxidation on pipe surface

Sl. No.	Property	Test Method	Condition	Requirement
d)	Cathodic disbondment resistance	ASTM G42	60ÁC. 30 days	15 mm increase in radius of disbondment max.
e)	Resistance to split propagation	TEST METHOD-1*		No cut propagation
f)	Resistance to circumferential edge loading	TEST METHOD-2*		50 KN minimum
g)	Resistance to local edge loading (chisel test)	TEST METHOD-3*		6 KN minimum

***Test Methods**

3.3 **Test Methods**

3.3.1 **Resistance to split propagation (Test Method -1)**

A rectangular piece of 50mm width by 150 mm length shall be cut from the material as delivered. A 5mm long, clean cut shall be made mid-way in the piece along once of the long edges perpendicular to this edge. The sample shall be mounted on a clamp that holds it securely and avoids any shrinking during testing.

The assembly shall be placed in an air-circulating oven present at 170^0C.

After 15 minutes, the sample shall be removed from the oven, allowed to cool down to room temperature and examined for cut propagation.

This test simulates the unlikely event when the sleeve gets cut during the installation phase. Sleeves based upon extruded polyelfin show a distinct tendency to propagate the cut along the total width of the sleeve. Sleeves suitable for HDD works shall not exhibit this behaviour.

3.3.2 **Resistance to circumferential edge loading (Test method -2)**

The sleeve shall be installed on a DN 200 three -layer PE coated steel pipe piece. A thick wall steel ring that fits a DN 200 three-layer PE coated steel pipe with a tolerance of 0.2+-0.2 mm shall be positioned against the front edge of the wear cone sleeve and then pushed towards the sleeve system at a constant speed of 5 mm/ min over a distance of 50 mm. The forces necessary shall continuously be registered. The minimum required force shall be less than 50 KN.

During the pushing or pulling operation, any obstacle protruding from the smooth pipe surface is loaded by the surrounding soil that passes by. This test simulates the shear forces that are exerted on to the sleeve by rigid soil type.

3.3.3 **Resistance to local edge loading (Chisel test: Test Method -3)**

The sleeve shall be installed on a DN 200 three-layer-PE coated steel pipe piece.

A chisel as depicted in Figure -1 shall be positioned against the front edge of the wear cone sleeve and, pushed parallel to the pipe surface towards the sleeve system at a constant speed of 5mm/ min over a distance of 50 mm. The forces necessary shall continuously be registered. The minimum required force should not be less than 6 KN.

During the pushing or pulling operation, the pipe may traverse soil area containing solid particles, such as stones, pebbles or crushed rock. These particles tend to rip away the pipe coating locally. Any obstacle protruding from the smooth pipe surface is lifted, leading to soil undercutting. This test determines the resistance of sleeve against this type of abuse.

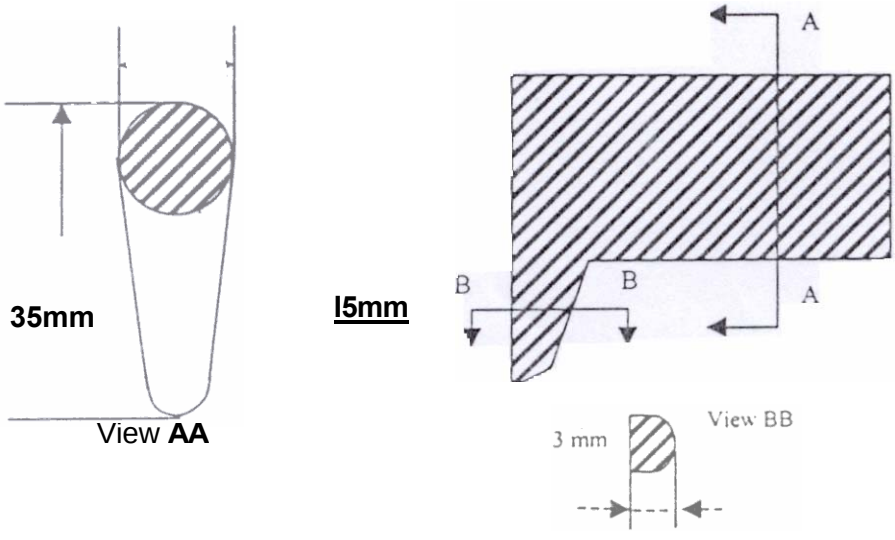


Figure- 1 Chisel

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 Ownerôs 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 2İ 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 20ÁC. At no time shall be blast cleaning be performed when the relative humidity exceeds 85%. Surface temperature must be at least 3ÁC 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 ñblueò 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 ôInspectionôand ôTestingôof 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 125ÁC, the sleeve shall shrink tightly around the substrate on to the wet-primer. At the time of application of the primer, th pipe surface temperature shall be at least 60ÁC 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 Oôclock 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 70^0C. 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 + 50ÁC.

5.2.3 All the coated joints shall be subjected to Holiday Detection test.

5.2.4 An installed sleeve with more than two holiday shall be stripped and a new one be installed.

6.0 **TESTING**

a) OWNER reserves the right to test one out of every 30 joint coating subject to a minimum of 2 joints. CONTRACTOR shall provide all assistance in removing and testing of field joint coatings. From each test sleeve, one or more strips of size 25 mm x 200 mm shall be cut one perpendicular to the pipe axis and slowly peeled off. This test shall be conducted between either sleeve and metal or sleeve and mill coating as per direction of Owner/ Engineer-in-charge.

b) The required peel strength shall be 60 N/cm (min.) at 23ÁC. 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 spark-tester 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.

Rev. : 0
Edition : 1

SPECIFICATION
FOR
PIPELINE CROSSINGS USING HORIZONTAL DIRECTIONAL DRILLING METHOD

SPECIFICATION NO.: MEC/S/05/21/75

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

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 REFERENCE DOCUMENTS

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

a. ASME B 31.4 : Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids.

b. ASME B 31.8 : Gas Transmission and Distribution Piping Systems.

c. OISD 226 : Natural Gas Transmission Pipeline and City Gas Distribution Network.

d. MECON's Standards : Navigable Waterway Pipeline Crossing Warning Sign MEC/S/05/21/10

e. MECON's Standards : Standard Specification for Pipeline Construction MEC/S/05/21/01

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

3.0 DESIGN AND ENGINEERING

3.1 The limits of each crossing shall be determined by the Contractor on the basis of crossing profile based on survey drawings, design, equipment, installation technique and site condition. Contractor shall furnish all engineering design calculation and crossing drawings etc. to owner for their approval prior to execution of the work.

3.2 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, cannals, 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.

3.3 The entry and exit points of the pipeline at ground level shall not come within the limits of crossing as defined in the crossing drawings.

3.4 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.

3.5 **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.

3.6 **Back-reamed hole and Pipeline Interface**

3.6.1 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

3.6.2 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.

3.6.3 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.

3.7 Contractor shall determine in the minimum allowable elastic bend radius for pipe from the following consideration:

3.7.1 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.

3.7.2. 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.

3.7.3 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.

3.7.4 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.

3.7.5 Contractor shall submit all calculations for Company's approval alongwith procedure.

3.8 **Pipeline Configuration along the Support String Before Entry Point**

3.8.1 Contractor shall determine the required pipeline configuration in order to allow smooth pull in the crossing entry point and admissible stress in the supported pipeline string. Pipeline combined stress shall not exceed 95% of the specified minimum yield strength for line pipe material.

3.8.2 Contractor shall furnish all calculation and specify the number of required supports, description of the supports, their co-ordinates and capacity in metric tons.

3.8.3 Contractor shall also furnish a drawing of the launching ramp indicating the pipeline configuration.

3.8.4 The distance between each roller shall also be specified and justified.

3.9 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.

3.10 All construction works shall be carried out in accordance with the construction drawings approved by Owner.

3.11 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.

4.0 **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.

4.1.0 **Installation Procedure**

4.1.1 Contractor shall, before commencing any work at site, submit for Owner's approval a detailed installation procedure.

4.1.2 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.

4.1.3 The time schedule shall be in accordance with overall time schedule for the project.

4.1.4 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.

4.2 **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.

4.3 **Pre-testing**

4.3.1 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.

4.3.2 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

4.3.3 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.

4.4 **Gauging**

4.4.1 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.

4.5 **Installation**

4.7.1 Installation shall be done in accordance with approval installation procedure.

4.7.2 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.

4.7.3 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.

4.7.4 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.

4.7.5 Contractor shall be responsible for maintaining the drilled hole till such time the pipeline is pulled in.

4.7.6 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.

4.7.7 Bentonite slurry of specified viscosity shall be pumped into the hole, preventing the wall from collapsing and protecting the pipeline coating.

4.6 **Contractor shall be responsible for the integrity of the corrosion coating.**

4.6.1 Before pull-back operation, megger test shall be done for the entire pipeline (externally corrosion coated) string made for crossing by HDD method.

4.6.2 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.

4.6.3 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.

4.6.4 If Contractor again fails to establish the integrity of coating of the bored pipeline string and the same is not acceptable to Owner, the above works shall not be continued further until the cause analysed and rectified by the Contractor to the entire satisfaction of Owner.

4.7 **Final Hydrostatic Test**

4.7.1 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.

4.7.2 **Test Procedure**

Contractor shall prepare for Company's approval a hydrostatic test procedure manual for pre-testing and post-installation testing of pipeline. The test procedure manual shall include, but shall not be limited to, the following items:

a. For the pipe section to be tested, a diagram indicating all fittings, vents, valves, temporary connections, relevant elevations and ratings. The diagram shall also indicate injection locations and intake and discharge lines.

b. Estimated amount of test water, water source, including required concentration of corrosion inhibitors and additives, procedure for inhibitor injection and control of concentration.

c. Filling and flushing procedures, including a complete description of all proposed equipment and instruments (including spares), their location and set-up.

d. The type and sequence of pigs and the pig tracking system for cleaning and removal of air pockets, pig inspection procedures, including procedure to be followed in case the gauging pig indicates damage.

e. Procedures for levelling and stabilization after filling and for pressurization and to allow for temperature stabilization.

f. Pressure testing procedure including a complete description of all proposed equipment and instruments (including spares), their location and set-up, and proposed system for observation and recording of data during the pressure test.

g. All calculations including air-volume calculations and pressure change due to temperature change calculations.

h. Procedure for detection and location of leaks.

i. Procedure for safe dewatering the pipeline section after testing, including a complete description of all proposed equipment and instruments (including spares), their location and set-up, the type and sequence of pigs and the pig tracking system along with the pig specifications.

j. Forms for recording the testing data.

4.7.3 Contractor shall furnish all necessary equipment & instrumentation for performing the work including all temporary piping, hydro test header and scraper launcher / receiver etc.

4.7.4 The test medium shall be fresh water to be arranged by the Contractor. The water to be used shall be filtered, shall not be contaminated, and free from sand of silt. Contractor shall submit laboratory test reports of water used for testing. Contractor shall provide Company approved corrosion inhibitors, oxygen scavengers and bactericides to be added to the test water. Contractor shall furnish and install all temporary piping, which may be necessary to connect from source of water to its pumps and manifolds / tankage.

4.7.5 Before filling operation, Contractor shall clean the pipeline by air driven pigs provided with spring loaded brushes and cups to remove all mill scale, rust / sand from the internal of pipe sections.

4.7.6 The hydrostatic test shall be considered as positive if pressure has kept a constant value throughout the test duration, except for changes due to temperature effects, and there is no abrupt pressure drop throughout the test duration.

If test section fails to maintain the specified test pressure after isolation, Contractor shall determine by search the location of leakage or failure. All leaks and failures within the pipe wall or longitudinal seam shall be repaired by replacement of entire joint or joints in which leakage or failure occurs. In those cases where leaks occur in circumferential welds the method of repair shall be determined by Company. Contractor shall comply with instructions of the Company whether to replace a section of the line pipe that includes the line leak or whether to repair the circumferential weld. This repair should, however, meet the requirements of welding specification contained herein. Where failures occur in pipeline field bends, bends shall be replaced with same degree of bends. After completion of repairs, the hydrostatic test shall be repeated in full, as per the approved procedures.

All work of reinstating line pipe, to replace failures, shall be done in accordance with the specifications contained herein.

Contractor shall haul and stockpile all damaged and defective pipes to storage locations designated by the Company. All cracks and splits resulting nom failures shall be coated with an application of grease to preserve the characteristics of failures nom corrosion. Joints of failed pipes shall be marked with paint, with a tag indicating failure details, date and location of failure and pressure at which failure occurred.

4.7.7 After completion of successful hydrotest of the above portion, the pipeline shall be capped and buried. Pipeline end position on the banks shall be marked on the ground by installing location markers on both banks approved by Company.

4.8 **Permanent Pipeline Markers**

On both banks of each river crossing, Contractor shall install a Navigable Waterway Pipeline Crossing Warning Sign in accordance with Std. No. MEC/S/05/21/05. Contractor shall supply all materials and fabricate and install the markers as per reference drawing. Wherever feasible, the pipeline markers shall be installed on the embankments, however, exact location shall be decided based on site conditions and as directed by Company.

4.9 **Fencing**

Wherever specified, Contractor shall supply all materials and install G.I. Wire Chain link security fencing of size 10 m x 10 m x 25 m high with lockable steel gate around the pipe ends and test stations for temporary C.P. on both sides of each river crossing.

4.10 **Idle Time Preservation of Pipeline**

When so stated in the Contract, Contractor shall supply all materials and consumable including water and inhibitor and shall install all piping connections, valves, instrumentation, etc., and perform all works for preservation of pipeline by pressurization with inhibited water. Contractor shall use approved inhibitors and shall determine the required dosages of inhibitors and pressure for idle time preservation of the pipeline for a period of maximum six months nom the date of completion of construction. Corrosion inhibitors and dosages shall be subject to Company's approval prior to use.

4.11 **Final Clean up**

4.11.1 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.

4.11.2 Contractor shall arrange for safe disposal of all surplus soil and bentonite slurry & corrosion inhibited test water so as to avoid any harm to the environment / occupants at locations duly approved by authorities and pollution control boards having jurisdiction and/or as instructed by Company without any extra cost.

5.0 **DOCUMENTATION**

5.1 In additional to the documents specified elsewhere in this specification. Contractor shall submit to the Owner the following documents/ records.

- Copies of the permits obtained from authorities having jurisdiction.

- Records of pre and post installation hydrostatic testing.
- Record of non-destructive testing of welds.
- Detailed drilling log and downhole data, including, but not limited to, the following :
  - i) Torque and pulling/pushing force
  - ii) Data on drilling fluid.
    - Density
    - Type of mud and additive employed.
    - Mixing, pumping and cleaning.

- Wash and drill pipe data, viz.,
  - i) Dimension and material properties.
  - ii) Data on API classification.
  - iii) Age of and type of inspection previously carried out on these pipes.

- Permits obtained from authorities having jurisdiction for the various works.
- Plan & profile of the drilled hole along with the water level variations.
- Records of hydrostatic pre-testing and final testing.
- Record of Non Destructive Testing of welds.
- Clearance certificates form the landowners and Authorities having jurisdiction regarding satisfactory clean-up and restoration of pipeline RoU and work areas.

- Clearance certificate from the land owners and authorities having jurisdiction regarding satisfactory clean-up and restoration of the pipeline ROW and work sites.

5.2 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.
- All As-Built drawings shall be prepared using software AutoCAD Release 2000 or above. Manually drafted drawings are not acceptable to Company. In addition, to the hard copies, as-built drawings shall also be submitted in electronic media i.e. CD / DVD.

5.3 All documents shall be in English language.

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

TECHNICAL SPECIFICATION
FOR
WARNING MATS

SPECIFICATION NO. : MEC/TS/05/62/042, Rev-1

SPECIFICATION FOR PE WARNING MATS FOR PIPELINE

Purpose	For using as a warning sign for Underground Pipeline
Width	OD + 100 mm, OD – Outer Dia of Steel Pipe 250 mm for PE pipeline up to 125 mm Dia OD + 100 mm, OD – Outer Dia of PE Pipe above 125 mm dia
Thickness	0.5 mm
Material of the mat	The material shall be of high density Polyethylene of virgin quality and non Biodegradable type. It shall have Non-Hazardous and Non-Toxic properties.
Colour of the mat	Golden Yellow with letters printed in RED of non-deletable type with high abrasion resistant.
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 4. **The Art work shall be printed in English and local language alternatively at every 1 mtr distance.**
Mechanical Properties of HDPE	
Tensile Strength	Minimum 200 kg/cm^2
Elongation at Break	Minimum 175%
Bundle Length	1.0 mm thick warning mat shall be supplied as 100 mtrs length in each bundle packed in PE Woven sack material.
Tests	Minimum following test has to be done with each batch of warning mat • Tensile Strength test • Elongation test • Impact Strength test • Color fastness test • Heat Stability test • Print Stability test

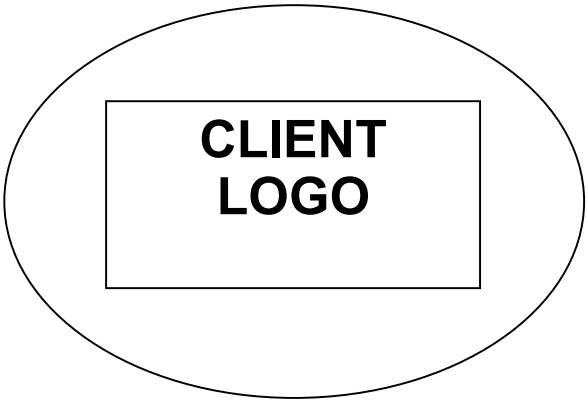
- Oxidation Induction test
- ESCR test
- Melt Flow Rate test
- Anti-Rodent Test.
- UV Stabilizer Test
- DSC Scan Test of Raw Material & Finish Goods.

Test Certificates : Vendor has to submit the all test certificates to Purchaser

Inspection : The manufacturer has to submit the QAP before commencement of production. Inspection of the material will be done at vendor's works by Client / MECON Representative. Vendor has to submit all test reports before inspection call. Any test failed during the inspection for the offered lot, the total lot will be rejected.

Documentation : Vendor shall submit all test reports including document regarding Toxicology data & ROHS compliance, documentary evidence regarding Non-biocide product, value of Lethal Dosage (LD), value of % dermal toxicity, details of active ingredient in the product and final inspection reports along with the supply of materials.

HIGHLY INFLAMMABLE GAS PIPELINE BELOW CLIENT NAME



IN EMERGENCY PLEASE CONTACT PHONE NOS. ……

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI - 110 092

TECHNICAL SPECIFICATION
FOR
LONG RADIUS BENDS

SPECIFICATION NO. : MEC/TS/05/62/015, Rev-1

CONTENTS

Revision No.	Date	Revised by	Checked by	Approved by

PREPARED BY :	CHECKED BY :	APPROVED BY :

1.0 SCOPE

This specification covers long radius steel pipe bends to be manufactured in accordance with the requirements of MSS-SP (Manufacturers Standardisation Society – Standard Practice) – 75, latest edition, to be used in pipeline system handling Natural Gas. The selection of options permitted by MSS-SP-75 shall be as described below. All applicable requirements contained in the MSS-SP-75 shall be fully valid unless cancelled, replaced or amended by more requirements as stated in this specification. In case of conflict between the requirements of this specification and MSS-SP-75, the requirements of this specification shall govern.

2.0 REFERENCE DOCUMENTS

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

a) ANSI B31.8 : Gas Transmission and Distribution Piping System.

b) ASME – Sec. VIII Div. 1 : Boiler and Pressure Vessel Code

c) ASME – Sec IX : Boiler & Pressure Vessel Code Welding and Brazing Qualifications

d) API Spec. 5L : Line Pipe

e) ASTM Part-I : Steel – Piping, Tubing, Fittings

In case of conflict between the above reference documents and this specification, the requirements of the specification shall prevail.

3.0 MATERIALS

3.1 Bends shall be fabricated from bare steel line pipe (to be issued as free issue item by Purchaser). The details of free issue line pipe material is given separately in LR Bend Data Sheet & Purchase Requisition.

3.2 All mechanical properties of the bends after finishing shall be same as pipe specification as referred in section 3.1. The following tests shall be conducted on finished bends and test procedures shall be as per pipe specification as referred in para 3.1.

3.2.1 One transverse tensile test will be conducted to establish the yield strength, ultimate tensile strength and elongation of :

a) Base material at inside radius of the bend.
b) Base material at outside radius of the bend.

3.2.2 One all weld tensile test will be conducted (wherever applicable) to establish yield strength, ultimate tensile strength and elongation of weld material on bend.

3.2.3 Three transverse Charpy-V-notch impact tests shall be conducted on full sized specimen of the same heat in accordance with ASTM A370 at 0°C for each of the following :

a) Base material at outside radius of the bend.
b) Weld material of bend

3.2.4 **Guided Bend Tests**

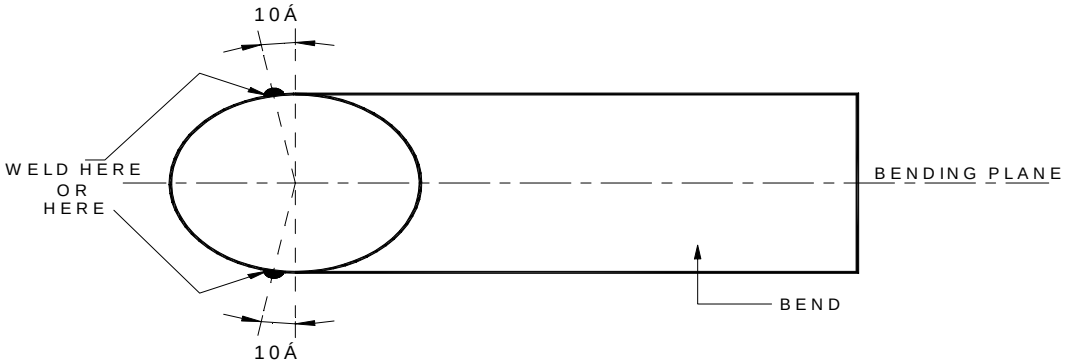
One face and one root guided bend weld test shall be performed on samples cut from one bend per heat of steel. The dimensions `A' in guided bend test shall not exceed 4.0 times the nominal wall thickness and dimension `B' shall be equal to A + 2t + 3.2mm.

4.0 MANUFACTURE

4.1 Bends shall be manufactured by hot bending of pipe applying induction heating only.

The adopted procedure shall be completed by suitable heat treatment to achieve the required mechanical and chemical properties of the finished bends and is accepted only after written approval of the Purchaser. The procedure shall ensure uniform bending without any defects other than those allowed in this specification and pipe specification as referred in para 3.1.

4.2 When bending, the weld wherever applicable shall be located at approx. 10° from the neutral zone, measured at outside of the bend as indicated in figure below.



4.3 Bevels at the ends shall be as specified in MSS-SP-75 unless otherwise specified differently in the material/ purchase requisition.

4.4 Bends shall not have any circumferential joint.

4.5 No repair by welding is allowed on any part of the bends.

4.6 The cooling of the bend immediately after bending shall be an interval cooling, alternatively with water and air at a minimum pressure of 2 atmospheres.

4.7 The procedure shall be such which shall not require any additional heat – treatment after bending. If such a heat treatment is required, it is permitted only after the written approval of purchaser and shall be carried out at Manufacturer's expense.

4.8 Bulges, dents and flat areas shall not appear within 100mm from end of the bend.

For the remaining part of the bend these deviations from the original contour of the pipe are permitted but the same shall be repaired, provided these deviations shall not exceed 6.5% of nominal wall thickness in height/ depth and the same shall not extend (in any direction) over a distance of more than 25% of nominal diameter.

4.9 The excess weld material wherever applicable at the inside of the bend shall be removed over a distance of 100mm at both ends.

4.10 **Tolerances**

The dimensions of bends shall be controlled to make sure that they are manufactured according to the tolerances indicated below over and above the requirements of MSS-SP-75

4.10.1 Minimum Inside Diameter : -2.5% of inside nominal diameter except 200mm from ends

Bend Angle : ±1°

Bend Radius : ± 1% of bending nominal Diameter

4.10.2 The manufacturer shall check the wall thickness of the pipe before and after bending along the outside radius either at distances approximately equal to pipe diameter or 300mm whichever is less. The measured wall thickness shall be atleast equal to :

tmin = 0.95 (tnom. $\triangle$ t)

tnom = nominal wall thickness as specified in the material/ purchase requisition.

$\triangle$ t = 0.35mm for a wall thickness smaller than 10mm.

$\triangle$ t = 0.50mm for a wall thickness 10mm or more.

4.10.3 Ovality may be defined as :

$$\frac{\text{OD max.} - \text{OD min}}{\text{OD nom.}}$$

The above value shall be < 1% within 100mm from each end and < 6% for remaining part of the bend. The measurement shall be made over the circumference of the bend either at distance approximately equal to pipe diameter or 300mm whichever is less.

4.10.4 **Wrinkles**

Measurements of the outside diameter shall be taken in the plane of the bend at locations where wrinkles are present (OD max.) and at locations where wrinkles are not present (OD min,). The acceptance limit shall be as defined below.

$$\frac{\text{OD max.} - \text{OD min}}{\text{OD nom.}} < 1\%$$

5.0 INSPECTION AND TESTS

5.1 The manufacturer shall perform all inspection and tests as per the requirements of this specification and MSS-SP-75 prior to shipment at his works. Such inspection and tests shall be, but not limited to, the following :

a) Verify that the unfinished product arriving at manufacturer's shop is in full compliance with the pipe specification as referred in para 3.1.
b) Visual Inspection.
c) Dimensional and tolerances check as per MSS-SP-75 and requirements of section 4.0 of this specification.
d) Check heat treatment, if carried out, as required and maintain its records.
e) Temperature against time recorder charts for each induction heating.
f) Material properties shall be checked to meet the requirements of section 3.0 of this specification.
g) The non-destructive inspection on the finished bend shall be carried out as given below :

- All longitudinal seam welds shall be fully radiographed and acceptance limits shall be as per pipe specification as referred in para 3.1.
- The full circumference of both ends of each bend after bevelling shall be ultrasonically tested for laminations over a length of 25mm and acceptance limits shall be as per pipe specification as referred in para 3.1.

5.2 Purchaser's Representative reserves the right to perform stagewise inspection and witness tests on all bends as indicated in para 5.1 at Manufacturer's works, prior to shipment.

Manufacturer shall give reasonable notice of time and shall provide without charge reasonable access and facilities required for inspection, to the Purchaser's Representative. Inspection and test performed or witnessed by Purchaser's Representative shall in no way relieve the Manufacturer's obligation to perform the required inspection and tests. Under no circumstances any action of the Purchaser's Representative shall relieve the Manufacturer of his responsibility for the material, design, quality and operation of the equipment.

5.3 **Test Certificates**

The Manufacturer shall produce the Certificates (in original) for all, but not limited to, the following :

a) Certificates of chemical analysis and mechanical tests carried out on pipe and bends separately.

b) Certificates of required non-destructive test inspection.

c) Certificates of heat treatments, if any.

d) Certificates of all other tests as required in this specification.

In case any of the above said certificates are not available during the final inspection, the supply shall be considered incomplete.

6.0 **MARKING, PACKING AND SHIPMENT**

6.1 All bends shall be marked as per MSS-SP-75.

6.2 All loose and foreign material i.e. rust, grease, etc. shall be removed from inside and outside of the bends.

6.3 All bends except bevelled ends shall be coated internally and externally with a thin film of zinc chromate red oxide paint for protection against corrosion during transit and storage. The coating shall be easily removable in the field. Manufacturer shall furnish the details for the same.

6.4 Both ends of all bends shall be suitably protected to avoid any damage during transit by means of metallic bevel protectors.

6.5 Package shall be marked legibly with suitable marking to indicate the following:

a) Order Number
b) Package Number
c) Manufacturer's Name
d) Size (Inches) and wall thickness (mm)

7.0 WARRANTY

Purchaser will be reimbursed by Manufacturer for any bend furnished on this order that fails under field hydrostatic test if such failure is caused by a defect in the bend which is outside the acceptance limits of this specification. The reimbursement cost shall include bend cost, labour cost and equipment rental for searching, excavation, cutting out and installation of replaced bend in position. The field hydrostatic test pressure will not exceed that value which will cause a calculated hoop stress equivalent to 100% of specified minimum yield strength of the attached pipe.

8.0 DOCUMENTATION

8.1 All documents shall be in English language.

8.2 At the time of bidding, bidder shall submit the following documents :

a) Reference list of previous supplies of bends of similar specifications.

b) Clause-wise list of deviation from this specification, if any.

c) Brief description of manufacturing and quality control facilities of the Manufacturer's works.

8.3 Within one week of placement of order the Manufacturer shall submit four copies, of the manufacturing process and quality assurance plan for pipe and bends.

Once the approval has been given by Purchaser any change in material and method of manufacture and quality control shall be notified to Purchaser whose approval in writing of all such changes shall be obtained before the bends are manufactured.

8.4 Within four weeks from the approval date Manufacturer shall submit one reproducible and six copies of the documents as stated in para 8.3 of this specification.

8.5 Prior to shipment, the Manufacturer shall submit one reproducible and six copies of test certificates as listed in para 5.3 of this specification.

Rev. : 0
Edition : 1

SPECIFICATION
FOR
SEAMLESS FITTINGS & FLANGES
[SIZE UPTO DN 400 mm (16”) NB]

SPECIFICATION NO.: MEC/TS/05/21/025

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION OIL & GAS SBU, DELHI		
TITLE	SEAMLESS FITTINGS & FLANGES [SIZE UPTO DN 400 mm (16ò) NB]	DOCUMENT NO. MEC/TS/05/21/025	Page 1 of 1 REVISION : 0 EDITION : 1

CONTENTS

PREPARED BY:	CHECKED BY:	APPROVED BY:	ISSUE DATE :
(Shalini Singh)	(Sunil Kumar)	(A.K. Johri)	Dec. 2008

1.0 SCOPE

This specification covers the minimum requirements for the design, manufacture and supply of following carbon steel flanges and fittings of size upto DN 400 mm (16") to be installed in onshore pipeline systems handling non-sour hydrocarbons in liquid or gaseous phase including Liquefied Petroleum Gas (LPG) :

- Flanges such as welding neck flanges, blind flanges, spectacle blinds, spacers and blinds etc.

- Seamless fittings such as tees, elbows, reducers, caps, outlets etc.

2.0 REFERENCE DOCUMENTS

2.1 Reference has been made in this specification to the latest edition (edition enforce at the time of issue of enquiry) of the following Codes, Standards and Specifications :

ASME B31.4	-	Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids
ASME B31.8	-	Gas Transmission and Distribution Piping Systems
ASME B16.5	-	Pipe Flanges and Flanged Fittings
ASME B16.9	-	Factory Made Wrought Steel Butt Welding Fittings
ASME B 16.11	-	Forged Steel Fittings, Socket Welding and Threaded
ASME B 16.48	-	Steel Line Blanks
ASME Sec VIII	-	Boiler and Pressure Vessel Code - Rules for Construction of Pressure Vessels
ASME Sec IX	-	Boiler and Pressure Vessel Code - Welding and Brazing Qualifications
ASTM A 370	-	Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
MSS-SP-25	-	Standard Marking System for Valves, Fittings, Flanges and Unions

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

2.2 In case of conflict between the requirements of this specification and the requirements of above referred Codes and Standards, the requirements of this specification shall govern.

3.0 **MANUFACTURER'S QUALIFICATION**

Manufacturer who intends bidding for fittings must possess the records of a successful proof test, in accordance with the provisions of ASME B16.9 / MSS-SP-75 as applicable.

4.0 MATERIAL

4.1 The Carbon Steel used in the manufacture of flanges and fittings shall be fully killed. Material for flanges and fittings shall comply with the material standard indicated in the Purchase Requisition. In addition, the material shall also meet the requirements specified hereinafter.

4.2 Each heat of steel used for the manufacture of flanges and fittings shall have Carbon Equivalent (CE) not greater than 0.45 calculated from check analysis in accordance with the 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 For flanges and fittings specified to be used for Gas service or LPG service, Charpy V-notch test shall be conducted on each heat of steel. Unless specified otherwise, the Charpy V-notch test shall be conducted at 0ÁC in accordance with the impact test provisions of ASTM A 370 for flanges and fittings.

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 22 Joules.

When Low Temperature Carbon Steel (LTCS) materials are specified for flanges and fittings in Purchase Requisition, the Charpy V-notch test requirements of applicable material standard shall be complied with.

4.4 For flanges and fittings specified to be used for Gas service or LPG service, Hardness test shall be carried out in accordance with ASTM A 370. Hardness testing shall cover at least 10% per item, per size, per heat, per manufacturing method. A full thickness cross section shall be taken for this purpose and the maximum hardness shall not exceed 248 HV_{10}.

4.5 In case of RTJ (Ring Type Joint) flanges, the groove hardness shall be minimum 140 BHN. Ring Joint flanges shall have octagonal section of Ring Joint.

5.0 DESIGN AND MANUFACTURE

5.1 Flanges such as weld neck flanges and blind flanges shall conform to the requirements of ASME B16.5.

5.2 Spectacle blind and spacer & blind shall conform to the requirements of ASME B 16.48.

5.3 Fittings such as tees, elbows, reducers, etc. shall be seamless type and shall conform to ASME B16.9 for sizes DN 50 mm (2") to DN 400 mm (16") (both sizes included) and ASME B 16.11 for sizes below ON 50 mm (2").

5.4 Fittings such as weldolets, sockolets, nippolets, etc. shall be manufactured in accordance with MSS-SP-97.

5.5 Type, face and face finish of flanges shall be as specified in Purchase Requisition.

5.6 Flanges and fittings manufactured from bar stock are not acceptable.

5.7 All butt weld ends shall be bevelled as per ASME B 16.5 / ASME B 16.9 / MSS-SP-97 as applicable.

5.8 Repair by welding on flanges and fittings is not permitted.

5.9 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 90Á from the extrusion. Fittings shall not have any circumferential joint .

6.0 INSPECTION AND TESTS

6.1 The Manufacturer shall perform all inspections and tests as per the requirement of this specification and the relevant codes, prior to shipment at his works. Such inspections and tests shall be, not but limited to the following :

a) All flanges and fittings shall be visually inspected. The internal and external surfaces of the flanges and fittings shall be free from any strikes, gauges and other detrimental defects.

b) Dimensional checks shall be carried out on finished products as per ASME B16.5 for flanges, ASME B16.48 for spacers and blinds and ASME B16.9 / MSS-SP-97 as applicable for fittings and as per this specification.

c) Chemical composition and mechanical properties shall be checked as per relevant material standards and this specification, for each heat of steel used.

d) All finished wrought weld ends subject to welding in field, shall be 100% tested for lamination type defects by ultrasonic test. Any lamination larger then 6.35 mm shall not be acceptable.

6.2 Purchaser's Inspector reserves the right to perform stage wise inspection and witness tests, as indicated in clause 6.1 of this specification at Manufacturer's Works prior to shipment. Manufacturer shall give reasonable notice' of time and shall provide, without charge, reasonable access and facilities required for inspection, to the Purchaser's Inspector.

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

7.0 TEST CERTIFICATES

Manufacturer shall furnish the following certificates:

a) Test certificates relevant to the chemical analysis and mechanical properties of the materials used for manufacture of flanges and fittings as per relevant standards and this specification.

b) Test Reports on non destructive testing.

c) Certificates for each fitting stating that it is capable of withstanding without leakage a test pressure, which results in a hoop stress equivalent to 100 % of

the specified minimum yield strength for the pipe with which the fitting is to be attached without impairment of serviceability.

8.0 PAINTING, MARKING AND SHIPMENT

8.1 After all inspection and tests required have been carried out; all external surfaces shall be thoroughly cleaned to remove grease, dust and rust and shall be applied with standard mill coating for protection against corrosion during transit and storage. The coating shall be easily removable in the field.

8.2 Ends of all fittings and weld neck flanges shall be suitably protected to avoid any damage during transit. Metallic or high impact plastic bevel protectors shall be provided for fittings and flanges. Flange face shall be suitably protected to avoid any damage during transit.

8.3 All flanges and fittings shall be marked as per applicable dimension / manufacturing standard.

9.0 DOCUMENTATION

Documentation to be submitted by Manufacturer to Company is summarized below. Number of Copies (Hard copies / soft copies etc.) shall be as indicated in CONTRACT document / Material Requisition.

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, the Manufacturer shall submit test certificates as listed in clause 7.0 of this specification.

9.3 All documents shall be in English Language only.

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

मेकॉन

TECHNICAL SPECIFICATION
FOR
ASSORTED PIPES

SPECIFICATION NO. : MEC/TS/05/62/59A, R-0

CONTENTS

Prepared By :	Checked By :	Approved By :

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 ≥ 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.)"

OR

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

$$E_t / 1.5 \geq$$
$$S_r / 1.5 \geq S_a$$
$$S_c \geq$$

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 (ÁF)											
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*
A 691 Gr. 1 ¼ Cr	*18900*	*18300*	*18000*	*17600*	*17300*	*16800*	*16300*	*15000*	*9900*	*6300*	*4200*	*2800*
A335 Gr. P2/ A691 Gr. 2 ¼ Cr	*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, clen and free from from moisture, dirt and loose foreign materials of any kind.

4.5 Pipes shall be protected from rust, corrosion and mechanical damage during transportation, shipment and storage.

4.6 Rust preventive used on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.

4.7 Both ends of the pipe shall be protected with the following material:

Plain end	:	Plastic cap
Bevel end	:	Wood, Metal or Plastic cover
Threaded end	:	Metal or Plastic threaded cap

4.8 End protectors to be used on bevelled ends shall be securely and tightly attached with belt or wire.

4.9 Steel end protectors to be used on galvanised pipes shall be galvanised.

ANNEXUREï I

3.0 **HYDROSTATIC TEST**

3.1 All pipes shall be hydrostatically tested.

3.2 The mill test pressure shall be as follows:

3.2.1 **Seamless, E.R.W. & Spiral Welded**

a) Carbon Steel

Material Standard	Test Pressure Standard
ASTM A 106 Gr. B	ASTM A 530
API 5L Gr. B, 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

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

c) Seamless Stainless Steel

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

d) Seamless Nickel Alloy

Material Standard	Test Pressure Standard
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. (16ò & above)

Material Standard	Test Pressure Standard
API 5L Gr.B 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 Gr.B) S=85% of SMYS for API 5L Gr.B T=Nominal Wall Thickness D=O.D. of Pipe

b) Stainless Steel E.FS.W. (2ò to 6ò)

The hydrostatic test pressure in kg/ cm^2 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. (8ò and above).

Material Standard	Test Pressure Standard
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

Material Standard	Test Pressure Standard
IS :1239	IS :1239
IS :3589	IS :3589

STANDARD TECHNICAL SPECIFICATION FOR BALL VALVES

SPECIFICATION NO.: MEC/TS/05/21/002

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

PREPARED BY:	CHECKED BY:	APPROVED BY:	ISSUE DATE :

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Rev.	Date	By		Verified	
					Name	Sig.	Name	Sig.
1.	Cl. No. 4.6	4	1	April 09	Gurdeep Singh		K.K. De	
2.	Overall Revision	All	1	July 20	K.P. Singh		A.K. Tyagi	

Abbreviations :

ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing and Materials
API	:	American Petroleum Institute
BHN	:	Brinell hardness number
DN	:	Nominal Size
HAZ	:	Heat Affected Zone
LC	:	Lock Close (valve locked in full close position)
LO	:	Lock Open (valve locked in full open position)
MSS-SP	:	Manufacturers Standardization Society ï Standard Practice
NDT	:	Non Destructive Testing
NPS	:	Nominal Pipe Size
RTJ	:	Ring Type Joint
SSPC	:	Steel Structures Painting Council

CONTENTS

1.0 **SCOPE**

This specification covers the minimum requirements for design, manufacture, testing and supply of carbon steel ball valves of size DN 50 mm (2ö) and above and ANSI pressure rating class 150 to 900 to be used in on-shore pipeline systems handling non-sour hydrocarbons in liquid or gaseous phase, including Liquefied Petroleum Gas (LPG).

This specification does not cover ball valves for sour hydrocarbon (liquid / gas) service as defined in NACE standard MR-01-75.

2.0 **REFERENCE DOCUMENTS**

2.1 All valves shall be manufactured and supplied in accordance with the latest edition of American Petroleum Institute (API) Specification 6D / ISO 14313, with additions and modifications as indicated in the following sections of this specification.

2.2 Reference has also been made in this specification to the latest edition of the following Codes, Standards and Specifications:

ASME B 16.5	:	Pipe flanges and flanged fittings
ASMEB 16.10	:	Face-to-face and end-to-end dimensions of valves
ASME B 16.25	:	Butt welding ends
ASME B 16.34	:	Valves ï flanged, threaded and welding ends
ASME B16.47	:	Large diameter steel flanges
ASME B 31.3	:	Process piping
ASME B 31.4	:	Pipeline transportation systems for liquid hydrocarbons and other liquids
ASME B 31.8	:	Gas transmission and distribution piping systems
ASME Sec VIII	:	Boiler and pressure vessel code - Rules for construction of pressure vessels
ASME Sec IX	:	Boiler and pressure vessel code - Welding and brazing qualifications
ASTM A 370	:	Standard test methods and definitions for mechanical testing of steel products
ASTM B 733	:	Autocatalytic nickel phosphorous coating on metals
API 6FA	:	Fire test for valves

API 607	:	Fire test for soft-seated quarter-turn valves
API 1104	:	Welding of pipelines and related facilities
BS EN ISO 10497	:	Testing of valves – Fire type-testing requirements
MSS-SP-6	:	Standard finishes for contact faces of pipe flanges and connecting-end flanges of valves and fittings
MSS-SP-44	:	Steel pipeline flanges
SSPC-VIS-1	:	Steel structures painting council-visual standard

2.3 **In case of conflict** between the requirements of this specification, API 6D and the Codes, Standards and Specifications referred in clause 2.2 above, the requirements of this specification shall govern. Order of precedence shall be as follows :

- Valve Data Sheets
- Material Requisition
- This Specification
- API 6D Specification
- Other Referred Codes & Standards
- Manufacturer's Standard

3.0 MATERIALS

3.1 Material for major components of the valves shall be as indicated in Valve Data Sheet. Other components shall be as per Manufacturer's standard (suitable for the service conditions indicated in Data Sheet) and shall be subject to approval by Purchaser. In addition, the material shall also meet the requirements specified hereinafter.

3.2 Carbon steel used for the manufacture of valves shall be fully killed.

3.3 The Carbon Equivalent (CE) of valve end connections which are subject to further field welding by Purchaser, shall not exceed 0.43% (as calculated by the following formula) on check analysis for each heat of steel used:

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

3.4 For Valves specified to be used for Gas service or LPG service, Charpy V-notch test, on each heat of base material shall be conducted as per API 6D Clause 8.5, for all pressure containing parts such as body, end flanges and welding ends as well as bolting material for pressure containing parts. Unless stated otherwise, the Charpy V-notch test shall be conducted at 0 ÁC. Test procedure shall conform to ASTM A370. The average absorbed energy value of three full sized specimens shall be 27 J. The

minimum impact energy value for any one specimen of the three specimens analysed as above, shall not be less than 22 J.

When Low Temperature Carbon Steel (LTCS) materials are specified in Valve Data Sheet or offered by Manufacturer, the Charpy V-notch test requirements of applicable material standard shall be complied with.

3.5 For all such valves where carbon steel is used as ball material, the ball shall have 75 micrometer (0.003 inch) thick Electroless Nickel Plating (ENP) as per ASTM B733 with following classification : SC2, Type II, Class 2. The hardness of plating shall be minimum 50 RC.

3.6 For valves specified to be used for Gas service or LPG service, hardness test shall be carried out as per ASTM A370 for each method of manufacture and each heat of steel used in the manufacture of valves. A full thickness cross-section shall be taken for this purpose and the maximum hardness of the materials of valve components shall not exceed 248 HV_{10}.

3.7 All process-wetted parts, metallic and non-metallic, shall be suitable for the fluids and service specified by the Purchaser. The service gas composition shall be as given elsewhere in the Material Requisition. In addition, Manufacturer shall confirm that all wetted parts are suitable for treated water / seawater environment, which may be used during field testing.

3.8 Non-metallic parts of the valves (including O-rings, soft seal etc.) intended for hydrocarbon gas service at pressures of PN 100 (600 #) and above shall be resistant to explosive decompression.

4.0 DESIGN AND CONSTRUCTION

4.1 Valve design shall meet the requirements of API 6D and other referred codes and shall be suitable for the service conditions indicated in Valve Data Sheet. The ASME Boiler & Pressure Vessel Code, Section VIII, Division 1, may be used to design the valve body. Allowable stress requirements shall comply with the provisions of ASME B31.3. In addition, corrosion allowance indicated in Valve Data Sheet shall be considered in valve design. However, the minimum wall thickness shall not be less than the minimum requirement of ASME B16.34. The Manufacturer shall have a valid license to use API 6D monogram for manufacture of ball valves.

4.2 For above ground valves, valve body design shall be either fully welded or bolted type, as indicated in Valve Data Sheet. Valve body joints with threads are not permitted.

For buried valves, valve body design shall be fully welded type only. Valve body joints with bolts or threads are not permitted.

4.3 Ball shall be of single piece, solid type construction.

4.4 Valves shall be Full Opening (FO) or Reduced Opening (RO) as indicated in Valve Data Sheet. FO valves shall be suitable for the passage of all types of pipeline scraper and inspection pigs on regular basis without causing damage to either the valve component or the pig. The FO valve shall provide an unobstructed profile for pigging operations in either direction. FO valves shall be designed to minimize accumulation of debris in the seat ring region to ensure that valve movement is not impeded.

The opening size of RO valves shall be corresponding to that of a FO valve of smaller nominal diameter as indicated in table below. For sizes of a particular rating not covered in API 6D, the opening sizes of the RO valve shall be as per Manufacturerôs standard.

Nominal Valve Size	Nominal Valve Size for Reduced Opening	Nominal Valve Size	Nominal Valve Size for Reduced Opening
DN mm (NPS inches)	DN mm (NPS inches)	DN mm (NPS inches)	DN mm (NPS inches)
50 (2)	50 (2)	600 (24)	500 (20)
80 (3)	50 (2)	650 (26)	550 (22)
100 (4)	80 (3)	700 (28)	600 (24)
150 (6)	100 (4)	750 (30)	600 (24)
200 (8)	150 (6)	800 (32)	650 (26)
250 (10)	200 (8)	850 (34)	700 (28)
300 (12)	250 (10)	900 (36)	750 (30)
350 (14)	250 (10)	950 (38)	800 (32)
400 (16)	300 (12)	1000 (40)	850 (34)
450 (18)	350 (14)	1050 (42)	900 (36)
500 (20)	400 (16)	1200 (48)	1050 (42)
550 (22)	450 (18)		

4.5 Ball mounting shall be trunnion / pivot type or as indicated in Valve Data Sheet. Ball mounting, either trunnion or floating, unless otherwise specified, shall be as follows.

Sl. No.	ANSI Pressure Rating	Nominal Valve Size (NPS inches)	
		Floating Ball	Trunnion Mounted
1.	150#	≤ 8ò	> 8ò
2.	300#	≤ 4ò	> 4ò
3.	600#	Nil	≥ 2ò

Valve design shall minimize the possibility of debris ingress into the trunnion as far as practicable.

4.6 Valve seats shall have metal to metal contact. O-rings or other seals, if used for drip tight sealing, shall be encased in a suitable groove in such a manner that it can not be removed from seat ring and there is no extrusion during opening or closing operation of valve at maximum differential pressure corresponding to valve class rating. The seat rings shall be so designed as to ensure sealing at low as well as high differential pressures.

4.7 Valves shall have double block and bleed feature to facilitate complete flushing, draining and venting of the valve body cavity.

4.8 For valves to be used in liquid service, the body cavity over-pressure shall be prevented by self relieving seat rings / assemblies. A pressure relief hole in the ball is not permitted. Self relieving seat rings shall relieve at a body cavity differential pressure not exceeding 50% of the valve class rating pressure.

4.9 Valves shall be designed to withstand a sustained internal vacuum of at least 1 (one) milli-bar in both open and closed positions.

4.10 FO valves of nominal size DN 200 mm (8”) & above and RO valves of nominal size DN 250 mm (10”) & above shall have provision for secondary sealant injection under full line pressure for seat and stem seals. All sealant injection connections shall be provided with a needle valve, a grease fitting and non-return valve. Valve design shall have a provision to replace the sealant injection fitting under full line pressure. Location and arrangement of sealant points shall be as per Figure-1.

4.11 Valves shall be provided with vent and drain connections. Location and arrangement of vents and drains shall be as per Figure-1. Body vent and drain shall be provided with valves (ball or plug type). Number and size shall be as per Figure-1.

4.12 Valve design shall ensure repair of stem seals / packing under full line pressure.

4.13 a) Valve ends shall be either flanged or butt welded or one end flanged and one end butt welded as indicated in Valve Data Sheet. Flanges of the flanged end cast/ forged body valves shall be integrally cast / forged with the body of valve. Face-to-face/ end-to-end dimensions shall conform to API 6D. Face-to-face and end-to-end dimensions for valve sizes not specified in API 6D shall be in accordance with ASME B 16.10. Face-to-face and end-to-end dimensions not shown in API 6D or in ASME B 16.10 shall be as per Manufacturer Standard and shall be subject to approval by Purchaser.

b) Flanged ends shall have flanges as per ASME B16.5 for valve sizes up to DN 600 mm (24 inches) excluding DN 550 mm (22 inches) and as per MSS-SP-44 / ASME B 16.47 series A for valve sizes DN 550 mm (22 inches) & for DN 650 mm (26 inches) and above. Flange face shall be either raised face or ring joint type (RTJ) as indicated in Valve Data Sheet. Flange face finish shall be serrated or smooth as indicated in Valve Data Sheet. Smooth finish when specified shall be 125 to 200 microinches AARH. In case of RTJ flanges, the groove hardness shall be minimum 140 BHN.

c) Butt weld end preparation shall be as per ASME B16.25. The thickness of the pipe to which the valve has to be welded shall be as indicated in Valve Data Sheet. Valves shall be without transition pups, unless otherwise specified in Valve Data sheet. In case significant difference exists between thickness of welding ends of valve and connecting pipe, the welding ends of valve shall have bevel preparation as per ASME B31.4 or ASME B31.8, as applicable.

4.14 Design of weld end valves shall be such that during field welding operations, the soft seals or plastic components of the valve (where ever used) are not liable to be damaged. The Manufacturer shall furnish necessary field welding instructions and post-weld test procedure to demonstrate integrity and leak-tightness of valves after field welding operations.

4.15 Valves shall be provided with ball position indicator and stops of rugged construction at the fully open and fully closed positions.

4.16 FO valves of nominal size ≥ DN 200 mm (8”) and RO valves of nominal size ≥ DN 250 mm (10”) shall be equipped with support foot and lifting lugs. Tapped holes and eye bolts shall not be used for lifting lugs. Height of support foot shall be kept a minimum. The location and size of support foot / lifting lugs shall ensure unrestrictive operation of vent / drain valves.

4.17 Valve design shall be such as to avoid bimetallic corrosion between carbon steel and high alloy steel components. Suitable insulation shall be provided as required.

4.18 Valves shall be of fire resistant design as per API 607/BS EN ISO 10497/API 6FA, as indicated in Valve Data Sheet.

4.19 Valves shall be provided with anti-static devices to ensure electrical continuity between stem / ball and valve body.

4.20 Valves shall be suitable for either buried or above ground installation as indicated in Valve Data Sheet.

4.21 When stem extension requirement is indicated in Valve Data Sheet, the valves shall have the following provisions :

a) Valves provided with stem extension shall have water proof outer casing. Length of stem extension shall be as indicated in Valve Data Sheet. The length indicated corresponds to the distance between centerline of the valve opening and the top of mounting flange for valve operating device (gear operator / power actuator as applicable).

b) Vent and drain connections and sealant injection lines shall be terminated adjacent to the valve operator by means of suitable piping anchored to the valve body. Pipe used shall be API 5L Gr. B / ASTM A 106 Gr. B, with Sch. 80. Fittings shall be ASTM A 105 / ASTM 234 Gr. WPB, Socket Welded, ANSI class 6000.

c) Stem extension and stem housing design shall be such that the complete assembly will form a rigid unit giving a positive drive under all conditions with no possibility of free movement between valve body, stem extension or its operator.

d) Outer casing of stem extension shall have 3/8" or ½" NPT plugs at the top and bottom, for draining and filling with oil to prevent internal corrosion.

4.22 **Operating Devices**

a) Valves shall have a power actuator or manual operator as indicated in Valve Data Sheet. In case of manual operator, valve sizes $\leq$ DN 100 mm (4 inches) shall be wrench operated and valve sizes $\geq$ DN 150 mm (6 inches) shall be gear operated. Each wrench – operated valve shall be supplied with wrench. Valve design shall be such that damage due to malfunctioning of the operator or its controls will only occur in the operator gear train or power cylinder and that damaged parts can be replaced without the valve cover being removed.

b) The power actuator shall be in accordance with the Purchaser specification issued for the purpose and as indicated in Valve and Actuator Data Sheet. Operating time shall be as indicated in Valve Data Sheet. Valve operating time shall correspond to full close to full open/full open to full close under maximum differential pressure corresponding to the valve rating. For actuated valves, the actuator torque output shall be 1.25 times the break torque required to operate the ball valve under the maximum differential pressure corresponding to the valve class rating.

c) For manual operator of all valves, the diameter of the hand wheel or the length of operating wrench shall conform to API 6D requirements and be such that under maximum differential pressure, the total force required to operate the valve does not exceed 350 N. Manufacturer shall also indicate the number of turns of hand wheel (in case of gear operators) required for operating the valve from full open to full close position.

d) Direction of operation of hand wheel or wrench shall be in clock-wise direction while closing the valve. Hand wheels shall not have protruding spokes.

e) Gear operators, when provided, shall have a self locking provision and shall be fully encased, in water proof/ splash proof/ dust proof/ weather proof enclosure and shall be filled with suitable grease.

f) Operating devices shall be designed for easy operation of the valve under maximum differential pressure corresponding to the valve rating.

4.23 All welds shall be made by welders and welding procedures qualified in accordance with the provisions of ASME Section IX. The procedure qualification shall include impact test and hardness test and shall meet the requirements of clauses 3.4 and 3.6 of this specification, respectively.

4.24 All welds shall be stress relieved in accordance with ASME Section VIII.

4.25 Repair by welding is not permitted for fabricated and forged body valves. However, repair by welding as per ASME B16.34 is permitted for cast body valves. Such repairs shall be carried out at casting supplier's care only. Repair shall be carried out before any heat treatment of casting is done. Repair welding procedure qualification shall also include impact test and hardness test and shall meet the requirements of clauses 3.4 & 3.6 of this specification, respectively.

4.26 The tolerance on internal diameter and out of roundness at the ends for welded end valves shall be as per applicable connected pipe specification as indicated in Valve Data Sheet.

4.27 When indicated in Material Requisition, valves shall have locking device to lock the valve either in full open (LO) or full close (LC) positions. Locking devices shall be permanently attached to the valve operator and shall not interfere with operation of the valve.

4.28 Valve stem shall be capable of withstanding the maximum operating torque required to operate the valve against the maximum differential pressure corresponding to applicable class rating. The combined stress shall not exceed the maximum allowable stresses specified in ASME Section VIII, Division I. In case of power actuated valves, the valve stem shall be designed for maximum output torque of the selected power actuator (including gear box, if any) at valve stem.

5.0 INSPECTION AND TESTS

5.1 The Manufacturer shall perform all inspection and tests as per the requirements of this specification and the relevant codes, prior to shipment, at his works. Such inspection and tests shall be, but not limited to, the following:

5.1.1 All valves shall be visually inspected. The internal and external surfaces of the valves shall be free from any strikes, gouges and other detrimental defects. The surfaces shall be thoroughly cleaned and free from dirt, rust and scales.

5.1.2 Dimensional check on all valves shall be carried out as per the Purchaser approved drawings.

5.1.3 Chemical composition and mechanical properties shall be checked as per relevant material standards and this specification, for each heat of steel used.

5.1.4 Non-destructive examination of individual valve material and components consisting of, but not limited to castings, forgings, plate and assembly welds shall be carried out by the Manufacturer.

a) Body castings of all valves shall be radiographically examined on 100% of the surface of critical areas as per ASME B16.34. Procedure and acceptance criteria shall be as per ASME B16.34. The extent of radiography shall be as follows:

ANSI Pressure Rating	Valve Size	Extent of Radiography
150 #	All sizes	Nil
300 #	≤ DN 400mm (16") ≥ DN 450mm (18")	Nil 100%
≥ 600 #	All sizes	100%

All castings shall be wet magnetic particle inspected 100% of the internal surfaces. Method and acceptance shall comply with ASME B.16.34.

b) All valves, with body fabricated from plates or made by forgings, shall be ultrasonically examined in accordance with the procedure and acceptance standard of Annexure E of ASME B16.34.

All forgings shall be wet magnetic particle inspected 100% of the internal surfaces. Method and acceptance shall comply with ASME B 16.34

c) Bodies and bonnets made by welded assembly of segments of castings, forgings, plates or combinations thereof shall be examined, as applicable, by methods of clause 5.1.4 a) for cast components or clause 5.1.4 b) for forged components and plates.

5.1.5 Full inspection by radiography shall be carried out on all welds of pressure containing parts. Acceptance criteria shall be as per ASME B 31.4 or ASME B31.8, as applicable, and API 1104.

5.1.6 Welds, which in Purchaser's opinion cannot be inspected by radiographic methods, shall be checked by ultrasonic or magnetic particle methods and acceptance criteria shall be as per ASME Section VIII, Division 1, Appendix 12 and Appendix 6, respectively.

5.1.7 a) All finished wrought weld ends subject to welding in field shall be 100% ultrasonically tested for lamination type defects for a distance of 50mm from the end. Laminations shall not be acceptable.

b) Weld ends of all cast valves subject to welding in field shall be 100% radiographically examined and acceptance criteria shall be as per ASME B16.34.

c) After final machining, all bevel surfaces shall be inspected by dye penetrant or wet magnetic particle methods. All defects longer than 6.35 mm are rejected, as are defects between 6.35 mm and 1.59mm that are separated by a distance less than 50 times their greatest length. Rejectable defects must be removed. Weld repair of bevel surface is not permitted.

5.1.8 All valves shall be tested in compliance with the requirements of API 6D. During pressure testing, valves shall not have sealant lines and other cavities filled with sealant, grease or other foreign material. The drain, vent and sealant lines shall be

either included in the hydrostatic shell test or tested independently. Test pressure shall be held for at least 30 minutes. No leakage is permissible during hydrostatic testing. The body cavity self-relieving feature meeting the requirements of clause 4.8 of this specification shall also be checked.

5.1.9 A supplementary air seat test as per API 6D (Annex B, Clause B.3.3, Type II) shall be carried out for all valves. A bubble tight seal is required without the use of any sealant. No leakage is allowed. Test pressure shall be held for at least 15 minutes.

5.1.10 Manufacturer who intends bidding, must submit at bid stage, certificate and report for successful fire type-tests for valves in accordance with API-607/ BS EN ISO 10497 / API 6FA, as applicable in Valve Data Sheet.

Failure to comply with this requirement shall be a cause of rejection of the Bidder's offer.

5.1.11 Valves shall be subjected to Operational Torque Test as per API 6D (Annex B, Clause B.6) under hydraulic pressure equal to maximum differential pressure corresponding to the valve pressure class rating.

For manual operator of all valves, it shall be established that the force required to operate the valve does not exceed the requirements stated in clause 4.22(c) of this specification.

5.1.12 Power actuated valves shall be tested after assembly of the valve and actuator at the valve Manufacturer's works. At least five Open-Close-Open cycles without internal pressure and five Open-Close-Open cycles with maximum differential pressure shall be performed on the valve actuator assembly. The time for Full Open to Full close shall be recorded during testing. If required, the actuator shall be adjusted to ensure that the opening and closing times are within the limits stated in Actuator Data Sheet issued for the purpose.

Hand operator provided on the actuator shall also be checked after above testing, for satisfactory manual over-ride performance.

These tests shall be conducted on minimum one valve out of a lot of five (5) valves of the same size, rating and the actuator model / type. In case the tests do not meet the requirements, retesting / rejection of the lot shall be decided by Purchaser's Inspector.

5.1.13 Subsequent to successful testing as specified in clause 5.1.11 and 5.1.12 above, one (1) valve out of the total ordered quantity shall be randomly selected by the Purchaser's Representative for cyclic testing as mentioned below :

a) The valve shall be subjected to at least 100 Open-Close-Open cycles with maximum differential pressure corresponding to the valve rating.

b) Subsequent to the above, the valve shall be subjected to hydrostatic test and supplementary air seat test in accordance with clause 5.1.8 and 5.1.9.

In case this valve fails to pass these tests, the valve shall be rejected and two more valves shall be selected randomly and subjected to testing as indicated above. If both valves pass these tests, all valves manufactured for the order (except the valve that failed) shall be deemed acceptable. If either of the two valves fails to pass these tests, all valves shall be rejected or each valve shall be tested at the option of Manufacturer.

Previously carried out test of similar nature shall be considered acceptable if the same has been carried out by Manufacturer in last two years. Valves of two sizes below and two sizes above the size of valve previously tested, and rating similar or one rating lower of valve tested previously, shall be qualified.

5.1.14 Checks shall be carried out to demonstrate that the dissimilar metal used in the valves are successfully insulated as per the requirement of clause 4.17 of this specification.

5.1.15 When indicated in Valve Data Sheet, valves shall be subjected to anti-static testing as per supplementary test requirement of API 6D (Annex B, Clause B.5).

5.2 Purchaser reserves the right to perform stage-wise inspection and witness tests as indicated in clause 5.1 above at Manufacturer's works prior to shipment. Manufacturer shall give reasonable access and facilities required for inspection to the Purchaser's Inspector.

Purchaser reserves the right to require additional testing at any time to confirm or further investigate a suspected fault. The cost incurred shall be to Manufacturer's account.

In no case shall any action of Purchaser or his Inspector relieve the Manufacturer of his responsibility for material, design, quality or operation of valves.

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

6.0 EXTENT OF INSPECTION & TESTING

6.1 Purchaser's Inspector shall perform inspection and witness tests on all valves or as indicated in the Quality Assurance Plan (QAP) attached with this specification.

6.2 The hydrostatic testing and cyclic opening and closing of the valves with the operator shall be witnessed by Purchaser's Inspector.

7.0 TEST CERTIFICATES

7.1 Manufacturer shall submit the following certificates:

a) Mill test certificates relevant to the chemical analysis and mechanical properties of the materials used for valve construction as per the relevant standards.

b) Test certificates of hydrostatic and pneumatic tests complete with records of timing and pressure of each test.

c) Test reports on radiograph and ultrasonic inspection.

d) Test report on operation of valves conforming to clause 5.1.11, 5.1.12 and 5.1.13 of this specification.

e) All other test reports and certificates as required by API 6D and this specification.

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

8.0 PAINTING, MARKING & SHIPMENT

8.1 Valve surface shall be thoroughly cleaned, freed from rust and grease and applied with sufficient coats of corrosion resistant paint. Surface preparation shall be carried out by shot blasting to SP-6 in accordance with "Steel Structures Painting Council – Visual Standard SSPC-VIS-1". For valves to be installed underground, when indicated in Valve Data Sheet, the external surfaces of the buried portion of valves shall be painted with three coats of suitable coal tar epoxy resin with a minimum dry film thickness of 300 microns.

8.2 Manufacturer shall indicate the type of corrosion resistant paint used, in the drawings submitted for approval.

8.3 All valves shall be marked as per API 6D. The units of marking shall be metric except Nominal Diameter which shall be in inches. Marking shall be done by die-stamping on the bonnet or on the housing. However, for buried valves, the marking shall be done on the above ground portion of the stem housing only.

8.4 Valve ends shall be suitably protected to avoid any damage during transit. All threaded and machined surfaces subject to corrosion shall be well protected by a coat of grease or other suitable material. All valves shall be provided with suitable protectors, for flange faces, securely attached to the valves. Bevel ends shall be protected with metallic or high impact plastic bevel protectors.

8.5 All sealant lines and other cavities of the valve shall be filled with sealant before shipment.

8.6 Packaging and shipping instructions shall be as per API 6D.

8.7 On packages, following shall be marked legibly with suitable marking ink :

a) Order Number
b) Manufacturer's Name
c) Valve Size and Rating
d) Tag Number
e) Serial Number

9.0 SPARES & ACCESSORIES

9.1 Manufacturer shall furnish list of recommended spares and accessories for valves required during start-up and commissioning and supply of such spares shall be included in the price quoted by Manufacturer.

9.2 Manufacturer shall furnish list of recommended spares and accessories required for two years of normal operation and maintenance of valves and price for such spares shall be quoted separately.

9.3 Manufacturer shall quote for spares & accessories as per Material Requisition.

10.0 DOCUMENTATION

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

a) General arrangement / assembly drawings showing all features and relative positions and sizes of vents, drains, gear operator / actuator, painting, coating and other external parts together with overall dimensions as well as weights of valve & actuator.

b) Sectional drawing showing major parts with reference numbers and material specification. In particular, a blow-up drawing of ball-seat assembly shall be furnished complying the requirement of clause 4.6 of this specification.

c) Reference list of similar ball valves manufactured and supplied in last five years indicating all relevant details including project, year, client, location, size, rating, service, etc.

d) Torque curves for the power actuated valves along with the break torque and maximum allowable stem torque. In addition, sizing criteria and torque calculations shall also be submitted for power actuated valves.

e) Descriptive technical catalogues of the Manufacturer.

f) Copy of valid API 6D certificate.

g) Details of support foot, including dimensions and distance from valve centre line to bottom of support foot.

h) Quality Assurance Plan enclosed with this tender duly signed, stamped and accepted.

i) List of recommended spares required during start-up and commissioning.

j) List of recommended spares required for 2 years of normal operation and maintenance.

k) Other documents / drawings / data as per Material Requisition.

10.2 Within two weeks of placement of order, the Manufacturer shall submit six copies of, but not limited to, the following drawings, documents and specifications for Purchaser's final approval :

a) Detailed sectional arrangement drawings showing all parts with reference numbers and material specifications as referred to in clause 10.1 above.

b) Assembly drawings with overall dimensions and features. Drawing shall also indicate the number of turns of hand wheel (in case of gear operators) required for operating the valve from full open to full close position and the painting scheme. Complete dimensional details of support foot (where applicable) shall be indicated in these drawings as referred to in clause 10.1 above.

c) Welding, heat treatment and testing procedures.

d) Procedure for cyclic testing.

e) Details of corrosion resistant paint to be applied on the valves.

f) Design calculation for pressure containing parts.

g) Other documents / drawings / data as per Material Requisition.

Manufacture of valves shall commence only after approval of the documents indicated in clause 10.2a) to 10.2c) above. Once approval has been given by Purchaser, any changes in design, material and method of manufacture shall be notified to Purchaser whose approval in writing of all changes shall be obtained before the valve is manufactured.

10.3 Within 2 weeks from the approval date, Manufacturer shall submit to Purchaser six copies of the approved drawings, documents and specifications as listed in clause 10.2 above.

10.4 Prior to shipment, Manufacturer shall submit six hard copies and six soft copies (on CD-ROMs) of the following:

a) Test certificates as per clause 7.0 of this specification.

b) Manual for installation, erection, maintenance and operation instructions, including a list of recommended spares for the valves.

c) Other documents / drawings / data as per Material Requisition.

10.5 All documents shall be in English language.

10.6 **The above documents & data requirements shall also be supplemented by all requirements of clause 2.0 of the Material Requisition.**

11.0 GUARANTEE

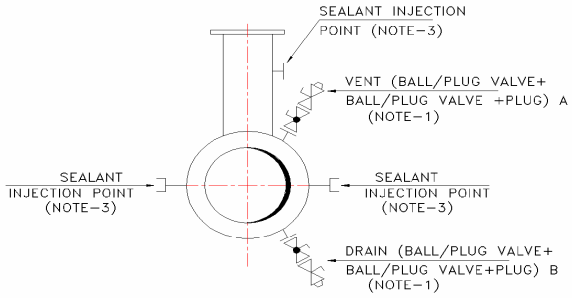
11.1 Manufacturer shall guarantee that the materials and machining of valves and fittings comply with the requirements in this specification and in the Purchase Order.

11.2 Manufacturer is bound to replace or repair all valve parts which should result defective due to inadequate engineering or to the quality of materials and machining.

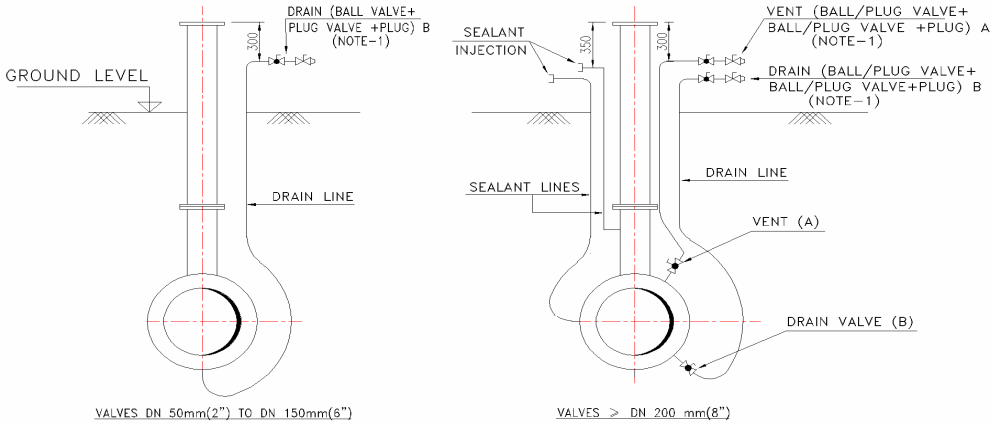
11.3 If valve defect or malfunctioning cannot be eliminated, Manufacturer shall replace the valve without delay,

11.4 Any defect occurring during the period of Guarantee shall be attended to by making all necessary modifications and repair of defective parts free of charge to the Purchaser as per the relevant clause of the bid document.

11.5 All expenses shall be to Manufacturer's account.



ABOVE GROUND INSTALLATION



UNDERGROUND INSTALLATION

SIZES OF VENT & DRAIN CONNECTIONS		
NOM. VALVE SIZE	A, DN(mm)	B, DN(mm)
50 TO 150	–	15
200 TO 600	15	25
750 & ABOVE	15	50 (REFER NOTE-2)

LEGEND:
- BALL VALVE
- PLUG VALVE
- PLUG

NOTES:
1. ALL VALVES (BALL OR PLUG) AND PLUGS FOR A AND B SHALL BE APPROVED BY THE PURCHASER.
2. VALVES OF SIZE 50mm SHALL BE MANUFACTURED AS PER API-6D.
3. SEALANT INJECTION POINTS SHALL BE PROVIDED FOR FULL OPENING VALVES OF NOMINAL VALVE SIZE 200mm (8") & ABOVE AND REDUCED OPENING VALVES OF NOMINAL VALVE SIZE, DN 250mm (10") AND ABOVE ONLY.
3. IN BURIED SECTION, ALL VENT & DRAIN CONNECTION SHALL BE OF WELDED CONSTRUCTION.

FIGURE-1

VENT, DRAIN & SEALANT INJECTION DETAILS

PROCESS & PIPING DESIGN SECTION
MECON LIMITED

DELHI - 110 092

TECHNICAL SPECIFICATION
FOR
PLUG VALVES
(NB ≥ 2")

SPECIFICATION NO.: MEC/TS/05/62/003, Rev-2

CONTENTS

1.0 **SCOPE**

This specification covers the minimum requirements for design, manufacture and supply of carbon steel plug valves of size DN 50mm (2") and above and ANSI Class 150# thru 900# for use in onshore pipeline systems handling non sour hydrocarbons in liquid phase or gaseous phase including Liquefied Petroleum Gas (LPG).

2.0 **REFERENCE DOCUMENTS**

2.1 All valves shall be manufactured and supplied in accordance with the Twenty Second Edition, January, 2002, or the latest edition of American Petroleum Institute (API) Specification 6D, twenty first edition, 1994 including supplement 1 & 2 thereof with additions and modifications as indicated in the following sections of this specification.

2.2 Reference has also been made in this specification to the latest edition of the following Codes, Standards and Specifications :

ASME B 16.5	:	Pipe flanges and flanged fittings
ASME B 16.25	:	Buttwelding ends
ASME B 16.34	:	Valves – Flanged, threaded and welding end
ASME B16.47	:	Large diameter steel flanges
ASME B 31.3	:	Chemical & process plant piping system
ASME B 31.4	:	Liquid transportation systems for hydrocarbons and other liquids
ASME B 31.8	:	Gas transmission and distribution piping systems
ASME Sec.VIII	:	Boiler and pressure vessel code
ASTM A 370	:	Standard test methods and definitions for mechanical testing of steel products
ASTM B 733	:	Autocatalytic nickel phosphorous coating on metals
API 6FA	:	Fire test for valves
API 1104	:	Welding of pipelines and related facilities
BS:6755 (Part-II)	:	Testing of valves – Specification for fire type - testing requirements
MSS-SP-6	:	Standard finishes for contact faces of pipe flanges and connecting-end flanges of valves and fittings

MSS-SP-44 : Steel pipeline flanges

SSPC-VIS-1 : Steel structures painting council-visual standard

2.3 **In case of conflict** between the requirements of this specification, API 6D and the Codes, Standards and Specifications referred in clause 2.2 above, the requirements of this specification shall govern. Order of precedence shall be as follows :

- Data Sheets
- This Specification
- API 6D Specification
- Other Referred Codes & Standards
- Manufacturer's Standard

3.0 MATERIALS & TEST PROCEDURES

3.1 Material for major components of the valves shall be as indicated in Valve Data Sheet. Other components shall be as per Manufacturer's standard which will be subject to approval by Purchaser.

3.2 Carbon steel used for the manufacture of valves shall be fully killed.

3.3 Chemical composition (check analysis) of valve end connection which are subject to further welding by Purchaser shall meet the following requirements for each heat of steel used:

a) Carbon : 0.22% (max.)
b) Manganese : 1.70 % (max.)
c) Silicon : 0.55 % (max.)
d) Phosphorus : 0.030 % (max.)
e) Sulphur : 0.030 % (max.)

Total percentage of Vanadium, Niobium and Titanium shall not exceed 0.20. Residual elements shall not exceed the following limits :

a) Nitrogen : 0.019 %
b) Nickel : 0.30 %
c) Copper : 0.20 %
d) Aluminum : 0.070 %
e) Chromium : 0.15 %
f) Molybdenum : 0.05 %

Carbon equivalent (CE) as calculated by the following shall not exceed 0.45%.

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

3.4 For valves specified for Gas Service or high vapour pressure liquid service, charpy V-Notch test on each heat of base material shall be conducted as per API 6D, for all pressure containing parts such as body, end flanges and welding ends as well as the bolting material for pressure containing parts. Unless specified otherwise in Valve Data Sheets, the Charpy impact test shall be conducted at 0°C. The Charpy impact test specimen shall be taken in the direction of principal grain flow and notched perpendicular to the original surface of plate or forging.

Unless specified otherwise in Valve Data Sheets, the minimum average absorbed energy per set of three specimens shall be 27 J with an individual minimum per specimen of 22 J.

3.5 For valves specified for Gas Service or high vapour pressure liquid service, the hardness of base material of body and principal parts of the valve such as plug, stem, etc., shall not exceed 22 RC.

3.6 Plug for valve size DN 200mm (8") and above or as specified in Valve Data Sheets shall have Electroless Nickel Plating (ENP) or equivalent. The hardness of plating shall be minimum 50 RC. Manufacturer shall ensure that the adhesive strength of plating is sufficient so as to prevent peeling of plating during operation of the valve.

3.7 All process-wetted parts, metallic and non-metallic, shall be suitable for the fluids and service specified by the Purchaser. The service gas composition when applicable shall be as given in Annexure-I.

4.0 DESIGN & CONSTRUCTION

4.1 The Manufacturer shall have a valid license to use API 6D monogram for manufacture of Plug Valves.

4.2 Valve pattern shall be short, regular or venturi as specified in the following table:

Class	Size Range, NB mm (inch)	Pattern
150	50-100 (2-4)	Short
	150-300 (6-12)	Regular
	350 (14) & above	Venturi
300	50-100 (2-4)	Short
	150-250 (6-10)	Regular
	300 (12) & above	Venturi
600	50-250 (2-10)	Regular
	300 (12) & above	Venturi
900	50-250 (2-10)	Regular
	300 (12) & above	Venturi

4.3 Valve shall have an inherent feature using line pressure to ensure that the line pressure cannot cause taper locking of the plug/ plug movement into taper i.e. valves shall be of pressure balanced design.

4.4 Cover shall be bolted to the body and screwed connections are not acceptable.

4.5 Soft seats to achieve a seal between plug and body are not permitted.

4.6 All valves shall have provisions for secondary sealant injection under full line pressure for seat and stem seals. Sealant injection points shall be provided with a ball type check valve or needle valve to replace the sealant injection fitting under full line pressure.

4.7 Valves shall have vent and drain connections as per API 6D.

4.8 When specified in the Valve Data Sheet, valves shall be designed to withstand a sustained internal vacuum of at least one milli-bar in both open and closed position.

4.9 Valve design shall ensure repair of gland packing under full line pressure.

4.10 a) Valve ends shall be either flanged or butt welded or one end flanged and one end butt welded as indicated in Valve Data Sheet. Flanges of the flanged end cast/ forged body valves shall be integrally cast/forged with the body of valve. Face-to-face/ end-to-end dimensions shall conform to API 6D.

b) Flanged end shall have dimensions as per ASME B16.5 for valve sizes upto DN 600mm (24 inches) excluding DN 550mm (22 inches) and as per MSS-SP-44 for valve sizes DN 550mm (22 inches) & for DN 650mm (26 inches) and above. Flange face shall be either raised face or ring joint type as indicated in Valve Data Sheet. Flange face finish shall be serrated or smooth as indicated in Valve Data Sheet. Smooth finish when specified shall be 125 to 200 AARH. In case of RTJ flanges, the groove hardness shall be minimum 140 BHN.

c) Butt weld end preparation shall be as per ASME B16.25. The thickness of the pipe to which the valve has to be welded shall be as indicated in Valve Data Sheet. Valves shall be without transition pups. In case significant difference exists between thickness of welding ends of valve and connecting pipe, the welding ends of valve shall have bevel preparation as per ASME B31.4 or ASME B31.8, as applicable.

4.11 Valves shall be provided with position indicator and stops at the fully open and fully closed positions.

4.12 Valves of size DN 200mm (8”) and above shall be equipped with lifting lugs. Tapped holes and eye bolts shall not be used for lifting lugs.

4.13 Valves shall have locking devices to be locked either in full open or full close position when indicated in the Valve Data Sheets. Locking devices shall be permanently attached to the valve operator and shall not interfere with operation of the valve.

4.14 Valves shall be of fire safe design as per BS:6755 (Part-II)/ API 6FA, if indicated in Valve Data Sheet.

4.15 Valves shall be suitable for either buried or above ground installation as indicated in the Valve Data Sheet.

4.16 Valves with stem extension, when indicated in Valve Data Sheet shall have following provisions :

a) Valves provided with stem extension shall have water proof outer casing. Length of stem extension shall be as indicated in the Valve Data Sheet. The length indicated corresponds to the distance between the centreline of the valve opening and the top of the mounting flange for valve operating device (gear operator/ power actuator as applicable).

b) Vent and drain connections shall be terminated adjacent to the valve operator by means of suitable piping anchored to the valve body. Pipe used shall be API 5L Gr. B/ ASTM A106 Gr. B, with Sch. 160. Fittings shall be ASTM A105/ ASTM A 234 Gr. WPB, Socket Welded, ANSI class 6000.

c) Sealant injection lines shall be extended and terminated adjacent to the valve operator in manner as indicated in (b) above.

d) Stem extension and stem housing design shall be such that the complete assembly will form a rigid unit giving a positive drive under all conditions with no possibility of free movements between valve body stem extension or its operator.

e) Outer casing of stem extension shall have 3/8" or ½" NPT plugs at the top and bottom, for draining and filling with oil to prevent internal corrosion.

4.17 **Operating Devices**

a) Valves shall have a power actuator or manual operator as indicated in the Valve Data Sheet. Manual operated valves of size $\leq$ DN 100mm (4") shall be wrench operated and valves of sizes $\geq$ DN 150mm (6") shall be gear operated. Each wrench operated valve shall be supplied with wrench. Valve design shall be such that damage due to malfunctioning of the operator or its controls will only occur in the operator gear train or power cylinder and damaged parts can be replaced without the bonnet being removed.

b) The power actuator shall be in accordance with the specification issued for the purpose and as indicated in the valve and actuator data sheet. Operating time shall be as indicated in valve data sheet. Valve operating time shall correspond to full close to full open / full open to full close under maximum differential pressure corresponding to the valve rating. For actuated valves, the actuator torque shall be atleast 1.25 times the maximum torque required to operate the valve under maximum differential pressure corresponding to the valve class rating.

c) Operating device shall be designed for easy operation of valve under maximum differential pressure corresponding to the valve rating.

d) For manual operation of all valves, the diameter of the hand wheel or the length of operating lever shall be such that under the maximum differential pressure, the total force required to operate the valve does not exceed 350 N. Manufacturer shall also indicate the number of turns of hand wheel (in case of gear operator), required to operate the valve from full open to full close position.

e) Direction of operation of hand wheel or wrench shall be in clock-wise direction while closing the valve. Hand wheels shall not have protruding spokes.

f) Gear operators, if specified, shall have a self locking provision and shall be fully encased in waterproof/ dustproof/ weatherproof/ splashproof enclosure and shall be filled with suitable grease.

4.18 Repair by welding is not permitted for fabricated and forged body valves. However repair by welding as per ASME B16.34 is permitted for cast body valves. Repair shall be carried out before any heat treatment of casting is done. Repair welding procedure qualification shall also include impact test and hardness test when required as per Clause 3.4 and 3.6 of this specification and shall meet the requirements as specified therein.

4.19 The tolerance on internal diameter and out of roundness at the ends for welded ends valves shall be as per connected pipe specification as indicated in the Valve Data Sheet.

4.20 Valve stem shall be capable of withstanding the maximum operating torque required to operate the valve against the maximum differential pressure corresponding to applicable class rating. The combined stress shall not exceed the maximum allowable stresses specified in ASME section VIII, Division-1.

For Power Actuated Valves, the valve stem shall be designed for maximum output torque of the selected power actuator (including gear box, if any) at the valves stem.

5.0 INSPECTION & TESTS

5.1 The Manufacturer shall perform all inspection and tests as per the requirements of this specification and the relevant codes, prior to shipment at his works. Such inspection and tests shall be, but not limited to, the following :

5.1.1 All valves shall be visually inspected.

5.1.2 Dimensional check shall be carried out as per the Purchaser approved drawings.

5.1.3 Chemical composition and mechanical properties shall be checked as per relevant material standards and this specification, for each heat of steel used.

5.1.4 a) Non-destructive examination of individual valve material and component consisting of but not limited to castings, forgings, plates and assembly welds shall be carried out by the Manufacturer.

b) Valves castings shall be radiographically examined at the cover and body portion, seat location, flanged body ends and circumference of ends to be field welded. Procedure and acceptance criteria shall be as per ASME B16.34. The extent of radiography shall be as follows :

ANSI Class 150-	All Sizes	-	Nil
ANSI Class 300-	≤ DN 400mm (16")	-	Nil
	≥ DN 450mm (18")	-	100%
ANSI Class 600- and above	All Sizes	-	100%

All castings shall be wet magnetic particle inspected 100 % of the internal surfaces. Method and acceptance shall comply with ASME B16.34.

c) Valve forgings shall be examined by ultrasonic method. Inspection procedure and acceptance criteria shall be as per Annexure E of ASME B16.34.

5.1.5 Areas which, in Purchaser's Inspector's opinion, cannot be inspected by radiographic methods shall be checked by ultrasonic or magnetic particle methods and acceptance criteria shall be as per ASME Sec-VIII, Division I, Appendix 12 and Appendix 6 respectively.

5.1.6 a) Weld ends of all cast valves shall be 100% radiographically examined and acceptance criteria shall be as per ASME B16.34.

b) After final machining all bevel surfaces shall be inspected by dye penetrant, or wet magnetic particle methods. Any defects longer than 6.35mm shall be rejected and also defects between 6.35mm and 1.59mm that are separated by a distance less than 50 times their greatest length. Weld repair of bevel surface is not permitted. Rejectable defects must be removed.

c) All finished wrought weld ends subject to welding in the field shall be 100% ultrasonically tested for lamination type defects for a distance of 50mm from the end. Laminations shall not be acceptable.

5.1.7 All valves shall be tested in compliance with the requirements of API 6D. Hydrostatic shell testing shall ensure that the whole of the shell is subjected to the test pressure. If necessary, the empty shell shall be pressure tested prior to assembly of the plug. The drain, vent and sealant lines shall be either included in the hydrostatic shell test or tested independently. No leakage is permissible during hydrostatic testing.

5.1.8 A supplementary air seat test as per API 6D shall be carried out for all valves. No leakage is allowed. Test pressure shall be held for at least 15 minutes.

5.1.9 Manufacturer who intends bidding must submit at bid stage, certificate and report for successful fire safe tests for all types of valves in accordance with BS:6755 (Part-II)/ API 6FA, as applicable in Valve Data Sheet.

Failure to comply with the requirement shall be a cause of rejection of the offer.

5.1.10 Valve shall be subjected to Operational Torque Test as per supplementary test requirement of API 6D under hydraulic pressure equal to the maximum differential pressure corresponding to the valve rating. The maximum handwheel force shall not exceed 350 N.

5.1.11 Power actuated valves shall be tested after assembly at the valve Manufacturer's works. Actuator shall be capable to allow minimum five consecutive "opening" and "closing" cycles. To achieve this, the Manufacturer shall provide "closing" and "opening" operations. This test shall be conducted on one valve out of a lot of five valves of the same size, rating and actuator type. In case the test result dose not meet the requirements, retesting/ rejection of the lot shall be as decided by Purchaser's Inspector.

The actuator shall be adjusted to ensure that opening and closing time is within the limits stated in Actuator Data Sheet issued for the purpose.

The hand operator installed on the actuator shall also be checked after the cyclic testing, for satisfactory manual over-ride performance.

5.2 Purchaser reserves the right to perform stagewise inspection and witness tests as indicated in para 5.1 at Manufacturer's works prior to shipment. Manufacturer shall give reasonable access and facilities required for inspection to Purchaser's Inspector.

Purchaser reserves the right to request additional testing at any time to confirm or further investigate a suspected fault. If the suspected fault is confirmed, the cost incurred shall be to Manufacturer's account.

In no case shall any action of Purchaser or his representative relieve the Manufacturer of his responsibility for material, design, quality or operation of valves.

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

6.0 EXTENT OF INSPECTION & TESTING

6.1 Purchaser's Inspector shall perform inspection and witness test on all valves as indicated in the Quality Assurance Plan (QAP) attached with this specification.

6.2 The hydrostatic testing and cyclic opening and closing of the valves with the operator shall be witnessed by Purchaser's Inspector.

7.0 TEST CERTIFICATES

7.1 Manufacturer shall submit the following certificates :

a) Mill test certificates relevant to the chemical analysis and mechanical properties of the materials used for valve construction as per the relevant standards.

b) Test certificates on hydrostatic and pneumatic test complete with records of timing and pressure of each test.

c) Test reports conforming to clause 5.1.9 of this specification, if applicable.

d) Test reports on radiographic and ultrasonic inspection.

e) Test reports on operation of valves conforming to clause 5.1.10 and 5.1.11 of this specification.

f) All other test reports and certificates as required by API 6D and this specification.

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

8.0 PAINTING, MARKING & SHIPMENT

8.1 Valve surface shall be thoroughly cleaned, freed from rust and grease and applied with sufficient coats of corrosion resistant paint. Surface preparation shall be carried out by shot blasting to SP 6 in accordance with "Steel Structures Painting Council - Visual Standard - SSPC-VIS-1". For the valves to be installed underground, when indicated in Valve Data Sheet, external surfaces of the buried portion of valves shall be painted with three coats of suitable coal tar epoxy resin with a minimum dry film thickness of 300 microns.

8.2 Manufacturer shall indicate the type of corrosion resistant paint used, in the drawings submitted for approval.

8.3 All valves shall be marked as per API 6D. The units of marking shall be metric except Nominal Diameter which shall be in inches. Marking shall be done by die-stamping on the bonnet or on the housing. However for buried valves the marking shall be done on the above ground portion of the stem housing only.

8.4 Valve ends shall be suitably protected to avoid any damage during transit. All threaded and machined surfaces subject to corrosion shall be well protected by a coat of grease or other suitable material. All valves shall be provided with suitable protectors, for flange faces, securely attached to the valves. Bevel ends shall be protected with metallic bevel protectors.

8.5 All sealant lines and other cavities of the valves shall be filled with sealant before shipment.

8.6 Packaging and shipping instructions shall be as per API 6D.

8.7 Packages shall be marked legibly, with suitable marking ink, the following.

a) Order Number
b) Manufacturer's Name
c) Valve Size and Rating
d) Tag Number
e) Serial Number

9.0 SPARES & ACCESSORIES

9.1 Manufacturer shall recommend and quote separately the spares for valves required for commissioning and two years of normal operation. List of such spares without price shall be indicated alongwith technical bid and separately with price.

9.2 Manufacturer shall recommend and quote unit price separately for the accessories (like wrench, sealant injector, etc.), sealant and special tools required for maintenance of valves.

10.0 DOCUMENTATION

10.1 At the time of bidding, the bidder shall submit the following documents :

a) General arrangement/ assembly drawings showing all features and relative positions & sizes of vents, drains, gear box & other external parts together with overall dimensions.

b) Sectional drawing showing major parts with reference numbers and material specification.

c) Reference list of similar plug valves manufactured and supplied in last five years, indicating all relevant details including project, year, client, location, size rating, service, etc.

d) Torque curves for the power actuated valves alongwith break torque and maximum allowable stem torque. In addition, sizing criteria and torque calculations shall also be submitted for power actuated valves.

e) Descriptive technical catalogues of the Manufacturer.

f) Copy of valid API 6D certificate, wherever applicable.

g) Details of support foot, including dimensions and distance from valve centre line to bottom of support foot.

h) Quality Assurance Plan enclosed with this tender duly signed, stamped and accepted.

IMPORTANT

The drawings to be submitted alongwith the bid shall be in total compliance with the requirement of technical specification and data sheets of the valves with no exception & deviation.

10.2 Within two weeks of placement of order, the manufacturer shall submit six copies of, but not limited to, the following drawings, documents and specifications for approval :

a) Design drawings and relevant calculations for pressure containing parts and other principle parts.

b) Detailed sectional arrangement drawing showing all parts with reference numbers and materials specification.

c) Assembly drawings with overall dimensions & clearances required and showing all features. Drawing shall also indicate the numbers of turns of handwheel (in case of gear operator) required for operating the valve from full open to full close position and the painting scheme.

d) Welding, heat treatment, testing and quality control procedures.

e) Details of corrosion resistant paint to be applied on the valves.

f) Design calculation for pressure containing parts.

Manufacture of valves shall commence only after approval of the above documents. Once approval has been given by Purchaser, any change in design, material and method of manufacture shall be notified to the Purchaser, whose approval in writing for all changes shall be obtained before the valves are manufactured.

10.3 Within 30 days from the approval date, Manufacturer shall submit one reproducible and six copies of the approved drawings, documents and specification as listed in clause 10.2 of this specification.

10.4 Prior to shipment, Manufacturer shall submit one reproducible and six copies of following :-

a) Test certificates as listed in clause 7.0 of this specification.
b) Manual for installation, erection instructions, maintenance and operation instructions, including a list of recommended spares for the valves.

10.5 All documents shall be in English Language.

11.0 GUARANTEE

11.1 Manufacturer shall guarantee that the materials and machining of valves and fittings comply with the requirements in this specification and in the Purchase Order.

11.2 Manufacturer is bound to replace or repair all valve parts which should result defective due to inadequate engineering or to the quality of materials and machining.

11.3 If valve defect or malfunctioning cannot be eliminated, Manufacturer shall replace the valve without delay.

11.4 Any defect occurring during the period of Guarantee shall be attended to by making all necessary modifications and repair of defective parts free of charge to the Purchaser as per the relevant clause of the bid document.

11.5 All expenses shall be to Manufacturer's account.

Edition : 1

SPECIFICATION
FOR
INSULATING JOINTS

SPECIFICATION NO.: MEC/TS/05/21/009

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

1.0 SCOPE

This specification cover the basic requirements for design manufacture, testing and supply of carbon steel insulating joints to be installed in onshore pipeline systems handling hydrocarbons in liquid or gaseous phase including Liquefied Petroleum Gas (LPG).

2.0 REFERENCE DOCUMENTS

2.1 Reference has been made in this specification to the latest edition of, the following Codes, Standards and Specifications.

a)	ASME B 31.8	Gas Transmission & Distribution piping System
b)	ASME B 31.4	Liquid transportation systems for hydrocarbons, LPG, Anhydrous Ammonia and Alcohols
c)	ASME B 16.5	Steel Pipe Flanges & Flanged Fittings
d)	ASTM A 370	Mechanical testing of Steel Product
e)	ANSI B 16.25	Butt Welding Ends
f)	ASME Section	Boiler & pressure Vessel Code viii & ix
g)	API 1104	Standard for welding pipelines and Related facilities.
h)	SSPC-VIS-1	Steel Structures painting Council Visual Standard.
i)	MSS-SP-53	Quality standard for steel castings and forgings for valves flanges and fittings and other piping components - magnetic particle examination method.
j)	MSS-SP-75	Specification for high test wrought welding fittings.
k)	NACE RP 0286	The electrical isolation of cathodically protected pipelines.

2.2 In case of conflict between the requirements of this specification and any code, Standard and Specification referred in Clause 2.1 above. Order of precedence shall be as follows :

- Data Sheets
- This Specification
- Other Referred Codes & Standards
- Manufacturer's Standard.

3.0 MATERIALS

3.1 Material for the pressure containing parts of the insulating joints shall be as indicated in the data sheets. Material for pups shall be equivalent or superior to the material of connecting pipeline which is indicated in the data sheets. Other part shall be as per manufacturer's standard suitable for the service condition indicated in Insulating Joint Data Sheets and shall be subject to approval by purchaser.

All process-wetted parts, metallic & non-metallic shall be suitable for the commissioning fluids & service specified by the purchaser. Manufacturer shall confirm that all wetted parts are suitable for treated water/seawater environment, which may be used during field testing.

3.2 Insulating joints which are subject to field welding by purchaser, shall have carbon equivalent (CE) not exceeding 0.45 based on check analysis for each heat of steel calculated according to the following formula :

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

3.3 When specified in the IJ Data Sheet, charpy V-notch test shall be conducted on each heat of base material, weld metal and heat affected zone of all pressure containing parts such as body, welding ends in accordance with the impact test provisions of ASTM A 370 at a temperature of 0° C. The charpy impact test specimens shall be taken in the direction of principal grain flow and notched perpendicular to the original surface of the plate of forging. Average impact energy value of three full sized specimens shall be 27 joules. Minimum impact energy value of any one specimen shall not be less than 80% of the average impact energy specified. No specimen shall exhibit less than 80% shear area.

When Low Temperature Carbon Steel (LCTS) materials are specified in Datasheet or offered by Manufacturer, the Charpy V-notch test requirements of applicable material standard shall be complied with.

3.4 Carbon steel used for the manufacture shall be fully killed

3.5 When specified in data sheet, hardness test shall be carried out as per ASTM A370 for each heat of steel used. The maximum hardness of base metal, weld metal and heat affected zone of all pressure parts shall be 248 HV_{10}, unless specified otherwise.

3.6 Insulation material shall be minimum 20 mm thick and shall comply section 5, NACE RP 0286.

4.0 DESIGN & CONSTRUCTION REQUIREMENTS

4.1 Mechanical

4.1.1 Insulating joints shall be of integral type fabricated by welding and with pups on either

side as shown in data sheet. A corrosion allowance as indicated in data sheet shall be considered in design. Bolted and threaded joints are not acceptable. Insulating Joints of design, not having closing welds, are not acceptable.

4.1.2 All materials used for the manufacture of the insulating joint shall be in accordance with clause 3.0 of this Specification.

4.1.3 Insulating joints shall be designed using the design principles of ASME Section-VIII Div. 1. The design shall be checked for the following two cases:

Case-I : Design Pressure (as per Data Sheet) + Axial Force (F)

The Axial force shall be calculated as under :

$F = 0.1 \times S \times A$

Where

S = SMYS of connected pipe (refer Data Sheet)
A = Metal cross-sectional area of connected pipe.

The allowable stress in this case shall be less than or equal to 0.5 x SMYS of insulating joint material.

Case-II : Hydrostatic Test Pressure

The allowable stress in this case shall be less than or equal to 95% of SMYS of insulating joint material.

All design parameters shall be as per Insulating Joint Data Sheet. Detailed calculations shall be submitted for Purchaser's approval.

4.1.4 Insulating joint design and materials shall be capable of being vacuum tested to 1 millibar.

4.1.5 The joint between pipe pup pieces and main forging shall be full penetration butt weld type. Weld design shall be such as resulting in a weld joint factor of 1.0.

4.1.6 Butt weld ends shall have ends as per ASME B16.25. However, end preparation for butt welding ends having unequal thickness with respect to connecting pipe, shall be as per ASME B31.4/ B31.8 as applicable.

4.1.7 The reinforcement of inside weld seam, in case pups fabricated from LSAW pipes, shall be removed for a distance of at least 50mm from each end.

4.1.8 Insulating joints shall allow free passage of scraper/ instrumented pigs. The internal bore shall be same as that of connecting pipe including its tolerances.

4.1.9 The insulating joint shall be formed by sandwiching and locking in positions the insulating material in a bell and spigot type of joint. The joint shall be assembled in such a way that its various components are firmly locked in position and the completed joint is capable of withstanding stresses due to designed operating conditions and field hydrostatic testing.

4.1.10 Insulating joints shall be suitable for aboveground or underground installations as indicated in the data sheets.

4.1.11 All welds shall be made by welders and welding procedures qualified in accordance with the provisions ASME section IX. The procedure qualification shall include impact test and hardness test and shall meet the requirements of clause 3.3, 3.5 of this specification.

4.1.12 Repair welding on parent metal is not allowed. Repair of welds shall be carried out only after specific approval by purchaser's representative for each repair. The repair welding shall be carried out by welders and welding procedures duly qualified as per ASME section IX and records for each repair shall be maintained. Repair welding procedure qualification shall also include impact test & hardness test when required as per Cl. No. 3.3 & 3.5 of this specification & shall meet the requirements as specified therein.

4.1.13 The Tolerance on Internal diameter at the welding end shall be as per applicable connected pipe specification as indicated in the datasheet.

4.1.14 Out of roundness measured at the root face of the welding ends shall not be more than 0.5% of the specified inside diameter.

4.2 **Electrical**

4.2.1 The average dielectric strength of the insulating joint shall be minimum 15 kilo Volts.

4.2.2 Two cleats as shown in data sheet shall be provided on the pups on either side of the insulating joint for connecting 10 mm^2 and 50 mm^2 cables for measurement/ shorting purposes. Cleats shall be attached to the insulating joint by welding.

5.0 INSPECTION AND TESTS

5.1 The manufacturer shall perform all inspection and tests as per the requirements of this specification and the relevant codes, prior to shipment at his works. Such inspection and tests shall be, but not limited to the following:

5.1.1 All insulating joints shall be visually inspected. The internal & external surfaces shall be free from any strikes, gauges & other detrimental & defects. The surfaces shall be thoroughly cleared & free from dirt, rust & scales.

5.1.2 Dimensional checks shall be carried out as per the purchaser approved drawings.

5.1.3 Chemical composition and mechanical properties including hardness shall be checked as per relevant material standards and this specification, for each heat of steel used.

5.1.4 Non-destructive inspection of insulating joints shall be carried out as given below:

a) 100% radiography shall be carried out on all butt & repair welds of pressure containing parts. Acceptance limits shall be as per API 1104.
Welds, which in purchaser's Representative opinion cannot be inspected by radiographic methods, shall be checked by ultrasonic or magnetic particle methods. Acceptance criteria shall be as per ASME Section VIII Appendix-12 and Appendix-6 respectively.

b) All finished weld ends shall be 100% ultrasonically tested for lamination type defects for a distance of 5Omm from the ends. Any lamination larger than 6.35 mm shall not be acceptable.

c) All forgings shall be wet magnetic particle inspected on 100% of forged surfaces. Method and acceptance shall comply MSS-SP-53.

d) All fillet weld of thickness < 6mm shall be examined 100% by magnetic particle inspection and ≥ 6mm shall be examined 100% by UT. Acceptance criteria for MPI & UT shall be as per ASME Sec.VIII Appendix-6 & Appendix-12 respectively.

5.1.5 Insulating joint shall be hydrostatically tested to a pressure as indicated in data sheet. The test duration shall be of 15 minutes.

5.1.6 After the hydrostatic test insulating joints shall be tested with air at 5 kg/cm^2 for 10 minutes. The tightness shall be checked by immersion or with a frothing agent. No leakage will be accepted.

5.1.7 **Dielectric Test**

a) Insulation resistance of each insulating joint shall be atleast 25 mega-ohms when checked with 500-1000 V DC.

b) Insulating joint before and after the hydrostatic test, shall be tested for dielectric integrity for one minute at 5000 V A.C., 50 cycles and the leakage current before and after hydrostatic test shall be equal. Testing time voltage and leakage shall be recorded and certified. No repair shall be permitted to the insulating joints failed in the above-mentioned tests.

5.2 Purchaser reserves the right to perform stage wise inspection and witness test as indicated in Para 5.1 at Manufacturer's works prior to shipment. Manufacturer shall give reasonable notice of time and shall provide without charge reasonable access and

facilities required for inspection to the purchaser's Representative.

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

6.0 TEST CERTIFICATES

6.1 Manufacturer shall submit following certificates to Purchaser's Representative.

a) Test certificates relevant to the chemical analysis and mechanical properties including hardness of the materials used for construction of insulating joint as per this specification and relevant standards.
b) Test reports on non-destructive testing.
c) Test certificates for hydrostatic and air tests.
d) Test certificate for electrical test.
e) Test report on vacuum test.

7.0 PAINTING, MARKING AND SHIPMENT.

7.1 Insulating joint surface shall be thoroughly cleaned, freed from rust and grease and applied with sufficient coats of corrosion resistant paint. Surface preparation shall be carried out by shot blasting to SP-6 in accordance with "steel structures painting council - Visual standard SSPC-VIS-I.". External surfaces of burried insulating joints shall be painted with three coats of suitable coal tar epoxy resin with a minimum dry film thickness of 300 microns.

Manufacturer shall indicate the type of corrosion resistant paint used, in the drawings submitted for approval.

7.2 Insulating joints shall be marked with indelible paint with the following data:-

a. Manufacturer's name
b. Suitable for _____ inch nominal diameter pipeline
c. End thickness in mm
d. Material
e. Design Pressure/ Hydrostatic Test Pressure
f. ANSI Class Rating
g. Tag No.
h. Year of Manufacture

7.3 Insulating joints shall be suitably protected to avoid any damage during transit. Metallic or high-impact plastic bevel protectors shall be provided to weld ends.

7.4 Only those insulating joints which have been inspected and certified by Purchaser shall be shipped.

8.0 **GUARANTEE**

8.1 The manufacturer shall guarantee that the materials used comply with the requirements of this specification.

8.2 Manufacturer shall replace or repair insulating joints found defective due to inadequate engineering or quality of material.

8.3 Manufacturer shall replace the insulating joint without delay if the defect or malfunctioning can not be eliminated.

8.4 Any defects occurring within 12 months from the date of installation or within 30 months from the date of despatch, whichever is earlier, shall be repaired making all necessary modifications and repair of defective parts free of charge to the purchaser.

9.0 **DOCUMENTATION**

9.1 All documents shall be in English Language.

9.2 At the time of bidding, Bidder shall submit the following documents:-

a) General arrangement drawing along with cross sectional view, overall dimensions and details of insulating materials recommended.
b) Reference lists of previous supplies of insulating joint of similar specification.
c) Clause wise list of deviation from this specification, if any.

9.3 Within three weeks of placement of order, the Manufacturer shall submit four copies of but not limited to the following drawings, documents and specifications for approval.

a) Fabrication drawings and relevant calculations for pressure containing parts.
b) Welding procedure and method of manufacture for all phases of manufacture.
c) Quality Control Manual & Quality Control Plan.

Once the approval has been given by purchaser any changes in design, material and method of manufacture shall be notified to the Purchaser whose approval in writing of all changes shall be obtained before the insulting joint are manufactured.

9.4 Within four weeks from the approval date Manufacturer shall submit one reproducible and six copies of the approved drawings, documents and specifications as listed in 9.3 of this specification.

9.5 Prior to shipment, the manufacturer shall submit one reproducible and six copies of the test certificates as listed in Clause 6.0 of this specification.

TECHNICAL / STANDARD SPECIFICATION

FOR

CIVIL & STRUCTURAL WORKS

SPECIFICATION
FOR
CIVIL WORKS - TERMINALS

SPECIFICATION NO. MEC/S/05/11/01

(CIVIL ENGINEERING SECTION)
MECON LIMITED
DELHI - 110 092

I N D E X

PART - I

MATERIALS

CONTENTS

1.0 GENERAL

1.1 Scope

This part deals with the requirements of materials for use in permanent work with regard to quality, testing, approval and storage, before they are used on work. This part is supplementary to Part-II: Workmanship and Other Parts of the Technical Specifications for civil works.

1.2 Standard

A high standard of quality is required for all materials used in permanent work. They shall be the best of the kind obtainable indigenously in each case and shall be procured from manufacturers of repute in order to ensure uniformity of quality and assurance of timely supply.

1.3 Approval and Tests

1.3.1 All materials to be used in permanent construction shall be subject to approval of the Engineer. The Contractor shall apply sufficiently in advance with samples of the materials including the supporting test results from the approved laboratory and other documentary evidence from the manufacturer wherever applicable and indicating the types of materials and their respective sources. The delivery of materials at site shall commence only after the approval of the quality, grading and sources of the materials.

1.3.2 The quality of all materials once approved shall be maintained throughout the period of construction and periodical tests shall be carried out to ensure that it is maintained. Such routine tests shall be listed under the different materials and/or as may be ordered by the Engineer from time to time.

1.3.3 Where a particulars "Brand" or "Make" of material is specified in the Schedule of Items or Technical Specifications, such "Brand" or Make" of material alone shall be used on the work. Should it become necessary for any reason such as non-availability, to use any material other than the specified "Brand" or "Make", the Contractor shall submit sample of the same to the Engineer for approval together with test certificates and other documents necessary for examining and giving approval thereof. Should such change or substitution of material subsequently approved result in use of material of price lower than that of the material specified in the Schedule of Items or Technical Specifications, the rates for the appropriate items of work affected by the substitution shall be proportionately reduced. In case the substitution results in use of material of price higher than that specified in the Schedule of Items or Technical Specifications, no upward revision of the rates will be allowed.

1.4 Codes

1.4.1 Unless mentioned otherwise, current versions of all codes, specifications and standards issued by the Indian Standards Institution and Indian Roads Congress shall be fully applicable to these specifications. In the absence of appropriate publication by ISI or IRC, adaptable specification of the International Organization for Standardization shall apply.

1.4.2 In case of any conflict in meaning between these specifications and those of ISI or IRC, the provisions of these specifications shall prevail.

1.5 Rejection of Materials

1.5.1 Any material brought to site which, in the opinion of the Engineer is damaged, contaminated, deteriorated or does not comply with the requirement of this specification, shall be rejected.

1.5.2 If the routine site tests or random site tests show that any of the materials, brought to site, do not comply in any way with the requirements of this specification, then that material shall be rejected.

1.5.3 The Contractor shall remove from site any and all such rejected material within the time specified by the Engineer.

2.0 MATERIALS FOR CONCRETE

2.1 Aggregates

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

2.1.2 Testing

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

2.1.3 Grading

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

2.1.3.1 Size and grading of fine aggregates

The grading shall conform to IS: 383 and shall be within the limits of Grading Zone-III. The maximum size of particle shall be 4.75mm and shall be graded down. Sand containing more than 10% of fine grains passing through 76 mesh sieve or having the fineness modulus less than 2 shall not be used for concrete work.

2.1.3.2 Size and grading of coarse aggregates

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

2.1.3.3 Fine aggregate for mortar and grout

The grading of fine aggregate for mortar and grout shall be within the limits of grading zone III and IV as defined in IS: 383.

2.1.4 Storage & stacking

Care shall be taken in the storage to avoid intrusion of any foreign materials into the aggregates and where two types of aggregates are stored close to each other, they shall be separated by a wall or plate. When stock piling care shall be taken to avoid forming pyramids resulting in segregation of different sized materials. The height of the stacks shall be generally limited to 150 cm.

2.2 Coarse Aggregates

2.2.1 Types

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

2.2.2 Stone chips

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

2.2.3 Gravel

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

2.2.4 Broken bricks

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

2.3 Fine Aggregates

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

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

2.3.3 Crusher dust

Crusher stone dust that is retained on 300 micron sieve may be used as replacement for certain quantum of sand aiming to improve the fineness modulus of fine aggregate. The quantum of replacement for sand shall be arrived at by suitable trial mixes. The Engineer will decide the final usage of crusher dust having regard to the circumstances.

2.4 Lime

Lime for mortars and concrete shall conform to IS: 712. The total of CaO and Mgo content in quick lime shall not be less than 85% (MgO shall not exceed 5%). Quicklime, after slaking, shall leave a residue of not more than 5% by weight on IS sieve 85.

2.5 Surkhi

Surkhi used in lime concrete for flooring, terracing etc., shall conform to IS: 1344.

2.6 Cement

Ordinary Portland cement complying with the requirements of IS:8112 shall be used for making plain and reinforced concrete. cement grout and mortar.

Other types of cement may be used depending upon the requirements of certain jobs with the approval of the Engineer. These shall conform to the following standards:-

Portland Pozzolana Cement	IS:1489
Rapid Hardening Portland Cement	IS:8041
53 Grade Ordinary Portland Cement	IS:12269
Hydrophobic Portland Cement	IS:8043
Sulphate Resisting Portland Cement	IS:12330

2.6.1 Testing of samples

The Contractor shall supply a copy of the manufacturer's test certificate for each consignment of cement supplied by him and consignments shall be used on work in the order of delivery. The Contractor shall supply samples of cement to the Engineer as frequently as he may require for testing. The sampling of cement for testing shall be

according to IS: 3535. All tests shall be in accordance with the relevant clauses of IS: 4031 & IS: 4032.

2.6.2 Contractor's responsibility

From the time that a consignment of cement is delivered at site and tested and approved by the Engineer until such time as the cement is used on the works, the Contractor shall be responsible for keeping the same in sound and acceptable condition. Any cement which deteriorates while in the Contractor's charge and is rejected as unsuitable by the Engineer, shall be removed from the site and outside the limits of work within two days of ordering such removal by the Engineer.

2.6.3 Stock of cement

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

2.6.4 Storage of cement

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

2.7 Water

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

2.8 Admixture for Concrete

2.8.1 Approval

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

2.8.2 Usage

2.8.2.1 Admixtures may be used to modify one or more of the following properties of FRESH CONCRETE.

a) To increase workability without increasing water content or to decrease the water content at the same workability.

b) To retard or accelerate both initial and final setting times.

c) To reduce or prevent settlement.

d) To create slight expansion in concrete and mortar.

e) To modify the rate or capacity for bleeding or both.

f) To reduce segregation of concrete, mortars and grouts.

g) To improve penetration and or pumpability of concrete, mortars and grouts.

h) To reduce rate of slump loss.

2.8.2.2 Admixtures may also be used to modify one or more of the following properties of HARDENED CONCRETE.

a) To retard or reduce heat generation during early hardening.

b) To accelerate the rate of strength development.

c) To increase the strength of concrete or mortar (Compressive, tensile or flexural).

d) To increase the durability or resistance to severe conditions of exposure including the application de-icing salts.

e) To decrease the capillary flow of water.

f) To decrease the permeability to liquids.

g) To control the expansion caused by the reaction of alkalis with certain aggregate constituents.

h) To produce cellular concrete.

i) To increase the bond of concrete to steel reinforcement.

j) To increase the bond between old and new concrete.

k) To improve impact resistance and abrasion resistance.

l) To inhibit the corrosion of embedded metal.

m) To produce coloured concrete or mortar.

While modifying any particular property, care shall be taken to ensure that other properties are not affected adversely.

2.8.3 Types

2.8.3.1 Integral water proofer

Admixtures used as integral water proofer shall be free of chlorides and sulphates and shall conform to IS: 2645. The application and dozes shall be as per manufacturer's specification.

2.8.3.2 Finely Divided mineral admixtures

1) CEMENTITIOUS - Natural cements like hydraulic lime, slag cements (mixtures of blast furnace slag and lime) and granulated blast furnace slag.

2) POZZOLANIC - A siliceous or siliceous and aluminium material which in itself possesses little or no cementitious value, but will in finely divided form and in presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties, e.g. Fly ashes, volcanic glass, diatomaceous earth and certain shales and clays either heat treated or natural.

3) OTHER - Finely divided quartz, silica sands dolomite and calcite limestone, marble, granite and other rocks, asbestos waste hydrated lime.

These being extremely fine powders, their mineral admixtures will influence the fresh paste in a manner similar to cement. They can be used to augment the cement in mixtures deficient in fines. Many concrete contain large amount of portland cement than necessary for strength requirements to provide workability or pumpability. A portion or all of this excess cement may be replaced with a suitable mineral admixture. They are usually used in the proportion of 15-35% by weight of the cement and in proportioning the concrete should be considered as part of the cementing medium, provided they are uniformly blended with cement.

The placeability of concrete containing blast furnace slag is generally greater than indicated by static slump test or water/cement ratio. In medium or rich concrete, the increase in water requirements caused by their use may reduce strength. Pozzolanic admixtures usually increases the strength of concrete especially at later ages. The addition of fly-ash, natural pozzolana and granulated slag in sufficient quantities will increase the sulphate resistance of concrete.

2.8.3.3 Accelerating admixtures

1) Calcium Chlorides will also affect the following properties;

   a) may increase drying, shrinkage and creep. The longer the concrete is allowed to cure, the less will be the effect on shrinkage and creep.

   b) may lower the resistance of concrete to freezing and thawing and to attack by sulphates and other injurious solutions.

   c) may increase the rate of temperature residue to the heat of hydration and in large sections may therefore increase the stresses caused by thermal contraction.

d) can cause corrosion of adequately embedded reinforcing steel in the concrete. Where large concentrations of stray currents are present, such as in concrete used in structures for electric railroads, power houses or electrolytic reduction plants.

e) galvanized metal embedded in concrete containing calcium chloride may be expected to corrode at an accelerated rate.

f) combinations of metals such as aluminium alloy, conduit and steel reinforcing should not be used in concrete containing calcium chloride as electrolytic corrosion may take place.

For allowable limits of calcium chloride refer ACI Committee 201.

Calcium Chloride will not increase the flexural strength of concrete to the same degree as the compressive strength and decreases in the flexural strength are generally obtained at or after 28 days. The total chloride content in the concrete should be limited as specified in IS: 456.

2) Calcium aluminate cement blended with portland cement:

Strength will be reduced significantly, shrinkage and swelling on immersion will increase drastically and durability will be poor.

2.8.3.4 Air-entraining admixture

a) The water reduction is possible due to entrained air. The volume of this water reduction is less than the volume of entrained air, therefore to compensate for the volume of entrained air, the fine aggregate volume must also be reduced.

b) Despite reduction in the water/cement ratio usually obtained by the use of air-entrainers, it may reduce strength, particularly, in concretes of high or moderate cement content.

2.8.3.5 Water reducing and set controlling admixtures

a) Admixtures of the hydroxylated carboxylic acid type may tend to increase the bleeding rate and segregation in concrete deficient in fines (aggregate fines of cement).

b) When prolonged retardation is employed care must be taken to prevent the drying of the concrete.

c) The water reducing admixture should be added at the same time in the mixing cycle, in order to obtain a uniform setting time among the batches.

d) Then admixtures in many cases will increase the slump loss.

e) Increases in the flexural strength of concrete containing water reducing admixtures are usually attained but they are not proportionately as great as the increase in the compressive strength.

2.8.4 General

2.8.4.1 Suitable remedial measures as recommended by the manufacturers and approved by the Engineer shall be taken to eliminate any disadvantages arising from the mix of admixtures.

2.8.4.2 While using the admixtures the maximum amount of chloride and sulphate expressed either in percentage of cement or concrete shall not exceed the limit as specified in the relevant I.S. codes.

2.9 Interval of Routine Test

2.9.1 The routine tests of materials, delivered at site, shall be at the following intervals :

Aggregates	-	Fortnightly or for every 200 m3 for each aggregate whichever is earlier.
Cement	-	Fortnightly or for each consignment, with-in 4 days of delivery.
Water	-	Once in two months for each source of supply.
Reinforcement	-	For each consignment within 4 days of delivery.

3.0 <u>STEEL</u>

3.1 For Reinforcement

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

i) Plain mild steel bars conforming to Grade-I of IS:432 "Mild Steel and Medium Tensile Steel and Hard Drawn Steel wire for Concrete Reinforcement:".

ii) Deformed mild steel bars conforming to IS:1139 "Hot Rolled Mild Steel, Medium Tensile Steel and High Yield Strength Steel Deformed Bars for Concrete Reinforcement".

iii) High Yield strength deformed bars conforming to IS:1786 "Cold Worked Steel High Strength Deformed Bars for Concrete Reinforcement".

iv) Reinforcement fabrics conforming to IS: 1566 "Hard Drawn Steel Wire Fabric for Concrete Reinforcement.

All reinforcement bars shall be of uniform cross sectional area and be free from loose mill scales, dust, loose rust, coats of paint, oil or other coatings which may destroy or reduce bond. Unit weight of reinforcement bars shall be according to IS:1786-1985.

3.2 For binding works

Binding wire for reinforcement shall be annealed steel wire 18-20 BWG or not less than 0.9 mm diameter conforming to z IS:280 - "Specification for Mild Steel Wire".

3.3 For light structural work and inserts

Steel for light structural work and for preparation of inserts and embedments shall conform to IS: 2062-1992 - "Steel for general structural purposes - Specifications".

3.4 Steel Tubes

Steel tubes for use in light structural work and inserts shall be of light or medium class (as may be specified on drawings or the schedule of items) and of grade YST 25 conforming to IS:1161 - "Specification for Steel Tubes for Structural Purposes".

3.5 Foundation Bolts

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

3.5.2 Nuts and locknuts shall conform to IS: 1363 - "Specification for Black Hexagon Bolts, Nuts and Lock Nuts (diameter 6-39 mm) and Black Hexagon Screws (diameter 6 - 24 mm)" and to IS: 3138 - "Specification for Hexagon Bolts and Nuts (M-42 to M-150)".

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

3.6 Steel Tubes for Non-structural Use

3.6.1 Steel tubes for non-structural use shall conform to IS: 1239 (Part-I) "Specification for Mild Steel Tubes, Tubular and Other Wrought Steel fittings, Part-I : Mild Steel Tubes".

3.6.2 Fittings for steel tubes used for non structural purposes shall conform to IS: 1239 (Part-II) "Specification for Mild Steel Tubular and Other Wrought Steel Pipe Fittings".

3.7 Threaded Fasteners

Bolts and nuts for fastening shall conform to IS: 1367 - "Technical Supply Conditions for Threaded Fasteners".

3.8 Testing

Test certificates from manufacturer shall be submitted for each consignment. Any additional test which the Engineer may require shall be done according to the relevant IS.

3.9 Cast Steel

3.9.1 Quality

Cast steel shall conform to IS: 1030 "Cast Steel for General Engineering Purpose". Unless otherwise specified, it shall conform to Grade-2.

3.10 Conduits

3.10.1 Steel for electrical wiring

Rigid steel conduits for electrical use shall conform to IS: 1653 for rigid pipes and to IS: 3480 for flexible conduits. Fittings for conduits shall conform to IS: 2667.

All conduit pipes shall be finished with galvanized or stove-enameled surface. All accessories shall be of threaded type and pipes shall be jointed by means of screwed couplers only. Bend in conduits shall be made to the dimension shown in drawing, but a minimum of 12 times the diameter. Where shown in drawing they shall be treated with anticorrosive preservative as specified.

3.10.2 Non-metallic for electrical wiring

Non-metallic conduits for electrical use shall conform to IS:2509 for rigid pipes and to IS: 6946 for flexible pipes. Fittings shall conform to IS: 3419.

Bends shall be achieved by bending the pipe by inserting suitable solid or inspection type normal bends, elbows or similar fittings.

4.0 ASBESTOS CEMENT PRODUCTS

4.1 General

Asbestos cement products shall be free from visible defects, uniform in colour, of required density, length, thickness and diameter within the allowable tolerance. They shall be obtained from an approved source of manufacture and stored safely. Methods of test shall be according to IS: 5913 - 'Method of Test for Asbestos Cement Products".

4.2 Building Boards

Building boards shall conform to IS:2098 - "Asbestos Cement Building Boards". They shall, when tested in two perpendicular directions, take a lead of not less than 15 kg for Class-A and 10 kg for Class-B boards. The boards shall show water absorption of not more than 40% of their dry weight.

4.3 Flat Sheets

Flat sheets shall conform to IS: 2096 - "Asbestos Cement Flat Sheets". They shall have a bending stress of not less than 225 kg/cm2 and a density of 1.6 kg/cm3 for compressed sheets and a bending stress of not less than 160 kg/cm2 and a density of 1.2 kg/cm3 for uncompressed sheets.

4.4 Pipes and fittings

Pressure pipes shall conform to IS: 1592 - "Asbestos Cement Pressure Pipes and to IS: 9627 - "Asbestos Cement Pressure Pipes (Light Duty)". Pipes for sewerage and drainage shall conform to IS: 6908 - "Asbestos Cement Pipes and Fittings for Sewerage and Drainage". Building pipes gutters and fittings shall conform to IS: 1626 - "Asbestos Cement Building Pipes and Pipe Fittings".

Pressure pipes shall satisfy hydraulic testing test and transverse crushing test as per IS.

4.5 Corrugated and Semi-Corrugated Sheets and Specials

These shall conform to IS: 459 - "Unreinforced Corrugated and Semi-Corrugated Asbestos Cement Sheets". Unless otherwise stated the sheets shall be corrugated and not less than 6mm thick. The sheets shall have a lead bearing capacity of not less than 5 N/mm width of specimen and shall not absorb more water than 28% of its dry weight.

5.0 BRICKS

5.1 Bricks

Bricks for masonry in foundations, walls and other locations shall be common burnt clay building bricks having minimum crushing strength of 50 kg/cm2, or such other strength as may be described in the Schedule of Items, when tested in accordance with IS: 1077 - "Common Burnt Clay Building Bricks". They shall be sound, hard and thoroughly well burnt, but not over-burnt, with uniform size having rectangular, faces with parallel sides and sharp straight right angled edges and be of uniform colour with fine compact uniform texture. Bricks shall be of uniform deep red cherry or copper colour. They shall be free from flaws, cracks and nodules of free lime. Water absorption after 24 hours immersion in cold water shall be not more than 20% by weight. They shall not absorb more than 10% by weight of water after immersion for six hours. They shall emit a clear metallic ringing sound when struck by a mallet and shall not break when dropped on their face, from a height of 60 cm. Fractured surface shall show homogenous, fine grained uniform texture, free from cracks, air holes, laminations, grits, lumps of lime, efflorescence or any other defect which may impair their strength, durability, appearance and usefulness for the purpose intended. Under-burnt or vitrified bricks shall not be used. Samples of bricks brought to the site shall be tested periodically for compression and other tests according to IS: 3495, Parts-I, II & III - "Method of Test for Burnt Clay Building Bricks". Where the size of bricks is not specifically mentioned , it shall be taken to mean conventional sizes as is commonly available in the area. The bricks shall be classified on the basis of average compressive strength as given in table – I of IS:1077-1992.

5.2 Handling

Bricks shall be unloaded by hand and carefully stacked and all broken bricks shall be removed from the site.

5.3 Samples and Inspection

Representative samples shall be submitted by the Contractor and approved samples retained by the Engineer for comparison and future reference. Bricks shall be obtained from approved manufacturer. All bricks shall be subject to inspection on the site and approval of the Engineer who may reject such consignments as are considered by him to be inferior to the quality specified. The Contractor shall provide all labour and plant required for the inspection and conduct such test as shall be required by the Engineer with out additional charges.

5.4 Brick Bats

Brick bats shall be obtained from well burnt bricks.

5.5 Exposed Bricks

5.5.1 Facing Bricks

The facing bricks made from suitable soils shall be free from cracks, flaws, nodules of free lime warpage and organic matter. These shall be thoroughly burnt and shall have plane rectangular faces with parallel sides and sharp straight right angled edges. Facing bricks shall have uniform colour and even texture. Unless otherwise specified, facing bricks shall be machine moulded. Selected hand moulded bricks may also be used as facing bricks where specified. As far as possible, total requirement of facing bricks for a work shall be arranged from the same kiln. Bricks with chipped edges and broken corners shall not be used.

5.5.2 Dimensions and Tolerances

The standard sizes of machine moulded facing bricks shall be as specified.

5.5.3 The permissible tolerances shall be as under :

	Dimensions Mm	Tolerance (For Machine moulded bricks) mm
Length	190 or 225	± 3
Width	90 or 111	± 1.5
Thickness	40 or 44	± 1.5

Note: Tolerance and Dimensions for selected hand moulded bricks ± 4mm in length and ± 3mm in width and thickness).

5.6 Laterite Stone Blocks

These shall conform to IS : 3620 - "Laterite Stone Blocks for Masonry". The laterite stone blocks shall have a minimum crushing strength of 20 kg/cm2. The blocks shall be minimum 15 cm thick and not exceeding 30 cm thick. They shall be dressed to the desired sizes and shapes with an axe. Laterite stones shall be well seasoned by exposure to air before dressing and using on work.

5.7 Stones

5.7.1 Stones used shall be strong, durable, dense, compact, close grained, homogeneous, fire resistant and shall be obtained from sources approved by Engineer. Stones shall additionally be hard, sound, free from cracks, decay and other flaws or weathering and shall be easily workable. Stones with round surfaces shall not be made use of.

5.7.2 Stones shall have a crushing strength of not less than 200 kg/cm2. Stones with lesser crushing strength may be used in works with prior approval of the Engineer. Stones shall be non-porous and when tested in accordance with IS : 1124 - "Method of Test for Determination of Water Absorption Etc.," shall show water absorption of less than 5% of its dry weight when soaked in water for 24 hours. Tests for durability and weathering shall be done in accordance with IS : 1126 and IS : 1125 respectively. The working of stones to required sizes and their dressing shall be as per IS : 1127 Recommendations for dimensions and workmanship of natural building stones for Masonry work and IS: 1129. Dressing of Natural Building Stones". Stones especially limestone and sand stones shall be well seasoned by exposure to air before use in construction works.

5.7.3 Size

Normally stones shall be of size that could be lifted and placed by hand, between 20 to 30 kg per piece. The length of stones shall not exceed 3 times the height and the breadth on base shall not be greater than 3/4 of the thickness of wall nor less than 15 cm. The height of stone may be upto 30 cm.

5.7.4 Dressing

5.7.4.1 Random rubble

Stones shall be hammer dressed on the face, the sides, and the beds to enable it to come into close proximity with the neighbouring stone. The bushings in the face shall not project more than 4 cm on all exposed faces and 1 cm on a face to be plastered.

5.7.4.2 Coursed rubble - First sort

Face stones shall be hammer dressed on all beds, and joints, so as to give them approximately rectangular block shape. These shall be squared on all joints and beds. The bed joint shall be rough chisel dressed for atleast 8 cm back from the face, and side joints for at least 4 cm such that no portion of the dressed surface is more than 6 mm from a straight edge placed on it. The bushing on the face shall not project more than 4 cm as an exposed face and one cm on a face to be plastered. The hammer dressed stone shall also have a rough tooling for a minimum width of 2.5 cm along the four edges of the face of the stone, when stone work is exposed.

5.7.4.3 Coursed rubble - Second sort

Dressing shall be as specified in 5.7.4.2 except that no portion of dressed surface shall exceed 10 mm from a straight edge placed on it.

5.7.4.4 Stone for veneering

Stone lining upto 8 cm shall be treated as veneering work. The stone shall be cut into slabs or required thickness along the planes parallel to the natural bed. Every stone shall be cut to the required size and shape so as to be free from any waviness and to give truly vertical and horizontal joints. Adjoining faces shall be fine chisel dressed to a depth of a 6 mm, so that when checked with a 60 cm straight edge, no point varies from it by more than 1 mm. All edges shall be chisel dressed to be true, square and free from chippings. Top and bottom faces shall be dressed to within 3 mm tolerance and vertical faces to within 6 mm tolerance, when checked with a 60 cm straight edge. Dressing at the back shall not be done.

5.8 Hollow and Solid Concrete Blocks

5.8.1 Cement concrete blocks used in the construction of concrete masonry load bearing as well as non-load bearing walls shall conform to the requirements of IS : 2185. Physical properties such as density, compressive strength, water absorption etc., shall be determined in accordance with the procedure laid down in IS : 2185 and shall conform to the requirement laid therein. When inspected visually all blocks shall be sound, free from cracks, broken edges, honey combing and other defects which would interfere with the proper placing of blocks or impair strength or permanence of construction.

5.8.2 Dimensions and tolerances

The blocks shall be made in sizes and shapes to suit the particular job and shall include stretcher, corner, double corner or pier, jamb, header, bullnose and floor units.

5.8.2.1 The nominal dimensions of concrete block shall be as follows:-

Length : 400, 500 or 600 mm
Height : 200 or 100 mm
Width : 50, 75, 100, 150, 200, 250 or 300 mm

In addition, blocks shall be manufactured in half lengths.

5.8.2.2 The maximum dimensional tolerances shall plus or minus 5 mm in length and plus or minus 3 mm in height and width.

5.8.3 Hollow blocks (open and closed cavity)

5.8.3.1 Grade-A blocks used as load bearing units shall have a minimum block density of 1500 kg/m3 and shall have minimum average compressive strength of 3.5, 4.5, 5.5 or 7.0 N/mm2 at 28 days as specified.

5.8.3.2 Grade-B blocks used as load bearing units shall have block density less than 1500 kg/m3, but not less than 1000 kg/m3 and shall have compressive strength of 2.0, 3.0, or 5.0 n/M3 or as specified.

5.8.3.3 Grade-C blocks used as non load bearing units shall have block density less than 1500 kg/m3, but not less than 1000 kg/m3 and compressive strength of 1.5 N/mm2 at 28 days.

5.8.4 Solid blocks

Solid blocks Grade-D used as load bearing units shall have a block density of not less than 1800 kg/m3 and compressive strength of 4.0 or 5.0 N/mm2 as specified.

5.8.5 Mix proportion

he concrete mix used for blocks shall not be richer than one part by volume of concrete six parts by volume of combined aggregates.

5.8.6 Surface texture and finish

Surface texture, that is, very fine close texture or coarse open texture and finish, whether coloured or not shall be according to the drawing, description in the Schedule of Items or Instructions of the Engineer.

5.8.7 Marking and certificate

The blocks shall be marked permanently with the Grade of each. Manufacturers test certificate shall be supplied with the delivery of each lot.

5.9 Cement, Lime and Water

Cement, lime and water shall conform to the specification in this series under the Section - 'Concrete'.

5.10 Sand for Masonry Mortar

Sand for masonry mortars shall be natural sand, crushed stone sand or crushed gravel and shall comply with IS : 2116 - "Sand for Masonry Mortars". The maximum size of sand particle for brick work shall be 2.5 mm and for rubble masonry 4.75 mm.

6.0 <u>SAND FOR PLASTERING</u>

Sand for use in mortars for internal wall, ceiling and external plastering and rendering

shall conform to 'A' grade of IS : 1542 - "Sand for Plastering". The maximum size of sand particle shall be 1.2 mm.

7.0 MATERIALS FOR FLOORING & PAVING

7.1 Cement and Binders

7.1.1 Cement

Cement, fine aggregates, reinforcement and water used shall comply with the requirements of concrete in series.

7.1.2 Lime

Lime wherever specified for mortar shall conform to IS: 712.

7.1.3 Surkhi

Surkhi used for lime concrete flooring shall conform to IS 1344.

7.1.4 Water

Water for construction shall be clean, soft, free from loam, salt and organic materials. Hard water shall not be used.

7.2 Aggregates

7.2.1 Brick Aggregate

Brick aggregates for lime concrete shall be obtained from well burnt or slightly over burnt brick bats. It shall be homogenous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter. Aggregate size shall be 40 mm to 10 mm graded.

7.2.2 Coarse Aggregate

7.2.2.1 Coarse aggregate shall conform to the requirements of this series.

7.2.2.2 For granolithic floor the screed bed shall comprise of aggregates size 15 mm and down graded and topping shall comprise of clean fine stone chippings, size 4 mm and down. For concrete floor with hardener treatment the topping shall comprise of stone chippings, size 6 mm and down and for in-situ terrazzo flooring, chippings shall be within sizes 12 mm to 6 mm graded. The marble chips for topping of terrazzo floor shall be of 3 - 6 mm size and shall conform to Grade-I of IS : 2114 "CP for laying in-situ terrazzo floor finish".

7.2.3 Common burnt clay bricks

Common burnt clay bricks shall conform to IS: 1077 and comply with requirements of specification - Masonry of this series.

7.2.4 Rubble

Rubble of approved quality shall be used and shall be clean and free from dirt. The loose and weathered sections shall be removed before use. Rubble used as hard core

shall have a least lateral dimension (thickness) between 100mm and 225 mm, depending on the thickness of hardcore.

7.3 Tiles

7.3.1 Terrazzo Tiles

Terrazzo tiles shall be machine made under a minimum pressure of 140 kg/cm2. It shall have a minimum total thickness of 20 mm including a minimum of 6 mm thick topping. It shall be of size, texture, colour, shade and pattern as specified in schedule of item and as approved by the Engineer.

7.3.2 White Glazed Tile

White glazed tiles shall be of approved manufacture and quality and shall conform to IS: 777 - "Glazed Earthenware Tiles. They shall be true in shape, free from haircracks, crazing spot chipped edges and corners and surface shall be perfectly flat without warps and of uniform colour. The top surface shall be glazed either gloss or matt as specified. The tiles shall be 150 mm x 150 mm or 100 mm x 100 mm size and shall not be less than 6 mm thick or as specified. The tolerance on facial dimension value shall be plus or minus 1.0 and plus or minus 0.5 mm on thickness. The specials such as coves, internal and external angles, beads, cornices and their corner pieces shall be of specified sizes and of thickness not less than the thickness of tiles.

7.3.3 Coloured tiles

Only Glaze shall be coloured as specified. The size and specification of tiles shall be same as for the white glazed tiles.

7.4 Natural stone

7.4.1 Natural stone slabs and tiles

The natural stone slabs shall be from selected quarry/ stock as specified in schedule of items which are hard, sound, dense and of homogenous texture free from cracks, decay, weathering and flaws. They should be hand or machine cut to the requisite thickness, size and be of colour indicated in schedule of items/drawing. Unless otherwise specified the slabs shall be minimum 300 mm x 300 mm and 20 mm thickness and tolerance of plus and minus 5 mm in dimensions and plus or minus 2 mm in thickness will be allowed. The stone slabs shall be brought from specific region as mentioned and of specific quality with top surfaces mentioned and specific quality with top surfaces finished smooth. All sides shall be fine chisel dressed to the full depth to allow finest possible joint.

The slabs shall be delivered to the site well protected against damage and stored in dry place under cover.

7.5 Adhesives

The adhesives used for laying linoleum, shall conform to IS: 1198 and for runner & PVC flooring it shall be as per manufacturer's recommendations of tiles for respective types of floors on which tiles are to be laid.

7.6 Pigments

Pigments incorporated in mortar or used for grouting shall be subject to approval of Engineer and as per table I of IS:2114

7.7 Hardening Agents

Hardening agents such as ironite used for "Cement Concrete Flooring with Hardener Treatment", shall be of quality approved by the Engineer for every work.

7.8 Dividing Strips

Dividing strips shall be of aluminium, glass or similar materials and of quality approved by the Engineer. Aluminium or other metal strips shall be 1.5 mm thick and glass 4 mm thick penetrating to the full depth of the flooring.

7.9 Marble Chips

It shall be in sizes varying from 1mm to 25mm and in different colours as per requirement. Marble chips shall be hard, sound, dense and homogeneous in texture with crystalline and coarse grains. It

8.0 TIMBER

8.1 General

All timber used for permanent works shall be new. It shall be well seasoned by a suitable process conforming to IS: 1141 before being planed to the required sizes. It shall be sound, straight, free from sap, radial cracks, decay, fungal growth, boxed heart, pitch pockets, borer holes, splits, loose knots, flaws or any other defects and shall show a clean surface when cut. Timber shall conform to the requirements of IS:1003. The finished components shall be given suitable preservative treatment wherever necessary.

8.2 Hollock (Terminalia Myriocarpa)

Hollock is not a durable wood unless properly treated. It can be readily treated with wood preservatives. It can be finished to fairly good surface, but needs careful filling before it is polished.

8.3 Country Wood

Country wood shall be belonging to the species or trade names as described in the Schedule of Items or drawing or otherwise directed by the Engineer. It shall be the best procurable.

8.4 Teak Wood

Teak wood shall be superior, first class or second class as specified and the best procurable, having uniform grains and free from any defect likely to impair the appearance of finished work.

8.4.1 Superior teak shall be Malabar, Dandeli or Balarshah teak in which no knot shall be larger than 1 cm diameter and the total area of knots not more than one percent. There shall be not less than six growth rings per 2.5 cm width.

8.4.2 First class teak shall be Balarshah or M.P. teak in which no knot shall be larger than 2.5

cm diameter and the total area of knot not more than one percent. There shall be not less than five growth rings per 2.5 cm width.

8.4.3 Second class teak shall be similar to first class teak except that knots upto 4 cm diameter and total area of knots not exceeding one and a half percent will be permitted. The number of growth rings per 2.5 cm width shall be not less than four.

8.5 Storage and Inspection

Timber shall be carefully stored and subject to inspection on site, piece by piece. The Engineer may reject such pieces as are considered by him not of the quality or meeting the requirements specified herein.

8.6 Moisture Content

Timber shall be accepted as well seasoned if its moisture content does not exceed the permissible limit as per IS:287.

8.7 Allowance for Bulk Timber

For bulk timber an allowance on the scantling specified 2% above or below the specified dimensions will be allowed.

8.8 Flush Door Shutters, Shelves

Flush door shutters, shall be wooden, solid core or cellular and hollow core type, as may be shown in drawing or described in the Schedule of Items or directed by Engineer. They shall be obtained from an approved source of manufacture covered on face with commercial ply, wood veneer or other finish as may be necessary. Solid core shutters shall conform to IS: 2202 and cellular or hollow core shutters to IS: 2191. The resin used shall be phenol formaldehyde. A full size sample door shall be offered for inspection and approval.

Shelves and vertical partitions of cupboards shall be of timber planks fibre board, particle board, block board or veneered particle board as specified. Thickness and type of planks or boards shall be as specified. Each shelf shall be a single piece and vertical partitions between two consecutive shelves shall be without any joint. Exposed edges of boards having particle board core shall be sealed with 3 mm thick single piece hardwood strips of width equal to the thickness of board with headless pins. The arrangement of shelves and vertical partitions shall be as per drawings or as directed by the Engineer-in-charge.

8.9 Unveneered Particle Board

Unveneered particle board shall conform to IS: 3087 for medium density and to IS: 3478 for high density.

8.10 Veneered Particle Board

Veneered particle board shall conform to IS: 3097.

8.11 Plywood

Plywood for permanent work such as in partitions etc., shall conform to IS: 303 having

commercial, teak, rose wood or other desired finish.

8.12 Block Board

8.12.1 Block boards have a solid core made up of uniform strip of wood each not exceeding 25mm in width, laid separately, or spot glued, or otherwise joined to form a slab which is glued, between two or more outer veneers, with the direction of the grain of the core block running at right angles to that of adjacent veneers. In any one blocks boards, the core strips shall be of one species of timber only. Face veneers may be decorative or commercial on both faces or decorative on one face and commercial on the other block boards shall be Grade-I (Exterior Grade) as per IS:1659-1990.

Both surfaces of the boards shall be sanded to a smooth finish.

8.12.2 Adhesives

The adhesives used for bonding shall be BWP type synthetic resin conforming to IS:848-4974 for Grade-I block boards.

8.12.3 Thickness and Tolerance

Block boards are available in thickness ranging from 12 to 50mm. Tolerance in thickness shall be ± 5% for boards upto and including 25mm thick and ± 2.5% for boards above 25mm thickness. Each board shall be of uniform thickness.

8.12.4 Testing

One sample for every 100 sqm or part thereof shall be taken and testing done as per IS:1659-1990. However, testing may not be done if the total requirement of block boards in a work is less than 30 sqm. All the samples tested shall meet the requirements of physical and mechanical properties of block boards specified in the relevant B.I.S. code.

8.12.5 Type of face veneers, thickness and grade of block boards shall be as specified. Unless otherwise stated, grade-I (exterior grade) block board bonded with BWP grade be used.

8.13 Wire Mesh Shutters

8.13.1 Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planned smooth and accurate to the full dimensions, rebates, roundings and mouldings as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted except as provided.

8.13.2 Stile and Rails

The specifications shall be as described. The stiles and rails shall be given a rebate to receive the wire gauze which shall from the panels.

8.13.3 Wire Gauze

This shall be unless specified otherwise conform. The wire gauze shall be bent at right angles in the rebates of stiles and rails, turned back and fixed tight with blue tacks at

about 75mm centre, fixed alternately in the two faces of the rebates. Over this, wooden heading shall be fixed with brads or small screws at about 75mm centres.

The space between the beading and rebates, where the wire gauze is bent, shall be nearly finished with putty, so that the end of the wire gauze may not be visible.

8.13.4 Fixing fittings, wooden cleats, blocks and measurement shall be as specified.

8.13.5 Rate

This includes the cost of materials and labour involved in all the operations described above.

9.0 FITTINGS FOR DOORS, WINDOWS ETC.

9.1 General

Fittings shall be of iron, brass, aluminium or as specified. These shall be well made, reasonably smooth and free from sharp edges, corners, flaws and other defects. Screw holes shall be countersunk to suit the head of specified wood screws. All hinge pins shall be of steel and their riveted heads shall be well formed.

Iron fittings shall be finished bright or black enameled or copper oxidized or painted as specified. Brass fittings shall be finished bright, oxidized or chromium plated and aluminium fittings shall be finished bright or anodized as specified. Fittings shall be got approved by the Engineer before fixing. Screws used for fittings shall be of the same metal and finish as the fittings. However, anodized cadmium/chromium plated MS screws of approved quality shall be used for fixing aluminium fittings.

9.2 Hinges

9.2.1 Butt hinges

These shall be mild steel butt hinges (medium), brass butt hinge (light/ ordinary). brass but hinge (heavy), brass oxidized butt hinges (light/ ordinary),brass oxidized butt hinges (heavy) extruded aluminium alloy butt hinges as specified. Brass and MS butt hinges shall conform generally to Indian Standard Specification for butt hinges IS: 205 and IS: 1341 respectively.

9.2.2 Parliament hinges

These shall be of mild steel or cast brass or as specified and shall generally conform to IS: 362.

9.2.3 Spring hinges

These shall be made of iron or brass casing with steel spring and shall conform generally to IS: 453. Hinges shall work smoothly and hold the door shutters truly vertical in closed position. The size of spring hinge shall be taken as length of its plate.

9.2.4 Piano hinges

These shall conform to IS: 3818 and shall be made of mild steel or aluminium alloy sheets. Mild steel hinges shall be finished with anticorrosive treatment or plating of

brass of nickel as specified. Piano hinges shall be fixed in the entire length of the cupboard shutters.

9.2.5 Tee hinges

These shall be made of MS sheets and finished bright. They shall conform to IS: 206.

9.3 Sliding Door Bolts

These shall be of aluminium and conform to IS: 2681. They shall be capable of smooth sliding action. Alternative materials may be adopted on the approval of the Engineer for specific locations.

9.4 Door Latch

This shall be mild steel, brass or as specified and shall be capable of smooth sliding action.

9.5 Tower Bolts

Tower bolts may be of one of the following types:_

i) Brass barrel tower bolt with cast brass barrel and rolled or drawn brass bolt.

ii) Brass barrel tower bolts with brass sheet barrel and rolled or drawn brass bolt.

iii) Anodized aluminium barrel tower bolt with barrel and bolt of extruded sections of aluminium alloy (12 mm dia shoot).

These shall generally conform to IS: 204 steel spring and ball shall be provided between the bolt and the barrel.

9.6 Door Handles

These shall be cast brass or of aluminium of specified size and of the shape and pattern as approved by the Engineer. These shall generally conform to IS: 208. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size and window handles of 75 mm size unless otherwise specified. These shall be fixed with 25 mm long wood screws.

9.7 Mortice Lock

Mortice lock with latch and pair of lever handles shall have steel casing and brass bolts and shall be right or left handed as shown in the drawing or as directed by the Engineer. It shall be of the best Indian make of approved quality and shall conform to IS: 2209. The shape and pattern shall be approved by the Engineer. The size of the lock shall be determined by its length. The lock for single leaf door shall have plain face and that for double leaf door a rebated face lever handles with springs shall be mounted on plates and shall weigh not less than 0.5 kg per pair. These shall be of brass, finished bright chromium plated or oxidized.

9.8 Floor Door Stopper

This shall be made of cast brass and shall have a rubber cushion. The type and pattern

will be as approved by the Engineer.

9.9 Hooks and Eyes

These shall be of hard drawn brass and shall generally conform to IS: 207.

9.10 Casement Window Fasteners

These shall be made of cast brass. Casement fasteners for single leaf window shutter shall be left or right handed as specified. These shall not weigh less than 0.20 kg per fastener.

9.11 Casement Brass Stays

These shall be made of cast brass. The stay shall be made from a channel section and shall not weigh less than that indicated below :-

200 mm.....	0.24 kg each
250 mm.....	0.28 kg each
300 mm.....	0.33 kg each

The shape and pattern of stays shall be approved by the Engineer.

9.12 Quadrant Stays

These shall be made of cast brass. The shape and pattern shall be approved by the Engineer. It shall not weigh less than 0.20 kg each.

9.13 Fan Light Pivots

These shall be made of cast brass and shall generally conform to IS: 1837. The base and socket plate shall be made from minimum 3.15 mm thick brass plate and projected pivot shall not be less than 12 mm diameter and 12 mm length cast in single pieces with the base plate.

9.14 Fan light catch

These shall be made of cast brass and shall generally conform to IS : 364. Steel springs of the catch shall be 0.90 mm dia 6 coils 12 mm internal diameter and 20 mm long. The pattern and the shape of the catch shall be as approved by the Engineer.

9.15 Chain with Hook for Fan Light

This shall be made of hard drawn brass or cast brass welded or twisted as specified and shall conform generally to IS: 3828. One end of the chain shall be provided with an eye and the other end with a staple. The minimum thickness of plates shall be 2.24 mm and the chain shall be 300mm long made from minimum 4 mm hard drawn wire.

9.16 Hasp and Staple

Hasp and staple (safety type) shall be made of cast brass and generally conform to ;IS: 363. The hinge pin which in all cases shall be of mild steel, shall be firm and its riveted head well formed. The movement of the hasp shall be free, easy and square and shall not have any play or shake. The hasp shall fit the staple correctly. The size shall be

determined by the length of the bigger leaf of the hasp.

9.17 Cupboard Lock

These shall be made of cast brass conforming to IS:729 and shall be of the best Indian make. The lock shall be easy in working, having duplicate keys.

9.18 Hydraulic Door Closer

These shall conform to IS: 3564 and be of brand approved by the Engineer for both left and right hand openings.

9.19 Steel Frames

Steel sections used for door frames, windows and ventilators shall conform to the IS Specification.

10.0 METAL DOORS, WINDOWS, VENTILATORS, COLLAPSIBLE GATES & ROLLING SHUTTERS

10.1 General

Materials used in the fabrication of doors, windows, and ventilators shall be the best procurable and conforming to relevant Indian Standards.

10.2 Steel Doors, Windows, Ventilators & Collapsible Gates

Steel sections used for fabrication of doors, windows ventilators & collapsible gates shall be standard rolled steel sections specified in IS: 1038, IS: 1977, IS: 1361 or IS: 7452 as appropriate or as specified in drawing and Schedule of Items. Rivets shall conform to IS: 1148.

10.3 Aluminium Doors, Windows & Ventilators

Aluminium sections used for fabrication of doors, windows ventilators partitions etc. shall be extruded sections specified in IS: 1948-1961 & 1949-1961 or as manufactured by Indian Aluminium Company Limited or approved equivalent. The alloy used shall conform to designation HE9 – WP of IS:733-1983.

10.4 Steel Rolling Shutters, Rolling Grills

These shall conform to IS:6248-1979.

10.5 MS Bolts etc.,

MS bolts, nuts, screws, washers, peg stays and other mild steel fittings shall be treated for corrosion as recommended by the relevant Indian Standards. Putty for glazing shall conform to IS: 419. Glass panes and glazing shall conform to the specification detailed under this series.

10.6 Hardware and fixtures shall be as specified in the drawings or Schedule of Items. All hardware and fixtures shall be able to withstand repeated use. Door closers shall be suitable for doors weighing 61 - 80 kg, unless otherwise stated. Each closer shall be

guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the closer replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance requirements and endurance test stated in IS: 3564 - Appendix-A.

10.7 The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer. In general, the mastic for fixing of metal frames shall conform to IS: 1081 and/or as approved by the Engineer.

11.0 GLASS

11.1 General

Plain, ground, frosted or rough cast wired glass shall be used as shown on the drawing or as specified in the Schedule of Items. It shall be procured from a reputed source of manufacture such as Hindustan Pilkington Glass Works Limited and be of the best quality. All glass panes shall be free from flaws, specks, bubbles etc., All the panes shall weigh not less than 7.5 kg per sqm. The tolerance of glass panes in length and width shall be plus or minus 2 mm.

11.2 Plain Transparent Glass

Plain transparent glass for glazing and framing shall conform to IS: 1761. It shall be free from flaws, specks, bubbles or distortions.

11.3 Ground and Frosted Glass

Glare reducing or heat absorbing glass shall be "Calorex" of Hindustan Pilkington or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.

11.4 Wired Glass

Wired glass shall be thick rolled glass with centrally embedded 24 g. Wire mesh of Georgian type. This may be clear or coloured, as shown in drawings or specified in Schedule of Items.

11.5 Thickness

Glass shall have the following thickness, unless otherwise stated in the Schedule of Items or drawings:-

Upto 60 cms x 60 cms	...	3 mm
-do- of larger size	...	4 mm
Plate glass for doors	...	5.5 mm
Rough cast wired	...	6 mm

11.6 Inspection

All glass shall be subject to inspection on the site. Glass found to suffer from defects shall be rejected. Samples submitted for inspection shall be selected so as to be representative of the consignment.

12.0 PAINTS

12.1 General

All paints, varnishes, distemper or other surface coating materials shall be of approved quality conforming to the appropriate Indian Standard, wherever such standard is available, and be obtained from a manufacturer of repute.

12.2 Sampling and Testing

The Engineer may, at his discretion, require samples of paint to be tested. In such cases testing will be according to IS: 101.

12.3 Storage

Paints, primers, distempers and varnishes shall be delivered in sealed containers. They shall be stored in cool dry condition to the satisfaction of the Engineer.

12.4 Paints for Priming

Ready mixed paints for priming coats of steel and iron work shall comply with IS: 2074 - "Ready Mixed Paint", "Red Oxide Zinc Chrome Priming".

12.5 Paints For Finishing

Ready mixed oil gloss paint where specified shall comply with IS: 129 "Ready Mixed Paint, Brushing, Finishing Semi- gloss, for General Purpose to IS Colours". Aluminium paints where specified on the drawings or ordered by Engineer shall comply with IS: 2339 - "Aluminium Paint for General Purposes in Duel Containers". Plastic Emulsion paint where specified for plastered surfaces of masonry and concrete work shall comply with IS: 5411 (Part _ I) and (Part _ II) for interior use and exterior use respectively.

12.6 White wash

White was shall be prepared from lime slaked on spot, mixed and stirred with sufficient water to make a thin cream.

12.7 Colour wash

Colour was shall be prepared by adding mineral colours, not affected by lime, to white wash.

12.8 Cement Paint

Cement paints shall comply with IS: 5410 and shall be of approved brand and manufacture. The shade shall be approved by the Engineer before its application.

12.9 Distemper

Dry/oil bound distemper of approved brand and manufacture shall be used. The shade shall be approved by the Engineer before application of the distemper.

12.10 Varnish

Varnish for the finishing coat shall be copal finish or super quality spar varnish of approved brand. Varnish for the under coat shall be flatting varnish of the same make as the top coats and shall be to the approval of the Engineer.

12.11 Polish

French spirit polish shall be of an approved make conforming to IS: 348. If it has to be prepared on site, the polish shall be made by dissolving 0.7 kg of best, shellac in 4.5 litres of methylated spirit without heating. To obtain required shade pigment may be added and mixed.

12.11.1 Where wax polishing is specified, it shall be prepared by heating two parts of "Bee Wax" and two parts of boiled linseed oil over a slow fire. When dissolved but still warm, one part of turpentine is to be added.

12.12 Plastic (Acrylic) emulsion Paint

Plastic emulsion paint of approved manufacturers like Jenson & Nicholson, Goodlass Nerolac, Shalimar, Berger, Asian and Garware paints only shall be used unless otherwise specified and shall comply with IS:5411(Part 1) – 1974 & (Part 2) – 1972 as applicable. Cement primer used for priming work both for oil bound distemper and plastic emulsion paint shall be of the same manufacture as that of distemper or plastic emulsion paint used. For dry distemper priming, whiting of approved quality shall be used.

12.13 Floor Polish – Paste

The polish shall consist mainly of waxes and organic solvents with or without water.
The paste of floor polish shall be of smooth consistency, homogeneous, semi solid mass and free from gritty material. It shall not flow at ordinary temperature. It shall be so constituted and prepared that on application by means of a clean cloth, it shall spread easily and evenly and shall give with minimum buffing a firm and glossy surface free from greasiness or tackiness. The polish film after spreading with a cloth shall not take more than 10 minutes to dry. The polished floor shall be neither slippery nor show any resistance to easy walking.
Floor polish paste shall conform to IS:8591-1977.

13.0 <u>WATER PROOFING MATERIALS</u>

13.1 Integral Cement Waterproofing Compounds

Integral cement waterproofing compounds, i.e. admixture for waterproofing purposes shall fully comply with the requirements of IS: 2645. Properties like permeability, setting time, compressive strength shall be in accordance with the requirements of this code when tested as per procedure laid therein. Calcium chloride content of the product used shall be made known to Engineer before use.

13.2 Bitumen

The bitumen bonding material for waterproofing shall conform to the requirements laid down in IS: 702, or IS: 73 or IS: 217 or IS: 454 depending upon whether industrial bitumen, paving bitumen or cutback bitumen is used. For selecting the particular type and grade of bitumen to be used the relevant item in Schedule of Items shall be referred

to.

13.3 Bitumen Primer

Bitumen primer used for application to concrete and masonry surfaces and bitumen for the purpose of waterproofing shall conform to requirements given in IS: 3384 and pass tests in accordance with the procedure laid down in appropriate IS mentioned in Table-I of IS: 3384. Bitumen primer should be free from water and shall preferably ;be made from the same grade of bitumen as used in bonding.

13.4 Bitumen Felt

Bitumen felts used for water proofing purposes shall be as specified in IS: 1322. Physical properties shall conform to the requirements and tests shall be carried out as per procedure laid down in IS: 1322. Base, (whether fibre or Hessian), type and grade of felt shall be as mentioned in the relevant items under Schedule of Items. Unless otherwise stated, hessian base felt Type-3, Grade-2 shall be used.

13.5 Bitumen Mastic

Bitumen mastic used for water proofing of roofs shall have the physical properties as mentioned in IS: 3037 when tested with the procedure laid down in appropriate IS mentioned in IS: 3037.

13.6 Bitumen Compounds

Bituminous compounds when used for waterproofing of porous masonry, concrete floors, walls and roofs shall conform to the requirements of IS: 1580. Physical properties shall be governed by the requirements of this code when tested in accordance with the procedure laid therein.

13.7 Surface Application Materials

Waterproofing material for application on mortar or concrete surface shall conform to IS: 9862. The primer shall be suitable for spray or brush application. It shall have properties enabling it to penetrate through pores or cracks and fill them up, making the surface impervious.

13.8 High Polymer, based Admixtures & Epoxy Based Emulsion & Paints

The materials used shall be high polymer based chloride and sulphide free cement and waterproofing additions and epoxy based waterproofing paints as per manufacturer's specification and approved by Engineer.

14.0 <u>WATER BAR</u>

14.1 General

Water bar for use in construction/expansion joints in concrete and reinforced concrete structures shall be of copper sheet, galvanized steel sheet, rubber or PVC as shown in drawing or described in the Schedule of Items. It shall be subject to approval of Engineer.

14.2 Jointing

The water bar shall have dimensions as shown in drawing. Where water bars are required to be lengthened or otherwise jointed the joining shall be done in such a way as to achieve a perfectly water-tight joint.

15.0 LEAD

15.1 General

Lead for joints in cast iron spigot and socket pipes shall be melted from pure soft pig lead conforming to Type-I of IS: 782. "Caulking Lead" where lead wool is allowed for caulking, it shall be equal to or better than Type-II of IS: 782. Lead flashing shall conform to IS: 405, "Lead Sheet".

16.0 BUILDING PAPER

Building paper shall be bitumen impregnated paper conforming to IS: 5134, or such other as may be approved by the Engineer.

16.1 Gypsum Building Materials

i) Non load Bearing Gypsum Partition Block (Solid or hollow type

The materials to be used for non load bearing construction (solid or hollow type) in the interior of building, protection of columns, elevated shafts etc. against fire shall conform to IS : 2489

ii) Gypsum Plaster Boards

These are intended to be used as vertical or horizontal lining in buildings. The boards manufactured conforming IS : 2095 and suitable to receive either direct surface decoration or gypsum plaster finishes shall be used for above work. Boards subjected to secondary manufacturing operation shall not be used for this work.

iii) Fibrous Gypsum Plaster Boards

These boards are manufactured as a composition of gypsum plaster and sisal or coconut or any other suitable fibre body of regular dimensions. These are used for covering walls, ceilings, partitions in normal dry environments in buildings. These have high fire- resisting properties. These boards shall conform to IS:8273.

17.0 FILLING MATERIAL

17.1 General

Filling material shall conform to what is shown in drawing, described in the Schedule of Items or otherwise directed by the Engineer. Earth or sand for filling under floors shall correspond to those described elsewhere in these specifications.

17.2 Mastic Bitumen

Mastic Bitumen shall conform to IS: 3037 or IS: 5871 as appropriate.

17.3 Flexible Boards

Flexible boards for use in expansion joints shall correspond to the description given in drawing or the Schedule of Items or instructions of the Engineer.

18.0 DRAINAGE & SANITATION (INTERNAL)

18.1 General

All materials, pipes, specials, fittings, fixtures etc., to be used in the works shall be of best quality and class specified in relevant IS Code. Where specified these shall be of specific manufacture and quality and shall be procured from manufacturer or their accredited stockists and be marked with manufacturers' names and trade mark. Contractor shall submit to the Engineer samples of all materials, pipes, specials, fittings fixtures for approval before use in the works. Such approved samples shall be retained by the Engineer until completion of works. Pipes and specials may be any or combination of following types:-

i) PVC Pipes
ii) Stone Ware Pipes
iii) HCI Pipes for soil waste & Ventilation
iv) CI Pipes for rain water
v) AC Pipes for rain water
vi) R.C.C Pipes

18.2 PVC Waste Pipe

This shall conform to relevant IS unless otherwise specified.

18.3 Stoneware Pipes & Fittings

All stoneware pipes, bends, gully traps and sewer traps shall be of the best salt glazed variety inside and outside, hard burnt dark grey colour, perfectly sound, free from fire cracks and imperfection of glaze, truly circular in cross section, perfectly straight, of standard nominal length and depth of socket and barrel. These shall be of approved manufacture and shall comply with the requirement of IS: 651.

18.4 HCI Pipe

All soil waste and vent pipes and fittings used in the work shall be cast iron and shall conform to IS: 1729. The pipes shall have spigot and socket ends, with bead on spigot end and shall be with or without ears. The pipes shall be free from cracks and other flaws. The interior of the pipe and fittings shall be clean, smooth painted inside and outside with PR Angus smith's solution or other anti-corrosive paint.
The standard weights and thickness of pipe shall comply with the requirements of IS: 1729. The tolerance on wall thickness and weight shall be minus 15 percent and minus 10 percent respectively. Pipes weighing more than the nominal weight given below may be accepted provided they comply in every other respect.

Nominal size	Weight per piece in Kg. excld. ears

	Overall length		
	1500 mm	1800 mm	2000 mm
50	9.56	11.41	12.65
75	13.83	16.52	18.37
100	18.14	21.67	24.15
150	26.70	31.92	35.66

Specials and Fittings shall include bends, offsets, branches of various types, junctions etc., as required for the work which shall be provided according to drawings and directions of the Engineer.
The specials and fittings shall be provided with access doors where so specified or directed by the Engineer. The access door fittings shall be of proper design so as not to form cavities in which the filth may accumulate. Doors shall be provided with 3 mm thick rubber insertion packing, and when closed and bolted they shall be water tight. The access doors shall have MS studs and bolts or screws or bolts and nuts.

18.5 Cast Iron Pipes : Rainwater pipe

Pipes shall be of approved manufacture, true, smooth and cylindrical, their inner and outer surfaces being as nearly as practicable concentric. These shall be sound and uniform casting, free from laps, pin holes or other imperfections and shall be neatly finished and carefully fitted with inside and outside. The ends of pipes shall be reasonably square to their axis.

Dimensions

CI rain water pipes shall be of the dia specified in the description of the item and shall be in full lengths of 1.8 meters including socket ends of the pipes, unless shorter lengths are required at junctions with fittings. The pipe lengths shall in each case be with sockets. The pipes shall be supplied without ears unless otherwise specifically mentioned.

The pipes supplied shall be factory painted with a tar based composition both inside and outside which shall be smooth and tenacious.
Every pipe shall ring clearly when struck all over with a light hand hammer. When shorter pipes are cut from full lengths they shall be cut with a hacksaw.

Where the pipes are to be embedded in masonry they shall be of Class of pipes as are used for soil and vent pipes. For the weights of different sizes of these pipes, the specifications under SCI and vent pipes may be referred to.

18.6 Water Closets

18.6.1 European Pattern W.C.

These shall be of Hindustan Sanitary-ware make A class equivalent or of approved Indian make and quality. Unless otherwise specified, these shall comprise of :-

a) White glazed earthenware wash down closet set with 'S' or 'P' trap.

b) 'Duco' spray painted 12.5 litres mosquito proof low level MS flushing cistern with valveless siphon, 15 mm ball cock, C.P. brass unions and couplings for the 32 mm dia

flush pipe, 20 mm dia overflow PVC pipe with mosquito proof cover etc.,

c) 'Duco' spray painted 1 1/4" (32 mm) dia GI telescopic flush pipe with buffer clamp, holder bat clamp and 38mm dia PVC pipe.

d) 'BESTOLITE' or equivalent white solid plastic W.C. seat and cover C.F. brass bar hinges, screws bolt, rubber buffers.

e) 15 mm PVC connection pipe with brass couplings at both ends and 15 mm brass CP cock.

f) Teak wood wooden blocks or other suitable fixing arrangement with screws and detofix for fixing WC in floor and putty joint with flush pipe and soil pipe.

18.6.2 Indian Pattern W.C.

These shall be of Hindustan Sanitary Ware make 'A' class or equivalent approved Indian make and quality. Unless otherwise specified these shall comprise of :-

a) White glazed earthenware WC pan back entry type.

b) White glazed earthenware 'P' or 'S' trap with or without vent.

c) 12.5 litres or approved make mosquito proof MS high level flushing cistern with valveless siphon, 15 mm ball cock, galvanised iron chain with with handle, cast iron brackets with wall plugs, brass unions and couplings for flush pipe, 20 mm dia overflow PVC pipe with mosquito proof cover etc.,

d) 32 mm dia GI telescopic/40 mm C.D high density PVC flush pipe with holder bat clamps.

e) One pair of white glazed earthen ware feet set in one cement mortar 1:3.

f) 15 mm PVC connection pipe with brass couplings and at both ends and 15 mm brass stop cock.

18.7 Wash Hand Basin

These shall be of Hindustan Sanitaryware make 'A' class or equivalent approved Indian make and quality. Unless otherwise specified these shall comprise of :-

a) White glazed earthenware basin with 2 nos. Concealed Cast Iron Brackets with wall plugs.

b) 1 no. 15 mm C.P. brass pillar taps.

c) 32 mm C.P. brass waste fittings, C.P. brass chain and rubber plug.

d) 32 mm PVC waste pipe with brass couplings/32 mm CP bottle trap.

e) 15 mm PVC connection pipes with brass couplings and 15 mm brass stop cock.

18.8 Sinks

These shall be of Hindustan Sanitaryware make 'A' class or equivalent approved Indian make and quality or grey mosaic sink of approved design with reinforcement etc., complete. Unless otherwise specified these shall comprise of the following:-

a) White glazed fire clay sink/mosaic as specified with outlet water overflow at end with 2 nos. cast iron brackets with wall plugs.

b) 38 mm C.P. brass waste fittings, C.P. brass chain and rubber plug.

c) 38 mm PVC waste pipe, with brass couplings complete/ 32 mm CP bottle trap.

18.9 Flat Back Lipped Urinal

These shall be of 'Hindustan Sanitaryware' or equivalent approved Indian make and quality. Unless otherwise specified these shall comprise of:-

a) White glazed earthenware urinal basin (back type).

b) CI/M.S mosquito proof high level automatic flushing cistern of capacity as specified in the Schedule of Quantities with all accessories, cast iron brackets with wall plugs, brass Unions and coupling for flush pipe, 20 mm dia overflow pipe with mosquito proof cover.

c) 25 mm dia GI flush pipe and spreaders with wall clips and brackets.

d) 15 mm PVC connection pipe with brass couplings joint at both ends and 15 mm brass stop cock.

e) 32 mm C.P. brass outlets complete with PVC waste.

18.10 Mirror Frames:

Mirror frame where specified shall be of fibre glass of approved shape, size, colour and make.

18.10.1 Mirror shall be of superior glass with edges rounded off or levelled as specified. It shall be free from flaws, specks or bubble and its thickness shall not be less than 5.5 mm. The glass for the mirror shall be uniformly silver plated at the back and shall be free from silvering defects. Silvering shall have a protective uniform covering of red lead paint.

18.11 Toilet Shelf

18.11.1 Glass shelf unit shall consist of an assembly of glass shelf, CP brass guard rail and supporting brackets. The shelf shall be of glass of best quality with edges rounded of and shall be free from flaws, specks, bubbles and of thickness not less than 5.5 mm. The shelf shall have guard rail, resting on rubber washers on glass plate.

18.11.2 Ceramics shelf shall be of shape, size and design as specified in the Schedule of Items.

18.12 Towel Rail

Towel rail shall be of CP brass/anodized aluminium with two brackets of same material, diameter and length as specified.

18.13 Toilet Paper Holder

Toilet paper holder shall be of CP brass, PVC with CP brass brackets, of approved made and designs.

18.14 Soap Container

Soap container shall be of CP brass, PVC with CP brass brackets of approved make and design.

18.15 CP Flush Valves 15 Litres for EWC

The CP flush valve (15.0 litres) for EWC shall be of 'ACCO' brand of Asia Continental Metallware Fabric or equivalent quality.

18.16 CP Flush Valve 5 Litres for Urinals

CP flush valve for urinal shall be of 'ACCO' brand of Asian Continental Metalware fabric or of equivalent quality.

18.17 Gully Trap

Each gully trap shall have one C.I. grating 150 mm x 150 mm and one water tight precast R.C. cover 300 x 300 x 40 mm thick with 1:1 1/2:3 mix concrete (one cement: one and half sand : 3 stone chips 20 mm down) including neat cement finish.

18.18 CI Manhole Cover

Manhole cover shall be CI type 450mm dia (internal) light duty 25 kg weight (cover and frame), heavy duty 128kg weight (cover & frame), 560 mm dia (internal) and shall be either single seal or double seal as specified in the Schedule of Items.

18.19 Polycrete Sanitary Fittings

Where specifically mentioned polycrete sanitary fittings manufactured by Gujarat Polycrete Pvt. Ltd., shall be used The pipe, fittings and appurtenances shall be of the description mentioned in for glazed vitreous fitting.

18.20 Fibre Glass Sink

Fibre glass sink where specified shall be of heavy duty (4 ply) of approved manufacturer, shape and size. The pipes and other appurtenances shall be of the description mentioned for the glazed vitreous sinks.

19.0 WATER SUPPLY & PLUMBING (INTERNAL)

19.1 General

This section deals with the specification of material for pipes, fittings, fixtures etc., to be used in water supply works.
All materials, pipes, fittings, fixtures to be used in the works shall be of the best quality of the class specified in relevant IS Code. Where specified these shall be of specific manufacture and quality and shall be procured from the manufacturer or their accredited stockist and be marked with manufacturers name and trade marks. The Contractor shall submit to the Engineer samples of all pipes, fittings, and fixtures for approval before being used in the works. Such approved samples shall be retained by the

Engineer until completion of works.

Pipes and pie fittings may be of any or combination of following types:

i) Wrought iron galvanised pipe

ii) PVC pipes

iii) Cast iron pipes

iv) Steel pies coated with bitumen composition inside and galvanised outside.

v) Reinforced concrete pipes

vi) Asbestos cement pipes

vii) Prestressed concrete pipes

viii) Lead (not to be used for potable water)

19.2 Galvanised Iron Pipes and Fittings

Generally pipes for installations in buildings shall be medium quality malleable steel galvanised pipe 'B' class for cold water supply and 'C' class for hot water supply, having threaded ends with socket at one end.

The details of standard pipes and sockets regarding nominal bore thickness and weight in kg/m are given below:-

PIPE DIA	DIMENSION OF PIPE		THICKNESS	DIMENSION OF ORDINARY SOCKETS		Wt. OF PIPE PLAIN END
	MAXIMUM (OUTSIDE DIA)	MINIMUM		OUTSIDE DIA (APPROX)	MINIMUM LENGTH	
mm	mm	mm	Mm	mm	mm	Kg/m
15	21.8	21.0	2.65	26.9	34	1.21
20	27.3	26.5	2.65	33.7	36	1.57
25	34.2	33.5	3.25	42.0	43	2.42
32	42.9	42.0	3.25	51.0	48	3.11
40	48.8	47.9	3.25	57.0	48	3.59
50	60.8	59.7	3.65	70.0	56	5.07
65	76.6	75.3	3.65	88.0	65	6.49
80	89.5	88.0	4.05	101.6	71	8.43

Note :- Manufacturing tolerances shall be permitted on tubes and sockets in addition to above. The galvanised iron pipes shall be of approved make and conform to IS and of tested

quality. The GI pipes shall be of threaded ends with a socket at one end only. The fittings for GI pipes shall be either galvanised wrought iron or galvanised malleable iron.

19.3 PVC Pipes

Polythene unplasticised pipes be procured from reputed and approved manufacturer and shall have marking in colour in accordance with relevant Indian Standards.

19.3.1 Fittings for PVC Pipes

These fittings shall be special flange compression fittings such as Alka Fan Fittings manufactured by ICI or other equivalent. Tee's, elbows, cross and reducers shall be provided with male & female joints.

19.3.2 Fittings for unplasticized PVC pipes

The fittings shall be injection mould and/or fabricated type.

19.4 R.C.C Asbestos, Prestressed Pipes and Fittings

These shall be of approved manufacture and quality and shall conform to relevant IS.

19.5 Cast Iron Pipes and Fittings

The cast iron pipes and fittings shall be of approved manufacture and quality and shall conform to IS: 1537 for pipes and IS: 1538 for fittings.

19.6 Steel Pipes

This shall conform to IS: 1239 & 3589. Steel pipes shall be coated with bituminous composition inside and galvanised outside.

19.7 Bib Tap and Stop Tap

Bib tap and stop tap for water services shall be of brass screw down type and shall conform to IS: 781. Minimum finished weight of bib and stop taps shall be as given below:

No. of size (mm)	Bib tap (kg)	Stop tap (kg)
10	0.30	0.35
15	0.40	0.40
20	0.75	0.75
25	1.25	1.30
32	-	1.80
40	-	2.25
50	-	3.85

The taps shall be tested under internal hydraulic pressure of at least 20 kg/cm2 and maintained at the pressure for a period of at least two minutes during which period it shall neither leak nor sweat.

19.8 Valves

Unless otherwise mentioned in the Schedule of Quantities these shall be of gun metal fullway valves of medium type and shall be of approved manufacture. These shall conform to relevant Indian Standard Specifications.

19.9 Storage Tank

Storage tank shall be either pressed steel, Galvanised iron, R.C.C or PVC of specified sizes, capacities, make, manufacture as specified in Schedule of Items. It shall have facilities for connecting inlet, outlet overflow and washout pipes and a top cover. Where tanks are to be fabricated by the Contractor the fabrication/R.C.C detailed drawings shall be got approved by Engineer.

20.0 EXTERNAL WATER SUPPLY, SEWERAGE & DRAINAGE

20.1 C.I. Pipes

Unless otherwise specified CI Pipe and specials, caulking lead, SW Pipe, RCC pipe shall conform to the following:-

i) CI pipe shall conform to IS: 1536 to 1537

ii) CI pipe fittings shall conform to IS: 1538.

iii) CI specials shall be of similar specification as specified for fittings in IS: 1538.

iv) Bolts and nuts shall be hexagonal bolts and nuts conforming to IS: 1363.

20.2 Washers

Spring washers conforming to latest edition of IS: 3063 shall be used near the pumps to take care of vibration. In other places plain washers conforming to IS: 2016 shall be used.

20.3 Gaskets

Gaskets shall be reinforced rubber sheet conforming to IS: 638.

20.4 Caulking Lead

All the spigot and socket joints shall be caulked by lead conforming to IS: 782.

20.5 Salt glazed stoneware pipes shall conform to IS: 651 and shall be laid as per IS: 3114.

20.6 CI pipes used for sewerage, under roads and other places shall conform to IS: 1536, and shall be laid as per IS: 31.

20.7 Steel pipes used for encasing shall conform to IS: 1239 and IS: 3589.

20.8 Cast iron manhole covers shall conform to IS: 1726.

20.9 Steel reinforcements shall conform to IS: 432.

20.10 RCC pipes used shall conform to IS: 458 and shall be laid as per IS: 783.

21.0 ROAD

21.1 General

Roads shall be understood to include road bed, the wearing surface, berms, foot-paths, kerbs, culverts and bridges.

21.2 Soling Stones

Material for soling shall be natural stone boulders or crushed blast furnace slab. Stone boulders shall consist of materials of uniform quality in sizes between 150 mm to 230 mm with total length not exceeding 300 mm. No stone shall weigh less than 3.5 kg. Stones shall be tough, angular, durable and generally free from flat, elongated, soft and disintegrated particles. They shall also be free from dirt or other objectionable matter and be obtained from quarries approved by the Engineer.

Crushed slag obtained from air-cooled blast furnace slag shall be angular, of reasonably uniform quality and density and generally be free from any thin, elongated, and soft pieces, dirt or other objectionable matter. The density of slag should not be less than 6.12 gm/cc and glassy material shall not exceed 20%. Water absorption when determined in accordance with IS: 2386 (Part-III). "Methods of Tests for Aggregates for Concrete: Specific Gravity, Density Voids, Absorption and Bulking", shall not exceed 10%.

21.3 Coarse Aggregate for Water Bound Macadam

Coarse aggregate for water bound macadam shall be natural gravel, crushed stone obtained from approved quarries or crushed blast furnace slag. Crushed stone shall be hard, durable, tough and of uniform quality, generally free from flat, elongated, soft and disintegrated particles. It shall have sharp edges and also not have excess of dirt and other objectionable matter. When tested as per IS: 2386 (Part-IV) for Los Angeles Abrasion Value or Aggregate Impact Value, the limiting values shall be 50% and 40% respectively for base course and 40% and 30% respectively for surfacing course. The flakiness index shall not exceed 15% when tested in accordance with IS: 2386 (Part-I) "Methods of Test for Aggregates for Concrete : Particle size and Shape". Crushed slag aggregates shall meet the requirements given for soling stones from blast furnace slag.

Size and grading requirements of coarse aggregates shall be as specified in Table-2 of IRC 19, "Standard Specification and Code of Practice for Water Bound Macadam". The grading number of the table shall correspond to the following layer thicknesses :-

Grading Number	Size Range	Layer Thickness
1.	90 mm to 40 mm	More than 90 mm
2.	63 mm to 40 mm	90 mm to 75 mm
3.	50 mm to 20 mm	75 mm to 50 mm

21.4 Screenings

Screenings used for filling voids in coarse aggregates for water bound macadam shall generally be of the same material as the coarse aggregate. Non-plastic materials such as Kankar nodules, moorum or gravel (other than river bore rounded aggregates) may be used, provided that the liquid limit and plasticity index are below 20 and 6 respectively. The fraction passing 75 microns sieve shall not exceed 10%. Size and grading of screenings shall be as specified in Table-3 of IRC-19. Type-A screening shall be used for grade number 1 coarse aggregate. Type-B screenings shall be used for grade number 3. Either Type-A or Type-B screenings may be used for grade number 2.

21.5 Stone Chips for Bituminous Surfacing

Course aggregate shall consist of crushed stone, crushed slag or crushed gravel (Shingle) retained on 2.36 mm sieve. The aggregates shall be clean, strong, durable and fairly cubical fragments free from disintegrated pieces, organic and other objectionable matter. The aggregates shall preferably by hydrophobic and of low porosity. The mechanical properties and grading shall be in accordance with IRC-29 "Tentative Specifications for 4 cm Asphaltic Concrete Surface Course", having aggregate inspect value 30%, Flakiness Index 25% and graded between 20mm and 2.36 mm.

21.6 Sand

Sand for use as fine aggregate in bituminous surfacing shall consist of crushed screenings, natural sand or a mixture of both, passing a 2.36mm sieve and retained on 75 micron sieve. It shall be clean, hard, durable, uncoated and dry, free from injurious, soft or flaky pieces and organic deleterious substances.

21.7 Binder

Binding material for water bound macadam shall consist of fine grained material such as stone dust, kankar modules or moorum. The plasticity index shall be between 4 to 9 when water bound macadam is to be used as surface course and upto 6 when used as sub/base or base course. Binder for bituminous surfacing shall be bitumen conforming to IS: 73, of grade 80/100 for tack coat and grade 30/40 for premixing.

21.8 Materials for Cement Concrete Roads

Materials for cement concrete in concrete roads shall conform to the relevant specifications under "Concrete" of this series, with the additional requirement that the Los Angeles Abrasion Value of Coarse Aggregates Shall not exceed 35%. The size and grading of aggregates shall conform to the requirements of IRC : 15.

21.9 Kerbs

Kerbs may be of stone, concrete or brick as may be shown in drawing or otherwise directed by Engineer.

21.9.1 Stone kerbs

Stones shall conform to the dimensions and shapes given in drawing. Exposed faces shall be dressed two lines.

21.9.2 Concrete kerbs

Shape and dimension shall conform to the drawing. They shall be precast and the road side top corner shall be given a chamfer.

22.0 MATERIALS NOT SPECIFIED

Any materials not fully specified in these specification and which may be offered for use in the works shall be subject to approval of Engineer, without which it shall not be used anywhere in the permanent works.

PART-II

WORKMANSHIP

CONTENTS

1.0 GENERAL

1.1 Standard

A high standard of workmanship in all trades will be required. The Contractor shall ensure that only skilled and experienced workmen are employed.

1.2 Supervision

The Contractor's supervising staff shall be fully qualified and experienced in the types of work being carried out under the supervision and shall be capable of ensuring that they are done well and efficiently.

1.3 Temporary works

Where required, the Contractor shall furnish such details of his temporary works as may be called for by the Engineer and the Contractor shall satisfy the Engineer as to their safety and efficiency. The Engineer may direct that temporary works, which he considers unsafe or insufficient, shall be removed and replaced in a satisfactory manner.

1.4 Codes

Unless mentioned otherwise, current versions of all codes, specifications and standards issued by the Indian Standards Institution and Indian Roads Congress, wherever mentioned, shall be fully applicable to these specifications. Where standards are not yet published by the ISI or IRC, adaptable British Standards or Specifications of the International Organization for standardization shall apply.

In case of any conflict in meaning between these specifications and those of ISI or IRC, the provisions of these specifications shall prevail.

1.5 Base lines and bench marks

The Contractor shall establish and maintain, to the satisfaction of Engineer, the base lines and bench marks, based on which the works are set out. Where such base lines and bench marks are provided by the Engineer, the Contractor shall maintain these throughout the period of construction without causing any disturbance to them.

1.6 Setting out

The Contractor shall set out all the works to be executed by him, in line with the standard base lines, levels, position and bench marks and truly as per drawings within the accepted tolerance limits at no extra cost to Owner. The Contractor shall be solely responsible for the setting out of all the works, to be executed by him and the approval of such setting out by the Engineer shall in no way absolve the Contractor his responsibility for carrying the work to the true lines, levels and positions as per drawings.

1.7 Dewatering

The Contractor shall carryout all the works, in dry and workable condition and maintain the same in dry condition till the final handing over of works at no extra cost to the Owner. For this the Contractor shall make all the necessary provisions of dewatering, wherever necessary, to the entire satisfaction of the Engineer.

1.8 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.

1.9 Protection of existing services

The Contractor shall take all precautions necessary to prevent damage to or interference with underground or overground services such as cables, drains, piping or piles, whether shown on drawings or not. Equipment etc., mounted in position shall be protected against falling debris etc., by means of tarpaulin or such other material.

1.10 Handing over of work site

On completion of work, the Contractor shall remove all rubbish, debris, surplus materials, temporary work etc., from the site. The site shall be handed over in a tidy and workmanlike manner.

2.0 EARTH WORK

2.1 Scope

This chapter deals with earth work and excavation for civil works in site, formation/oversite leveling, foundations, cutting and grading for roads/pavement and railways, canals, embankments other than water retaining embankments trenching for drainage and other buried services and the like.

2.2 General

The Contractor shall carry out the excavation strictly to the lines and levels, in conformity with the drawings or instructions of the Engineer.

2.3 Setting out

Before commencement of earthwork block levels of existing ground shall be taken by the Contractor jointly with the Engineer plotted and signed in token of acceptance of ground levels. Excavation shall not be commenced until the initial ground levels have recorded and accepted. Reference lines, bench marks and base lines shall be set out by the Contractor for control of earthwork operation. Setting out shall be done with pegs, blocks, bamboo poles or rails marking boundaries or center lines, as the case may be, and the same maintained for reference and future checking Chainage stones at regular intervals shall be set up for embankments. All setting out operations shall be got checked and approved by Engineer. However, such checking and approval by the Engineer shall in no way absolve the Contractor of his responsibilities for carrying out the work to the true lines, levels and positions as per drawing, and in case any error is noticed at any stage in the contractor's work, it shall be corrected/rectified by him without any cost to the Owner.

2.4 Site clearance and demolition

The site shall be cleared of all trees, stumps, roots, brush wood, bushes and other objectionable materials. Useful and saleable material shall be the property of the Owner and shall be stacked properly as directed by the Engineer. The areas to be covered with

embankments shall be stripped of top soil to required depths to expose acceptable founding strata. Top soil unsuitable for use in embankment construction and other fills shall be disposed off as directed. All combustible materials shall be stacked and burnt in locations sufficiently remote to eliminate all danger of fire hazards. All old concrete, brick works and drains which interfere with construction works shall be dismantled with the approval of the Engineer taking all necessary precautions prescribed in safety specification. Top soil which is suitable for use in construction work shall be stockpiled for later use. Other objectionable materials such as trash, debris, stones, brick, broken concrete, scrap metal etc., shall be disposed off as directed by the Engineer. Payment for cutting and removal of trees, stumps, dismantling existing structures and stripping shall be regulated by the description in the Schedule of Items or Part V of these specifications.

2.5 Classification of soil

The Engineer will decide the classification of any particular soil. Classification of soil shall be as under:

A) Ordinary Soil

Soils which yield to ordinary application of pick and shovel, phawra rake or other ordinary digging implements without offering much resistance, shall be classified as ordinary soil. This includes organic soil, turf, sand, gravel, loam clay, mud, peat, black cotton soil, soft shale and loose mourn.

B) Hard Soil

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

C) Soft, Rock/Decomposed Rock

This comprises of rock or boulders which may be quarried or split with crow bars, pavement breakers etc., This include lime stone, sand stone, weathered rocks and hard conglomerates, and existing structures embedded in earth and tarred macadam roads, pavements, met in the excavation. The fact that contractor resorts to blasting for his own reasons shall not mean that the rock is hard and classified as hard rock.

D) Hard Rock

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

2.6 Method of excavation

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

2.7 Excavation of soils other than hard rock

Excavation shall be carried out in the most expeditious and efficient manner to the lines and levels as indicated in drawings or as directed by Engineer. Prior approval of the Engineer shall be taken for the method to be adopted for excavation including dimensions, side slopes, dewatering, shoring etc., Such approval shall not make the Engineer responsible for any consequent damage or loss caused. All precautions shall be taken to preserve the material below and beyond line of excavation in soundest condition. All damages done beyond limits of excavation shall be made good by the Contractor at his own cost in a manner approved by the Engineer. All excavated materials shall be removed to spoil heaps, dumping yards or transported for filling as may be necessary. When soil heaps are formed for future use, heaps shall be protected from washing away due to rain or surface run off. The sides of excavation shall be maintained in stable condition by adequate steppings and batter. To prevent entry of surface water and accumulation of subsoil water in excavated areas, suitable drainage arrangements as may be needed and directed by Engineer, shall be provided and maintained. Pumped out water shall be drained off properly avoiding damage to other existing works. If any pipelines, cables or service lines are likely to exposed, excavation around these services shall be carried out manually and all such services shall be adequately supported and protected.

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

2.8 Excavation in hard rock

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

Blasting operations shall be carried out by a licensed Blaster. The quality and quantity of explosives, size and spacing of holes depth of holes etc., shall be such that they will neither open seams nor damage or shatter the rock beyond the specified lines of excavation. A tolerance of 150 mm will however be allowed beyond the excavation lines. As excavation approaches final stages, the depth of holes and the amount of explosives used shall reduced progressively to avoid over breakage or damage to founding strata. Any fissures, cracks and voids below prescribed depth of excavation shall be corrected by removing loose pieces, shattered or affected rock and replaced by

lean concrete of M-5 grade in the case of foundations. Where excavated surface is to receive structural concrete, the surface shall be cleaned of dust and other objectionable materials.

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

2.9 Cutting and filling for site leveling

Excavation and filling operations for site leveling shall be so planned and executed, that transportation and re-handling are minimized. The sides of excavation and fills shall be maintained in stable condition by adequate batters, steppings and dewatering. Materials not desirable shall be disposed off in area indicated by Engineer. When it is required to blend the material, it shall be done by selective excavation and filling operation. Wells, ponds, cesspools and water logged areas shall be emptied of water and de-slushed before filling. Filling shall be done in horizontal layers not exceeding 150 mm in thickness. All clods shall be broken before placing the fill. Earth moving equipment shall be allowed to ply over the fill to permit compaction. Adequate allowance shall be made for subsidence of fill material. Levels shall be taken and excess or shortfall shall be made good by appropriate cutting or filling.

2.10 Excavation for trenches

Excavation for trenches shall be carried out in materials excavated to enable laying of service lines or drainage channels or any other desired purpose. Excavation shall be done to lines and levels shown in drawings and shall be done providing adequate measures for stability. Vertical wooden reapers or light rails shall be erected at uniform levels at places where changes of direction and gradients occur. Center lines shall be marked on horizontal repress or rails, laid across the trenches. Depths of excavation and pipe invert levels shall be checked by means of boning rods of appropriate lengths. Trench beds shall be trimmed and rammed with sprinkling of sand or moorum to required gradients for continuously supporting the pipelines. Trenches shall be locally deepened and widened to receive sockets and permit joints to be inspected.

2.11 Excavations for foundations

Excavation for foundation shall be done to the lines and levels indicated in the drawings. Excavated material shall be transported and stored at convenient spots for reuse in back filling of foundations and other fills. Surplus material shall be spread and levelled at dumping areas. Side slopes of excavation and/or shoring shall be adequate from consideration of stability and working space. When so required and authorized by Engineer, the sides of excavation shall be protected with proper shoring, strutting, sheeting and sand bags etc., These shall be removed only when work in the pit is completed, with the approval of the Engineer. When it is felt that removal of supports may result in side collapse or settlement of adjoining ground or endanger adjoining structures and foundations, they shall be left permanently in position. The last 150 mm of excavation shall be done and the bottom trimmed to the required levels only when concreting is imminent. If at any point the natural ground is disturbed or loosened for any reason, it shall be consolidated by tamping or rolling or made up with concrete of M-5 grade, if so ordered by the Engineer. Where the soil encountered at depths indicated in drawings is loose or weak, it shall be further excavated to levels of firm strata as may be directed by the Engineer and filled with lean concrete of M-5 grade. If

the bottom of excavation has been left exposed not through neglect or fault of the Contractor and it has become deleteriously affected by atmospheric action and water, such portion of deteriorated foundation material shall be removed and made good by lean concrete of grade M- 5, such extras will be paid for.

2.11.1 For deep excavation in the proximity of existing buildings, foundations, streets, railway tracks, underground cabling, gas piping, water and drainage lines, and the like, adequate appropriate precautions shall be taken to protect such structures or works from damage, displacement or settlement, either as an immediate result of the excavation or as after effect, discernable with the passage of time. The method of protection of existing structures and services may include sheet piling, shoring, strutting slinging or any other method including dewatering. Payment for such protective work shall be governed by the description given in the Schedule of Items for the particular work.

2.11.2 For excavation adjoining existing piles care shall be taken to ensure that no pile under any circumstances is exposed from the top for a height exceeding 2 meters. No strutting shall be done against exposed piles, nor exposed piles ever used for tying guy ropes or supports either temporarily or permanently.

2.12 Excess excavation

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

i) Excess excavation in case of site leveling shall be made good by filling and compacting with material same as the surrounding material. Degree of compaction shall be at least the same as the surrounding material.

ii) Excess excavation in case of trenches shall be made good by filling and compacting with selected earth to the same compaction as the surrounding material or as directed by Engineer. This shall be done in layers not exceeding 150 mm thick, moistened and thoroughly compacted by tamping.

iii) Excess excavation in case of foundation beyond required depths shall be made good by filling with lean concrete of M-5 grade.

2.13 Disposal of excavated materials

Excavated materials that are unsuitable for use in construction works or in excess of construction requirements shall be disposed off in dumping yards or in locations indicated by Engineer. Waste piles/heaps shall be located in such places where they will not interfere with natural flow of rain water access or transport or with the access to nearby structures. When required, they shall be levelled and trimmed to such lines and levels as indicated by Engineer.

2.14 Back filling of trenches

Trenches shall be backfilled after pipes or service lines are tested and approved. Filling shall be done with earth in 150 mm thick layers free from unwanted material and well rammed. Soft material shall be used in bottom of trenches upto a level of 150 mm

above the top of pipes before backfilling with other fill materials. All clods and lumps shall be broken before placement. Care shall be taken not to disturb, break or damage the pipes during backfilling and compaction process.

2.15 Backfilling of foundations

Backfilling of foundations shall be done using suitable soils from excavations. Soil shall be free from organic matter and other materials which would affect the stability of the fill and shall be free from boulders, brick bats wood pieces and other injurious materials, lumps and clods. Before commencement of backfilling of foundations, all shoring and formwork, bits of timber, cement bags and all other rubbish shall be removed. Hydro-insulation, Bitumen painting or application of anti-corrosive protective and anti-termite treatments shall have been completed. Backfilling operation shall not commence without approval of Engineer. Backfilling shall be carried out in well compacted layers of 150 mm thickness. Each layers shall have near optimum moisture content. Layers will extend to the entire width of excavation and shall be sprinkled with water during compaction process. Ramming shall be done to achieve firm compaction. Backfill shall be trimmed and finished to lines and levels indicated in the drawings and/or as directed by the Engineer.

2.16 Filling under floors

Material for filling under floors shall be soil free from harmful minerals, vegetable matter etc., and shall not be expansive soils. Filling shall be done in well compaction layers not exceeding 150 mm in thickness. Each layer shall be compacted to 95% Standard Procter Density. Sufficient soaking shall be done before compaction. The entire area to be covered by flooring shall be finally dressed and trimmed to required levels.

2.17 Load bearing fills

Load bearing fills include embankments for roads and railways and such other earth fills above ground levels provided for protection of fuel oil tanks, pads for storage tanks, drain bunds and the like.

Fill materials shall either be selected earth obtained from excavations for site leveling, trenches and foundations or from selected borrow areas as may be required. Soils selected for filling in embankments shall be of uniform quality and free from boulders, organic materials and other objectionable matter. Soils having high silt and clay content and having laboratory maximum dry density less than 1.44 gms per c.c. shall not be used for load bearing fills. For fills greater than 3 m in height soils shall have laboratory density not less than 1.52 gms per c.c. Soils for top 500 mm of fills for roads and railways shall have laboratory density not less than 1.65 gms per c.c. and shall not have marked selling and shrinkage properties.

Foundation preparation for embankments shall be done as prescribed under site clearance. The founding strata shall be compacted as much as possible by rolling or tamping before placement of fill material. The water content of founding strata should be same as that specified for embankment fill. Any pockets of loose material or depressions left in founding strata as a result of clearing operation shall be filled and compacted with the same material as the surrounding founding strata. When an embankment is to be placed on steep sloping ground the surface of the ground shall be trenched in steps or trenched or broken up in such a manner that the new materials bonds well with the founding strata.

Fill material shall not be placed until foundation has been inspected and approved by Engineer. Material shall be placed in even, continuous, horizontal layers over full width of embankment in well compacted layers not exceeding 200 mm thickness. Each layer shall be compacted by means of smooth rubber tyred rollers, sheep-foot rollers, tractors, tampers or other mechanical means as may be found suitable for the location. Before rolling the water content shall be checked and corrected by sprinkling with water or adding dry material or aeration as may be required. This shall be followed by mixing and the layer left for soaking before compaction. The water content shall be within plus or minus 2% of Standard Proctor Optimum. Density of compacted layers shall be determined by sand replacement method. Average compacted density shall be at least 95% of Standard Proctor Density. The number of tests to be conducted for determination of moisture content and density shall be as provided by the Engineer.

Side slopes of embankments shall be formed alongwith the main embankment. No side dumping shall be done for the formation of slopes. When required the width of each layer shall be constructed slightly in excess of required width and slopes trimmed to remove loose edge materials and completed to lines shown in drawings or as directed by the Engineer.

Subgrade for road works shall be thoroughly wetted sufficiently in advance of placing of any base course and it shall be ensured that it is firm and moist for at least 50 mm below the surface. Should the subgrade for any reason be loose or have density less than required, it shall be re-compacted and refinished. Excessive loss of moisture in the subgrade shall be prevented by sprinkling and/or scaling. No traffic or hauling equipment shall be permitted to play on finished subgrade and any damage caused to such portion shall be made good by the Contractor at his own cost.

2.18 Turfing

The slopes of embankment shall be dressed to line and slightly roughened to bond and hold a surface dressing consisting of 150 mm humus layer of soil. The entire surface shall then be covered with turf consisting of blocks or strips of grass of approved species. The sod shall include a net of roots and earth at least 75 mm thick. The sod shall be laid on slope in close contact and then tamped in place so as to close and fill the joints between blocks.

Immediately after placing the turfed slope shall be thoroughly wetted and kept wet for a sufficient period to assure plant growth. Watering shall be continued until the grass taken root firmly and the whole area presents a uniform appearance. In the event that the plant growth has not taken place within the period of maintenance such areas or patches shall be redone by the Contractor at his own cost.

3.0 ANTI-TERMITE TREATMENT

3.1 Scope

The scope of work includes setting up a chemical barrier against attack by subterranean termites while the building is under construction.

3.2 Execution

3.2.1 General

All work shall in general be executed as specified in IS: 6313 Part-II and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

3.2.2 Chemicals and rate of application

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals	Concentration by weight, percentage
Dieldrin	0.5
Heptachlor (IS:6439 -1972)	0.5
Aldrin (IS: 1308 -1964)	0.5
Chlordane (IS: 2632 -1966)	1.0

3.2.2.1 Treatment of pits, trenches and basement excavations

Foundations, basements etc., may either be fully enveloped by the chemical barrier or the treatment may start 500mm below ground level. The bottom surface and sides of excavation (upto a height of about 300 mm) for column pits, walls, trenches and basements shall be treated with chemicals at the rate of 5 litres per sqm of surface area. Backfill around columns, walls, etc., shall be treated at the rate of 15 litres per sqm of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150mm centres close to the wall surface and spraying the chemicals in the specified dose.

3.2.2.2 Treatment of top surface of plinth filling

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crow-bars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres per sqm of surface shall be applied prior to laying soling or subgrade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

3.2.2.3 Treatment of doors, windows & soil surrounding pipes, Wastes and conduits

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building. All the wooden door/window frames on the ground floor of the buildings shall be treated with the insecticide solution.

3.2.2.4 Treatment of expansion joints

These shall receive special attention and shall be treated in a manner approved by the Engineer.

3.3 Acceptance Criteria

The Contractor shall give a 10 year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialized agency for the job to keep the building free of termites for the specified period at no extra cost to the Owner.

4.0 CONCRETE PLAIN & REINFORCED

4.1 Scope

This chapter covers the workmanship, special requirements & regulations with which the contractor must comply to achieve the following two objectives :

(a) The provision, at all locations on the site, of dense workable concrete, having the specified characteristic strength.

(b) The placing of concrete at all elevations, well compacted by vibrations, in well aligned and well fixed formwork ensuring the internal and external dimensions of structures as per drawings and maintaining the size, shape number and locations of reinforcements, inserts etc., as specified in the drawings providing the surface finish after stripping off the formwork to ensure the structural configurations as per drawings as well within the specified tolerance limits, curing and guaranteeing the characteristic strength, all as specified.

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

4.2 Materials

For materials reference to Part-I (Materials) shall be made.

4.3 Grades of Concrete

The grades of concrete shall be in accordance with the following table. The grade of concrete to be used in each section of work will be shown in the drawings or in the schedule of items :

GRADE OF CONCRETE	CHARACTERISTIC STRENGTH i.e. COMPRESSIVE STRENGTH OF 15 CMS CUBES AT 28 DAYS (N/mm^2)	NOMINAL MAX. AGGREGATE SIZE (mm)
M-5A (Lean Concrete)	5	63
M-5B (Lean Concrete)	5	40
M-7.5A	7.5	63

GRADE OF CONCRETE	CHARACTERISTIC STRENGTH i.e. COMPRESSIVE STRENGTH OF 15 CMS CUBES AT 28 DAYS (N/mm^2)	NOMINAL MAX. AGGREGATE SIZE (mm)
(Lean Concrete)		
M-7.5B (Lean Concrete)	7.5	40
M-10 A	10	63
M-10 B	10	40
M-10 C	10	20
M-10 D	10	12
M-15 A	15	63
M-15 B	15	40
M-15 C	15	20
M-15 D	15	12
M-20 A	20	63
M-20 B	20	40
M-20 C	20	20
M-20 D	20	12
M-25 C	25	20
M-25 D	25	12
M-30 C	30	20
M-30 D	30	12
M-35 C	35	20
M-35 D	35	12

Notes: A,B,C,D mentioned along with grade of concrete correspond to the maximum size of coarse aggregates being 63mm, 40mm, 20mm and 12mm respectively.
Unless otherwise specified in the drawings or schedule of items the maximum nominal size of coarse aggregates for different grades of concrete shall be as under :

(a) For concreting in very narrow space or in very small thickness .. 12 mm

(b) For all reinforced concrete work except in massive foundations .. 20 mm

(c) For all ordinary plain concrete and massive reinforced foundations .. 40 mm

4.4 Mix Design

4.4.1 General

At the commencement of the contract the Contractor shall make preliminary tests to determine the proportions by weight of cement, fine aggregates, coarse aggregates and water necessary to produce required grades of concrete. The mix proportions shall be selected to ensure that workability of the fresh concrete is suitable for the conditions of handling and placing and when concrete hardens, it shall have the required strength, durability and surface finish. The Contractor shall get approval of Engineer to such proportions before he starts concreting. However, such approval shall not relieve the Contractor of his responsibility to produce concrete having compressive strengths as laid down in the foregoing Table.

No departure from the approved proportions will be permitted during the works unless and until the Engineer gives written authorization for any change in proportion. The Engineer shall have authority at any time to check whether the mixing of concrete is being carried out according to the approved proportions.

4.4.2 For the all major and important R.C. works and for all special works, the design of mixes shall be made by the Contractor at his own cost, for each grade of concrete as well as for various workability. The design of mixes shall be made according to relevant I.S. codes or to approved standard methods.

4.4.3 The concrete made by designing the mix is termed hereinafter as "Design Mix Concrete".

4.5 Water/Cement Ratio

4.5.1 Where a particular water/cement ratio is stipulated in the design or drawing alongwith the characteristic grade of concrete the design of mix shall be carried out by adjusting the other variable factors to obtain the characteristic strength of concrete with stipulated water/cement ratio.

4.5.2 In the structures where the impermeability and shrinkage of concrete have an important bearing on the durability and serviceability of the structures, such as water retaining structures, basements, underground premises, tunnels, pump houses, exposed structures near sea side or deserts, prestressed structure, thin precast members etc., the water cement ratio shall be kept low and preferably not exceeding 0.45.

4.5.3 The water cement ratio, as achieved in the Mix Design, or as specified in the drawings shall be adhered to strictly and shall not be varied without the permission of the Engineer.

4.6 Workability

4.6.1 The workability of fresh concrete shall be such that the concrete is just suitable for the conditions of handling & placing so that after compaction if becomes completely consistent and homogeneously surrounds all the reinforcement and completely fills the formwork.

4.6.2 The workability of fresh concrete at the place of batching/mixing shall be measured by compacting factor test and at the place of disposition by means of slump test. During

the finalization of Trial Mixes, the relationship between compacting factor and slump test shall be established for each grade of concrete as well as for various levels of workability.

4.6.3 Normally, in the condition of low water cement ratio as well as for medium/high workability, the workability shall be achieved by increasing the cement content.

4.6.4 In cases where the cement content is to be limited to reduce the heat of hydration, and the water/cement ratio is also to be kept low to reduce the permeability or due to other requirements the desired workability may be achieved with use of limited doses of platiciser or air entraining agent. In such cases the method of mixing and dosage of the plasticiser/air entraining agent shall be according to the manufacturer's specification and with the approval of the Engineer.

4.7 Durability

The durability of concrete, depending on the exposure condition, is to be taken into account while designing the mix. For given aggregates, the cement content should be sufficient to make sufficiently low water cement ratio and Appendix A of IS: 456 shall be taken as guideline for durability considerations.

4.8 Trial Mixes

4.8.1 After approval of the Mix Design by the Engineer, the Contractor shall make in presence of Engineer the Trial Mixes for each grade of concrete as well as for required workability.

4.8.2 Before starting the trial mixes, necessary preparatory works like determination of sieve analysis of the aggregates, densities of different ingredients, moisture contents in the aggregates, shall be completed according to the relevant I.S. Codes.

4.8.3 Each trial mix shall be handled and compacted by the method which the Contractor proposes to use for that mix in the works and the mixes shall not show tendency of inadequate compaction by the method proposed.

4.8.4 The compacting factor and the slump of each trial mix shall be determined immediately after mixing and the values shall not exceed the maximum value obtained in the mix design.

4.8.5 Five numbers of 150 mm test cubes shall be made from each trial mix. These shall be cured and tested in accordance with relevant I.S. codes. In order to have the specified characteristic strength in the field, the concrete mix as designed in the Design Mix shall have higher average compressive strength depending on the degree of quality control at site.

4.8.6 Before commencement of the concreting works of particular grade of concrete, the Contractor must complete the work of trial mixes and subsequent testing of the test cubes obtained therefrom and the desire of the Approved Mix for that particular grade of concrete.

4.8.7 The entire cost of all the trial mixes including all the preparatory works for trial mixes, preparation of test cubes and their testing shall be borne by the Contractor.

4.9 Nominal Mix Concrete

4.9.1 Nominal mix concrete may be used for all concrete of Grade M-10 and below. If design mix concrete cannot be used for any reason for Grade M-15 & M-20, nominal mix concrete may be used with the permission of Engineer, Nominal mix concrete shall not be used, in any case for Grade of concrete above M-20.

4.9.2 The proportioning of materials for nominal mix concrete shall be in accordance with Table-3 of clause 8.3 of I.S. 456. The stipulations of Clauses 8.3.1 & 8.3.2 of IS: 456 shall also be taken into consideration.

4.10 Volumetric Mix Concrete

Where concrete is specified in volumetric proportions such as 1:4:8, 1:3:6, 1:2:4, 1:1 1/2:3, 1:1:2 etc., in the schedule of items, coarse and fine aggregates shall be measured by volume and cement by weight. The water cement ratio shall be within 0.45 to 0.70 depending upon the workability.

4.11 Batching of Concrete

4.11.1 Cement

Cement shall always be batched by weight. A separate weighing device shall be provided for weighing cement. Where the weight of cement is determined by accepting the weight per bag, number of bags shall be weighed separately to determine the average net weight of cement per bag and the same shall be checked regularly.

4.11.2 Aggregates

4.11.3 For both Design Mix concrete and Nominal Mix concrete, the aggregates (coarse and fine) shall be batched by weight.

4.11.4 In particular cases, or where weight-batching is not possible proportioning by volume batching may be allowed by the Engineer, provided the Contractor guarantees the uniformity of aggregates through out the period of construction. For this purpose, the Contractor shall submit to the Engineer sufficient data indicating the weight/volume relationship of aggregates for different types of concrete and after such approval, periodic checks on the weight/volume relationship of the aggregates shall be made by the Contractor to the satisfaction of the Engineer. Where aggregates are moist and volume batching is adopted, allowance shall be bulking in accordance with I.S. 2386 (Part-III).

4.11.5 Suitable adjustments shall be made for the variation in the weight of aggregates due to variation in their moisture contents.

4.12 Water

4.12.1 Water may be measured either by weight or by volume. When measured by volume, it shall be by well calibrated conical shaped jar or vessel or from a calibrated tank filled to the mixer.

4.12.2 Adjustment of water due to moisture contents in coarse and fine aggregates

It is very important to maintain the water cement ratio constant at its correct value. For the correct determination of amount of water to be added in the concrete mix, to maintain the water cement ratio constant, the amount of moisture content in both coarse

and fine aggregates shall be taken into consideration, be as frequently as possible, the frequency for a given job being determined by the Engineer according to weather conditions.

4.12.3 Determination of moisture content in the aggregates

Determination of moisture content in the aggregates shall be according to I.S. 2386 (Part-III). Where tests are not conducted, the amount of surface water may be estimated from the following table :

Aggregates	Surface water carried by Aggregates	
	% by weight	Lir/m^3
Very wet sand	7.5	120
Moderately wet sand	5.0	80
Moist sand	2.5	40
Moist gravel stone chips.	1.25 - 2.5	20-40
+Coarser the aggregate, less the water it will carry.		

4.12.4 Admixtures

Any solid admixture, to be added, shall be measured by weight, but liquid or semi-liquid admixture may be measured by weight or volume.

4.12.5 Accuracy of batching

The accuracy of batching shall be within the following tolerance:

Cement within plus or minus 2% by weight.

Aggregate within plus or minus 5% by weight.

Water within plus or minus 0.5% by weight.

4.13 Mixing & Transportation of concrete

4.13.1 Mixing of Concrete

4.13.1.1 Machine mixing

Concrete shall always be mixed in mechanical mixer. Water shall not, normally, be charged into the drum of the mixer until all other ingredients are already in the drum and mixed for atleast one minute. Mixing shall be continued until there is uniform distribution of materials and the mass is uniform in colour and consistency. The mixing time from the time of adding water shall in accordance with IS: 1791 but in no case less than 2 minutes or atleast 40 revolutions.

4.13.1.2 Hand mixing

When hand mixing is permitted by the Engineer it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand mixing 10% extra cement shall be added to each batch at no extra cost to the Owner.

4.13.2 Transportation of concrete

4.13.2.1 Concrete shall be transported from the place of mixing to the place of placing concrete as rapidly as practicable by means which will prevent the segregation or loss of any of the ingredients and maintain the required workability. No water shall be mixed with the concrete after it has left the mixer.

4.13.2.2 Where concrete is transported over long distances, the Contractor shall provide suitable means by which different grades of concrete are readily indentifiable at the place of final deposit.

4.14 Preparatory Works/Surface Preparation

4.14.1 For concrete directly on earth foundation

4.14.1.1 Earth foundation on which direct placement of concrete is specified, shall be rammed and consolidated as directed by the Engineer such that it does not crumble and get mixed with concrete during or after placement. If the foundation is quite wet, the same shall be kept dry and then sufficiently consolidated, if necessary, a thin top layer of the wet soil shall be removed and replaced by sand or other suitable materials as directed by the Engineer without any cost to the Owner. Care shall also be taken that earth from the sides also does not get mixed with the concrete, during or after placement, before it has sufficiently set and hardened.

4.14.1.2 The earth foundation, over which concrete is to be placed direct, shall not be kept abandoned at the specified level and concrete shall be placed immediately following the final preparation of the formation otherwise suitable measures shall be taken, as directed by the Engineer without any cost to the Owner.

4.14.2 For construction joints

All such joints shall have continuous square bond grooves to produce a substantial and waster-tight key. Where the placement of concrete has to be resumed on a surface which has hardened, it shall be roughened, cleaned by wire or bristle brushing, compressed air, water jet etc., and thoroughly wetted. For vertical construction joints a neat cement slurry shall be applied on the surface immediate before the placement of concrete. For horizontal joints the surface shall be covered with a layer of mortar about 10 to 15 mm thick composed of cement and sand in the same proportion as the cement and sand in the concrete mix freshly mixed and applied immediately before placing of the concrete. On this surface (i.e. on the surface of joints) a layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against old work, particular attention being paid to corners and close spots. To ensure water tightness, care shall be taken to punn concrete properly against the old surface.

4.14.3 On vertical surfaces of masonry

When the concrete is placed on the vertical surface of masonry (as in the case of thin concrete fins projected from the vertical masonry surface), a groove of dimension as directed by the Engineer shall be cut in the masonry to ensure a proper bond and the surface shall be cleaned thoroughly. Before the placement of concrete, the surface shall be kept moist by spraying water at least for the period of 2 hours and a thick coat of cement slurry shall be applied immediately before the placement of concrete.

4.14.4 Inside the formwork (cleaning, surface preparation etc.,)

The interior of the form works, where the concrete is to be placed, shall be thoroughly washed by high pressure water jet or air jet to completely clean the entire volume from all sort of dirt, grease/oil, foreign and deleterious materials etc. The reinforcement shall be completely clean and free from all sorts of dirt, grease/oil, rust, foreign/deleterious materials etc., Before placement of concrete, the form works coming in contact with concrete, shall be coated highly with form oil or raw linseed oil material or provided with any approved material to prevent adhesion of concrete to the form work, but utmost care shall be taken so that such oily material do not come in contact with the reinforcement.

4.15 Placing and Compaction of Concrete

4.15.1 The concrete shall be placed and compacted before setting commences and should not be subsequently disturbed. No water shall be mixed with the concrete after it has left the mixer. Method of placing should be such as to preclude segregation. Approved mechanical vibrator shall be used for compacting concrete, and concrete shall not be non-vibrated or under vibrated. No concrete shall be placed until the place of deposit has been thoroughly inspected and approved by the Engineer. all inserts and embedments properly secured in position and checked and forms properly oiled. No concrete shall be placed in the absence of the Engineer.

4.15.2 Concrete shall be placed on clean bed having the designed level. The bed shall be cleaned of all debris and other objectionable materials. Seepage water, if any, shall be controlled or diverted.

4.15.3 Concreting shall not be carried on during rains unless all precautions have been taken by the Contractor and necessary permission has been given by the Engineer. Suitable measures shall be taken to control the temperature of concrete.

4.15.4 Where plums are permitted is massive concrete, they shall be washed and carefully placed. No stone shall be closer than 30 cm to an exposed face, nor nearer than 15 cm to an adjacent stone.

4.15.5 Concrete shall not be dropped from a height of more than 2m except through a chute, the design and type of which shall be subject to approval of the Engineer.

4.15.6 The concrete shall be placed, spread and compacted by approved mechanical vibrator. Vibrators shall not be used for pushing concrete to adjoining areas.

4.15.7 For members involving vertical placing of concrete (e.g. columns, walls etc.,), each lift shall be deposited in horizontal layer extending for the full width between shuttering and of such depth that each layer can be easily and effectively vibrated and incorporated with the layer below by means of compaction being employed.

4.15.8 For members involving horizontal placing of concrete (e.g. slabs, beams etc.,) the concrete shall be placed along the line of starting point in such quantities as will allow members to be cast to their full depth along the full width between side shuttering and then gradually brought towards the finishing point along its entire front parallel to the starting line. Vibration and surface finish shall follow behind the placement as closely as possible.

4.15.9 Utmost care shall be taken to avoid the displacement of reinforcements/embedded parts or movement of formwork or damage to faces of the form work or transmission of any harmful vibration/shocks to the concrete which has not yet hardened sufficiently.

4.15.10 All members shall be concreted at such a rate that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable.

4.15.11 Should any unforeseen occurrence result in a stoppage of concreting for one hour or such other time as might allow the concrete, already placed, to begin to set before the next batches can be placed, the Contractor shall make at his own cost, suitable tongue, and groove construction joint, as approved by the Engineer. Any additional reinforcement required as directed by the Engineer shall also be provided by the Contractor at his own cost. Before placement of new batches of concrete over that construction joint, the surface preparation according to this specification stipulated earlier, shall be done by the Contractor.

4,15.12 The concrete shall be worked well up against whatever surface it adjoins and compacted to such a degree that it reaches its maximum density as a homogeneous mass, free from air and water holes and penetrates to all corners of moulds and shuttering and completely surrounds the reinforcement. All measures shall be taken to make the shape, size, and location of the finished concrete including its embedments, holes, openings etc., well within the accepted tolerance limit.

4.16 Construction Joint & Cold Joints

4.16.1 Construction joints

4.16.1.1 Normally, the construction joints including crank inducing joints shall be constructed as per locations and details indicated on the drawings.

4.16.1.2 Where the location of the joint is not specified in the drawings, it shall be in accordance with the following guide lines :

(a) <u>In Columns</u>

(i) <u>In case of Projection from basement slab</u>

300 mm from the top of base slab or 75 mm from the top of the haunches whichever is higher

(ii) In framing of beam at different elevation, 75 mm below the lowest soffit of the beam and in case of projection from beams and slabs 75 mm from the top surface of the beam/slab or at the top surface of beam/Slab whichever facilities formwork.

(iii) For columns below flat slabs 75 mm below the lowest soffit of the slab.

(b) In walls (horizontal construction joints)

(i) Walls projecting from base slab

300 mm from top of base slab.

(ii) Walls supporting the suspended slab

75 mm from the lowest soffit of the slab.

Note:- In the case of water retaining structures and structures under the influence of ground water, approved water bars of suitable size shall be provided to make the joint completely water-tight.

(c) In beams

Beams shall be cast, as a rule, without a joint. But if provision of a joint is unavoidable, the joint from simply supported beam shall be vertical and at the middle of the span in continuous beam, the same shall be at the point of minimum shear force.

(d) In suspended slabs

(i) In slab of small span, there shall be no construction joints.

(ii) In slabs of large span and continuous slabs, construction joint, if allowed by the Engineer shall be vertical at the middle of span and at the right angles to the principal reinforcement.

(e) In walls (Vertical construction joint)

As a rule, walls shall be cast monolithically without any vertical construction joint, unless specified in the drawing. However, for a long wall, the Engineer may allow vertical construction joint and the same shall be at the place of minimum shear force. In water retaining structures and in structures under the influence of ground water approved water bars of suitable size shall be provided to make the joints completely water tight.

(f) In slabs resting on ground

(i) For Plain concrete

Concreting shall be done in alternate panels not exceeding 10 sqm in area. The largest panel dimension shall be 5 m.

(ii) For nominally reinforced slab

The area of pour shall not exceed 40 sqm and the maximum panel dimension shall not exceed 8m.

(iii) For the basement slabs which act as structural member

There shall be no construction joint.

(g) In ribbed beam

The beams shall be cast monolithically with the slab in one continuous operation.

4.16.1.3 In all construction joints the reinforcements shall pass through as per drawings and the same shall not be disturbed in any way.

4.16.1.4 The vertical construction joints shall be provided by insertion of board keeping provision for passage of reinforcement/fixtures/embedments. All construction joints shall be made to form a tongue and groove joint.

4.16.2 Cold joint

An advancing face of a concrete pour, which could not be covered before expiry of initial setting time for unexpected reasons, is called a cold joint. The Contractor shall remain always vigilant to avoid cold joints. If however, a cold joint is formed due to unavoidable reasons, the following procedures shall be adopted for treating it:

(a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly over the old surface and the fresh concrete alongwith the old concrete shall be vibrated systematically and thoroughly.

(b) In case the concrete has hardened a bit more than (a), but can still be easily removed by a light hand pick, the surface shall be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. Then a rich mortar layer of 12 mm thickness, shall be placed on the cold joint and then the fresh concrete shall be placed on the mortar layer and vibrated thoroughly, penetrating deep in to the layer of concrete.

(c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise inspite of extensive vibration, a tongue and groove joint shall be made by removing some of the older concrete and the joint shall be left to harden at least for 12-24 hours. It will then be treated as regular construction joint and the surface preparation of the same, before placement of concrete, shall be as described in the appropriate clauses of these specifications.

4.17 Requirements for Concreting in Special Cases

4.17.1 Concreting in deep lifts

Placing of concrete in lifts exceeding 3 M in columns & 2 M in walls is in the category of deep lifts.

4.17.1.1 Before commencement of work, the contractor shall submit for the approval of the Engineer, the details of the methods he propose to adopt for concreting.

4.17.1.2 The placement of concrete shall preferably be by tremie chute or any other approved method.

4.17.1.3 In structures of heavy/complicated reinforcement or in complicated form works, the contractor shall provide sufficient number of windows in the form works as directed by

the Engineer to check the placement and compaction of concrete in different stages. Such windows shall be closed as soon as the concreting reaches the bottom level of the same.

4.17.2 Concreting under water

When it is necessary to deposit concrete under water, the special requirements, over and above those of this specification shall be in accordance with Clause 13.2 of IS: 456.

4.17.3 Cold weather concreting

When conditions are such that the ambient temperature may be expected to be 4.5 C degree or below during the placing and curing period, the work shall conform to IS: 7861 (Part-II).

4.17.4 Hot weather concreting

When concreting in very hot weather the Contractor shall take all precautions as stipulated in IS: 7861 (Part-I) and stagger the work to cooler parts of the day to ensure that the temperature of wet concrete used, specially in massive structure, does not exceed 38 degree 'C'.

Positive temperature control by methods like pre-cooling, post cooling or cooling of concrete by circulating cold water through small embedded pipe lines inside concrete, if required, shall be specified and shall be undertaken.

4.17.5 Concreting in the area exposed directly along sea coast

The special requirements, over and above those of this specification shall be in accordance with clause 13.3 of IS: 456.

4.17.6 Concreting in large pours (mass concrete)

4.17.6.1 The aim of controlling the concreting in large pours is to reduce cracking caused by shrinkage due to heat of hydration. The Contractor shall submit detailed proposal to the Engineer for approval about the method of pouring and the measures to reduce heat of hydration, which he proposes to adopt.

4.17.6.2 The maximum height of lifts will depend on the type of cement used. The use of cement having low heat of hydration, could allow greater lifts.

4.17.6.3 The Contractor shall provide all the necessary arrangements like precooling of aggregates, cooling of fresh concreting by passing cold water through pipes placed inside the concrete or such other measures at least 48 hours before the placement of concrete and also provide the facility for recording of temperature at least 24 hours prior to placement of concrete.

4.17.6.4 The minimum interval between concreting of successive lifts, separated by horizontal construction joint, shall be six days or as directed by the Engineer.

4.17.6.5 The minimum interval between the concreting of adjacent pours separated by vertical construction joints shall be three (3) days, or as directed by the Engineer.

4.18 Finishes to Exposed Surfaces of Concrete

The Contractor is to include his quoted rate for concrete, the provision of normal finishes in both formed & unformed surfaces as and where required by the Engineer without any extra cost to the owner. Some common finishes are indicated below:

4.18.1 Surface which do not require plastering

Surface in contact with casings shall be brought to a fair and even surface by working the concrete smooth against casings with a steel trowel while it is being deposited and also by working over the surface with a trowel immediately after the removal of the casings or centerings, removing any irregularities and stopping air holes, etc. Use of mortar plaster is not permissible for correcting levels, removing unevenness etc. However, if, in the opinion of the Engineer, such plastering is unavoidable then the thickness of plaster shall in no case exceeds 5 mm and the plastering shall be in cement mortar.(1:3).

4.18.2 Faces of foundations which will be back filled

Neither the smoothness of the surface not the positions of the joints in the form work are important. Small blemishes caused by entrapped air are permitted. No special surface finish is required.

4.18.3 Exposed surfaces which need plastering

Surfaces of beams/columns flushing with the block work or other structures where is intended to plaster, shall be hacked adequately as soon as the shuttering is stripped off so that proper bond with the plaster can develop.

4.18.4 Surface for non-integral finish

Where a non-integral finish such as floor finish is specified or required, the surface of the concrete shall be struck off at the specified levels shall be finished and finished rough.

4.18.5 For monolithic finish

Where no more finishing course is to be applied as in the case of basement floor, industrial flooring or the screed concrete flooring etc, the concrete shall be completed and struck off at the specified levels and slopes with a screed, board and then floated with a wooden float. Steel trowelling is then started after the concrete has hardened enough to prevent the excess of fines and water to rise to the surface but not hard enough to prevent proper finishing. Trowelling shall be such that the surface is flat, smooth and neatly finished.

4.19 Curing of Concrete

4.19.1 General

The purpose of curing is either to provide sufficient water at optimum temperature or to prevent loss of moisture from the concrete itself so that the cement inside the concrete is sufficiently hydrated which of course in slow and prolonged process. As soon as the concrete has hardened sufficiently the curing shall be started.

4.19.2 Different methods of curing

Any one of the following may be used for curing as approved by the Engineer.

(a) Curing by direct water.

(b) Curing by covering the concrete with absorbent material and kept damp.

(c) Covering the concrete with an impervious sheet.

(d) Curing by providing protective membrane.

(e) Curing by chemical coating.

4.19.3 Curing by direct water

This is done either by ponding or spraying water.

(a) Ponding

Ponding is widely used for curing slab and pavements. Earth bunds are formed over the slabs and water is pumped or poured into them and the same is replenished at interval to make up for the loss of evaporation. As this type of curing is one of the best methods, 10 days of curing after final setting is sufficient.

(b) By spraying water

Curing is done by spraying water by suitable means at approved time intervals. While spraying it shall be ensured that the complete area is covered. In order to avoid cracking, cold water shall not be applied to massive members immediately after striking the form work, while the concrete is still warm. Alternate wetting and over drying shall be avoided.

Curing by spraying water shall be continued at least for 18 days.

4.19.4 Curing of concrete with absorbent material kept damp

The entire concrete surface is covered either with hessian, burlap, sawdust, sand, canvas or similar material and kept wet continuously for atleast 12 days after final setting.

4.19.5 Curing by covering concrete surface with an impervious sheet

This is achieved by covering the entire concrete surface with water proof paper or plastic sheets specially manufactured for this purpose. The waterproof papers are stuck together by adhesive compound and the plastic sheets can be welded at site.

Such type of covering shall be kept at least for 24 days after the final setting. It is preferable to have sheet as white in appearance since the white colour will reflect hot sunrays and keep the concrete temperature at reasonable level.

4.19.6 Curing by providing protective membrane by applying a curing compound

This is achieved by applying a membrane forming compound (curing compound) over the concrete surface. Generally these are available in emulsion form, liquid. The

application of the curing compound should be started immediately after stripping off the shuttering in case of formed surface and after the surface has hardened in case of unformed surface.

The curing compound membrane forming emulsion dry up within 3 to 4 hours after application and forms a continuous coherent adhesive membrane over the concrete surface. Such membrane serves as a physical barrier to prevent the loss of moisture from the concrete itself. Membrane forming emulsions are generally coloured black or white to improve visibility for ensuring uniform application. Black colour shall never be used for curing in very hot weather. In order to prevent glare, a colouring pigment may be added to white compounds.

(a) Black curing compounds are either Bituminous or Asphaltic emulsions and shall be used to the surface which are to be covered by back filling or on the floor which is to be covered with tiles and linoleum.

(b) White curing compound shall be used to the surfaces of tall structures under exposure of hot sun where other method of curing cannot be properly ensured.

4.19.7 Curing by chemical coating

For chemical curing sodium silicate or calcium chloride is used. The use of calcium chloride shall be done without the approval of the Engineer. Normally the sodium silicate mixed with water is applied over concrete surface and when it dries up it forms a thin varnish like film which fills up the pores and surface voids and prevents evaporation of water. This also acts like curing compound but only difference is that curing compounds are available in ready mixed emulsion forms while sodium silicate is to be mixed with water at site.

4.19.8 Limitation to use of different methods of curing

(i) Curing by the processes as indicated in 4.19.3 and 4.19.4 give very good results in normal warm climate for maturity of concrete.

(ii) In cold weather, the process as indicated in 4.19.4 gives very good result for maturity of concrete.

(iii) Where water cement ratio is less than 0.5 the methods indicated in 4.19.6 and 4.19.7 shall not be used.

(iv) In warm climate also, where the methods of curing as indicated in 4.19.3 or 4.19.4 cannot be properly ensured, any suitable method of curing as indicated in 4.19.5 to 4.19.7 as approved/directed by the Engineer shall be adopted.

4.20 Testing of Concrete

4.20.1 General

The Contractor shall carryout, entirely at his own cost, all sampling and testing in accordance with the relevant I.S. standards and as supplemented herein. The Contractor shall get all tests done in approved Laboratory and submit to the Engineer, the test result in triplicate within 3 days after completion of the test.

4.20.2 Consistency test (tests of fresh concrete)

4.20.2.1 At the place of deposition/pouring of the concrete, to control the consistency, slump tests and/or compacting factor tests shall be carried out by the Contractor in accordance with I.S. 199 as directed by the Engineer.

4.20.2.2 The results of the slump tests/compacting factor tests shall be recorded in a register for reference duly signed by both the Contractor and the Engineer. That register shall be considered as the property of the Owner and shall be kept by the Contractor at site in safe custody.

4.20.2.3 The results of the slump tests/compacting factor tests shall tally, within accepted variation of plus or minus 12% with the results in the respective design mix, in case of mix design concrete and with the values indicated in the table under clause 6.1 of IS: 456 in case of nominal mix concrete.

4.20.2.4 For any particular batch of concrete, if the results do not conform to the requirements as specified in 15.2.3 or do not conform to any requirement of this specification, the Engineer has the right to reject that batch and the Contractor shall remove the same immediately from the site, at no cost to the Owner.

4.20.3 Strength test of concrete

4.20.3.1 While placing concrete, the Contractor shall make 6 nos. of 15 cm test cubes from particular batches of concrete as desired by the Engineer. The frequency of taking test cubes shall be either according to clause 14.2 of IS: 456 or as directed by the Engineer.

4.20.3.2 The cubes shall be prepared, cured and tested according to IS: 516. Out of 6 nos. of test cubes 3 shall be tested for compressive strength at 7 days after casting and the remaining 3 at 28 days after casting.

4.20.3.3 A register shall be maintained at site by the Contractor with the following details entered and signed by both the Contractor and the Engineer. That register shall be considered as the property of the Owner.

(a) Reference to the specific structural member

(b) Mark on cubes

(c) The grade of concrete

(d) The mix of concrete

(e) Date and time of casting

(f) Crushing strength at 7 days

(g) Crushing strength at 28 days

(h) Any other information directed by the Engineer.

4.20.4 Acceptance criteria for test cubes

The acceptance criteria of concrete on strength requirement shall be in accordance with the stipulations under clause 15 of IS: 456.

4.20.5 Non-destructive tests on hardened concrete

4.20.5.1 If there is doubt about the strength or quality of a particular work or the test results do not comply with the acceptance criteria as stipulated under clause 15 of IS: 456, non-destructive tests on hardened concrete like core test and/or load tests or other type of non destructive tests like ultrasonic impulse test etc. shall be carried out, as may be directed by the Engineer, by the Contractor at entirely his own cost.

4.20.5.2 The core tests and load tests shall comply with the requirements of clause 16.3 and 16.5 of IS: 456 respectively. In case of other types of special tests like ultrasonic impulse test etc., the stipulation of clause 16.6 of IS: 456 shall be applicable.

4.20.6 Concrete below specified strength

In case of failure of test cubes to meet the specified requirements the Engineer may take one of the following actions:-

1) Reject the work and instruct that section of the works to which the failed cubes relate shall be cut out and replaced at Contractor's expense.

2) Instruct the Contractor to carryout additional test and/or works to ensure the soundness of the structure at Contractor's expense.

3) Accept the work with reduction in the rate in appropriate item.

4.20.7 Concrete failed in non-destruction tests

In case the test results of the core tests or load tests in a particular work do not comply with the requirements of respective clause (16.3 for core test and 16.5 for load tests) of IS: 456 the whole or part of the work concerned shall be dismantled and replaced by the Contractor as may be directed by the Engineer at no extra cost to the Owner and to the satisfaction of the Engineer. No payment for the dismantled concrete including relevant form work, reinforcement, embedded fixtures etc. shall be made. In the course of dismantling if any damage occurs to the adjacent structure or embedded item, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

4.21 Steel Reinforcement

4.21.1 Material

Material shall be as specified in the respective schedule of Items. The specifications of materials shall be as per Part-I.

4.21.2 Storage

Steel reinforcement shall be stored in such a manner that they are not in direct contract with ground. Bars of different classifications and sizes shall be stored separately. In cases of long storage or in coastal areas, reinforcement shall be stacked above ground level by atleast 15 cm, and a coat of cement wash shall be given to prevent scaling and rusting.

4.21.3 Bending and placing

Bending and placing of bars shall be in conformity with IS: 2502 "Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement" and IS: 456 - "Code of Practice for Plain and Reinforced Concrete".

4.21.4 Welding of Reinforcement

Welding of mild steel reinforcement bars conforming to IS:432 (Part-I) shall be done in accordance with IS: 2751 - "Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete construction" with additional precaution that for lap welded joints the throat thickness of weld beads shall be atleast 3 mm or 0.6 times the nominal size of weld (which is the radius of bar) whichever is more.

Welding of cold worked high strength deformed bars conforming to IS: 1786 shall be done using electric arc welding process using low hydrogen electrodes (Ferro Weld- I or Ferro Weld-II or equivalent). Oxyacetylene welding shall not be used.

Butt welding of bars upto 32 mm diameter for vertical splices shall be done either by single bevel grove weld or double bevel groove weld, with bevel angle 45 degree. Butt welding of bars upto 32 mm diameter for horizontal splices shall be done either by single Vee-grove weld or double Vee grove weld with chamfered angle of 45 degree to 60 degree. The diameter of welded joint shall be 1.2 times the diameter of bar. Edge preparation for butt welding shall be done by shearing, machining and grinding. Oxyacetylene flame shall not be used for cutting. Chamfered faces shall be smooth finished by hand file if required.

Lap welding of bars upto 20 mm diameter shall have a minimum bead length of 12 times the diameter of bar or 200 mm whichever is more arranged on one or both sides. The throat thickness of weld beads shall be 5 mm or 0.75 times the nominal size of weld (which is the radius of bar) whichever is more. In case of unsymmetrical lap weld with weld bead on one side only, the maximum length of each weld bead shall be 6 times the diameter of bar or 100 mm (whichever is more), separated by an equal length in between weld beads. Splice bars used in symmetrical weld joint shall have same diameter as the parent bars. Lap joint with single splice bars shall have weld beads on both sides.

Lap welding of bars above 20 mm shall be done using splice plate or splice angle. Thickness of splice plate shall not be less than 0,65 times the diameter of bar and width shall not be less than twice the diameter of bar. The size of splice angle shall be such that its area of cross section is atleast 1.62 times the area of bar being spliced.

More than one third of the bars shall not be welded at any one section and welded joints shall be staggered at a distance of 50 times the diameter of bars. Welding shall not be done at bends or curved parts of bars and it shall be located atleast at a distance of 50 times the diameter of bar from bends.

Tests

Test pieces of welded bars shall be selected and tested in accordance with the provisions of IS: 2751. The number of tests will be as laid down in IS: 2751 or such larger number as the Engineer may decide having regard to the circumstances.

4.21.5 Cleaning

All steel for reinforcement shall be free from loose scales, rust coatings oil, grease, paint or other harmful matters immediately before placing the concrete. To ensure this reinforcements with rust coatings shall be cleaned thoroughly before bending/placement of the same.

4.21.6 Placing in position

All reinforcements shall be accurately fixed and maintained in positions as shown on the drawings and by adequate means like mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by annealed soft steel wire or by tack welding in case of bars larger than 25 mm dia, as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers.

4.21.7 Clear cover

Clear cover shall be as specified in the drawings. If nothing is specified in the drawing the clear cover shall be in accordance with the relevant clause of IS: 456.

4.21.8 Light structural work and embedded metallic parts, conduits,

4.21.8.1 Fabrication of metallic parts & light structural works

Fabrication of all structural steel work shall be done in accordance with IS: 800 - "Code of Practice for use of Structural Steel in General Building Construction". All workmanship shall be equal to the best practice in modern structural shops. Greatest accuracy shall be observed in the manufacture of every part and all identical parts shall be strictly inter-changeable. Steel work shall be shop fitted and shop assembled as far as practicable to minimize on site work and to meet transport restrictions. All materials shall be straight and if necessary before being worked shall be straightened of flattened by pressure and shall be free from twists. Shearing or flame cutting may be used and the resulting edges shall be clean and straight. Flame cut edges shall be planed/cleaned by chipping or grinding. Sheared members shall be free from distortion at sheared edges. Welding and welded work shall conform to IS: 816 - "Code of Practice for use of metal arc welding for General Construction in Mild Steel". Mild steel electrodes conforming to IS: 814 "Specification for covered electrodes for metal arc welding of mills steel (third revision) shall be used.

4.21.8.2 Transportation and Storage

All pieces shall be properly identified and bundled for transportation to work site. Care shall be exercised in the delivery, handling and storage of material to ensure that material is not damaged in any manner. Materials shall be kept free of dirt, grease and foreign matter and shall be stored properly on skids or any other suitable supports to avoid contact with ground, damage due to twisting, bending etc.

4.21.8.3 Erection of light structural work

Erection of light structural work shall be carried out in accordance with the provisions of

IS: 800. No component which is bend or twisted shall be put in place until the defects are corrected. Components seriously damaged during handling shall be replaced. No riveting, permanent bolting or welding shall be done until proper alignment has been completed. Whenever field welding is to be done it shall be in accordance with the requirements of shop fabrication. Shop paints shall be removed before field welding for a distance of atleast 50 mm on either side of the joints.

4.21.8.4.1 Erection of embedded metallic parts, inserts, conduits

Bolts and inserts shall be securely fixed in position as shown in the drawings, before commencement of concreting. Bolts shall be checked for accuracy in alignment on both the axes. Limits of tolerance in alignment and level shall be as shown in the drawing or described elsewhere in these specifications.

Where bolts are housed in sleeves, special care shall be taken after concreting is over and has partly set to ensure that the bolts move within the sleeves. The annular space of the sleeve shall be plugged with suitable stoppers to prevent the ingress of water, grit, dust, rubbish or other foreign material into it, both during and after concreting. Opened conduits shall be plugged similarly. Where channels, U-shaped profiles or other similar inserts are required to be placed in concrete, special care shall be taken to keep the grooves of such profiles free from the ingress of concrete, slurry etc., by suitable packing material, if necessary. All threads for bolts and inserts shall be greased at intervals and kept covered to prevent damage.

4.21.8.4.2 Necessary templates, jigs, fixtures, supports shall be used as may be specified or required or directed by the Engineer free of cost to the Owner.

Exposed surfaces of embedded materials shall be painted with one coat of anticorrosive paint or bituminous paint, as desired, without any extra cost to the Owner.

4.22 Shuttering

4.22.1 General

All shuttering, formwork, supports and staging shall be designed by the Contractor and be subject to approval by the Engineer. The Contractor shall submit drawings and calculations to the Engineer for scrutiny when called upon to do so. The shuttering shall be designed for a live load of 400 Kg/Cm2 in addition to the weight of the green concrete, or such other load as the Engineer may specify. The Contractor shall be responsible for the correctness and strength of the formwork including its supports and centering and approval by the Engineer will not relieve him of his responsibilities.

4.22.2 Material

The staging and supports may be of round or sawn timber or tubular or other shapes in steel. Round timber shall preferably extend over the full height in one piece. These shall be securely jointed or otherwise fastened and spaced at suitable intervals as the design may warrant. They shall be suitably braced at regular intervals horizontally and diagonally.

The form work shall be of steel plate on steel frame, wooden boards with steel sheet lining, or plywood or season timber board. Where ornamental and curved surfaces are required the material shall be very good seasoned timber or plywood which can be shaped correctly.

4.22.3 Fixing

The shuttering shall conform to the shapes, lines, levels and dimensions shown in the drawing. It shall be fixed in perfect alignment and securely braced so as to be able to withstand, without appreciable displacement, deflection of movement of any kind, the weight of all construction, movement of persons and plant. It shall be so constructed as to remain rigid during the placing and compacting of concrete without shifting or yielding and shall be sufficiently water tight to prevent loss of slurry from the concrete.

All props shall be supported on sole plates and double wedges. At the time of removing props these wedges shall be gently eased and not knocked out. The form work shall be so designed that the sides are independent of the soffit and the side forms can be removed easily without any damage or shock to the concrete.

4.22.4 Wrought shuttering

Wrought shuttering shall be such as to produce a first class fair face on the concrete free from board marks or any other disfigurements. This shall be used for exposed surfaces where specified or directed by the Engineer. It may be made of heavy quality plywood or steel sheets having smooth, plain surface.

The joints in shuttering shall be arranged in a regular pattern approved by the Engineer. Wrought shuttering shall be aligned within a tolerance of 3 mm.

4.22.5 Rough shuttering

Rough shuttering shall be used for all surface of concrete walls, footings etc., which are not exposed in the finished work or which are to receive plaster and as directed by the Engineer. It may be made of timber, ordinary plywood or steel sheets.

4.22.6 Slipform shuttering

Slip forms, where used, shall provide a smooth, even surface true to dimensions and alignment. The concrete surface produced by such shuttering shall be free from fines, bulges and unseemly off-sets. Slipforms shall have prior approval of the Engineer and the Contractor shall submit complete information required in this regard.

4.22.7 Special provision

4.22.7.1 Wherever concreting of narrow member is required to be carried out within shutters of considerable depth, temporary openings in the sides of the shutters shall, if so directed by the Engineer, be provided to facilitate cleaning, pouring and consolidation of concrete.

4.22.7.2 In liquid retaining structures and structures below ground water level, through bolts for the purpose of securing and aligning the form work shall not be used.

4.22.7.3 Forms shall be given an upward camber, if so desired by the Engineer, to ensure that long beams do not have any sag. The camber may be 1 in 250 or as the Engineer may direct.

4.22.7.4 The joints in form work shall be sealed by adhesive tapes or by other means, to prevent any leakage of slurry or mortar.

4.22.8 Preparation for concreting

Before any concreting is commenced the shuttering shall be carefully examined for dimensional accuracy and safety of construction. The space to be occupied by concrete shall be thoroughly cleaned out to remove rubbish, debris, shavings and saw dust. The surface in contact with concrete shall be coated with an approved substance such as mould oil or other non-staining mineral oil to prevent adhesion. Where necessary the surface shall be wetted to prevent absorption of moisture from concrete. Care shall be taken to avoid the reinforcements coming in contact with shutter oil.

4.22.9 Removing

4.22.9.1 Removal of forms shall never be started until the concrete has thoroughly set and aged to attain sufficient strength to carry twice its own weight plus the live load that is likely to come over it during construction.

4.22.9.2 Removal of forms shall not entail chipping or disfiguring of the concrete surface. Shuttering shall be removed without shock or vibration and shall be eased off carefully in order to allow the structure to take up its load gradually.

4.22.9.3 Under normal circumstances (generally where temperatures are above 21 degree 'C'), and where ordinary portland cement is used shuttering may be struck after the expiry of the following periods :-

i)	Walls, columns and vertical faces the Engineer.	..	24 to 48 hours as may be directed by
ii)	Bottom of slab upto 4.5 m span	..	7 days
iii)	Bottom of slab above 4.5 m span, bottom of beam and arch, rise upto 6 m span	..	14 days
iv)	Bottom of beam and arch rise over 6 m span	..	21 days

These periods may be increased at the discretion of the Engineer. Special care shall be taken while striking the shuttering of cantilevered slabs and beams, portal frames etc.,

4.22.9.4 Before removing the form work, the Contractor must notify the Engineer to enable him to inspect the condition of the finished concrete immediately after the removal of the form works.

4.22.10 Contractor's responsibility

Any damage resulting from faulty preparation, premature or careless removal of shuttering shall be made good by the Contractor at his own expense.

4.22.11 Irrecoverable shuttering

In cases where the shuttering cannot be removed without damaging the structure itself or where removal of shuttering is rendered impossible due to the nature of construction or where the Engineer may so instruct, such shuttering shall be classified as irrecoverable shuttering. However, such abandoning of shuttering will be permitted only in situations where it will not remain exposed or otherwise cause damage of any kind.

4.22.12 Metal Forms

Where permanently left-in-place metal forms or deck are shown in drawings or otherwise ordered to be provided by the Engineer, they shall satisfy the requirements with regard to load carrying capacity. The metal forms shall be obtained from a reputed manufacturer, whose performance guarantee shall be obtained and submitted to the Engineer. Designs and drawings giving full details shall be submitted to the Engineer in advance for approval.

4.23 Damp Proof Course Concrete

4.23.1 Thickness

It shall be as specified in the drawings/ schedule of items.

4.23.2 Mix

The grade of mix shall be as specified in the drawing or schedule of quantities. If nothing is specified, the mix shall be 1 part of cement : 1 1/2 part of coarse sand : 3 parts of stone chips. The stone chips shall be 12 mm down graded.

Approved water proofing admixture shall be mixed with cement as per manufacturer's specifications. The water cement ratio shall be as low as possible to increase the impermeability of concrete and in no case more than 0.5.

4.23.3 Preparation of base surface

The base surface shall be well roughened by chipping and brushing with steel brush and shall be cleaned of all dirt, dust, grease, oil and all other foreign & deleterious materials. Then the surface shall be well moistened with water.

4.23.4 Placing and compaction

Just prior to placement of D.P.C. Concrete, a thick coat of cement slurry shall be applied on the base surface. The placement shall be as specified for the concrete in beams. The concrete shall be well compacted to make at dense.

4.23.5 Finishing

When the concrete has set enough but remains still green, the top surface shall be marked in regular pattern by steel trowel so as to have proper bond with the future work.

4.23.6 Curing

The D.P.C. coarse shall be kept continuously moist at least 10 days.

4.24 Grout

4.24.1 Scope

The scope covers the grouting under base plates, grouting between the joints of precast concrete, grouting the pockets/holes/opening etc.

4.24.2 Grouting under base plates

Grouting under base plates of equipment/structures shall be of cement mortar 1:2 for thickness upto 25 mm. For thickness exceeding 25 mm, concrete of grade specified in the drawing or minimum M-20 grade using 10 mm down graded aggregates shall be used. The grout shall be placed in position well rammed until the whole space is completely filled with concrete. No vibrators shall be used. Quick setting cements shall be used in the preparation of mortar or concrete, where so specified.

The grout shall either be "dry" concrete or mortar or "wet expanding" concrete or mortar as the Engineer may direct. A dry grout shall have a slump not exceeding 6 mm. It shall be rammed under the horizontal surface with the aid of suitable tools. A "wet expanding" grout shall have a slump of atleast 125 mm but not exceeding 225 mm. To this shall be added an expanding admixture approved by the Engineer and according to the Manufacturer's instructions.

4.24.3 Grouting the joints of precast members

The requirements are same as that described in 4.24.2 except that the slump shall be much less (the slump in this case shall be within 75 mm to 125 mm as per the requirements) and in the case the thickness of the joint is 30 mm or less the mix shall be 1 part of quick setting cement and 1 1/2 parts of coarse sand. Some times dry mortars i.e. mortar with slump less than 6 mm is used for grouting the joints of precast members.

4.24.4 Grouting pockets/holes in concrete

Depending upon the size of the pockets/holes in the concrete, the mix of the grout shall be either of concrete or of cement sand mortars. Normally the grade of such concrete/mortar shall be M-20 unless specified otherwise. In filling the holes of foundation bolts and expanding admixture of approved type shall be used as per manufacturer's specification.

4.24.5 Workmanship

4.24.5.1 The surface of the concrete over which grouting is to be applied shall be thoroughly prepared to provide a clean rough surface. If necessary, chipping shall be carried out on such surface to make it completely rough. Then the surface shall be wetted. Bolt pockets shall be cleaned immediately before the base plate is placed in position.

4.24.5.2 Before placement of grout, the surfaces (except in the case of bolt holes) shall be wetted with cement slurry. In case of bolt holes/pockets water from such pockets shall be thoroughly removed by some suitable means and no cement slurry shall be applied.

4.24.5.3 Hand mixing is not permitted and the grout shall always be machine mixed. If however in some special cases where the quantity of grout is so small that it cannot be machine mixed, hand mixing may be allowed but the same shall be done under the strict supervision of an experienced supervisor of the Contractor.

4.24.5.4 The grout shall be placed within 30 minutes of being mixed. The grout shall be poured and then worked into position by suitable means until the space is completely filled. The Contractor shall take all possible measures during grouting so that the grout fills the space completely and thoroughly. Where the gap is very small or unapproachable for the placement of concrete, the Contractor shall grout by pressure grouting and in that case the mix may be of cement sand mortar of the appropriate grade but in any case the water cement ratio shall be as low as possible.

4.24.6 Curing

After 10 hours of grouting, the same shall be covered with wet gunny bags and the surface shall be kept continuously moist atleast for 10 days.

4.25 Concreting in Water Retaining Structures

The basic specifications as regards 'mix' design, placing, compacting, curing etc. shall conform to the requirements as specified herein before of this Chapter. Over and above the materials and workmanship shall conform to the stipulations of IS: 3370 (Part-I & II) to make dense and impervious concrete. As specified herein before all the construction joints shall be provided with approved water bars. The expansion and construction joints, if any, shall be provided with the requirements as specified in the drawing or as directed by the Engineer.

4.26 Application of Live Load

The designated live load shall be allowed on any structure only after 28 days, after proper curing is carried out on the last concrete poured in structure.

5.0 MASONRY

5.1 General

This specification deals with masonry and allied works in foundation, plinth and superstructure.

5.2 Materials

For specifications of materials Part-I shall be referred.

5.3 Selection of Mortars

Mortar for masonry shall conform generally to IS: 2250, "Code of Practice for Preparation and Use of Masonry Mortars", and proportion shall be as specified in the drawing or in the Schedule of Items.

5.4 Lime Mortar

Field slaking of lime shall be done in accordance with IS: 1635, "Code of Practice for Field Slaking of Lime, and Preparation of Putty".

5.4.1 Hydrated lime mixed with water to form putty shall be stored at least for 24 hours before used well covered and protected against evaporation. For quick lime, sufficient water shall be added for slaking and forming a cream and the same screened through a No. 10 sieve and stored for at least 7 days before use.

5.4.2 Lime putty and sand of proper proportion, with addition of necessary water, shall be mixed on a water-tight platform and then thoroughly ground in a mortar mill. It shall then be stored ready for use, well covered and protected to avoid evaporation and drying of mortar. In case cement is needed to be added to the lime-sand mortar, required quantity of cement shall be added and again mixed for at least three minutes preferably in a mechanical mixer, with addition of minimum quantity of water to achieve workable consistency. Lime mortar shall be used within 72 hours of mixing.

5.5 Cement Mortar

5.5.1 Cement and sand of requisite quantity shall be mixed dry, preferably in a mechanical mixer and further mixed after adding the required quantity of water to achieve workable consistency and uniform colour.

5.5.2 Fresh mixed mortar shall be used for masonry work. Subsequent thinning by addition of water shall not be permitted.

5.5.3 Cement sand and cement lime mortars or lime mortar with hydraulic lime shall be used as soon as possible after addition of water, but in no case later than 2 hours.

5.5.4 Old and stale mortar and mortar picked up from droppings in masonry work shall generally be not used.

5.6 Brick Work

5.6.1 Storage and handling bricks

Bricks shall not be dumped at site. They shall be carefully handled and carefully stacked in regular tiers to avoid breakage and defacement of bricks and prevent contamination by mud or other materials. The supply of bricks shall be so arranged that as far as possible at least two days' requirement of bricks is available at site at any time. Bricks selected for different situations of work shall be stacked separately.

5.6.2 Soaking & Cleaning bricks

Bricks required for masonry shall be cleaned to be free from dirt, dust and sand and fully soaked in clean water by submerging in vats before use, till air bubbling ceases. The bricks shall not be too wet at the time of use. After soaking they shall be removed from the tank sufficiently early so that at the time of laying they are skin dry and stacked on a clean space.

5.6.3 Setting out

The building lines shall be set out by the Contractor as per clause 7 of IS: 2212 and got checked by the Engineer.

5.6.4 Laying of bricks

5.6.4.1 Bricks shall be laid in English bond, unless otherwise specified, with frogs upward over a full bed of evenly laid mortar, and slightly pressed and tapped into final position to the lines levels and shape as shown in the drawing fully embedded in mortar. All joints including inside faces shall be flushed and packed. No more than 8 courses shall generally be laid in a day. The first course itself shall be made horizontal by providing

enough mortar in the bed joint to fill up any undulations. The horizontalness of courses and the verticality of wall shall be checked very often with spirit level and plumb bob respectively.

5.6.4.2 Mortar joints shall be such that the height of four courses of brick laid in mortar shall not increase by more than 25 mm the height of the same bricks laid dry. Horizontal joints shall be truly horizontal and vertical joints shall line up in every alternate course. The joints shall not exceed 10 mm in thickness and shall be well finished and neatly struck. The joints shall be kept uniform throughout the brick work. All the brick joints of the face works shall be neatly raked out to a minimum depth of 15 mm with the help of raking tools and the faces of brick wall cleaned with wire brush to remove any splashes of mortar before the close of the day's work, while the mortar is still green and the last brick layer shall be cleaned with wire brush and the frogs free from mortar.

5.6.4.3 Walls coming in contact with R.C.C. structures shall perfectly be bonded with MS inserts or lugs where shown on drawings and the sides butting against the R.C.C structures neatly and efficiently flashed and packed with rich mortar & cement slurry at no extra cost (cost of MS inserts or lugs used shall be measured and paid separately under relevant items). Where such lugs are not required to be provided, brick work shall be built tightly against columns, slabs or other structural parts, around door and window frames with proper distance to permit caulked joint. Where drawings indicate structural steel column or beam to be partly or wholly covered with brick work, bricks shall be built closely against all flanges and webs, with all spaces between steel and brick work filled solid with mortar not less than 10 mm thick.

5.6.4.4 Damaged or broken brick or brick bats shall not normally be used in brick work. Cut bricks may be used to complete bond or as closures or around irregular openings.

5.6.4.5 Bricks shall not be thrown from heights to the ground, but shall be handled carefully and put gently in position to avoid damaging their edges.

5.6.4.6 Selected bricks of regular shape and dimension shall be used for face work.

5.6.4.7 Making of grooves, sleeves and chases shall be done during the construction to the lines, levels and position as shown in the drawing or as instructed by the Engineer. Such sleeves shall slope outward in external walls so that their surface cannot form channels for the easy passage of water inside.

5.6.4.8 Fixtures, plugs, frames etc., if any, shall be built in at the right places to the lines & levels as shown in the drawings while laying the course and not later by disturbing the brick work already laid.

5.6.4.9 Brick walls of one brick thick or less shall have one selected face in true plane and walls more than one brick thick shall have both the faces of wall in true plane.

5.6.4.10 All connected brick work shall be carried out simultaneously with uniform heights throughout the work, and in exceptional cases, with the approval of the Engineer, the brick work built in any part of the work may be lower than another adjoining wall/connected wall by a maximum of 60 cm and the difference in height of adjoining wall/connecting wall shall be raked back according to bond by stepping at an angle not steeper than 45 degree, without sacrificing the necessary bond, horizontalness of layers, verticality of joints and the wall. Toothing shall not be allowed in brick work, for raking back.

The top layer just below the R.C.C slab or beam shall be laid with frogs down over a layer of mortar on full width.

5.6.4.11 Openings in brick work

Openings shall be made in brick work, which may be of any shape, size, at all levels, heights or depths, including round openings, as shown in the drawing or as directed by the Engineer, maintaining the necessary bond using a minimum of cut bricks. Openings in external face walls, the sills, jambs, soffit of opening may be rebated and the sill shall be sloped slightly for drainage of rain water.

5.6.4.12 Architectural features

All projecting architectural features such as in plinth projections, string courses or cornices shall be effectively bonded into the brick work to ensure stability. Such architectural features shall be set straight and true with the finished joints. Where such features are not to be plastered over, they shall be built with bricks of even size, good shape and quality, which have durability, resistance to abrasion and moisture penetration.

5.6.4.13 Sun shades and such projecting features which depend on the weight of brick masonry over them for stability, shall be kept supported till such time as the brick masonry above is built and hardened sufficiently.

5.6.4.14 All exposed brick work shall be rubbed down, thoroughly washed, cleaned and pointed as specified. Where face bricks of specific quality are used the same shall be rubbed with carborundum stone.

5.6.5 Half-brick masonry

5.6.5.1 The work of half-brick work shall be done in the same manner as for brick work except that all courses shall be laid in stretchers. Both faces shall be true to plane and the joints raked on both faces.

Where reinforcement is considered necessary or shown in drawing, MS bars shall be provided as stipulated in the Schedule of Items. The reinforcement shall be cleaned of rust and loose scale with a wire brush, and shall be laid straight on the mortar and lapped with the dowel bars provided in the column, securely anchoring them at their ends where the half-brick wall butts. The batching of mortar usually shall be in the proportion of 1:4 or as stipulated in the Schedule of Items. Half of the mortar for the joints shall first be laid and the other half laid after the reinforcement is laid in position, so that the reinforcement is fully embedded in position.

5.6.6 Brick on edge masonry

The work brick on edge masonry wall in superstructure shall be done in the same manner as mentioned for brick work except that it shall always be reinforced with a mesh of 18 gauge netting of approved variety and embedded in cement mortar at interval as specified in the Schedule of Items. The wire netting shall be continuously laid and securely anchored with the dowel bars provided & projecting from the walls/RCC structure or steel structures at their ends where the 75 mm thick brick wall butts. The batching of mortar usually shall be in the proportion of 1:3 or as stipulated in the Schedule of Items.

5.6.7 Protection of brick work

The brick wall shall be protected and covered with gunny bags or water proof sheets from the effects of inclement weather, rain, frost, etc., during the construction and until the mortar sets. Care shall be taken during construction that the edges of jambs, sills and soffit of openings are not damages.

5.6.8 Exposed Brick Work

5.6.8.1 Physical Requirements

Facing bricks shall be of class designation 75 unless otherwise specified. Average compressive strength shall not be less than 7.5 N/mm^2 water absorption shall not exceed 20 per cent by weight and efflorescence rating shall be nil when tested in accordance with the procedure laid down and tolerance in dimensions shall be checked as per the laid down procedure.

Mortar, Soaking of Bricks and laying shall be as follows :

Mortar

The mortar for the bricks work shall be as specified, and conform to accepted standards. Lime shall not be used where reinforcement is provided in brick work.

Soaking of Bricks

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks. Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. The bricks required for masonry work using mud mortar shall not be soaked. When the bricks are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place where they are not again spoiled by dirt earth etc.

5.6.8.2 Joints in the exposed brick work shall be truly horizontal and vertical and kept uniform with the help of wooden or steel strips. The thickness of joints shall be as follows**.**

5.6.8.2.1 Joints

The thickness of all types of joints including brick wall joints and cross joints shall be such that four course and three joints taken consecutively shall measures as follows :

i) In case of modular bricks conforming to IS:1077-1986 specification for common burnt clay buildings bricks, equal to 39 cm.

ii) In case of non-modular bricks, it shall be equal to 31 cm.

Note: Specified thickness of joints shall be of 1 cm deviation from the specified thickness of all joints shall not exceed one-fifth of specified thickness.

5.6.8.2.2 Finishing of Joints

The face of brick work may be finished flush or by pointing. In flush finishing either the

face joints of the mortar shall be worked out while still green to give a finished surface flush with the face of the brick work or the joints shall be squarely raked out to a depth of 1 cm while the mortar is still green for subsequently plastering. The faces of brick work shall be cleaned with wire brush so as to remove any splashes of mortar during the course of raising the brick work. In pointing, the joints shall be squarely raked out to a depth of 1.5 cm while the mortar is still green and raked joints shall be brushed to remove dust and loose particles and well wetted, and shall be later refilled with mortar to give ruled finish. Some such finishes are `flush', `weathered', ruled. etc.

5.6.9 Curing

All brick works shall be kept moist for 10 days after laying.

5.6.10 Scaffolding

5.6.10.1 Necessary and suitable scaffolding shall be provided at all heights to facilitate the construction of brick wall. Scaffolding shall be sound, strong and all supports and other members shall be sufficiently strong and rigid, stiffened with necessary bracings and shall be firmly connected to the walls securing them against swing or sway. Planks shall be laid over the scaffolding at required levels. Scaffolding shall preferably be of tubular steel, although the Engineer may permit other material, depending upon the circumstances.

5.6.10.2 Scaffolding shall be double, having two sets of vertical supports, particularly for the face wall and all exposed brick work. Single scaffolding may be used for buildings upto two storeys high or at other locations, if permitted by the Engineer. In such case the inner ends of horizontal members shall rest in holes provided in header course only. Such holes shall not be allowed in pillars under one meter in width, or immediately near the skew backs or arches. The holes thus left in masonry shall be filled with bricks set in rich mortar and the surface made good on removal of scaffolding.

5.6.10.3 If for any reason the Contractor is required to erect scaffolding in property other than that belonging to the Owner, including municipal corporation or local bodies, necessary permission shall be obtained by the Contractor from the appropriate authorities and necessary licensing fees shall have to be borne by him.

5.6.10.4 All scaffoldings once erected shall be allowed to remain in position, efficiently maintained by the Contractor, till all the finishing works required to be done are completed and shall not be removed without the approval of the Engineer.

The Contractor shall allow workmen of other trades to make reasonable use of the scaffolding without any extra cost.

5.6.10.5 Fixing of wooden frames

Unless otherwise specified, wooden door and window frames shall be fixed in the openings generally with MS hold- fasts of adequate size and strength securely embedded in the brick work for sufficient length, during the progress of work, or chases shall be made in the brick work and the frames may be fitted later on and subsequently fixed by filling the opening with cement concrete not less than 1:2:4 by volume.

5.6.11 Cavity walls

Cavity walls shall be made in accordance with Clause 10.12 of IS: 2212. A cavity wall comprises of two leaves, each leaf being built of masonry units and separated by a cavity and tied together with metal ties or bonding units to ensure that the two leaves act as one structural unit, the space between the leaves being either left a continuous cavity or filled with a non-load bearing insulating and water proofing material.

Thickness of each leave of a cavity wall shall not be less than 75 mm. Where the outer leaf is half masonry unit in thickness, the uninterrupted height and length of this leaf shall be limited so as to avoid undue loosening of ties due to differential movements between the two leaves. The outer leaf shall therefore be supported at least at every third storey or at every 10 m of height whichever is less and at every 10 m or less along the length.

5.6.12 Arches

Small arches/flat arches shall be made as shown in the drawings with selected good bricks of approved quality over timber centering or templates generally in rings of half brick length. For face brick work the bricks shall be specially selected and sought to shape to get radial joints uniform. Necessary allowance shall be made for any slight settlement or to correct any apparent sagging. The mortar to be used for arches shall be as specified in the Schedule of Items. The joints shall be raked out and treated as required in general brick work. The centering and shuttering shall be retained in position till the brick work in arch ring is completely set and strength achieved, and shall not be removed without the approval of the Engineer.

5.6.13 Honey-Comb brick work

The work shall be as mentioned for general brick work. Bricks shall be laid in cement mortar 1:4. All edges shall be struck flush to give an even surface on both faces. Joints shall be raked and pointed or plastered as specified in the Schedule of Items. The thickness of the brick honey-comb work shall be usually half brick or as specified in the Schedule of Items. The openings of the hone-comb brick work shall be equal and alternate with half bricks laid with a minimum bearing of 2.5 cm on either side.

5.7 Stone Masonry

5.7.1 General

All aspects of the work shall be in conformity with the "Code of Practice for Construction of Stone Masonry, IS:1597 (Part-I & II) - 1992. Relevant clauses under brick work, such as setting out, making chases, openings, fixing frames and plugs, protection curing, scaffolding etc., shall apply to stone masonry and concrete block masonry.

5.7.2 Mortar

The mortar used shall be as specified in the Schedule of Items or drawing.

5.7.3 Holes and Plugs

Holes in stone walls shall be left for water supply, plumbing, sanitation, electrification, etc., where shown on drawings or ordered by the Engineer as the work proceeds. These holes shall, on completion, be made good to match with the adjoining wall. The Contractor shall provide and fix wooden plugs, water supply piping and electric conduit pipes etc. where so specified.

5.7.4 Random Rubble Masonry

5.7.4.1 Laying

All stones shall be wetted and cleaned of all dust and loose materials before laying, Stones shall be laid on their natural beds, fitted carefully to the adjacent stones to form neat and close joints fully packed with mortar and chips and spalls of stone may also be used wherever necessary to avoid thick mortar bed or joints. Walls shall be carried to plumb or to the specified batter. Stones may be brought to level courses at plinth, window sills and roof levels and the leveling shall be done with concrete comprising of 1 part of the mortar as used for the masonry and 2 parts of 20mm down graded hard stone chips at no extra cost. Bond shall be provided by fitting in closely the adjacent stones and by using bond stones running through the thickness of wall in a line from the face to back with at least one bond stone, or a set of bond stones, for every 0.5 sq.mm of the wall surface. Face stones shall extend and bond well into the backing. These shall be arranged to break joints as much as possible, and to avoid long vertical lines of joints.

5.7.4.2 Quoins

Quoins shall be of selected stones, neatly dressed with hammer or chisel to form the required angle and laid header and stretcher alternately. No quoin stone shall be smaller than 0.25 cum (25 dcum in volume and it shall also not be less than 300mm in length, 25% of them being not less than 500mm in length).

5.7.4.3 Joints

The stones shall be so laid that the joints are fully packed with mortar and chips and face joints shall not be more than 20mm thick. When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying, otherwise the joints shall be raked to a minimum depth of 20mm by raking tool during the progress of work, when the mortar is still green.

5.7.5 Coursed Rubble Masonry – First Sort

5.7.5.1 Laying

All stones shall be wetted before use. The walls shall be carried up truly plumb or to specified batter. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. The height of each course shall not be less than 15cm nor more than 30cm.

Face stones shall be laid alternate headers and stretchers. No pinning shall be allowed on the face. No face stone shall be less in breadth than its height and at least one third of the stones shall tail into the work for length not less than twice their height.

The hearting or the interior filling of the wall shall consist of stones carefully laid on their proper beds in mortar, chips and spalls of stone being used where necessary to avoid thick beds of joints of mortar and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The chips shall not be used below the hearting stone to bring these upto the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in heating and these shall not exceed 10% of the quantity of stone masonry. The masonry in a structure shall be carried up regularly but where breaks are unavoidable, the joints shall be raked back at an angle not steeper than 45 degree. Toothing shall not be allowed.

5.7.5.2 Bond Stones

Bond stone or a set of bond stones shall be inserted 1.5 to 1.8 metres apart, in every course.

5.7.5.3 Quoins

The quoins, shall be of the same height as the course in which these occur. These shall be at least 45 cm long and shall be laid stretches and headers alternately. These shall be laid square on the beds, which shall be rough-chisel dressed to a depth of at least 10cm. In case of exposed work, these stones shall have a minimum of 2.5 cm wide chisel drafts at four edges, all the edges being in the same plane.

5.7.5.4 Joints

All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar, face joints not be more than one cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20mm by raking tool during the progress of work, when the mortar is still green.

5.7.6 Coursed Rubble Masonry – First Sort

5.7.6.1 Laying

Shall be as specified in 5.7.5.1 except that the use of chips shall not exceed 15% of the quantity of stone masonry, and stone in each course need not be of the same height but more than two stones shall not be used in the height of a course.

5.7.5.2 Bond Stones, Quoins

Shall be as specified for first sort respectively.

5.7.5.4 Joints

All be joints shall be horizontal and all side joints vertical, All points shall be fully packed with mortar, face joints shall not be more than 2 cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20mm by raking tool during the progress of work, when the mortar is still green.

6.0 <u>PILING</u>

6.1 General

This specification deals with the requirements regarding workmanship of bored and driven, cast-in-situ reinforced concrete piles.

The workmanship shall conform with the provisions of the following codes and standard specifications in particular:

IS: 456 - Code of Practice for Plain Reinforced Concrete.

IS: 2911 - Code of Practice for Design Construction of Pile Foundations, Part I & IV.

6.2 Materials & Workmanship

6.2.1 Concrete

Concrete shall conform to the specification "Concrete Plain and Reinforced" in this series.

6.2.2 Reinforcement

Reinforcement shall conform to the specification "Concrete" in this series.

6.2.3 Sequence

In case of bored piles, boring shall proceed by alternately driving the casing and extracting the bored material with the boring tools. While boring in soft material liable to cavitation, boring tools shall not be operated at level below the toe of the casing. Care shall be taken to ensure that the volume of water added to the bore is no more than the minimum necessary for the operation of the boring tools. The casing shall be driven down through the soft material to penetrate a hard stratum not subjected to cavitation and shall be sealed in this material as far as possible. Thereafter the boring shall be continued by means of the boring tools until the approved bearing layer is reached. The bearing layer shall consist of sound materials capable of safely sustaining the load imposed by the pile and shall be consistent in quality for a depth of minimum 300 mm. in the pile bore.

The piles shall be driven with due consideration for safety of adjacent structure by a method which leaves their strength unimpaired and which develop and retain the required bearing resistance.

Where the soil is such that driving of a pile causes previously installed pipes to heave, load test shall be conducted.

6.2.4 Jetting

When jetting is used, it shall be carried out in such a manner that the carrying capacity of the piles already in position and the safety of the existing structures are not impaired. Jetting shall be stopped not less than one meter above the final expected bottom of the pile and the pile shall be carried down until the required resistance is obtained. If there is evidence that the jetting has disturbed the load carrying capacity of previously installed piles, those piles which have been disturbed shall be rejected.

6.2.5 Jacking

If sufficient overhead space is not available due to the existing structures which cannot be removed, driving of piles by jacking or other similar methods without impact shall be adopted. The carrying capacity of a pile installed by such methods shall taken to be not more than 50% of the load or force used to install the pile.

6.2.6 Spacing

All piles shall have minimum spacing on centres of 2 d for bored piles and 2.5 d for driven piles (where d is the diameter of the pile), subject to a minimum of 100cm.

No pile of uniform section shall have diameter of less than 200 mm upto 12 m long piles & not less than 300 mm for length between 12 m and 15 m. For piles longer than 15 m, the minimum diameter shall be 400 mm. The longitudinal reinforcement shall be a minimum of 0.8% of the pile cross- section or 6 rods of 16 mm dia whichever is more. The transverse reinforcement shall not be less than 0.2% of the gross volume of the pile in the form of helical binders.

6.2.7 Cast-in-situ piles

Immediately before concreting the bore hole shall be cleaned of all the loose material, debris etc. Concrete shall be so placed as to fill the entire volume of the bore hole without the formation of voids caused by the faulty compaction or entrapped air. Great care shall be taken to ensure that the fluid alluvial soil does not penetrate between batches of the concrete.

Concrete shall not normally be placed through water and in unavoidable cases such concreting shall be done with necessary precautions. The ground water shall be balanced by adding fresh water to the bore and the concreting shall be placed by means of an enclosed placer or by tremie pipe. In case of bored piles after the uncased portion of the bottom of the bore has been concreted, further concrete is to be added. The sequence of placing concrete and withdrawing the casing shall be so arranged that the head of concrete above the bottom of casing is never less than 3 meters. Once the concreting of the pile is commenced the work shall proceed without interruption until the pile is completed.

Concreting of the pile shall continue until the pile is fully formed upto a level not less than 600 mm above the soffit of the pile cap. Extraction of casing shall be done in such a way that no necking or shearing of the concrete in the shaft takes place.

6.2.8 Trimming of Piles

Completed piles shall be trimmed to the cut-off levels as shown on the drawings when sound concrete has been formed. In the event of trimming being carried below the cut-off level, the pile shall be made up to the correct cut-off level with concrete of the same quality as used in the piles. Reinforcement shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile-cap. The minimum distance of keying of the pile into the pile cap shall be 50 mm. All concrete and cement shall be removed from the bars, which shall also be wire-brushed to remove any loose rust, dirt and scale.

6.2.9 Lengthening of piles

Where it is necessary to increase the length of any pile after it has been driven, the head of the pile shall be cut-off to expose the reinforcement for a full bond length of the bars to lap with the new bars. The exposed surface of the concrete shall be hacked to from a key, brushed to remove loose material and covered with 25 mm. thick cement mortar (1:2 mix) immediately before the new concrete is placed.

6.2.10 Load test

Atleast 1% of the piles driven shall be tested to an overload of 50% above the working load of the pile and 0.1% of the piles driven shall be tested to an overload of 100% above the working load of the pile.

The longest practicable time shall be allowed to escape between driving and testing to allow the recovery of soil conditions around the pile and it shall not be less than two weeks.

The gross settlement under test load of any pile shall not exceed 12 mm in case of 150% working load tests, and 20 mm in case of 200% working load tests.

6.2.11 Standard of acceptance

The piles shall be accepted as satisfactory only when the work has been executed in accordance with this specification and the Standards stated hereinafter.

(a) The head of the pile shall be within 65 mm of the specified position on the drawings.

(b) The pile shall not be out of plumb by more than 1 in 100.

(c) The toe of the pile shall be at the approved bearing level in each case.

(d) The total volume of concrete shall not be less than 10% and not more than 40% greater than the calculated volume. The calculated volume for this purpose shall be the cross-sectional area inside the casting multiplied by the length of the shaft. The concrete shall show the specified strength as indicated by the cube test results.

(e) The results of the load tests carried out in accordance with the contract and with the specifications for load testing shall satisfactory.

6.2.12 Defective piles

If an individual pile fails to meet the requirements specified in clause above such pile may be deemed to be defective.

When any pile is found defective, one or more of the following remedial measures shall be carried out :

(a) Replacement of defective piles
(b) Driving additional piles.
(c) Alteration in design of pile caps.

6.2.13 Recording

For each pile, a record of the following data shall be kept:

(1) The date and time of commence & finishing of the driving operation.

(2) The particulars of the equipment and method of driving.

(3) The location and type of the pile, with a reference to approved drawings.

(4) The diameter of the pile.

(5) The length and cut-off level of the pile.

(6) The quantities of concrete, reinforcement, cement and w/c ratio used.

(7) The sequence of the driving in pile groups.

(8) The final set for the last ten blows.

(9) The test load and settlement for test piles as required under clause of load testing.

7.0 PLASTERING AND POINTING

7.1 Materials

The specification of materials shall conform to the requirements as specified in Part-I.

7.2 Plastering

7.2.1 General

Plastering shall be done in accordance with provisions of IS: 1661. Mix proportions of mortar for plastering and thickness of plaster shall be as given either in the drawing, or as per Schedule of Items or as directed by the Engineer. For special plaster work, necessary admixtures shall be added to mortar in required proportion as per manufacturer's specifications or as specified herein.

7.2.2 Preparation of surface

The surface to be plastered shall be cleaned of all extraneous matter and rubbish. In masonry the joints shall be raked to a minimum depth of 12 mm and cleaned with wire brush. Concrete surfaces to be plastered shall be roughened and hacked to form key for plastering. All plastered surfaces shall be finished smooth with a wooden float in one plane and all internal angles shall be finished slightly rounded. If desired by the Engineer, any unevenness shall be rubbed down by carborundum stones. The surface to be plastered shall be wetted evenly before the application of plastering.

For one coat plastering the plaster shall be laid slightly thicker than the specified thickness and the surface then levelled with flat wooden float to the required thickness. For two coat plaster work, the first coat (usually half of total thickness) shall be applied as detailed above except that the surface shall be left rough and keys formed for the application of second coat. The second coat shall be laid on with a wooden float to the specified thickness and shall be applied a day or two after the first coat has set, but has not dried up.

Cement mortar for plastering work shall be used within 30 minutes after adding water to cement and should be kept agitated at intervals of 20 minutes.

Unless otherwise specified cement punning shall be done over the plastered surface by sprinkling neat cement powder evenly on the surface and rubbed smoothly with a trowel to give a fine coating, at no extra cost. The plaster shall be kept wet for atleast seven days and protected from extremes of temperature and weather during this period.

The arrises of doors and windows shall have richer mortar 1:3 in a width of 75 mm on

either side or as required at respective location.

7.3 Cement Pointing

7.3.1 Where shown on drawing, Schedule of Items, or as directed by the Engineer, exposed brick faces shall be cement rule pointed. The mortar shall be raked out of the joints to a depth of 12 mm. The dust shall be brushed out of the joints and the wall well wetted.

Unless otherwise specified the pointing shall be made with cement and sand mixed in proportion 1:3 with water proofing compound. The joints of the pointed work shall be neatly finished truly vertical and horizontal or as directed and the lines shall be kept wet till the cementing material has set and become hard. If required, the whole brick face shall be rubbed and polished with fine grade of carborundum stones. Particular care shall be taken to see that no brick face or brick edge is damaged during this work.

7.3.2 Flush Pointing

The mortar shall be pressed into the joints and shall be finished flush and levelled. The edges shall be neatly trimmed with trowel and straight edges.

7.3.3 Ruled Pointing

The joint shall be initially formed as for flush pointing and then, while mortar is still green , a groove of required shape and size shall be formed by running a forming tool straight along the centre line of the joint till a smooth and hard surface is obtained. The vertical joints shall also be finished in similar way. The pointing line shall be uniform in width and truly horizontal in case of floors and ceilings.

7.4 Rough Cast Concrete Facing

7.4.1 The surface shall be prepared as for Cement plaster and then 2 cm backing coat of cement sand mortar 1:3 shall be applied. Subsequently, a top coat 12 mm average thick cement and stone chips mixture in proportion 1:3 (stone chips 10 mm size and below) shall be applied by throwing the mixture on top with trowel to produce uniform rough texture. The surface shall afterwards be cured for 10 days. After curing, the surface shall be brushed with hard wire brush to remove loose chips from the surface. A coat of cement was shall then be applied.

7.4.2 Rendered sand faced cement plaster

The surface shall be cleaned of all dust and dirt and the brick work thoroughly watered. The backing coat shall be 12 mm thick of cement plaster proportion 1:4 (1 cement and 4 sand) and keys shall be formed on the surface. After curing this coat sufficiently, the finishing coat 6 mm thick consisting of grey cement and screened coarse sand to required gradation (1:3) shall be applied and finished to the desired texture to the satisfaction of the Engineer.

7.4.3 Plaster moulding

Where specified, plaster moulding shall be strictly as per drawings and details, and shall run clean and true from proper templates and moulds, to the entire satisfaction of the Engineer. Rates shall include for brick or concrete cores and for any necessary dubbing in cement mortar or brick or metal lath curing and final finish as desired. Where desired, all angles in internal moulding work shall be covered to a radius of 50 mm or as directed

without any extra charges.

7.5 Punning with Lime or Plaster of Paris

7.5.1 Lime Punning

Lime punning shall be carried out with best quality approved lime. Lime shall be properly stirred, tempered with water to form a homogeneous mass and strained through fine cloth. The punning shall be laid and rubbed and trowelled to an uniform smooth even finish using special trowels. Any unevenness shall be rubbed down with fine sand paper. The plaster must be dry before the lime punning is applied.

The lime paste shall be kept wet until use and no more quantity than can be consumed in 10 days shall be prepared at a time.

7.5.2 Plaster of paris punning

This shall be provided by using the best quality of plaster of paris from approved manufacturer. Unless otherwise specified same procedure of lime punning shall be followed for getting uniform smooth finish.

8.0 FLOORING, PAVING & FACING

8.1 Scope

Flooring Paving and facing includes flooring, skirting and dado of various types encountered in plants, buildings, pavements etc. as described under respective heads.

8.2 Materials

Materials shall conform to Part-I of this series.

8.3 General

Flooring, skirting & dado may have to be done in discontinuous strips or areas to suit the needs of erection and commissioning of equipment. Flooring shall be done in close co-ordination with erection of equipment or other services and shall keep pace with the demands in respect of commissioning of individual equipment. No claims for extra shall be tenable for reasons of discontinuity of work or delay in having areas available for work.

Unless otherwise specifically included in the Schedule of Quantities or stated in the description of work, no extra shall be payable for works such as forming coves at internal angles, nosing at plinths, steps, window sills and stair treads, dishing in bath rooms and toilet and cutting to line and fair finish to top edge of skirting and dado. Thickness mentioned shall be the minimum.

8.4 Sub-base

Flooring at ground level having sub-base of sand or earth as specified shall be laid in layers of 15 cm, watered and consolidated by rolling with hand roller or ramming with iron rammer and with butt ends of the crow bars. When filling reaches the required level, the surface shall be flooded with water for 24 hours, allowed to dry and then rammed and consolidated to avoid any settlement later. The thickness of the sub-base

shall be as specified either in the drawing or in the Schedule of Items.

8.5 Subgrade

The surface shall be brought to the desired level before subgrade is laid.

8.5.1 Hard core subgrade

Where hardcore subgrade is specified, stone/slag boulders/laterite boulders shall be laid closely stacked together, the longer edge being laid vertically. All interstices shall be filled with smaller particles of the same material or with gravel or red earth. The top surface shall be spread with loose moorum sufficient to cover the gap and to achieve uniform top surface. The surface shall then be adequately watered and rolled by roller.

Hard core shall be laid to form the desired slope in the finished floor.

8.5.2 Brick Khoa subgrade

Over burnt bricks shall be used for getting brick khoa as per sizes described in Schedule of Items. The khoa shall be laid uniformly and rammed in dry and wet conditions so as to get a uniform compact surface.

8.5.3 Concrete subgrade

The concrete subgrade shall be allowed to set for seven days and the flooring shall be laid in the next three days.

The flooring shall be commenced within 48 hours if the subgrade is of lean cement concrete, failing this the surface of the subgrade shall be lightly brushed with steel wire, wetted and smeared with a coat of cement slurry @ 2 kg/sqm. to get a good bond between subgrade and flooring. The subgrade shall be provided with slope as specified.

8.6 Brick Flooring

Laying and finishing of brick flooring shall, in general conform to IS : 5766. Where dry brick paving is specified the bricks shall be laid on their long edges on prepared subgrade or on rammed earth formed to desired slope in floor. Bricks shall be laid with gaps of about 6 mm, lightly tamped and brought to proper level and fall as indicated. The joints shall then be filled with sand.

Where bricks are specified to be laid in cement mortar, mortar mix shall be 1:6 (1 cement : 6 sand) unless otherwise shown on the drawings/Schedule of Items. When lime mortar is specified, mix proportions shall be 1:5 (1 lime : 5 surkhi) unless otherwise shown in drawings. Mechanical mixing shall be employed for preparing mortar unless otherwise permitted by Engineer. Cement mortar shall be consumed before initial setting has taken place. Bricks shall be sufficiently soaked in water before use.

Unless otherwise directed, the bricks shall be laid in herring-bone pattern with their long axes at 45'C to the length of the paving.

8.7 Cement Concrete Flooring with Integral Finish

Cement concrete shall be mixed, laid, consolidated and cured as described in Chapter "Concrete". Laying of concrete shall be done in alternate panels. The size and division

of panels shall be as per direction of Engineer. The mix or grade of concrete shall be as specified in Schedule of Items.

The finished surface may be rendered smooth using 2 mm thick neat cement slurry using 2.2 kg of cement per square meter area of flooring or may be trowel finished to provide an appearance of fine and smooth textured surface and in panels or in geometric pattern as specified in Schedule of Items or as directed by Engineer.

8.8 Concrete Flooring with Granolithic Finish (Artificial Stone Flooring)

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete. The subgrade shall be either brick khoa/lime concrete/cement concrete, as specified. Flooring shall be laid & finished according to IS : 5491.

8.8.1 Thickness

Unless otherwise mentioned the thickness of flooring including topping shall be either 25 mm or 40 mm or 50 mm as shown on drawing. The net thickness of topping shall be 6 mm for 25 mm thick floor, 10 mm for 40 mm and 12 mm for 50mm thick floor.

An additional allowance of 2mm in thickness of topping shall be made for cutting and grinding margin wherever polishing is specified in the item. The rate of item will be inclusive of this.

8.8.2 Mix

For base or under bed course, the mix shall be 1:2:4 concrete, unless specified otherwise. The mix of the topping shall consist of 1 part cement :1 part coarse sand : 2 parts coarse aggregated by volume. The coarse aggregate shall very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

8.8.3 Laying

a) Laying of monolithic topping

The concrete base or under bed shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The surface shall remain sufficiently rough to take the finish.

For large areas the laying shall be in panels of maximum 2.5 sqm. area. The panels shall be laid in chequered board pattern. Within about 3 hours of laying the base while it is still fully 'green' the topping shall be laid evenly to proper thickness and grade. The tapping shall be pressed firmly and rigorously to form full board with the base/under bed.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips. The trowelling of flooring shall be such that a fine smooth textured appearance comes.

(b) Laying of topping separately on hardened base

The base concrete shall be prepared as stated in Clause 2.4 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc., shall be same as for monolithic topping.

8.8.4 General

The junction of the floors with all plaster dado or skirting shall be rounded of with 1:1 cement sand mortar & polished.

8.8.5 Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for atleast 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to use during this period.

8.8.6 Grinding & finishing

Where grinding is specified, it shall start only after the finish has fully set. The grinding shall be done with carborundum stone of No. 60, then No. 80 and then 120 as per the method as specified in in-situ mosaic flooring. After final polishing, the floor shall be rubbed with oxalic acid and then wax polished.

8.9 Dado & Skirting Work (Grey Cement Skirting/Dado)

A backing coat of 12 mm thick and 15 mm thick shall be applied on walls after proper dabbing of the surface for a finished thickness of 18 mm and 21 mm thick respectively, with cement plaster of proportion 1:4 (1 cement and 4 approved quality sand). Over this a top coat 6 mm thick consisting of one cement to one stone chips 3 mm nominal size shall be applied. If grinding and polishing specified, the same shall be done as per granolithic flooring with carborundum stones.

8.10 Terrazzo Flooring & Facing

General

The terrazzo work shall be done by an approved firm or specialists. Marble clips used for facing coat of terrazzo work shall be of best quality (from Dehradun or other approved source and of uniform tint and colour and shall be approved by the Engineer before using in the work. All terrazzo work shall be polished on completion followed by a final wax polish of approved quality.

Terrazzo work shall be done either cast-in-situ or with precast tiles as specified in the Schedule of Quantities Unless otherwise specified thickness for cast-in-situ terrazzo work shall be 25 mm including base course and for tiles 20 mm excluding mortar bed.

The rate for terrazzo work shall include any coving of internal angles, nosing at plinth, steps and sills, set backs, mitres, flashing as per direction of the Engineer.

8.10.1 Cast-in-situ terrazzo flooring

It shall consist of an underbed and a tapping laid over an already matured concrete subgrade.

8.10.1.1 Thickness

Unless specified otherwise, the total thickness of the finished flooring shall be either 25 mm or 40 mm of which the tapping shall be minimum 6 mm (net) for 25 mm and minimum 10 mm for 40 mm flooring. A minimum allowance of 2 mm in the tapping shall be kept for grinding and polishing so as to achieve the minimum specified thickness of tapping.

All junctions of vertical with horizontal planes shall be rounded neatly to uniform radius of 25 mm.

8.10.1.2 Mix

i) Underbed course

The underbed for floors and similar horizontal surface shall consist of a mix of 1 part cement, 2 parts sand and 4 parts stone chips by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only minimum water to be added to give a workable consistency.

ii) Topping

Topping shall consist cement (grey or white) as specified with or without colour pigment, marble powder and marble chips. The proportion of cement and marble powder shall be 3 parts of cement to one part of marble powder by weight.

The proportion of marble chips to 4 parts of cement marble powder mix mixed by volume. For grey chocolate or similar shades ordinary cement with approved colouring pigments may be used instead of coloured cements. Care shall be taken to ensure an even and uniform disposition of the marble chips.

8.10.1.3 Laying

i) Laying of underbed

The underbed shall be laid in alternate lays of chequered pattern. The panels shall not be more than 2 sqm. in area of which no side shall be more than 2.0 m long. For exposed locations the maximum area of a panel shall be 2.0 sqm. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent. Cement slurry @ 2 kg/sqm. shall be applied before laying over cement concrete/RCC surface/plastered surface.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plug toping. In case of in-situ dado work, the sections shall not be more than 60 cm x 60 cm and the aluminium, glass or any other material strips provided similarly. (The cost of these strips shall be held covered by the rate for terrazzo work unless otherwise specified).

ii) Laying of topping

After laying, the underbed shall be levelled compacted and brought to proper grade with screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat 'green' but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly land brushed in just before laying the toppling. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous lcement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in an even pattern of distribution.

8.10.1.4 Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

8.10.1.5 Grinding & polishing

After 48 hours of laying of floor when floor is hardened, first cutting shall be done with special rapid cutting grit of coarse grade (no. 60) till the marble chips are evenly exposed and floor is smooth. The floor shall then be washed and cleaned to remove mud and grindings, a grout of cement and colouring pigment in same proportion of the topping shall be applied to cover the pin holes. The surface shall be cured for 5 to 7 days and then ground with machine fitted fine grit blocks (No. 120). The surface shall be again cleaned and repaired as mentioned above and shall be cured for 3 to 5 days. Finally the third grinding shall be done with machine fitted with fine/grade clocks (No. 320) to get even and smooth surface without pin holes. The finished surface should show the marble chips evenly exposed.

Where use of machine for polishing is not feasible/possible rubbing and polishing by hand shall be done in the same manner as specified for machine polishing except that carborundum of coarse grade (No. 60, 80 and 120) for first, second & final polishing. After the floor is polished to the satisfaction of the Engineer, it shall be rubbed with oxalic acid and finally wax polished with 'Mansion' or similar approved floor polish to the entire satisfaction of Engineer.

8.10.2 Terrazzo cast-in-situ facing, skirting and dado

The work shall be carried out in the same manner as that for terrazzo cast-in-situ floors except that the base or bedding course shall consist of 1:3 cement mortar (1 cement & 3 medium sand) of 12 mm or 15 mm or 19 mm thickness or total thickness 18 mm or 21 mm or 25 mm respectively. As specified earlier, the bedding course shall be laid in panel (not more than 60 cm x 60 cm) divided by glass/ aluminium strips minimum thickness. The topping shall be of 6 mm thick finished and shall be laid when the backing plaster is still green. Special care shall be taken to see that the surface are properly cured.

8.10.3 Terrazzo tile finished flooring/facing

The work will consist of manufactured terrazzo tile and an underbed.

8.10.3.1 Thickness

The total (net) thickness including the underbed shall be 40 mm for flooring and other

horizontal surface and 32 mm for vertical surfaces like dado/skirting. The necessary allowance for cutting and grinding shall be kept to have the specified finished thickness.

8.10.3.2 Tiles : terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tiles shall be pressed hydraulically to a minimum of 140 kg. per sqcm.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 8 mm (net) for flooring & 6 mm (net) for vertical surface. The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary grey cement and 3 parts of stone chips by weight mixed with water.

The ingredients for topping shall be same as cast-in-situ terrazzo. The thickness of the topping, as specified above, shall be net after grinding & polishing. First grinding shall be given to the tiles at the shop before delivery.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles.

8.10.3.3 Mix : underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surface it shall be about 12 mm thick and composed of 1 part cement 3 parts coarse sand by weight.

8.10.3.4 Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The base surface shall be roughened for better bond. Before laying the underbed, over the base/subgrade a coat of cement slurry shall be applied over the subgrade. Before the underbed has time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect. When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moistened allowed to mature undisturbed for 7 days.

Heavy traffic shall not be allowed.

If desired dividing strips as specified under Cl may be used for dividing the work into suitable panels.

8.10.3.5 Grinding and polishing

Procedure shall be same as in-situ terrazzo finished flooring. Grinding shall not commence earlier than 14 days after laying of tiles.

8.11 Glazed Tile Finished Flooring & Facing

This finish shall be composed of glazed earthen coarse tiles with an underbed laid over a concrete or masonry base.

8.11.1 Thickness

Unless specified the total thickness shall be 21 mm for flooring & 18 mm for dado/skirting the underbed.

The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

8.11.2 Tiles : Glazed

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 6 mm thick unless otherwise specified. The tolerance shall be plus or minus 1.5 mm for length and breadth and plus or minus 0.5 mm for thickness specials like internal and external angles, beads, covers, cornices, corner pieces etc., shall match. The top surface of the tiles shall be glazed with a gloss or matt unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform, and fractured section shall be fine grained in textures, dense and homogeneous.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

8.11.3 Mix : underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water of any other mix if specified.

8.11.4 Laying & finishing

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. Before laying the underbed, over the base/subgrade of coat of cement slurry shall be applied over the subgrade. Before the underbed has time to set and while it is still fairly moist but firm, cement shall be hand dusted over it and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The joints shall be practically invisible and filled with non-staining white cement/white cement mixed with pigment for coloured tiles. Internal angles shall be provided with 'specials' and a 75 mm high border of approved colour shall be provided at the top of dado. Drains shall be provided with 'specials'. The tiles shall be thoroughly cleaned after completion. The tiles shall be laid

to the slope specified in the drawings and truly vertical on walls when used as skirting.

8.11.5 Curing & cleaning

After flushing painting the treatment cured for 7 days by keeping it wet. The surface shall be then cleaned with soap or suitable detergent, washed fully and wiped with soft cloth to prevent scratching before handling over.

8.12 Chemical Resistant Tiles Flooring/Facing
(Either of natural stone or prepared tiles)

This shall include all verieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry. The Contractor shall get it done by specialised manufacturer & get guarantee of performance.

8.12.1 Tiles

The chemical resistant tiles as detailed in the Schedule of Items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have atleast compression strength of 700 kg/cm2. The surface shall be abrasion resistant and durable.

8.12.2 Laying

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

8.13 Chemical Resistant in Situ Finished Flooring/Facing

Chemical resistant in situ finish shall be as called for in the Schedule of Items. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The Contractor shall get it done by a specialised manufacturer, get guarantee of performance from the organisation and pass it on to the owner in addition to his own guarantee.

8.14 Mastic Asphalt Flooring

8.14.1 General

The type and thickness of flooring, viz., heavy duty, acid resisting etc., the treatment of the sub-floor and the type of finish shall be as per Schedule of Items or as shown on drawings or otherwise directed by the Engineer. The flooring shall be laid to the levels or slope shown on drawings, skirtings and channels and outlets for drainage shall similarly be provided, and the floor shall be laid and finished in accordance with the Indian Standard Code of Practice for laying Mastic Asphalt Flooring IS : 1196. The work shall be done by a firm of specialists approved by the Engineer.

The flooring shall be done with Asphalt concrete in heated condition at temperature

range of 180'C to 205'C and the workmanship should be in such a manner that the finished floor shall be quite hard, resilient, heavy duty abrasion resistant and impervious. The weight of the asphalt concrete shall be aproximately 2.2 T/M3 and the hardness number of the mastic asphalt, without coarse aggregates, at 35'C shall remain within 4 to 10.

8.14.2 Material

Binder : It shall be blown grade bitumen conforming to IS : 702 and preferably 85/25 or 95/15 grade bitumen shall be used.

Fine Aggregates : Asphalt concrete when used forflooring, the fine aggregates shall be specifically graded silica powder or any approved inert material graded suitably. If lime stone powder is used the calcium carbonate content shall not beless than 80% by weight. For any floor where no acids or alkalies come in contact the lime stone powder can also be used.

The gradation of the fine aggregates shall conform to Table-II of IS : 1195.

Coarse Aggregate : It shall be either siliceous sand or crushed silicious stone suitably graded and the gradation shall conform to Table-III of IS : 1195.

8.14.3 Composition for asphalt concrete

The percentage of coarse aggregates shall approximately conform to table-IV of IS : 1195.

However, average proportion will be as under by weight.

Bitumen - 18 to 22%

Cement - 5%

Fine Aggregates - 35% to 45%

Coarse Aggregate - 30% to 40%

8.14.4 Preparation of mastic asphalt

(i) Fine aggregates and coarse aggregates to be fried on different container upto a temperature of 170'C to 205'C.

(ii) The bitumen shall be heated to a temperature of 180'C.

(iii) Then the beated bitumen shall be mixed with the fired aggregates (both fine & coarse) and cement and the whole thing shall be cooked in a cooking plant or in any approved form for a period of 5/6 hours until the materials are thoroughly mixed and the temperature at no time shall exceed 205'C.

8.14.5 Laying of asphalt concrete

(i) Cleaning surface to make free from all the foreign materials upto the satisfaction of the Engineer.

(ii) Applying of one coat of primer in form of emulsion consisting of not less than 50% of bitumen in weight.

(iii) Providing one coat of hot bitumen (for vertical face blown grade is essential) for fixing the underlay over it.

(iv) Providing one layer of "underlay" over item (iii) above and that underlay shall be made of hassian saturated in bitumen.

(v) Providing one coat of hot bitumen over the "Underlay" (the bitumen shall conform to either IS : 73 or IS : 702 as desired by the Engineer).

(vi) The prepared asphalt concrete is then put in position and laid with hot trowels (temp. of trowels not less than 200'C) by continuous rubbing with constant pressure.

(vii) The finishing coarse: Applying one coat of hot bitmen of low penetration and high softening point. The surface should be finished by continuous rubbing to give a glazy finished surface upto the full satisfaction of the Engineer.

8.14.6 Sampling and testing

Before commencing the works the Contractor shall make at site sufficient nos. of samples of different compositions as specified in sub-head 20.3 for testing of the mastic asphalt as specified in the relevant IS codes and for approval of the Engineer.

After approval of the sample by the Engineer, the Contractor shall start the work and that will be carried on the basis of the composition of the approved sample. The work shall be checked and tested at regular intervals. The Contractor shall supply at least 10 nos. of properly made samples per 1000 M2 of the works for testing and the test results of the samples must tally with the result of approved sample.

All the costs regarding sampling, testing etc., shall be borne by the Contractor.

8.15 P.V.C. Sheet/Tiles Flooring

8.15.1 Base

It shall be laid on a base that is finished even and smooth such as concrete, metal lor timber boarding.

8.15.2 Materials

The P.V.C. flooring material shall conform to IS : 3462-1966. It shall consist of a thoroughly blended composition of thermoplastic binder, filler and pigments.

8.15.3 Adhesive

Rubber based adhesives are suitable for fixing PVC flooring over concrete, wooden and metal sub-floors, PVA based adhesives may be used for concrete and wooden

sub-floors. PVA based adhesives are not suitable for metallic surfaces and also for locations where there is constant spillage of water.

8.15.4 General

Sheets can be used for flooring. But for skirting only the tiles shall be used. The colour & texture shall be as approved by the Engineer.

8.15.5 Preparation of base/sub grade

Before laying PVC sheets/tiles, it is essential to ensure that the base is thoroughly dry and damp-proof. In case of new work a period of 4 to 8 weeks shall be allowed for drying the sub-floor under normal conditions.

In concrete sub-floors the same shall be painted with two coats of bitumen (conforming to IS : 1580-1969) applied at the rate of 1.5 kg/sq.m.

Over that a levelling course of specified thickness (if not specified the same maly be of average thickness of 15 mm) with 1 : 4 cement course sand mortar shall be provided with a finish just suitable to receive the flooring sheets/line. After that, the same shall be cured and then made dry.

8.15.6 Laying and fixing

Before commencing the laying operations, the sub-floor shall be examined for evenness and dryness. The sub-floor shall then be cleaned with a dry cloth.

The adhesive shall be applied by using a notched trowel to the sub-floor and to edge and to the back side of the PVC sheet or tile flooring. When the adhesive is just tack free the PVC flooring sheet/tiles shall be carefully laid in position the air will be completely squeezed out between the sheet and the background surface. After laying in position, it shall be pressed with suitable roller to develop proper contact with the sub-floor. The sheets shall be laid edge to edge so that there is minimum gap between joints. The alignment should be checked after laying of each row of sheet is completed. If the alignment is not perfect, the sheets may be trimmed by using a straight edge.

Any adhesive which may squeeze up between sheets or tiles should be wiped off immediately with a wet cloth before the adhesive hardens. If, by chance, adhesive dries up and hardens on the surface of the sheet or tile, it should be removed with a suitable solvent.

8.15.7 Protection and finish

A minimum period of 24 hours shall be given after layiing the flooring for developing proper bond of the adhesive. During this period, the flooring shall not be put to service. It is preferable to lay the PVC flooring after the completion of plastering, painging and other decorative finish works so as to avoid any accidental damage to the flooring.

When the flooring has been securely fixed, it shall be cleaned with a wet cloth soaked in warm soap solution (two spoons of soap in 5 litres of warm water).

8.16 Acceptance Criteria

The Contractors shall satisfy the Engineer specially for the workmanship of the following finished floor :-

(a) Level, slope, plumb as the case may be
(c) Alignment of joints, dividing strip etc.
(d) Colour, texture
(e) Surface finish
(f) Thickness of joints including the workmanship in joints.
(g) Details at edges, junctions etc.
(h) Performance
(i) Precautions specified for durability.

9.0 WOOD WORK

9.1 General

Wood work shall be neatly and truly finished to exact dimensions and details as per drawings, without patching or plugging of any kind and rebates, roundings and mouldings as shown in drawings made before assembling. Exposed work shall be finished smooth with well planed faces.

All assembly of shutters of doors, windows, ventilators and frames thereof shall be exactly at right angles. In the case of frames, the right angle shall be checked from the inside surfaces of the respective members.

All door and window frames shall be clamped together so as to be square and flat at the time of delivery. Door frames without sills shall be fitted with temporary stretchers.

Horns of frames and other parts that go into or butt against the masonry, shall be protected against moisture and decay with two coats of coal tar or other approved protective material.

All surfaces of the door, window and ventilator frames and shutters which are required to be painted ultimately shall be covered evenly by brush painting with a priming coat of a white lead based primer. In the case of doors to be polished or varnished, a priming coat of approved polish or varnish shall be given before delivery. No primer shall be applied to the wood work until it has been inspected and passed by the Engineer.

9.2 Joinery

All heads, posts, transoms and mullions etc., of doors, windows and ventilators shall be made out of single pieces of timber only. The heads and post shall be through- tenoned into the mortices of the jamb posts to the full width of the latter and the thickness of the tenon shall be not less than 1.25 cm. The tenons shall be close fitting into the mortices and pinned with corrosion resisting metal pins not less than 8 mm diameter or with wood dowels not less than 10 mm diameter. The depth of rebate in frames for housing the shutters shall in all cases be 1.25 cm and the rebate in shutters for closing in double shutter doors or windows shall be not less than 2 cm.

Unless otherwise specified, all joints shall be mortice and tenon joints with the ends of the tenons exposed to view. Joints shall fit truly and fully without fillings. The contact surfaces of tenons and mortices shall be treated, before putting together, with an

approved adhesive conforming to the relevant IS specifications.

9.3 Shrinkage & Tolerance

The arrangement, joining and fixing of all joinery work shall be such that shrinkage in any part and in any direction shall not impair the strength and appearance of the finished work.

The tolerance on overall dimensions shall be within the limits prescribed in IS:1003.

9.4 Fixing

Door and window frames shall generally be built in at the time the walls are constructed. Alternatively, where permitted by the Engineer, the frames may be subsequently fixed into prepared openings for which purpose holes to accommodate the hold fasts shall be left at the time of construction. The method of fixing shall be as described elsewhere in these. Where the frames are subsequently fixed into prepared openings in the wall such openings should be 25 mm more than the overall width of the door, window or ventilator frame to allow minimum 12.5 mm plaster on each jamb. The height of the unfinished opening shall depend upon whether a threshold is required or not. While fixing the door care shall be taken to see that at least 6 mm space is left between the door and the finished floor. The MS clamps fixed to the frame shall be inserted in the holes and jammed in cement concrete M-15 with 10 mm down graded stone chips after holding the frame in proper position to the line level and plumb.

9.5 Tarring

Timber in contact with earth, concrete, plaster or masonry shall be treated with one coat of coal tar before fixing in position.

9.6 Fittings

on each side of a door frame, one at the center point, and the other two at 30 cm from the top and the bottom of the door frames. In the case of windows and ventilators, a pair on each side shall be fixed at quarter points of the frames. Unless otherwise specified the hold-fasts shall be of mild steel plate 40 x 3 x 250 mm long, fish tailed at one end and screwed to the frame in the formed rebates.

Generally, each door shutter shall be fixed to the frame with three hinges of approved manufacture, one at the center and the other two approximately 24 cm from the top and bottom of the shutter. Each window shutter shall be fixed to its frame with two hinges at the quarter points.

Locks, handles, door closers, stoppers etc., shall be fitted as shown in drawing or described in the Schedule of Items.

9.7 Doors, Windows and Ventilators

Dimensions of the various components of doors, windows and ventilators shall be in accordance with IS : 1003, Table- III or as shown on the drawings.

9.8 Paneled Shutters

Solid wood panels shall be made of one or more pieces of timber, preferably not less

than 12.5 cm nor more than 20 cm. in width, as specified in IS : 1033. When made from more than one piece, the piece shall be joined with a continuous tongue and groove joint, glued together and reinforced with metal dowels. Unless otherwise specified, the thickness of the panels for 4 cm thick shutters shall be 2 cm and that for 2.5 cm thick shutters, 1.25 cm.

9.9 Glazed Shutters

The openings for glazed shutters shall be rebated and moulded out of solid timber, and shall be provided with mitered glazing beads, loosely fixed in position. Plain sheet glass for panels shall be of approved quality as specified earlier. Wherever specified, ground glass or frosted glass of approved quality shall be used in place of plain sheet glass.

9.10 Flush Door Shutters

Unless otherwise specified, flush door shutters shall be not less than 4 cm thick, with a solid/cellular core, a teak wood frame, and faced with approved quality of plywood on both faces. The core and stock shall be made from well seasoned approved timber and treated with approved preservatives. The plywood faces shall be glued on to the solid/cellular core with waterproof glue under pressure. The construction of flush doors shall be such that no difficulty should arise in fixing mortice locks, hydraulic door closers etc. The shutters shall be rebated in the case of the double leaf doors.

9.11 Wire Mesh Shutters

The wire gauze shall be bent in angles in the rebates of stiles and rails, turned and fixed tight with blue tacks at about 75mm fixed alternately in the two faces of the rebates. Over this, wooden heading shall be fixed with brads or small screws at about 75mm centres.

9.12 Hand rails of width and depth as specified in the item shall be measured in running meters upto two places of decimal.

9.13 Cupboard Shelves etc.

Planks for shelves shall be planed on all faces and edges. In case of boards they shall be sawn to the required size truly straight and square. Timber battens 25 x 40 mm unless otherwise specified shall be planed smooth and fixed inside the cupboard with wooden plugs and screws. Shelves shall be fixed to the battens and vertical portions shall be held in position by fixing them to the battens and shelves using screws. hardwood strips for edge sealing of the boards shall be planed smooth and fixed with headless nails. Tolerance in width shall be ± 1.5mm and in thickness 1 mm.

9.14 Hardware Fittings for Doors, Windows & Ventilators

All mortice or rim locks, latches, cabinet and wardrobe locks, hydraulic door closers, floor springs etc. shall be of Godrej, Everite make or of similar approved make. The rate shall include for all necessary screws, other adjuncts, fixing in position and is for the completed work. The finish shall be as specified in the schedule of quantities. Door , window and ventilator fittings shall be as per specifications already described. The rates for doors, windows and ventilator shutters shall include the cost of fixing the fittings, with the necessary screws to the shutters and the frame. The cost of fittings only shall be paid separately. Where specified in the schedule of quantities, the cost of fittings shall be included in the rates for doors , windows and ventilator shutters. In such case the

contractor shall supply and fix the various fittings strictly to the standard laid down in the schedule of hardware fittings and no separate payment for this shall be made.

9.15 Inspection

The Contractor shall provide all facilities to the Engineer for the inspection of the goods at his premises. No primer shall be applied to wood work until it has been inspected and passed by the Engineer. The Engineer shall have the option of rejecting any article or asking for replacement of any article found to be defective or not complying with the requirements of this specification and the relevant Indian Standards.

10.0 METAL DOORS, WINDOWS, VENTILATORS & COLLAPSIBLE GATES

10.1 General

Doors, windows and ventilators etc., shall be truly square and flat, i.e. free from twist and warp. The general fabrication shall conform t IS : 1038 and IS : 1361 as appropriate.

10.1.1 Frames shall be constructed of sections which have been cut to length and mitered. They shall be morticed, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Flash butt welded construction with mitered corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties/weather bars installed in place. All frames shall be square and flat. Door thresholds shall be provided as shown on drawing. Doors without threshold shall have bottom tie of approved type.

10.1.2 The Contractor shall obtain doors, windows, ventilators etc., from an approved manufacturer. The Contractor shall first submit for the approval of the Engineer, the name and address of the manufacturer whose metal casements and doors and windows he intends to use, together with typical drawings and specifications, describing the details of construction for each type of door/window/ventilator etc.

10.1.3 All steel doors, windows and ventilators shall be either galvanized or painted. All steel surfaces shall first be thoroughly cleaned free of rust, scale or dirt and mill scale by pickling or similar process and they shall be painted with one coat of an approved primer conforming to IS : 102 before despatch. Alternatively they may be galvanized by the "Hot Dip" zinc spray or electro- galvanizing process as described in IS : 1361.

10.2 Fixing

Doors, windows and ventilators shall not be built in at the time the walls are constructed but shall be subsequently fixed into prepared openings, as laid down in IS : 1081. Holes to accommodate the fixing lugs are to be left or cut, and the casements fixed after all the rough masonry and plaster work have been finalised. The lugs of the casement shall be jammed in cement concrete (15C Mark) after holding the casement in proper position, line and level.

The width of the clear unfinished opening in the wall should be 25 mm more than the overall width of the door frame to allow for 12.5 mm plaster on each jamb. The height of the unfinished opening shall depend upon whether a threshold is required or not. While fixing the door, care shall be taken to see that at least 6 mm space is left between the door and the finished floor.

10.3 Fittings

Hardware shall be fixed as late as possible, preferably just before the final coat of paint is applied. It shall be fitted in a workmanlike manner, so that it may not work loose and in such a way that screws and pins are not marked and mutilated by hammers and screw drivers. It shall be tested for correct operation. Where specified, doors shall be fitted with a three-way bolting device which can be operated from outside as well as inside, and a locking system, which can similarly be operated from either side. Solid steel bolt handles shall be provided, one on the outside and one on the inside of each shutter. In case of doors provided with a service door, the lock shall be fitted on the service door. All materials shall be the best procurable and shall conform to the relevant IS specifications.

10.4 Normal Steel Plate Doors

Steel doors may be of the hinged type or sliding/folding type, single shutter or double shutter, and of single- walled or double walled construction, as specified on the drawings or Schedule of Items. All doors shall be provided with a sturdy frame and hold fasts for fixing into the wall. Unless otherwise specified, the frame shall be prepared from mild steel angles of size not less than 65 x 65 x 6 mm electrically welded at the corners and the shutter shall be made from flat steel sheet of 18 gauge thickness with a frame of mild steel angles not less than 50 x 50 x 6 mm all round, suitably braced. The whole shutter shall be of welded construction and shall be hung at the sides by means of three or four hinges as specified.

10.4.1 Double Plate flush door shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of two outer sheets or 18G steel sheets, rigidly connected and reinforced inside with continuous vertical 20G stiffeners, spot welded in position at not more than 150 mm on centres. Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and head, shall have proper level on lock stiles and rails and shall be reinforced at corners to prevent sagging or twisting. Spires or double doors shall have meeting style edges beveled or rebated. Where shown on drawing, or in the Schedule of Items, the doors shall be sound-deadened by filling the inside voids with mineral wool or other suitable approved materials. Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push-plates and other surface hardware where necessary. Any drilling and tapering required for surface hardware shall be done at site. Where shown in drawing, provisions, shall be made for fixing glazing, vision panels, louvers etc. Glazing mouldings shall be of 18 g steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louver blades shall be V or Z shaped sections.

10.4.2 Single sheet door shutters

Single sheet doors shall be made from best quality 18g mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with a semitubular edge and central stiffening rail which shall convey the lock and other fixture. The frames shall be made from best quality steel sections. Wherever required or shown on drawings, provision for fixing glass panes, louvers etc., shall be made.

The manufacturing shall done as specified in "Double Plate Flush Door Shutters".

10.5 Sliding Doors

Shall be either double plate or single plate construction as shown in drawings and Schedule of Items, made out of 18 gauge steel sheets with adequate stiffeners. The Contractor shall specify the weight of the door in his shop drawing and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where shown in drawings or in the Schedule of Items, the Contractor shall make provision for openings in the door for mono-rail beams. Doors when closed shall effectively exclude rain water from seeping in. When called for in schedule, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

10.6 Pressed Steel Doors

All pressed steel doors shall be obtained from an approved manufacturer. The frame and shutters shall be fabricated from cold rolled or pressed steel sections. Unless otherwise specified, the thickness of all sheets used for frames shall be not less than 5 mm. The shutters shall be made of sheet steel of 2 mm thickness for single shutter doors and double shutter doors with or without service door. The plates shall be adequately stiffened with suitably placed stiffeners.

The double-walled door shutter shall consist of two plates each 2.5 mm thick, separated by a gap of 33 mm in between making an overall thickness of 38 mm or as shown in drawing. The plates shall be adequately stiffened by means of suitably spaced horizontal steel stiffeners.

10.7 Steel Windows, Sashes, Ventilators, etc.

These shall conform to IS : 1038 and IS : 1361 as appropriate and as shown in drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc.

10.7.1 Where composite unit openings are shown in drawings, the individual window units shall be joined together with requisite transoms and mullions. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown in drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

All welds at the corner of casement shall be done by flash butt welding process and dressed flush on all exposed and contact surfaces.

10.8 Collapsible Gate (Steel)

Mild steel collapsible gates shall be obtained from an approved manufacturer. These shall be of mid bar type made out of double channels each 20 x 10 x 2 mm with 20 x 5 mm diagonals and shall be top hung with roller bearings, and fitted with locking arrangement.

Collapsible gates under 3.0 meter height shall generally have 3 sets of lattices and those over 3.0 meter height, 4 sets of lattices. Guide tracks shall be fitted at the top and

bottom, of T-iron 40 x 40 x 6 mm with 40 mm dia bearings in every fourth double channel.

10.9 Aluminium Doors, Windows, Frames

10.9.1 Anodised tubular aluminium doors shall be of approved make and shall be of size and design as per relevant drawing. Unless otherwise specified, the door frame shall be of 101.4mm x 44.6mm and shutter of 50mm tubular extrusions, 3mm thick. The opening arrangement shall be single action or double action as shown in drawings with spring hinges in floor. The glazing shall be 5.5mm thick plain glass panes fixed with necessary gaskets and aluminium beading strip. The door shall be provided with one security lock. The shutters shall be provided with 1.6mm thick 300 x 150mm push plates and 1.6mm thick 300mm wide kick plate of anodised aluminium for full width of door inside and outside.

The door frames shall be polished and anodised with approved colour. The average thickness of anodic coating shall not be less than 15 microns as per IS:1868-1982. Door frame shall be provided with approved anchors @ 90cm c/c maximum for fixing.

10.9.2 Aluminium Windows

Alimunium windows and ventilators shall conform to IS:1948-1961 or equivalent as approved by the Engineer. Fixed frame shall be manufactured from aluminium alloy conforming to ISS-HE-9 WP. The fixtures like handles, stoppers, stays, etc., shall also be anodized aluminium and shall be of approved make. Glazing shall be 4mm thick plain glass and shall be fixed with glazing clips and metal putty. It shall conform to IS:1081-1960. Average anodizing coating to windows ventilation and fixtures shall not be less than 15 microns as per IS:1868-1982.

10.9.3 All work shall be fitted and shop assembled to a first job, and ready for erection. Shop joins shall be made to hair lines and then welded or braced by such method as will produce a uniform colour througout the work. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be shap fit type without visible screws and shall be of sizes to accommodate glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

11.0 <u>GLAZING</u>

11.1 General

Glazing shall be done with plain, frosted or ground glass or wired cast glass as shown on drawings, described in the Schedule of Items or approved by the Engineer. The method of glazing adopted shall be such that movement of the structure, to which the securing is done, does not transmit strain to windows, doors or ventilators as the case may be. The work shall generally conform to IS : 1081, Code of Practice for Fixing and Glazing of Metal Doors, Windows & Ventilators. The material for putting shall consist of whiting and linseed oil, raw-mixed in such proportion as to form a paste conforming to IS : 419.

11.2 Doors, Windows, Ventilators, etc.

Windows and ventilators shall be designed for putty glazing fixed from outside and

glazed doors for fixing from inside. In addition, spring type glazing clips shall be provided at intervals of 30 cm, or as shown otherwise on drawings or described in the Schedule of Items. These shall be inserted into holes drilled in the shutters or frames as the case may be.

All glazing shall be puttied to the shutters or frames with good quality putty in addition to glazing clips. Glass panes shall not be placed directly against the metal/timber. A thin layer of putty shall be evenly spread over the glazing rebate and the glass pressed firmly against it. It shall be secured in position by means of teak wood beds for wooden shutters. Glass panes shall be sent without spraining and shall be bedded in putty and back puttied, except where moulding or gasket are specified. Putty, mastic cement etc., shall be smoothly finished to even lines. Figured glass shall be set with smooth side out. After completion of glazing work, all dirt stains, excess putty etc., shall be removed and the glass panes shall be left in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the Contractor's cost.

11.3 Fixed Glazing

This shall consist of steel glazing bars as shown on drawings or described in the Schedule of Item and be subject to approval of Engineer. The glazing parts shall be securely fixed in their frame and shall be weather-proof. All glazing shall be flashed to the surrounding so as to be weather-proof. Glass shall be fixed to the a strangles with glazing clips and putty.

12.0 WHITE WASHING, COLOUR WASHING AND PAINTING

12.1 Scope

This chapter deals with white washing, colour washing, distempering, cement washing, emulsion painting, silicate painting etc., to concrete and masonry surfaces and painting to the wood works and steel works.

12.2 Materials

Materials shall conform to Part-I of this series.

12.3 White Washing, Colour Washing

12.3.1 General

Wherever scaffolding is required/necessary, it shall be erected on double support tied together by horizontal pieces, over which the scaffolding planks shall be fixed. No part of it shall rest on or touch the surface which is being washed. Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls. For white washing the ceiling, proper stage scaffolding shall be erected. The surface on which wash is to be applied shall be thoroughly brushed free from mortar droppings and foreign matter.

12.3.2 White wash

The wash shall be prepared from fresh stone white lime of approved quality and shall be thoroughly slaked on the spot mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for 24 hours and then shall be screened through a clean course cloth. 4 Kg of gum dissolved in hot water shall be added to each cubic

meter of the cream.

The approximate quantity of water to be added in making the cream will be 5 litres of water to 1 kg of lime. Indigo upto 3 gm per kg of lime dissolved in water shall then be added and wash stirred well. Water shall then be added at the rate of about 6 litres per kg of lime to produce a milky solution. The white wash shall be applied with approved brushes to the specified number of coats. The operation for each coat shall consist of stroke of brush given from the top downwards, another from the bottom upwards over the first stroke and similarly one stroke horizontally from the right and another from the left before it dries.

Each coat shall be allowed to dry before the next-one is applied and shall subjected to inspection and approval by the Engineer. No portion of the surface shall be left out initially to be patched up later on.

The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed. Doors, windows, floors and such other parts of the building not to be white washed shall be protected from being splashed upon.

12.3.3 Colour wash

A priming coat of white wash with lime shall be applied before applying two or more coats of the colour wash (as specified). Entire surface should represent a smooth and uniform finish. Sample of colour wash shall be duly approved by the Engineer before application. Same specification as that of white wash shall be followed for colour wash also using necessary amount of colouring ingredient of approved tint.

12.3.4 White washing with whiting

Whiting (ground white chalk) shall be dissolved in sufficient quantity of hard water and thoroughly stirred to form a thin slurry which shall then be screened through a clean coarse cloth. 2 Kg of gum and 0.4 kg of copper sulphate dissolved separately in hot water shall be added for every cum. of slurry which shall then be diluted with water to the consistency of milk so as to make wash ready for use. Other specification remains same as per white washing with lime.

12.4 Cement primer coat

The surface shall be thoroughly cleaned of dust etc., and shall be allowed to dry for at least 48 hours. It shall then be rubbed thoroughly be sand paper to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry. The cement primer shall preferably be applied by brushing and not by spraying. Horizontal strokes shall be given first and vertical strokes shall be applied immediately, afterwards. This entire operation will constitute one coat. The surface shall be finished as smooth as possible, leaving no brush marks.

12.5 Water proof cement paint

The prepared surface shall be thoroughly wetted with clean water before water proof cement paint is applied. The paint shall be prepared strictly as per manufacturer's specifications, in the absence of which it shall be mixed in two stages. The first stage

shall comprise of 2 parts of water proof cement paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. The paint shall be mixed in such quantities as can be used up within an hour of its mixing.

Paint shall be applied with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that direct heat of the sun on the surface is avoided. Method of application shall be similar to oil bound distemper. The completed surface shall be watered, after the day's work. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted and a uniform shade should be obtained after application of paint. Cement paint shall not be applied on surfaces already treated with white wash, colour wash, distemper, varnish paint etc., and on gypsum, wood and metal surfaces.

12.6 Oil bound distemper

The surface shall be prepared as for 'Cement Primer Coat'. A primer coat of cement primer or distemper shall be applied as specified in the description of the item. After the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth, taking care not to rub the priming coat out. All loose particles shall be dusted off. One coat of distemper properly diluted with thinner, shall be applied with brushes/rollers in horizontal strokes followed immediately by vertical ones which together constitute one coat. The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied to obtained an even shade. A time interval of at least 24 hours shall be allowed between consecutive coats. The brushes shall be of 15 cm. double bristled type. They shall be maintained in proper condition and those that are dirty or caked will not be allowed to be used.

12.7 Dry Distemper

The surface shall be prepared in the same manner as for oil bound distemper. A primer coat using approved primer or sizes shall be applied. Distemper prepared as per manufacturer's direction shall be applied and each coat shall be allowed to dry before subsequent coat is applied. The finished surface shall be free from chalking when rubbed, even, uniform and shall show no brush marks.

12.8 Plastic emulsion paint

The surface on which plastic paint has to be laid must be thoroughly cleaned and prepared and all defects rectified. The surface shall be dry and rubbed smooth by means of sand paper to the satisfaction of the Engineer. One coat sealer and two coats of plastic emulsion paint are to be applied. The work is to be carried out under direct guidance and instructions from the manufacturers whose expert advise and supervision are to be made available in order to achieve the high grade finish. The painters employed for this work must be capable of producing the highest standard of workmanship required. If the finish is of doubtful nature, the contractor shall have to rectify at his own cost to the entire satisfaction of the Engineer.

Plastic emulsion paint of 'Jenson Nicholson' or equivalent quality and of approved colour and shade shall only be used.

12.9 Silicate paint

Silicate paint shall consist of two parts mixed in the ratio of 1 : 1 by volume.

a) Liquid part consisting of liquid glass whose density has been reduced to 1.15 to 1.20 by addition of water.

b) Solid part consisting of a pigment and chalk in the ratio of 1 : 9 by weight. Pigment shall be selected on the basis of colour requirement and shall have the approval of the Engineer.

The two parts shall be mixed thoroughly and the paint passing through a sieve of 600 mesh per sq.cm. only shall be used for painting. The paint shall be used within 12 hours after mixing and the painting shall not be carried out in open sunlight or under moist conditions.

12.10 Bitumen painting

Bitumen painting to concrete surface shall be done as follows :

i) Hot application

The surface shall be cleaned of all mud etc., before painting. The honey-combs and other defects of concrete surfaces to be painted shall be rectified properly. Any projection of binding wire shall be cut to keep it 10 mm inside the concrete surface and then filled with mortar. Before application the surface shall be absolute dry.

Bitumen of standard quality of 20/30 or equivalent shall be heated to the temperature specified by the maker and then applied hot with brushes on the prepared surface. The surface shall be allowed to cool before applying the second coat.

ii) Cold application

The surface shall be prepared in the same way as for hot application. The bitumen emulsion of approved quality shall be applied with special brushes.

Where acid resistant treatment is specified such surface shall be covered with approved acid resisting coating to the satisfaction of the Engineer. Before the coating is applied, the surface shall be properly cleaned and prepared in the manner described above.

12.11 Tarring

i) Timber surfaces in contact with earth/ concrete/plaster shall be treated with one coat of hot tar mixture before fixing as specified in schedule.

ii) If required steel work in holdfasts and the like shall be treated as above and sanded in addition before being fixed in position.

12.12 Painting to Timber & Steel Surface

12.12.1 General

The priming coat for steel/wood work shall be applied after the surface has been prepared. After the priming coat has dried, all nails, screw holes and cracks shall be filled with putty and surface smoothened with sand paper.

All stains of paint to glasses, walls, fittings and fixtures etc. shall be cleaned thoroughly by applying required turpentine or thinner. The contractor's rate shall include all these.

12.12.2 Painting to timber

i) Unless otherwise specified, all timber surfaces shall be treated with one priming coat, one under coat and one finishing coat. Under coat and finishing coat shall be synthetic enamel and priming coat shall be of pink primer or as specified in schedule of quantities and as approved. In case the surface are to be polished or varnished, a priming coat of approved polish or varnish shall be given. No primer shall be applied to wood work until it has been inspected and passed by the Engineer.

ii) Polishing

The surface to be polished shall be prepared in the same manner as specified under painting.

The number of coats to be applied shall be as specified.

The polish shall be applied with a pad consisting of cotton wool inside a clean white cloth. Several coats shall be applied with light sand papering from time to time and cleaning the dust before applying next coat except the final coat. The final coat of the polish shall be rubbed thoroughly until the wood feels perfectly dry when touched and gives a satisfactory smooth shining.

12.12.3 Painting to steel surfaces

12.12.3.1 General

All surfaces shall be thoroughly cleaned of all dirt, grease, rust and mill scale. Areas which become inaccessible after assembly shall be painted before assembly after cleaning the surfaces as described above. The surfaces shall be perfectly dry before painting.

Wherever shop primer painting is damaged, the surfaces shall be thoroughly cleaned and touched up with corresponding primer.

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.

12.12.3.2 Steel structures

Unless otherwise specified all structures shall be painted with two coats of primer as specified and approved. One coat shall be applied at shop and the second coat at site. All structures after erection shall be given two coats of finishing paint and shall be of synthetic enamel of approved colour. The under coat shall have different tint to distinguish from the finishing coat.

12.12.3.3 Galvanized iron sheets

All plain and CGI sheets requires surface pre-treatment or use of other patented primer to ensure adhesion of paint to zinc coated surfaces. Such pre-treatment shall be as per manufacturer's specifications. Where pre-treatment is adopted one coat of primer paint of suitable quality shall be applied. Unless otherwise specified the finishing coats shall consist of an under-coat of an aluminium paint having blue tint and a second coat of aluminium paint having aluminium colour.

12.12.3.4 Structures exposed to corrosion

Structures exposed to corrosive atmosphere, acid fumes, chemical action etc., shall be given two coats of primer, one at shop and one at site and two coats of finishing anticorrosive paint of reputed manufacturer. Red lead primers are not permitted. The finishing coats shall be of specified colour. The type and procedure of such painting shall be as per manufacturer's specification and the same shall be subject to Engineer's approval.

12.12.3.5 Structures exposed to heat

Structures exposed to heat shall be given two coats of primer, one at Shop and one at Site and two finishing site coats of heat resistant paint of suitable commercial type in accordance with relevant standards or manufacturer's specification, and shall be subject to the Engineer's approval.

12.12.3.6 Structures embedded

Exposed surfaces of embedded parts shall be given two coats of read lead graphite primer at shop and finished with two coats of anti-corrosive paint at site after embedment. Type of paint and procedure of painting shall be as per relevant standards or as per manufacturer's instructions. Surfaces to be field welded shall have no paint applied within 100 mm of the welding zone.

13.0 INTERNAL WATER SUPPLY PLUMBING, DRAINAGE & SANITATION

13.1 Scope of Work

The work comprises supply, laying testing, commissioning etc. of water supply, plumbing, drainage & sanitation.
The work includes the following activities connected with the job :

i) Supply and delivery of all required pipes and other materials.

ii) Earthwork in excavation for trenches, pits/ chambers/ manholes etc.

iii) Civil works connected with the laying/erection of pipe lines such as making holes in the wall etc. and repairing them after pipe erection, construction of pipe supports, valve chambers, manholes, bedding and covering of pipe laying wherever required.

iv) Laying and jointing of pipe lines as per relevant IS codes.

v) Testing of pipe lines after laying as per IS or any other standard test.

vi) Back filling of trenches after successful & satisfactory testing.

vii) Disinfection of the complete piping system in the case of water supply.

viii) Commissioning of entire network.

ix) Safe custody of the pipes/materials/equipment/work and other obligation stated elsewhere in the specification.

x) Any other activities which are not mentioned above but essential and required.

13.1.1 Materials

The materials shall conform to Part-I of this series.

13.2 Water Supply & Plumbing

13.2.1 General

13.2.1.1 General requirements

The Contractor shall lay all the pipes and fittings in the best workman like manner by skilled workmen and licensed plumbers in conformity with the regulations and requirements of the local appropriate authorities and to the satisfaction of the Engineer. Unless otherwise specified water supply works in buildings shall be carried out in accordance with IS : 2065 "Code of Practice for Water Supply in Buildings".

13.2.2 Installation

All works like earth work, masonry, concrete, steel work, cutting holes, chases in brick or in concrete works, cutting of roads, repairs and rectifications associated directly with the installation of water supply system shall come under the scope of the contractor and shall be governed by the specification of the relevant chapter.

13.2.3 Laying

Before lowering down the pipes for laying the trenches shall be checked against crack by means of light hammering and for any other damage. All fixing shall be carefully aligned and spaced at a distance from the main structure to give reasonable all round access for maintenance and inspection and laid true to line plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface holder or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. Pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer. Pipes embedded in floors and wall shall be securely bound with bituminous impregnated type and so fixed as to allow for any movement due to expansion and contraction. Adequate width shall be provided to lay the pipes as per standard practice.

Excavation below the required level is not permitted. The contractor shall make good

any excess excavation as directed by the Engineer.

Soft spots in the bottom of beds for pipe lines in rock shall be levelled with sand or soft soil or concrete as approved by the Engineer and the thickness of the layer shall not be less than 100 mm.

13.2.4 Excavation for pipe lines in trenches

Excavation shall comply with chapter 2. The sides of pits and trenches shall be adequately supported at all times, except where otherwise directed by the Engineer.

13.2.5 Underground piping in and around building

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable, and as shown in the drawing and instructed by the Engineer. The thrust blocks shall be provided wherever required.
The size and depth of the trench shall be as approved by the Engineer. Backfilling in trenches shall be done with selected fine earth, unless otherwise permitted, in 150 mm layers and carefully consolidated and well treated so that it does not set as a drainage channel. Special care shall be taken while filling in the vicinity of the pipe to avoid damages. Before backfilling the laid pipe shall be fully tested and approved.

13.2.6 Concealed piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the adjoining structure by making chases in walls/floors and these shall be secured by hooks and the chases filled with concrete 1:2:4 (1 cement, 2 sand and 4 aggregate). The contractor will rectify if required the chases, openings and conduits, supplement and make good after laying and testing of the concealed pipelines.

13.2.7 GI Piping

13.2.7.1 The pipes shall be fixed in longest lengths possible with all necessary bends, tees, couplings, reducing sockets and tees etc. in perfect straight lines both vertically and horizontally.

13.2.7.2 All exposed GI pipes shall be fixed at least 15 mm clear of wall face with holder bat clamps at suitable places not exceeding (2.5 meters) center to center. Where the pipes are laid in chases in walls as shown in the drawing, these shall be secured to walls by hooks. Cases in walls and floors shall be filled in with cement concrete 1:2:4. Where the pipes are to be run underground these may be laid at least 60 cm below ground level.

13.2.7.3 The joints of pipes and fittings shall be sealed with red lead paint and fine spun yarn. Joints must be perfectly water tight when put under maximum test pressure.

13.2.7.4 Unless otherwise specified the exposed portion of pipes and fittings shall be given two coats of approved paint over a coat of approved priming. For pipes laid underground, these shall be treated with two coats of bituminous paint.

13.2.8 Jointing of pipes

The interior of all pipes and joints shall be cleaned before jointing commences. Jointing of pipes shall be done in such a manner as to render them completely leakproof and durable. Instruction of the manufacturer shall be followed unless desired otherwise by

the Engineer. However, the general norms and recommended practice for different types of pipes are given below for guidance :

(a) Cast Iron

i) Spigot and socket joints :

Interior surface of bells and exterior surface of smooth ends of pipes shall be cleared of redundant insulting cover and other foreign materials particularly of oil, burning off materials from bells and smooth pipe ends is not permitted. Sharp rises on interior bell surface shall be smoothed out.

Bells should be lined up, in compliance with direction of pipe. Laying work shall be started from lower points.

Lead Joint :

The joint is made by first caulking in with packing material hemp, resin of bituminous strand or rubber rings upto half depth and filling the remainder by running in molten lead taking care that no dross enters the joint and then thoroughly caulking the lead. The lead need not extend into the joint further than the back of the groove formed in the socket. After completing the joint it shall not be allowed to move. For rectification the joint shall be completely redone.

ii) Flanged joints :

Flanged joints shall be made by jointing rings of good quality, smooth and hard compressed fibre material of thickness not less than 1.5 mm and of such width as to fit inside the circle of bolt. Diagonally opposite bolts shall be tightened in pairs and in stages so that degree of all bolts in a joint are similar. Damaged gaskets shall be replaced.

(b) For Steel Pipes

Plain ended steel pipes may be jointed by welding. Screwed and socket joints shall be carefully tightened. Care shall be taken to remove any burring from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer.

(c) For GI Pipes

Threads shall be cut with sharp tools, and before jointing all scale shall be removed from pipes by suitable means. The screw threads of the pipe shall be cleaned out and the joint made by screwing the fitting after treating the threads with approved pipe jointing compound. Once a joint has been screwed up it shall not be backed off unless threads are re-cleaned and new compound applied.

(d) For Asbestos cement pipes

Socket and spigot ended pipes shall be jointed by caulking with tarred gaskets and grouted with 1:3 cement sand mortar.

(e) For Lead Pipe

Lead and lead alloy pipes shall be jointed with wiped solder joints.

(f) For Concrete Pipe

Concrete pipes may be socket and spigot ended, collar or bend jointed. Joint shall be effected by caulking with tarred rope yarn and the socket completely filled in with 1:3 cement sand mortar. A fillet being worked round the socket extending for a length not less than 50 mm from the face of the socket.

(g) For PVC pipe

The joint shall be either solvent weld joints or of loose collar type with two rubber rings. The fittings, joints and installation shall be done as per recommendations of manufacturer.

(h) Tyton joint
The manufacturer's instruction shall be strictly followed in making such joints. Tyton joints shall be made by push-on type 'tyton' rubber gasket and such rubber gasket shall conform to the specification stipulated by the pipe manufacturer. The tools specified by the pipe manufacturer shall be used to secure the joint fully.

13.2.9 Precautions

(a) All water supply pipes shall be so laid and so fixed and maintained as to be and remain completely water tight.

(b) During installation open ends of each pipe shall be protected by suitable covers or plugs so that the ends, thread, sockets or spigot are not damaged and no foreign materials can make its way into the pipe line.

(c) Due care should be taken to ensure that there shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting containing impure water or water liable to contamination or of an uncertain quality of water which has been used for any other purpose.

(d) Fittings and fixtures liable to be stolen shall be fitted and fixed just before testing and handing over.

13.2.10 Painting

When mentioned in the schedule of item underground steel and cast iron pipes shall be treated with 2 coats of anticorrosive bituminous paint on the outside surface after cleaning the surface from soil, dust, moisture, rust, scales soot etc. When painting is to be done for pipes above ground GI pipes shall be given a coat of zinc chromate primer, C.I. & MS pipes shall be given one coat of red lead or zinc chromate primer over which at least 2 coats of best quality and manufacture as approved by the Engineer shall be provided or as specified in the schedule of item.

13.2.11 Water meters

Water meter shall be installed in the building at suitable location on the main supply line to the building/dwelling units.

13.2.12 Ferrule and stop cock box with chamber :

Square cast iron surface box 15 cm square and 22.5 cm deep weighing not less than 4.54 kg with hinged lid shall be provided in masonry chamber. Top of box shall be made flush with the finished level of the chamber. The chamber 25 cm x 25 cm inside shall be with half brick wall in cement mortar 1:4 over a bed concrete of 75 mm thick in proportion 1:4:8 with stone chips. The inside wall faces shall be plastered with 12 mm thick cement mortar 1:4 finished smooth with a floating coat of neat cement.
The exposed surfaces of cast iron box and cover shall be treated with two coats of bituminous paint.

13.2.13 Inspection, Testing and Acceptance

13.2.13.1 Pipes, fittings and fixtures before laying

All pipes, fittings and appliances shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

13.2.13.2 Testing of pipes after laying

a) The contractor shall ensure the safety of the pipework under test and provide all necessary stoppers, testing apparatus etc, that are required for testing.

b) The contractor shall be responsible for any damage done to pipework and ancillary work while testing and shall replace any pipe or fitting which does not satisfactorily withstand the test.

c) The contractor shall give written notice of the times at which tests are to take place. On completion of each test two copies of the complete records shall be given to the Engineer.

d) The work will not be considered complete until the tests have proved satisfactory and a certificate issued by the Engineer.

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits and then tested under pressure. The test pressure shall be 6kg/cm2 or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or a large diameter, by a power driven test pump, provided that pump is not left unattended. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrate before the test. The pump having been stopped, the test pressure shall maintain itself without measurable loss for at least five minutes. The end of the main shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

13.2.13.3 Testing of service pipes and fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off tape are closed, the service pipes shall be absolutely watertight. All piping, fittings and appliance shall be checked for satisfactory support and protection from damage, corrosion and frost.

13.2.14 Storage Tank

13.2.14.1 Pressed steel tank

Pressed sheet water storage tanks shall be of nominal size and capacity as mentioned in the Schedule of Item and fabricated with all flanges external/internal or bottom flange internal and side flanges external, as shown on drawings or schedule of items. Inlet, overflow vent pipes manholes shall be arranged and provided as shown in drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50 mm

above the bottom of the tank and there shall be 150 mm free board at the top of the tank. The fabricator shall supply 5 prints of fabrication drawing to the Engineer for prior approval showing thickness of plates, method of jointing the plates, all supports, stays, gussets etc. Pads, cleats etc., required for supporting the tanks shall also be supplied by the manufacturer.

All tanks shall be supplied with mosquito-proof top with manhole not less than 450 mm diameter. Tanks deeper than 1.00 Meter shall be provided with MS internal access ladder adjacent to the manhole. Meter level indicator shall be provided if asked for. Two coats of anti- corrosive paint over a suitable primer shall be applied to both internal a external surface of tanks. The paint shall be so selected as not to impart any taste or odour of water and be of lead free composition.

13.2.14.2 GI water tank

GI water tanks shall be procured from a reputed manufacturer. The design shall be good enough to withstand the loads safely Galvanized iron water storage tank shall be made of minimum 16 gauge galvanized iron sheet. Plain sheets shall be fixed at the corner to angle iron frames by means of 6 mm rivets at 40 mm pitch for tanks upto 1000 litres capacity and 8 mm rivets at 35 mm pitch for tanks above 1000 litres capacity. Tanks above 1000 litres shall have 20 mm dia. galvanised iron stays, one fixed to angle framing at top and two in the body of the tank for extra strength. Holes for riveting shall be drilled and not punched. White lead shall be applied to the joints before riveting.
Tanks shall have 400 mm dia. holes at the top with hinged covers. The covers shall be made of galvanised iron sheet with angle iron frame. The cover shall be just loose but close fitting to keep out dust and mosquito and will not be airtight. It shall be complete with lockable arrangement.

Tanks unless otherwise specified shall be provided with rising main inlets of 40 mm dia galvanised iron pipe or as shown on drawing and 25 mm dia GI overflow pipe and 25 mm washout with plug. The rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing. The ball valve shall permit the entry of water when the tank is empty and disconnect the supply when the tank is full. It consists of a hollow floating ball made of copper plastic or hard rubber, 110 mm in diameter attached to an arm which is so pivoted that the end near the pivot close the orifice of the main when the ball is raised to the required height of water in the tank and opens the main as soon as the ball drops with the fall of water level as it is drawn off through the distribution. The ball valve shall be fixed to the tank independent of the pipe and set in such a position that the body of the ball valve submerge when the tank is full upto the water line. The ball valve shall be so adjusted as to limit the level of the water in the tank below the lip of the overflow pipe, and above the maximum water filled level shall be as per the standard norms for GI water tanks.

13.2.14.3 Water reservoirs made of concrete or masonry shall be governed by the specification of the relevant chapter. It shall have, inlet, outlet, overflow and wash out with plug and a top MS/CI cover as per schedule of items and drawings.

13.3 Drainage and Sanitation (Internal)

13.3.1 Scope

This section covers the layout and construction of drains for waste water, surface water and sewage together with all fittings and fixtures inclusive of ancillary works, such as connections, manholes and inspection chambers used within and around the building

and the connection to a public sewer upto treatment work, septic tank and soak pit. All sewerage and drainage works shall be executed in accordance with specifications given for different works. All sewerage and drainage works shall be executed by a licensed plumbing supervisor or a licensed plumber and in accordance with IS : 1742 "Code of Practice for Building Drainage " unless otherwise specified.

13.3.1.1 Installation

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and shall be located so as to allow easy maintenance.
All pipelines, fittings and fixtures shall be installed leakproof when the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gasses.

13.3.2 Rainwater downcomers

Rainwater downcomers shall be standard cast iron or asbestos cement pipes. In case where specifically desired, MS pipes may also be used. MS pipes shall be painted outside with two coats of anticorrosive paint over a coat of primer. Rainwater downcomers shall run along and be secured to walls columns, etc. Where desired by the Engineer these may have to be installed in chases cut in the structure. All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clamp type, split ring type or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed. Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings. All horizontal pipes shall have a minimum fall in 1 in 100.

13.3.3 Gutter

The gutters shall be made of GI or A.C., gutters shall be supplied by reputed specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the sloes perfectly uniform. GI gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no deflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated of MS brackets. All junctions shall be thoroughly watertight. The joints may be made by riveting, bolting or soldering. All joints between successive lengths of gutters shall have an overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

13.3.4 Soil and drainage pipes

13.3.4.1 Gradients:

If not specified the minimum gradients of soil and drainage pipe line shall be as follows :

100 mm nominal dia : 1 in 35
150 mm nominal dia : 1 in 65
230 mm nominal dia : 1 in 120
300 mm nominal dia : 1 in 200

13.3.4.2 Relation with water supply pipe lines :

Unless specifically cleared by the Engineer, under no circumstances shall special drainage and soil pipes be allowed to come close to water supply pipelines.

13.3.4.3 Laying

Each separate pipe shall be individually set for lines and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 16 m apart. The excavation shall be boned in at least one in every 2 m. The foot of the boning rod shall be set on a block of wood of the exact thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

13.3.4.4 Support and protection on pipelines :

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

Where pipes are not bedded on concrete, the bed shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of sand or gravel as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.
The minimum support and protection for glazed stoneware pipes shall be as follows :

a) When cover is less than 1 meter and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased surrounded with concrete as per relevant IS.

b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pips, the sewer shall be bedded on concrete 1:4:8 mix with 20 mm aggregates down.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched with concrete of 1:4:8 mix with 20 mm down aggregates.

d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased/surrounded with 1:4:8 concrete 20 mm down aggregate.

Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6)

nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The support shall be unyielding and strong enough. Atleast one support shall be located close to ends. Spacing of intermediate support shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means. Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

13.3.4.5 Entry into structures

For entry of the pipe lines into any building or structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. Where openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

13.3.4.6 Ducts

Where soil, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connecting waste water drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin or backflow

13.3.4.7 Traps and Ventilating pipes

Pipes carrying the sewage from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap. Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof top of the building or as shown on drawings. All vertical ventilating, antisyphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer.
Connecting to existing sewer lines shall be through a manhole. Manholes shall be provided with standard covers, usually C.I or as desired by the Engineer. The covers shall be close fitting so as to prevent gases from coming out.

13.3.4.8 Cutting of pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

13.3.4.9 Jointing

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.
All joints between pipes, pipes and fittings and manholes shall be gastight when above ground and watertight when underground. Method of jointing shall be as per instructions of the pipe and fitting manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) Cast Iron Pipes

Socket and spigot pipes shall be jointed by cast lead joints. The spigot shall be centered in the socket of the next pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured into fill the reminder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like "Tyton" joints etc. shall follow the instructions of the manufacturers.

In special cases if flanged joint are accepted by the Engineer the joints shall be made leakproof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete pipes :

Care shall be taken to place the collar centrally over the joint.

c) Glazed stoneware pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the socket. The reminder of the socket shall be filled with a stiff mixture of cement mortar of 1:1 proportion. When the socket is filled, a fillet shall be formed round the joint with a trowel, forming an angle of 45 degree with the barrel of the pipe. The newly made joints shall be protected, until set, from sun and rain and shall be covered with damp sacking or other suitable materials.

d) Vitrified clay pipes :

These shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact and glazed to make them acid resistant and impervious, and shall be obtained from approved manufacturer.

Special care shall be taken in handling these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1) which shall have very little water and levelled to form a splayed fillet at an angel of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi- circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead pipes :

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm and 9 cm respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) Polyethylene pipes :

The joints shall be thermowelded or bolted as per manufacturer's instructions.

g) Jointing cast iron pipes with stoneware pipes :
Where any cast iron soil pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe or drain communicating with a sewer the beaded spigot end or such cast iron soil pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe or drain and the joint made with mortar consisting of one part of cement and one part of clean sharp sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of caulking tool.

h) Jointing stoneware with cast iron pipes :
Where any water closet pan or earthenware trap connected to such a pan is to be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fibre.

13.3.5 Trenches and other excavations

Excavation shall be carried out according to chapter 2, Earthwork.
Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to become such as endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.
Turf, top soil or other surface material shall be set aside turf being carefully rolled and stacked for use in reinstatement. All excavations shall be properly timbered, where necessary. Efficient arrangements for dewatering during excavation and keeping it dry till back filling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.
Where the excavation proceeds through roads necessary permissions shall be secured by the contractor from the appropriate authorities.
Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe for packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand.
Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All settlements shall be made good regularly to minimize inconvenience or traffic where applicable.

13.3.6 Installation of fittings & fixtures

13.3.6.1 General

All fitting & fixtures shall be laid out as per drawings in proper line, level and shall be firmly secured to floors with screws and ditto fix and to walls with wall plugs and screws. Unless otherwise specified only C.P. Brass screws shall used for fixing sanitary fittings to wall plugs and floors.

13.3.6.2 European pattern WC

Water closet shall be fixed with floor with ditto fix and screw and soil, vent pipe with putty.

13.3.6.3 Indian Pattern WC

The water closet pan shall be sunk into the floor and embedded in a cushion of average 150 mm cement concrete 1:4:8 (1 cement, 4 sand and 8 broken brick ballast of 40 mm size). The concrete shall be left 125 mm below the top level of the pan so as to allow for flooring and its bed concrete. The joint between the pan and trap shall be made with cement mortar 1:1 and joint between trap and CI soil and waste pipe to be made with lead. All the joints shall be leak proof. The WC floor shall slope towards the pan.
The cast iron cistern, brackets and flush pipe etc. shall be painted with two coats of approved paint, over a coat of approved paint, over a coat of approved priming.

13.3.6.4 Wash basin and sink

Wash basin and sink shall be fixed to C.I. concealed brackets. The brackets shall be fixed to teak wood wall plugs with screws.

13.3.6.5 Urinals

The urinal shall be fixed to the walls with C.P. Brass screws fixed to teak wood wall plugs. Urinal partitions shall be fixed to walls by making chases in walls and grouting the same in 1:2:4 concrete.

13.3.6.6 Mirror

Fixed type mirror shall be screwed to wall plugs with CP brass screws and shall have a backing of asbestos or similar material.
Swivel type mirror shall be fixed with C.P. brackets which shall be fixed to wall plugs with CP brass screws.

13.3.6.7 Soap tray/toilet paper holder

This shall be of flush mounting design and shall be housed in walls by making chases and grouting the same in cement mortar 1:3. All other fittings shall be fixed with screw or as per manufacturer's specification.

13.3.6.8 Towel rail

This shall be fixed with CP Brass screws which shall be fixed to wall plugs.

13.3.6.9 The gully trap shall be fixed on 100 mm thick bed and encased to the full height of trap (and of square base of 600 mm) with cement concrete or proportion 1:4:8 with 40 mm broken stone aggregate. The gully outlet shall be jointed to the branch drain as specified or directed by the Engineer.

13.3.6.10 Masonry chamber for Gully Trap - After fixing and testing gully and branch drain, a brick masonry chamber 300 mm x 300 mm x 450 mm deep or as specified (internal dimensions) in cement mortar 1:4 (1 cement and 4 sand) shall be built with half brick thick wall round the gully trap from the top of the concrete. The internal faces of the chamber shall be finished smooth with 15 mm thick cement plaster (1:4) and neat cement finish. The outside of brick wall exposed to outside shall be finished with 12 mm thick cement plaster 1:4. The precast R.C. cover shall be fixed in groove made in 100 mm thick concrete base of proportion 1:2:4 and made water tight by providing suitable beading in the band.

13.3.7 Septic tank and effluent disposal

13.3.7.1 Septic tank

Septic tank shall consist of the tank itself with inlet and outlets therefrom complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawing. This item shall also include ventilating pipe of at least 100 mm dia whose top shall be provided with a suitable mosquito proof wire mesh and cowl. Ventilating pipe shall extend to a height of about 2 meters when the septic tank is at least 15 meters away from the nearest building and to a height of 2 meters above the top of building when it is located closer than 15 meters. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

13.3.7.2 Effluent disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approved or into a neck pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed S W pipes laid in a trench filled with broken bricks.

13.3.7.3 The soak pit shall be complete as shown on drawing. In absence of a detailed drawing it shall consist of a 900 mm dia pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks set in comment mortar (1:6) and filled with brick bats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

13.3.7.4 Open jointed S W pipes

Minimum dia of the S W pipes shall be 200 mm nominal. The trench for laying the pipes shall be minimum 600 x 600 mm. The joints of the pipes shall be left unsealed.

13.3.7.5 Commissioning septic tank

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cowdung may be introduced.

13.3.8 Manhole/Inspection chambers

Necessary excavation as required for the manhole shall be done true to dimensions and levels as shown in the drawing. The manhole chamber shall be built with brick work in cement mortar 1:4 on a base of 100 mm thick cement concrete 1:4:8 with 40 mm down aggregate or as specified. The concrete bed shall extend beyond the external face of brick work on all sides by at least 75 mm. The thickness of wall shall be as indicated. The brick work shall be carefully built in English bond, the jointing faces of each brick being well buttered with cement mortar before laying so as to ensure a fully joint.

The inside of the walls shall be plastered with 15 mm thick cement mortar 1:4 and finished with a floating coat of neat cement and outside shall be plastered with 12 mm thick C.M. 1:4.
The channels and benching shall be done in cement concrete 1:2:4 with 20 mm down stone aggregate and finished with 12 mm thick cement plaster in C.M. 1:3. The channels shall be semicircular in the bottom half and of diameter equal to the sewer. Above the horizontal diameter and the top edge shall be suitably rounded off. The Branch channels shall also be similarly constructed with respect to benching but at their junction with the main channel it shall be suitably rounded of in the direction of flow of the main channel. The benching at the sides shall be carried up in a slope of 1 in 3.

The branch channels shall be similarly constructed with respect to benching but at their junction with the main channel, an appropriate fall suitably rounded off in the direction of the main channel shall be given.
All angles shall be rounded to 75 mm radius with cement mortar 1:4 and shall be rendered smooth. The internal surfaces shall have a hard impervious finish obtained by using a steel trowel.
The manhole chamber shall be covered on top with RCC (1:2:4) slab with necessary reinforcement as per drawings. Unless otherwise specified circular type light duty M.H. cover with single seal weighing 25 kg. will be provided in each RCC cover.

13.3.9 Testing and acceptance

13.3.9.1 Inspection before installation

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

13.3.9.2 Testing of pipelines

Comprehensive tests of all pipe lines shall be made by stimulating conditions of use. The method of actual test shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.
General guidance for the tests are given below :

13.3.9.3 Smoke Test

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the

combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

13.3.9.4 Water test

For pipes other than cast iron
Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.
Subsidence of test water may be due to one or more of the following causes :

a) Absorption by pipes and joints.
b) Sweating of pipes or joints.
c) Leakage at joints or from defective pipes.
d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut and made good.

13.3.9.5 For cast iron pipes

Cast iron sewers and drains shall be tested as for glazedware and concrete pipes. The drain plug shall be suitably strutted to prevent their being forced out of the pipe during the test.

13.3.9.5.1 For straightness

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball will roll down the invert of the pipe and emerge at the lower end and ;

ii) By means of a mirror at one end of the line and lamp at the other. If the pipe line is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.

13.3.9.6 Testing septic tank

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm.

13.3.9.7 Fixtures etc.,

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

14.0 EXTERNAL WATER SUPPLY, SEWERAGE & DRAINAGE

14.1 Scope of Work

The work comprises supply, laying, testing, commissioning etc., of water supply sewerage & drainage network as specified.
The work includes the following activities connected with the job.

i) Supply and delivery of all required pipes and other materials.

ii) Earth work in excavation for trenches and pits/ manholes.

iii) Civil works connected with the laying/erection of pipe lines such as making holes in the walls etc., and repairing them after pipe erection, construction of pipe supports, valve chambers, concrete manholes, preparation of concrete bedding and covering for pipe laying wherever required etc.

iv) Laying and jointing of the pipelines as per relevant IS codes.

v) Testing of the pipelines after laying as per IS or any other standard test.

vi) Back filling of the trenches after successful and satisfactory completion of tests for the pipeline laid.

vii) Disinfection of the complete piping system in the case of water supply.

viii) Commissioning of entire network laid.

ix) Safe custody of types/material/equipment/work and other obligations stated elsewhere in the specification.

x) Any other activities which are not mentioned above but essential and required.

14.2 Materials

The materials shall conform to part-I of this series.

14.3 Water Supply (External)

14.3.1 Excavation of trenches & pits

Excavation shall be carried out according to Chapter-2, Earthwork.
Before starting earth work in excavation, temporary drainage arrangement shall be provided to prevent surface water entering the trenches and pits at the cost of Contractor.

Excavation of trenches and pits for pipelines shall be carried out in shortest possible time so as to avoid sinking of ground and consequent damage to the pipelines.
Excavation of trenches for pipelines and surface drains, shall be in exact accordance with the plans and section, alignment, levels and gradients as indicated on the drawings or as directed at site by the Engineer. The final bed must be dressed, levelled or trimmed to proper gradient and rammed with sprinkling of sand and got passed by the Engineer before laying blinding concrete of pipes. No excavation shall be made below the specified levels without written permission of the Engineer. Should any excavation be taken below the specified level due to carelessness of the Contractor, he will fill in such excavation at his own expense with lean cement concrete (1:5:10) well rammed in

position.

14.3.2 Back filling

For the purpose of back filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench to its top.

ZONE-"A" From the bottom of the trenches to the level of the center line of the pipe.

ZONE-"B" From the level of the center line of the pipe to a level 300 mm above the top.

ZONE-"C" From a level 300 mm above the top to the top of the trench.

Trenches shall not be back filled until the pipe joints have been tested, alignment and gradient passed by the Engineer but back filling shall be done atleast from the bottom of the trench to the level of the centerline of the pipe (ZONE "A") leaving 450 mm on either side of the joints uncovered with earth till testing is completed. These joints should however be kept covered with mats, gunny, straws etc., to avoid damage to joints by temperature effects.
While back filling care should be taken to ensure that no damage shelled be done to the pipeline. All back fill materials shall be free from cinders, ashes, slag, refuse, rubbish, vegetables or organic material, lumpy or foreign material, boulders, rocks or stones or other materials which in the opinion of the Engineer is unsuitable or deleterious. However, materials containing stones upto 20 cm as the greatest dimension may be used in Zone-"C" unless specified otherwise herein.
Backfilling in Zone-"A" shall be done by hand with sand, fine gravel or other approved material placed in layers of 80 mm and compacted by tamping. The back filling material shall be deposited in the trench for its full width of each side of the pipe, fitting and appurtenances simultaneously.

Backfilling in Zone-"B" shall be done by hand or approved mechanical methods. Special care being taken to avoid injuring or moving the pipes. The type of back fill materials to be used and the method of placing and consolidating shall be prescribed by the Engineer to suit individual locations.
Back filling in Zone-"C" shall be done by hand or approved mechanical methods. The type of back fill materials and method of filling shall be as prescribed by the Engineer.

Paving and metalling shall be reinstated in as good order as before removal and the Contractor shall do adequate ramming and watering of under layers to guard against subsequent settlement.

14.3.3 Custody of pipes

The Contractor shall remain responsible for the safe custody of pipes, special and other materials supplied by him/issued to him either free or on cost recoverable basis till these are laid installed, tested, back filled etc., and handed over to the Engineer.
The Contractor shall verify the conditions of the pipes, specials etc., at the time of receipt from sources and shall be responsible for all damages during handling, transporting, laying, installing, testing etc., and the cost of such damages shall be borne by the Contractor.

14.3.4 Erection/laying of pipelines

i) Erection of all equipment shall be carried out with highly skilled workers.

ii) The pipelines shall be laid and supported properly and it shall be deemed as a contractual obligation that the lines are not thrown out of alignment or lifted off during commissioning and subsequent operation.

14.3.5 Pipeline erection

a) Overhead pipelines

i) Suitable slopes , draining arrangements and air vents/air release valves shall be provided.

ii) Sliding and fixed supports shall be provided, wherever necessary.

iii) As far as possible joints shall be located at 1/3 span of supports.

b) Underground pipelines
All the underground pipelines shall be laid in accordance with IS : 3114 and the following shall be included in the scope of work of the Contractor.

14.3.5 Pipe jointing

The type of jointing will be defined in the details working and tender schedule i.e. whether they should be (i) socket and spigot with molten lead or lead wool joint or (ii) flanged joint.

14.3.6.1 Socket & spigot joints

a) Molten lead joints
Unless otherwise specified, socket and spigot joints shall be done with molten lead.
The spigot shall be cleaned of the coating, carefully entered in the socket of the adjacent pipe by one or more laps of white damp spun yarn, sufficient yarn only being driven into the socket to leave the depth of the lead specified. The proper depth of each joint shall be tested before running the lead by passing completely round it a wooden gauge, notched out to the correct depth of lead, the notch being held close up against the face of the socket. The pipes shall be carefully packed underneath so that they shall bear properly throughout their whole length.
The lead shall be carefully skinned of all scale when melted in a cast iron pot or patent melting machine. The joints must be perfectly dug before being run with lead. The pipes shall again be examined for line and level and the space left in the socket shall be filled in generally by pouring in melted lead. This may be done best by using proper loading rings or if these are not available, by wrapping a ring or hamp rope. Covered with clay round the pipe at the end of the sockets leaving a hole into which lead shall be poured. For large pipes, it is also necessary to leave one or more air vents around lower half of the joints. The lead shall be rendered thoroughly fluid and each joint shall be filled at one pouring. If the pipe is too large for the joint to be filled from one ladle, two or more ladles shall be used. It is to be noted that the lead should be heated to such a temperature as will ensure that it flows completely around the joint. Overheating of lead shall be avoided.

After a section of convenient length has been leaded, caulking shall be commenced. The lead shall be freed from the loading pipe outside the socket of the other pipe with a flat chisel, and then caulked around 3 separate times, with proper caulking tools of increasing thickness and a hammer 2 to 3 kg in weight in such a manner as to make the joints sound and water tight. After being well and evenly set, the joint is to be left flush

neat and even with the socket. The approximate weight of lead and spun yarn for different size of cast iron pipe socket and spigot joints, as per IS : 3114 are given in the following Table-I.

TABLE-I

QUANTITY OF LEAD AND SPUN YARN FOR DIFFERENT SIZES OF PIPES

Nominal size of pipe mm	Lead/Joint kg	Spun yarn/ Joint kg.
80	1.8	0.10
100	2.2	0.18
125	2.6	0.20
150	3.4	0.20
200	5.0	0.30
250	6.1	0.35
300	7.2	0.48
350	8.4	0.60
400	9.5	0.75
450	14.0	0.95
500	15.0	1.00
600	19.0	1.20
700	22.0	1.35
750	25.0	1.45
800	31.5	1.53
900	35.0	1.88
1000	41.0	2.05
1100	46.0	2.40
1200	50.0	2.60
1500	66.5	2.80

b) Lead wool joint

In the event of the Engineer specifying or permitting the use of lead wool the joint shall be made as follows :-

While hampen spun yarn shall be driven into the socket and thoroughly caulked with suitable caulking tools. Lead wool shall then be introduced and this caulking shall be repeated with each turn of lead wool under which the socket is fully within 3 mm and the wool of the lead wool uncompressed into dense mass. The joint shall then be finally pressed with finishing tool. The table giving the quantity of lead wool and yarn to be used in different sizes of pipes is given in the following Table-2.

TABLE-2

Nominal Internal dia in mm	Lead Wool Weight in kg	Spun Yarn Weight in Kg.
80	1.30	0.17
100	1.70	0.23
150	2.41	0.34
175	2.89	0.37
200	3.37	0.57

225	3.63	0.64
250	4.11	0.74
300	4.82	0.82
350	6.04	1.17
375	6.52	1.25
400	7.00	1.33
450	9.64	1.84
500	10.86	1.99
600	12.79	2.83
750	5.68	3.52
825	17.12	3.88
900	18.80	4.25
1200	28.44	6.01

Note : Higher tolerance may be permitted under special circumstances depending upon site condition for quality of lead wool and spun yarn.

14.3.6.2 Flanged joints

Flanged joints should be made by painting the facing of the flanged with graphite or red lead freely. Packing should be of rubber insertion cloth 3 ply and of approved thickness. The packing should be of full diameter of the flange with proper pipe hole and bolt holes cut out and even at both the inner and outer edges. All the bolts shall be tightened up evenly on all sides keeping the longitudinal axes of adjoining pipe in exactly the same straight line.

The interior of the pipe must be carefully free from all dust and/other foreign matters as the work proceeds. For this purpose a disc plate or brush sufficiently long to pass two or more joints from the end of the pipe last laid shall be continuously drawn forward as the pipes are laid.

The ends of the pipes must be securely protected preferably with wooden plugs during the process of the work. The pipes laid must not be made receptacles either for tools, cloth or any other matter during progress of the work.

14.3.7 Fixing specials and fittings

All fittings shall be fixed carefully and the heavy pieces shall be suitably supported at the time of erection on wooden pieces and after erection on suitable masonry supports.

a) Fixing of sluice valves

The sluice valves to be fixed on the pipeline shall be examined, cleaned and placed in the position indicated by the Engineer. The valves shall be placed on the pipelines in valve chambers constructed according to the drawings furnished to the Contractor. The depth at which the valve is to be laid shall vary where necessary under the orders in writing of the Engineer. The dimensions of the concrete and masonry shall also vary where necessary on receipt of written orders from the Engineer. The valves shall be supported in the valve chamber so that no stress or strain occurs at the flange or other joints of the valve. The valves shall be carefully protected from lime or other dust by a suitable covering and the pit itself shall be cleaned of lime mortar and other refuse.

b) Fixing of non-return valves

The non-return valve to the fixed on the delivery line of the pump shall be examined, cleared and placed in position indicated by the Engineering. The non-return valve shall be fixed with proper alignment.

c) Fixing of foot valves

The foot valve to be fixed on the suction line of the pump shall be examined, cleaned and placed in position indicated by the Engineer.

14.3.8 Inspection & testing

a) If required all materials shall be inspected by the Engineer before despatch to site. All the tests shall be carried out in the manufacturer's works and necessary test certificates shall be furnished as proof of such testing. The Contractor shall intimate the Engineer atleast two weeks in advance for any such inspection/testing. All facilities for inspection/ testing shall be provided by the Contractor.

b) After completion of erection all pipelines shall be inspected by the representative of the Contractor and the Engineer. Any discrepancy, defect pointed out during this inspection shall be made good by the Contractor to the entire satisfaction of the Engineer without additional cost.

c) All pipes with valve and fittings shall be tested to 1.5 times maximum working pressure. The pressure should remain constant for a period of 8 hours. All arrangements for testing shall be done by the Contractor. Any defect found during testing shall be made good by the Contractor to the entire satisfaction of Engineer and the test shall be repeated till acceptable results are achieved. Any special tools, instrument or equipment required for these tests shall be provided by the Contractor for tests only.

d) All oils, lubricants and other consumables required during tests and trials of different equipment shall be supplied by the Contractor.

14.3.9 Painting

i) All equipment, valves and other exposed steel parts shall be given a cost of red oxide, zinc chromate or red lead and two coats of final paint according to the colour scheme of the Purchaser.

ii) All the exposed pipes and fittings shall be painted with two coats of paints of approved quality.

14.3.10 Commissioning

The system shall be commissioned after all necessary tests have been conducted successfully. All lubricants, oils, and other consumables required for commissioning of the system shall be supplied by the Contractor. Commissioning of the equipment to be supplied, if any, by the Owner, shall be carried out by the Contractor under guidance of the representatives of the supplier of these equipment and Engineer. Any adjustment and/or changes/rectifications that may be found necessary during commissioning of these equipment shall be carried out by the Contractor.

14.4 Sewerage & Drainage (External)

14.4.1 Excavation of trenches & pits & excavated materials

Same specification as for "Water Supply" shall be followed in respect of excavation of trenches and pits.

14.4.2 Stoneware pipelines

14.4.2.1 Back filling

Trenches shall not be back filled until the pipe joints have been tested, alignment and gradient passed by the Engineer, but back filling shall be done at least for equal depth of the diameter of the pipe or 300 mm whichever is greater over the pipes leaving 450 mm on either side of the joints uncovered with earth till the testing is completed. These joints should however be kept covered with mats, gunny bags, straws etc., to avoid damage to joints by temperature effects.

While back filling care should be taken to ensure that no damage is done to the pipelines. The first 300 mm of filling material immediately over and around the pipe should be of soft material free from clods and stones etc. The remainder of the filling materials shall be watered and rammed in layers not exceeding 250 mm at a time.
Paving and metalling shall be reinstated in as good order as before laying of the pipelines.

Unless otherwise required by the Engineer, there shall be a minimum cover of 700 mm over the pipes and at road crossing etc., it shall not be less than 1000 mm.
Unless otherwise specified in the schedule of items the cost of the work involved under this clause shall be held to be inclusive in the contract rate for supplying and/or laying of the pipes.

14.4.2.2 Laying of pipes

The laying of the pipelines shall commence only after the levels of the bottom of the trench at various points have been checked by the Engineer. Cracked pipes whether at the socket or in the body shall be rejected. All SW pipes shall be fitted together on the surface of the ground to ensure a proper fit before they are lowered. The bowels spigots and sockets shall be properly cleaned and brushed, if necessary, then lowered by hand to the bottom of the trench.
The pipes shall be carefully laid to the alignment, levels and gradients shown on the plans and sections, and great care shall be taken to prevent, sand, earth or other matter from entering the pipes during laying. As it is not permitted to rectify errors of grade by packing up underneath with earth, care should be taken in excavating and slight scraping, if necessary, done to bring to grade. The pipes between manholes shall be laid truly in straight lines without vertical or horizontal undulations.
Encasing of the pipes during laying shall be in accordance with IS : 4127 (latest revision) and shall be done with mass concrete in proportion (1:4:8) to prevent ground water from entering the pipelines.
All inverts shall be laid from site rail fixed at the true levels, with proper boning rod. The sight rails and boning rods shall be provided, fixed and maintained by the Contractor at his own expense.

The pipes shall be laid, sockets facing up the gradient, beginning at the lower end, and with the sockets, resting in the socket rest holes out in the trench bottom. Each pipe shall be laid singly and no pipe shall be laid until the trench has been excavated to its required depth to a distance of twenty yards in front of the pipes to be laid.
No pipes of any description shall be covered until they have been passed by the Engineer.

14.4.2.3 Jointing of pipes

In each joint, a gasket of tarred yarn shall be passed round the joint and inserted in it by means of suitable jointing tools. Strings of white hampen spun yarn shall then be added

and well rammed home. The yarn shall be moistened to avoid its absorbing moisture from cement mortar.
The yarn should be so placed as to center the spigot of one pipe within the socket of the other and shall prevent the jointing mortar penetrating inside the pipe where it might set and interfere with the flow of sewage.

The cement shall be thoroughly mixed with medium sand in the proportion of 1:1 (1 cement : 1 sand) and then just enough water shall be added to make the mix plastic. On no account, the mortar shall be made soft or sloppy. The mix shall then be carefully inserted by hand into the joint.
Special care shall be taken for inserting the mortar into the portion of the joint underneath the pipe. When the cement mortar has been inserted, it shall be punched or caulked into the joint with wooden caulking tools, and more cement mortar shall be added until the space of the joint has been filled completely with tightly caulked cement.

No fillet of cement shall be added.
No mortar which is older than 30 minutes shall be permitted.
The inside of each pipe shall be carefully wiped out with a mop or scrapper sufficiently long to pass two joints from the end of the pipe and any projecting cement shall be removed.

All pipes entering the manholes should be set in cement mortar 1:3 and a completely watertight junction effected.

14.4.2.4 Testing of pipes

Testing of pipes shall be done wholly at contractor's expense inclusive of apparatus, provision of water etc., and/or as per IS : 4127.
After cement has had time to set, the pipes shall be tested in lengths between manholes in the following 'manner'. In the lowest manhole a plug shall be inserted in the pipe. The disc in the pipe and at the upper manhole shall be fitted with a filling pipe with a right angle bend and an air cock. The length of pipe shall then be filled with water by means of the pipe shall then be filled with water by means of the pipe connection on the upper disc. The air cock in the upper disc shall be kept open, while the pipeline is being filled to permit the escape of air.

When the pipes have been filled with water and air excluded, the air cock shall be shut and water shall be poured into a conical "Filler" attached to the testing and filling pipe of the disc in the upper manhole until water remains in the filler. The testing or filling pipe shall then be raised and fastened so that the height of the pipe is six feet, which will be the usual test pressure for stone ware pipe joints.
The test will be for an hour or such longer period as may be set by the Engineer. If the water level does not fall more than 25 mm in the length of 90 meter, the test may be considered satisfactory.

If it is found that certain pipe joints are leaking, the water shall be run off and joints recaulked with cement mortar and the test repeated till it is proved by the Contractor that the joints are leak-proof.

14.4.2.5 Concrete bedding & cover

Unless otherwise specified in the Schedule of Quantities, all SW pipes shall be laid on a bed of cement concrete, space being left under each joint for making the joints. After successful completion of tests the spaces left shall be covered with cement concrete,

and the pipe shall be covered with cement concrete on either side of slope away towards the side of the concrete bed. The proportion of cement concrete as well as the dimensions of concrete bedding and covering shall be as per Schedule of Items and drawing.
Where sewers have less than 1.2 m cover at places of heavy traffic, these shall be surrounded with mass concrete if desired by the Engineer.

14.4.3 RCC pipeline

14.4.3.1 Handling & laying of pipes

Reasonable care shall be exercise in loading, transporting and unloading of concrete pipes. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain block is recommended.
All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used.
If the sides of the trench are not vertical, the toes of side slopes shall end at the top of the pipe, and practically vertical sided trench shall be dug from these down to the subgrade.

Trench shall be of sufficient width to provide free working space on each side of the pipe. The free working space shall be, preferably, not more than one third of the diameter of the pipe and not less than 15 cm on either side.
Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used.
Pipes shall be laid true to line and grade as specified. Laying of pipes shall always proceed upgrade of a slope. Where pipes have spigot the socket joints, the socket ends shall face upstream. In the case of pipes with joints to be made with loose collars, the collars shall be slipped on before the next pipe is laid. Adequate and proper expansion joints shall be provided, wherever necessary.

The sections of the pipe shall be jointed together in such a manner that there shall be as little unevenness as possible along the inside of the pipe.
In cases where the foundation conditions are unusual such as in the proximity of trees or poles, under existing or proposed tracks under manholes etc., the pipe shall be encased in low strength concrete bedding or compacted sand or gravel.
In places where the natural foundation is inadequate, the pipes shall be laid either in a concrete cradle supported on proper foundations or on any other suitably designed structure.

Pipes laid in trenches in earth shall be bedded evenly and firmly and as far up the haunches of the pipes as to safely transmit the load expected from the backfill through the pipe to the bed. This shall be done either by excavating the bottom of the trench to fit the curve of the pipe or by compacting the earth under the around the curve of the pipe to form an even bed. Necessary provision shall be made for joints wherever required.
When the pipe is laid in a trench in rock, hard clay, shale or other hard material and space below the pipe shall be excavated and replaced with an equalizing bed of concrete, sand or compacted earth. In no place shall the pipe be laid directly on such hard material.

Bedding of the pipes in trench shall follow the specifications as per IS : 783.
Trenches shall be kept free from water until the material in the joints has hardened.
When the pipe is closed and the trench liable to be flooded by rain, care shall be taken to prevent the pipe from floating.

Walking on the completed pipe shall not be permitted until the trench has been back filled to a height atleast 30 cm over the pipe, except as may be necessary in tamping or backfilling.
Trenches shall be backfilled immediately after the pipe has been laid, to a depth of 30 cm above the pipe (subject to the condition that the jointing material has hardened). The backfill material shall be selected and deposited with reference to the future safety of the pipe. Only suitable soils, clean, free from boulders, large roots, excessive amounts of sods or other vegetation and free from lumps, shall be used and care shall be taken where back filling not to injure or disturb the pipe or the joints.
The tamping around the pipe shall be done by hand or other hand operated mechanical means. The water content of the soil shall be as near to the optimum moisture content as possible.
Filling of the trench shall be carried on simultaneously on both sides of the pipe in such a manner that unequal pressure does not occur.

14.4.3 Jointing of pipes

The joints shall be either spigot and socket joint or collar joints. The joints may be rigid or flexible type. Specification of joints shall follow IS : 783.
In case of rigid joint, the caulking material shall be slightly dampened mix of cement and sand (1:2), rammed with caulking irons.

Every joint shall be kept wet for about ten days for maturing. The section of the pipeline laid and jointed shall be covered immediately to protect it from weather effects. A minimum coat of 10 cm is considered adequate. The joints may be left exposed for observation.
Expansion joint shall be provided for buried lines at maximum interval of 45 m, but for exposed pipes, the joint interval shall not exceed 15 m, cast iron or steel collar, and lead caulking conforming to IS : 782 shall be used for expansion joints. In the case of spigot and socket joint an adopter piece and a collar for making an expansion joint shall be provided. Where flexible rubber joints are used, expansion joints need not be provided.

14.4.4 Testing of pipes

When testing a pipeline hydraulically the line shall be filled completely with water and kept filled for a week. In testing pipelines, a seepage allowance of 2.5 litres per kilometer per hour per centimeter diameter of the pipe shall be permissible. The pipelines can be tested similar to stoneware pipes.

14.4.5 Manholes

All manholes shall be of the size and type as given in the Schedule and shall be provided as per drawing or as desired. All the manholes shall be circular in shape. The bed shall be in cement concrete of Mark-100B (Size of coarse aggregate 40 mm and down) of 100 mm thickness or as shown in the drawing and shall be projected out 75 mm from the outside face of the wall all round. The working part including channeling, benching etc., made of P.C.C. shall be of grade-15C. All manholes shall be plastered inside 20 mm thick in 1:3 cement plaster and finished with a floating coat of neat cement.

Concrete used for precast RCC cover slabs shall be of grade 20C and shall be constructed as per drawing.

The top level of manholes shall be generally 100 mm above the surrounding ground levels or as directed by the Engineer. Channeling inside the manhole shall be done in smooth bends.

The end of pipe shall be neatly built in and finished in cement mortar 1:3.
Cast iron water sealed manhole cover and frames, 560 mm clear opening and nominal weight 128 kg shall be provided for each manhole and shall be in accordance with IS:1726. Manhole covers with double seals shall be provided within compound near the buildings.
Step irons shall be provided with two coats of bituminous paint and shall be as per drawing.
In cases where branch pipe sewers enter the manhole or main pipe sewer at a level more than 1m, from the main sewer, a drop connection shall be provided. The extra pipe length required for this connection will be paid under item for pipelines. No other extra payment will be allowed.

All exposed surfaces of cast iron frame and cover shall be painted with two coats of bituminous painting.
The rate of manholes shall be inclusive of excavation in all kinds of soil, dewatering, shorting, planking, back filling in layers of 150 mm, watering, consolidating and top dressing, removal of surplus soil, bricks, masonry, cement concrete work, RCC cover slabs, CI manhole cover and step iron providing all connections, channels, benching, painting etc., and is for complete work.

14.4.6 Marker plates

Marker plate indicating the particular service installed shall be provided along the routes of pipes laid below ground. These shall be of mild steel, with the type of service and direction of flow painted on it. The markers shall sit firmly in a concrete base and installed at all corners and turning points. Over straight runs markers shall be spaced at 100 m intervals generally.

15.0 ROAD WORK

15.1 General

Road works in general shall be constructed according to the requirements to the various specifications and codes of practices of the Indian Roads Congress.

Works such as earthwork, masonry, concreting and the like, wherever they occur in association with construction of roads, shall be governed by the respective specifications of these series.

15.2 Trenching and Preparation of Subgrade

The surface of the formation of width equal to that of soling coat shall first be cut to a depth below the proposed finished level equal to the combined depth of soling and wearing coat, (due allowance being made for consolidation), and dressed parallel to the finished profile. Any roots of bushes, trees etc., shall be taken out to the full depth and the cavities thus formed shall be filled up and rammed. The subgrade shall then be consolidated with a road roller true to proper camber and grade, and surplus earth shall be disposed off as directed by the Engineer.

15.3 Ash Carpet

Wherever the ground is soft and slushy, ash carpet consisting of common boiler ash shall be laid to 5 cm thickness over the subgrade and then rolled. In firm ground no ash carpet is necessary and boulder soiling shall be laid directly over the soling.

15.4 Boulder Soling

Boulders shall be hand packed true to camber and grade and shall be of the thickness specified. The boulders shall be laid in such a manner that the gap in between them is reduced to a minimum.

It shall then be rolled with a power roller of not less than 10 tons, so that the boulders are well locked together and the top surface of the soling is perfectly true to camber and grade. Any disturbance in grade or camber shall be rectified. The top surface shall then be blinded with atleast 5 cm of moorum of approved quality or any other approved material, and rolled wet to obtain proper compaction. The Contractor shall supply camber board, spirit level, straight edge etc., at site for checking the camber and grade at any time during the execution of work.

15.5 Kerbs

Concrete or stone kerbs, where shown in drawings, shall be fixed in position after laying and consolidation of soling. They shall be fixed true to line and level and secured and position by approved means.

15.6 Water Bound Macadam Surfacing

The construction of water bound macadam shall be carried out according to IRC:19, "Standard Specification and Code of Practice for Water Bound Macadam".

15.7 Preparation of Base and Shoulders

The subgrade shall be reshaped to the required grade and camber. Where water bound macadam is to be laid over an existing black top surface, 50 mm x 50 mm furrows shall be cut in the existing surface at 1 m intervals inclined 45 degree to the center line of the carriageway, before laying of coarse aggregates. Necessary arrangements shall be made for the lateral confinement of aggregates by constructing shoulders in advance.

15.8 Spreading Coarse Aggregate

The coarse aggregates shall be spread uniformly and evenly upon the prepared base in required quantities from stock piles along the roadside or directly from vehicles. In no case shall these be dumped in heaps directly on the base. The aggregates shall be spread to proper profile by using templates placed across the road about 6 mm apart. Where possible, mechanical devices shall be used to spread the aggregates uniformly.

The water bound macadam layer shall be constructed in layers of not more than 75 mm thickness. However, the Engineer may permit courses of 100 mm compacted thickness to be constructed in a single layer. Each layer shall be tested by depth blocks. No segregation of large or fine particles shall be allowed.

15.9 Rolling

The coarse aggregates spread as described above shall be compacted to full width by

rolling with either three wheel power roller of 6 to 10 tonnes capacity or an equivalent vibratory roller. The weight of roller shall depend on the type of coarse aggregate.

The rolling shall begin from edges and after the edges have been compacted, progress gradually towards the center, parallel to the center line of the road, uniformly lapping each proceeding rear wheel track by one half width. On super elevated portions, rolling shall commence from the lower edge. Where screenings are to be applied, rolling shall be discontinued when the aggregates are partially compacted with sufficient voids to permit application of screenings. Where screenings are not to be applied, as in the case of crushable aggregates compaction shall be continued until the aggregates are thoroughly keyed, with no creeping of stones ahead of the roller. Slight sprinkling of water may be done during rolling, if necessary.

Rolling shall not be done when the subgrade is soft or yielding nor when it causes a wave like motion in the base course. If irregularities develop during rolling, which exceed 12 mm when tested with a 3m straight edge, the surface shall be loosened and aggregates added or removed before rolling again. The surface shall be checked by template for camber. In no case shall screenings be used to make up depressions.

15.10 Application of Screenings

After coarse aggregates have been rolled, screenings to fill the interstices shall be applied gradually over the surface in thin layers. Dry rolling shall be done when the screenings are being spread, so that the jarring effect of roller causes them to settle into the voids of the coarse aggregates. Damp and wet screenings shall not be used and the spreading, rolling and brooming of screenings shall be taken up on sections which can be completed within one day's operation.

15.11 Sprinkling and Grouting

After application of screenings, the surface shall be copiously sprinkled with water, swept and rolled. The sprinkling, sweeping and rolling operations shall be continued and additional screenings applied where necessary until the coarse aggregates are well blended and firmly set and a grout of screenings and water form ahead of the wheels of the roller.

15.12 Application of Binding Material

After the application of screenings, binding material, where it is required to be used, shall be applied at a uniform and slow rate in two or more successive thin layers to a thickness of 2.5 cm. After each application of binding material, the surface shall be copiously sprinkled with water and the resulting slurry swept in with brooms, so as to fill the voids properly. This shall be followed by rolling with a 6-10 tonne roller, during which, water shall be applied to the wheels to wash down the binding material that may get stuck to them. The spreading of binding material, sprinkling of water, sweeping with brooms and rolling shall continue until the slurry of binding material and water forms a wave ahead of the wheels of moving roller.

15.13 Setting and Drying

After final compaction the road shall be allowed to cure overnight. Next morning, hungry spots shall be filled with screenings or binding material, lightly sprinkled with water and rolled. No traffic shall be allowed till the macadam sets.

15.14 Surface Evenness

The surface evenness of completed water bound macadam course in longitudinal direction shall be within 12 mm when tested with a 3 m straight edge and in cross profile within 8 mm when checked with a template.

15.15 Bituminous Pavements

15.15.1 Bitumen premix carpet

15.15.2 Surface preparation

Waterbound macadam surface on which black topping is to be provided shall be thoroughly cleaned of dust, loose materials, caked mud and other foreign material with the help of wire brush, chisel, picks etc. Cleaning shall be such as to expose the stone metal to a depth of 1 to 2 mm without dislodging the interlock of the metal. All dust and other materials thus removed shall be thrown away at a suitable place as directed by the Engineer.

Any potholes, depressions and undulations found after cleaning shall be made good with premixed chippings, and well rammed.

15.15.3 Tack coat

Just before the application of tack coat, the surface shall be thoroughly cleaned by gunny bags.

Bitumen heated to 177 degree to 188 degree 'C' shall be spread on the prepared surface uniformly at the rate of 1 kg/sqm. by means of sprayers. It shall be applied just ahead of and keeping pace with, laying of premix carpet.

15.15.4 Premix carpet

In preparing premix carpet the following method shall be adopted.

Bitumen heated to a temperature of 177 degree 'C' to 188 degree 'C' shall be first mixed in an asphalt mixer with hot metal chips at the rate of 60 kg/cbm of metal and thoroughly mixed, till chips are completely coated with bitumen. Sand shall then be added and a further quantity of hot bitumen at the rate of 110 kg/cbm of sand shall be added to the mixer and mixed till complete coating of aggregate with bitumen is obtained.

The Premix shall be emptied on to wheel barrows or stretchers and carried to the site of work. It shall then be spread uniformly on the prepared surface with rakes, to the desired thickness and camber. When the premix has been laid for a length of 15-20 meters it shall be rolled. Rolling shall commence from edges and proceed towards the center. The roller wheels shall be moistened continuously so as to prevent metal chips sticking to it. After preliminary rolling, all honeycombs shall be filled up with smaller size precoated chips, and rolled again. Camber and grade shall be checked at every stage to ensure correctness, and any defect found shall be rectified.

The following quantities of materials shall be used per 100 sqm. of bituminous macadam.

Sl. No.	Description	4cm thick carpet	5 cm thick carpet
1.	Slag/ stone chips	4 cbm	4.8 cbm
2.	Sand	2 cbm	2.4 cbm
3.	Binder for premixing the sand @ 60 kg/cbm of chips	240 kg	288 kg
4.	Binder for premixing the chips @ 120 kg/cbm of sand	240 kg	288 kg
5.	Binder for tack coat @ 1 kg/sqm of road surface	100 kg	100 kg

15.15.5 Asphaltic concrete

Asphaltic concrete surface course shall be prepared, laid and finished in accordance with the Indian Roads Congress "Tentative Specification for 4 cm Asphaltic Concrete Surface Course", IRC : 29.

15.15.6 Surface evenness

The finished surface of premix carpet and asphaltic concrete shall be tested with a straight edge 4.5 m long and any irregularity greater than 6 mm shall be corrected.

15.16 Cement Concrete Roads

Cement concrete roads shall be constructed in accordance with IRC : 15, "Standard Specification and Code of Practice for Construction of Concrete Roads".

15.17 Berms

Shoulders and berms shall be prepared as shown on the drawings. Work on making berms shall not lag more than 100 meters behind the water bound macadam consolidation. Suitable drains shall be cut on the berms so that the water bound macadam surface is kept drained till bituminous macadam is laid.

15.18 Kerbs

Kerbs shall be laid and set in place before completing the bituminous or concrete wearing surface as well as the wearing surface of footpath sitting shall be done in mortar where so specified with Schedule of Items. They shall be laid and set in such a way as to obtain straight lines in the finished work, the top surface matching with the finished surface of footpath.

Where the road edge forms a curve, the kerbs shall follow such curve.

Gaps shall be left as shown in drawings or as may be required to provide for drainage.

15.19 Bridges and Culverts

Bridges and culverts shall be constructed according to the specifications of Indian Roads Congress. Relevant chapters of earthwork, concrete, masonry etc., of these series shall apply.

15.20 Boulder Pitching

Wherever specified, boulder pitching shall be provided at the inlet and outlet of pipe culverts, or for embankments of bridges. The subgrade shall first be dressed to level or slight slope as indicated. The transverse slope of the pitching shall be made strictly in accordance with the drawings or as directed by the Engineer.

15.21 Scarifying & Dismantling

Where a new carriageway abuts or includes an existing carriageway and the Engineer so directs, the surface of the latter shall be scarified, adjusted and reshaped to conform with the existing and new camber or crossfall. Materials from the existing road shall be used or disposed off as directed by the Engineer.

Where dismantling of the existing road has been specified, the various layers of the road viz., bituminous macadam, waterbound macadam and soling shall be scarified separately. Scarifying can be done either by hand picks, or by means of scarifiers fixed to the roller. When a roller is used for scarifying, crushing of the metal shall be avoided by moving the metal clear of roller wheels after the scarifier has passed over it. The loosened material shall then be combed by means of rakes to bring out most of the larger stone. If necessary, the larger stones thus collected shall be screened to separate fine particles if any.

The remaining metal shall then be removed and screened to recover reusable metal. Different grades of metal shall be stacked separately and measured.

15.22 Diversions

Where the construction of the road or culvert or bridge is in progress, the road shall be closed to traffic and a suitable diversion shall be provided for traffic by the Contractor, as directed by the Engineer.

The road shall be closed by the erection of barriers and suitable sign boards at both ends which shall be provided with lights at night. Both during night and during day, one man shall be posted at each barrier to suitably divert the traffic and to keep the light burning during the night. night.

16.0 WATERPROOFING TO ROOFS & BASEMENTS & WATERPROOFING PAINTS

16.1 Scope

This chapter deals with different types of waterproofing on roof and different types of damp proofing treatment in basement.

16.2 Material

The materials shall conform to Part-I.

16.3 General Workmanship

The waterproofing to roofs and basements being specialized works the Contractor shall get these done by specialized firms/agencies.

16.4 Painting with Hot Bitumen

The surface to be painted shall be thoroughly dried and shall be cleaned, with wire brushes and cotton or gunny cloth of all loose materials and scales. The surface shall further be cleaned with a piece of cloth lightly soaked in kerosene oil. Bitumen shall be brought to the site in its original container and this shall not be removed from site till the painting job is completed. Before applying the main coatings of hot bitumen paints, one coat of bituminous primer shall be applied. The number of coats of hot bitumen shall either two coats or as specified in the Schedule of Items. The bitumen of approved quality (either of grade 80/100 or 30/40) shall be applied to the surface after heating it to the manufacturer's specifications. Care shall be taken to see that no blank patches are left and the quality of bitumen to be spread shall be as specified and shall be to the satisfaction of the ENGINEER.

16.5 Painting with Bitumen Emulsion

Before applying, the surface shall be cleaned thoroughly. Generally two coats of Bitumen Emulsion are provided over a coat of emulsion primer. Since the painting is with emulsion, the surface need not be made dry.

16.6 <u>Waterproofing of Roof</u>

16.6.1 With Mud Phuska

Prior to laying of mud phuska preparation of surface by removing loose materials from the roof top shall be done. Mud phuska shall be laid in layer of minimum 100mm thk. (average) of damped brick consolidated and plastered with 25mm thick mud mortar (soil shall be cohesive) mixed with bhusa (wheat straw) @10 kg per cum of earth. Brick tiles of class designation 100 are properly laid over mud phuska. Gaps between tiles are grouted with 1:3 cement mortar mixed with integral waterproof compound @ 2% by weight of cement. The surface of the finished roof shall be kept wet for a period of not less than 7 days. For better result a layer of hot bitumen over the finished roof shall be done. Care shall be exercised while doing the roof finish work to compact the mud phuska layer to the maximum density. Refer IS : 2115 – 1980 for application of mud phuska over flat roof.

16.6.2 With bitumen felt

Prior to laying the insulation, roof gradient shall be checked. If necessary, the roof shall be regarded by screed to ensure everywhere a run off gradient of not less than 1 in 120. The screed shall consist of one part cement and four parts medium to coarse sand by volume. The screed shall be cured for 7 days. The surface shall then be cleaned of all foreign matter by wire brushing and dusting.

Waterproofing unless specified otherwise in drawings shall be the "heavy treatment type" with primer coat as described in IS : 1346. The method of laying roofing treatment, surface finishing with pea gravels, special mode of treatment for drain outlets, projecting pipes, parapet walls, expansion joints, gutters, timber roofs etc., shall conform to IS : 1346. The number of layers of felts shall be as specified in the drawing or Schedule of

Items. The bonding bituminous material shall be of grade 30/40 and the minimum quantity of hot bitumen to be applied, shall be 1.2 kg/m2. Unless specified otherwise, the bituminous felts shall be hessian bases of Type-3 Grade-2. Pea gravel finish may be substituted by a coat of bituminous aluminium paint, where so specified in the Schedule of Items.

The cement mortar used for filling the chases shall be of mix 1:4 and the cement concrete for fillets shall be of the same grade as the roof slab.

Where special surface finish with precast concrete or clay tiles is specified, it shall be in accordance with the relevant chapter of this series.

16.6.3 With bitumen mastic

The work shall be carried out generally in accordance with IS : 4365 "Code of Practice for Application of Bitumen Mastic for Waterproofing of Roofs" or according to the manufacturer's specifications. The work shall be carried out by a firm of specialists in the trade.

The type of underlay or primer, thickness of application, surface finish etc., shall be as shown on drawing or described in the Schedule of Items. Melting shall be done in a mechanical mixer by gradually heating to about 200 degree 'C'. Coarse aggregate where required shall be added to the hot bitumen and stirred.

Each coat shall be spread evenly and uniformly by means of a float to the required thickness. Timber gauges shall be used to regulate the thickness. Particular care shall be taken to tuck the mastic into grooves on vertical surfaces, at joints, around pipes or other projections and at junction of adjoining bays.

16.7 <u>Waterproofing for Basement</u>

16.7.1 The specification covers the requirements of waterproofing of basements, tunnels, ducts, pits, bunkers, etc.

The material used shall be bitumen felt type-3 of grade-2 conforming to IS:1322, together with the specified bonding material and primer.

Waterproofing shall be provided on the outside of walls and top of the floors and shall be carried 150 mm above ground level.

The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be :

i) For depths upto five meters below ground .. 2 layers.
ii) For depths beyond five meters .. 3 layers.

The method of laying the bitumen felts and workmanship shall be general conform to IS : 1609.

Waterproofing work shall be taken in hand only when the sub-soil water level is at its lowest the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed. For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps. In case of large excavation areas where it is necessary to dewater under the floor, additional land

drains shall be formed across the excavation, to adequately drain the area. Adequate arrangements shall be made to prevent the sides of excavation from slipping while the work is in progress.

The base concrete of mud-mat shall be rendered smooth by a 20 mm thick sand-cement plaster (6:1). Any sharp corner over which the waterproofing course is to be laid shall be eased out by means of cement mortar fillets 7.5 cm in radius.

The surface must be dry before the next operation is carried out. Blown bitumen conforming to IS : 702 shall be applied hot over the prepared surface at the rate of 1.5 kg/m2 for the first layer and for every other subsequent layer(s). The laying of felt over the bitumen so applied shall always commence on the floor, and shall be carried to the walls only after treatment of the floor is complete. The minimum overlapping of joints at sides and ends of felts shall be 10 cm. Joints for subsequent layers of felt shall be staggered. All joints shall be completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar 1:3 or 6 cm thick cement concrete type 150B or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the waterproofing treatment to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way, the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth, where necessary with a coat of cement plaster 1:5, the felts laid as for the floor ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar 1:6 over the projecting mud-mat, the space between the wall and felt being grouted with cement slurry. Sufficient care shall be taken to ensure a perfect bond between the waterproofing on the floor and that on the walls.

The treatment on the wall shall be carried 150 mm above the surface of ground and tucked into a grove 6.5 cm. wide and 7.5 cm deep, the chase being filled with cement mortar (1:4).

Where waterproofing is done to the roof of an underground structure, such as a tunnel, it shall be done in a similar way. The structural concrete shall be rendered smooth, hot bitumen and bitumen felts applied in the same way as for the floor and walls, and over this shall be laid a protective layer of cement concrete mark-100, 7.5 cm thick.

16.7.2 With epoxy based emulsion

Over the mud-mat a 20 mm plaster is to be provided to make the surface even.

On the plastered surface of the mud-mat, three coats of epoxy based leakproof emulsion shall be applied with reasonable gap between each coat in order to permit sufficient drying time.

After the painting is over a 20 mm thick plaster is again to be provided before placement of R.C.C. in order to protect the film surface of the paint from the positive damage which may occur during the process of rod binding of R.C.C. The protective layer of plaster can be eliminated but precaution should be taken that during the process of rod binding if any, damages happen should be immediately rectified by making patch painting only on the affected portion and as such a complete vigilance is to be kept to rectify the

defect.

After the rod binding is over the concreting should be done with high polymer based chloride and sulphide free cement waterproofing additive/admixtures @ 2% by weight of cement althrough the floor area and althrough the vertically raised walls of four sides which shall remain underground upto a depth of 8 meter and above from ground level.

After the concreting and immediately after de-shuttering cleaning of the concrete surface on the external faces of the walls are to be done and then three coats of epoxy based leakproof emulsion shall be applied with a reasonable gap between the each coat before back filling. If the back filling is with hard material again a protective layer of plaster shall also be applied on the external faces of walls in order to avoid damages on the painted surface.

If the back filling is with soft sandy or alluvial soil there is no necessity for protective layer of plastering as mentioned above.

Epoxy based paint can be applied on the wet surface hence there shall be no stoppage of the normal progress of the project works.

16.8 Surface Application

Waterproofing done by surface application of bitumen based or epoxy based material shall conform strictly to the recommendations of the manufacturer. The work shall be carried out by a firm of specialists in the trade.

16.9 Water Proofing by Self Adhesive HDPE Membrane System

16.9.1 The material used shall be HDPE film cross laminated to a bitumen backed compound for self adhesion on concrete/ masonry surface, together with specified primer for achieving a high level of water proofing.

The entire work shall be executed as an effective and manufacture – such as “Bituthene – 1000 X-HC” of Grace Construction Products, UK; “SUPERTENE – 5000X” of STP Ltd., India; or any other make of standard and proven performance.

16.9.2 The following specifications shall be followed (Generally the specification shall be the line with recommendations of the manufacturer/ supplier of HDPE based waterproofing system.

<u>On Horizontal Surfaces</u>

Make the surface smooth, even and free from loose dust, cement particles standing water, sharp protrusions and hollows etc. first by cleaning and then by applying two coats of cement slurry with plaster mix (in specified proportion) of approved quality and manufacture.

An approved quality bituminous primer shall be applied (as per recommendations of the manufacture/ supplier of water proofing system) in two coats.

Apply the approved quality and manufacture self adhesive membrane having cross laminated HDPE film of 100 micron thickness impregnated in designated bituminous compound having an overall thickness of 1.5mm (weighing not less than 1.5 kg/m^2) on prepared surfaces using approved methodology of application.

RC concrete/ concrete screed shall be laid using an approved make and quality waterproofing admixture in recommended proportions as per specifications.

On Vertical Surfaces

Make the surface smooth, even and free from loose dust, cement particles standing water, sharp protrusions and hollows etc. first by cleaning and then by applying two coats of cement slurry with plaster mix (in specified proportion) of approved quality and manufacture.

At specified locations a 20mm thick waterproofing plaster in CM 1:3 shall be applied before next phase of work. The waterproofing admixture shall be mixed at specified rate.

An approved quality bituminous primer shall be applied (as per recommendations to the manufacture/ supplier of water proofing system) in two coats.

Apply the approved quality and manufacture self adhesive membrane having laminated HDPE film of 100 micron thickness impregnated in designated bituminous compound having an overall thickness of 1.5mm (weighing not less than 1.5 kg/m^2) on prepared surfaces using approved methodology of application.

Construct a protective lining of 230mm thick brick masonry using CM 1:4. Apply two coats of cement slurry with plaster mix (in specified proportions) of approved quality and manufacture.

Apply 20mm thick waterproof plaster in CM 1:3 mixed (in recommended mix) with water-repelling admixture of approved quality and manufacture.

16.9.2 The sheets used shall be of maximum practicable length and width so as to keep the number of joints to a minimum. Membrane shall be properly anchored at edges/ ends by pressing or heating. The joints to have panels of approved length and width generally as per recommendations of the manufacturer.

16.9.3 The work shall be carried out by a company of specialists, completely in line with the specifications; product/ manufacturers specification to the entire satisfaction of the Engineer-in-charge.

16.10 Guarantee

For the waterproofing on the roof as well as for underground basements the Contractor shall give guarantee in writing for the period of 7 to 10 years as specified in the Schedule of Item. For such guarantee the Contractor shall get guarantee from the manufacturer/ specialized firms and forward the same to the Engineer. However, the Contractor shall be fully responsible for the serviceability of the waterproofing treatment throughout the guarantee period and any leakage during that guarantee period shall be stopped by the Contractor at no cost to the Owner and without disturbing working facility of the Owner.

17.0 MISCELLANEOUS

17.1 False Ceiling

17.1.1 Scope

This chapter deals with the specification for various types of false ceiling as listed below :

a) Wooden ceiling (solid wood) and decorative ply.

b) Ceiling with insulating Building Board/ Particle Boards etc.

c) AC Sheet and ply wood ceiling.

d) Plaster of Paris (Gypsum Anhydrous) ceiling over wooden frame.

e) Plaster of Paris (Gypsum Anhydrous) Tiles ceiling.

f) Wooden cover, fillets, beading for ceiling.

17.1.2 General

17.1.2.1 Materials

All materials shall be in accordance with the general specifications of materials, Part-I, Schedule of Items and as shown in drawings.

Special finishing materials as specified in schedule of item shall be procured from the specified source and got fixed by employing skilled worker in the trade under direct supervision of the manufacturer.

17.1.3 Openings for Installation of Light Fittings

Openings in the ceiling for installation of A/C grills, light fittings shall be provided as per drawings.

17.1.4 Recess for Pelmet

Recess for the installation of pelmets shall be provided where shown in drawings along the windows/ doors.

17.1.5 Grills

Grills made of wooden, M.S. Aluminium, PVC or any other material as necessary shall be provided as indicated in the drawing.

17.1.6 Frame Work

The type of frame to receive the ceiling material may be of wood, aluminium or M.S. as specified in the schedule of item and as mentioned in the drawing.

17.1.7 Wooden Framing for False Ceiling

Unless otherwise specified in schedule of items the wooden frame work shall be of following description :-

The frame work of false ceiling shall be of approved quality teak wood scantlings, the runners shall be 75 x 50mm size and shall be spaced at 1200mm c/c and the battens

shall be 50 x 50mm size spaced at 600mm c/c (approx.) forming a grid of 600 x 600 mm of any other grid suitable for fixing the false ceiling material and its size. The runner and battens shall be joined by halving joint using counter sunk 6mm bolt with washer of required length with soffit of runner and batten in perfect level. The heading joints between runners shall be made with lap joins using 2 nos. 6mm dia counter sunk bolts with washer. Heading lap joints between batten shall be made with suitable size screws. The wall ends of the runner shall be embedded in the wall (50mm deep) and shall be grunted with 1:2:4 cement concrete. The soffit of frame work shall be made perfectly horizontal. The teak wood frames shall be treated with 2 coats of wood preservations treatment before fixing the tiles/ boards as the case may be.

The main runners of frames shall be suspended by M.S. flat 40 x 3 mm/ 12mm dia M.S. round/ T.S. hangers placed at 1200mm c/c (approx.), the top end of the hanger shall be hocked to R.C.C. reinforcement of slab or fixed to M.S. flat cleats installed in slab for the purpose or hooked to purlins of the trusses. The hangers may be twisted or ends of M.S. round/ T.S. hanger flattened to allow for fixing the same with T.W. frame or M.S. cleats with bolts of suitable size.

For teak wood framings of shaped ceilings the spacings of frames and hangers levels of false ceiling etc., shall be required to obtain the shapes/ drops and profile of the ceiling and to the requirement of ceiling material. The frames shall be locally adjusted to create openings of required sizes for installation of light fittings, grills of air conditioning system.

17.1.8 Metal Framing

17.1.8.1 Galvanised pressed steel framing system

Galvanised pressed steel framing system for false ceiling shall be procured from reputed manufacturer and installed by specialist agencies under technical guidance of the manufacturer and strictly as per their specifications. Unless specified otherwise these shall consist of G.I. rectangular pipes at 900mm c/c suspended by M.S. hanger fixed to R.C.C. slab with M.S. cleats and cross channels fixed to rectangular pipes at 450mm c/c as per “Galvolock” system of M/s Eastern Interior Pvt. Ltd. or equivalent. Ceiling materials shall be fixed to cross channels as per specifications of the manufacturer.

Framing shall be adjusted to provide openings for the light fittings and air-conditioning grills but these shall be supported independently and not on the framing.

17.1.8.2 Aluminium Grid Ceiling Framing System

Framing for Aluminium grid false ceiling system shall be of reputed manufacturer Bestlok, Eezilock or equivalent. It shall consist of aluminium main tee and cross tee’s suspended by adjustable hangers fixed to R.C.C. floor with cleats. The grid may be 600 x 600mm, 1200 x 600mm or as per drawings. Ceiling materials, shall be fixed to frames strictly as per manufacturers specification.

17.1.9 Fixing of Ceiling

17.1.9.1 Wooden Ceiling with Planks

These shall be of class of wood and thickness as specified in schedule of items. Unless specified otherwise the width of the ceiling board shall be 100mm to 150mm and shall be planed true on the exposed surface. The maximum length of the finished board shall

be 1800mm. The boards/ strips shall be joined with tongue and grove joints and heading joints in adjacent board of the same strip shall be square butt type neatly finished. These joints shall be staggered in alternate strip or line. The boards shall be fixed to T.W. battens by headless brass pins. Moulding beads at junctions with walls and other locations as per drawings shall be provided. Necessary opening for installation of light fittings and A/C grill shall be provided and junctions if required shall be finished with moulded beads.

17.1.9.2 Decorative Ply Ceiling

These shall be with decorative selected group matched ply to Teak Ply, white cedar ply or any other approved class of veneer ply in strips, square or rectangular panel matching the ply of wall panelling, if any, in the same room and of thickness as per schedule of item and drawings. The strip ply, square/ rectangular panels shall be fixed to T.W. frame work with panel pins. Moulded beads of same wood as that of ply of matching shade shall be provided at junctions with walls and as specified in drawings.

Where specific pattern of grains and shade in required the ply cut into shapes as per design may be pasted on a backing ply with adhesive and such made panels shall be fixed to framing.

The ceiling shall be checked for line, and levels and exposed surfaces shall be sand papered and finally polished with colourless polish to achieve matt satin natural finish.

17.1.9.3 Ceiling with insulation board/ particle boards

Insulation boards shall be of approved manufacturer, shade, design and thickness as specified in schedule of items and drawings. These may be plain, textured, perforated with natural finish or with white finished surface.

The boards shall be cut to suit the panel sizes of ceiling with special tools and by skilled workmen strictly as per manufacturers specifications. The board shall be fixed to T.W. frames with brass screws or as per manufacturers recommendation and in case of metal frames as per recommendations of the manufacturer of the ceiling system. The joints where exposed shall be of uniform thickness (3mm to 6mm) and pattern as shown in drawings.

The ceiling shall be checked for line and level and exposed surfaces prepared appropriately to receive the paint as specified in schedule of item and drawings.

17.2 Expansion and Isolation Joints

17.2.1 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved-laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior to approval of the method of

forming the joints should be obtained from the Engineer before starting the work.

17.2.2 Bitumen impregnated board

Bitumen impregnated fibre board of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

17.2.3 Joint sealing strips

17.2.3.1 General

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water. The sealing strips will be either metallic like GI, Aluminium or Copper, or Non-metallic like rubber or PVC

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The jointing procedure shall be as per the manufacturer's recommendations revised if necessary, by the Engineer. If desired by the Engineer, joints in rubber seals; may have to be vulcanised.

17.2.3.2 Metal sealing strips

Metal sealing strips shall be either GI, Aluminium or Copper and formed straight, U-shaped, Z-shaped or any other shape and of thickness as indicated in the drawing and schedule of items and/or as instructed by the Engineer.

The transverse joints will be gas welded using brass rods and approved flux. In case it is found that the joints cannot be made leakproof, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor without any additional cost to the Owner. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

a) <u>GI Strips</u>
GI strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The Strips shall be strong, durable, without any rust or crease. At the joints, the overlapping should be for a minimum length of 50 mm.

b) <u>Aluminium strips</u>
Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737. A minimum lap of 50 mm length is required at the joints.

c) <u>Copper strips</u>
The copper strips shall be minimum 18 SWG in thickness and 300 mm width unless specified otherwise and shall conform to the relevant Indian Standards.

It should be cleaned thoroughly before use to expose fresh surface, without any

reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

17.2.3.3 Non-metallic sealing strips

These will be normally in Rubber or PVC Rubber or PVC joint seals can be of shape having any combination of the following features :

a) Plain
b) Central bulb
c) Dumb-bell or flattened ends
d) Ribbed and corrugated wings
e) V-shaped

Transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The actual size and shape; shall be as shown in drawings/Schedule of Items and or as directed by the Engineer.

The method of forming these joints, laps etc., shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

a) Rubber sealing strips

The minimum thickness of rubber sealing strips shall be 3 mm and the minimum width 100 mm. The material will be natural rubber and the resistant to corrosion, abrasion and to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows :

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/mm^2
Maximum Safe Continuous Temperature	:	75 Degree 'C'
Ultimate Elongation	:	Not less than 350%

b) PVC sealing strips

The minimum thickness of P.V.C sealing strips will be 3 mm and the minimum width 100 mm. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contract with during use. The physical properties will generally be as follows:

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to 80A
Tensile Strength	:	10 - 15 N/mm^2

Maximum Safe Continuous Temperature	:	70 Degree 'C'
Ultimate Elongation	:	Not less than 275%

17.2.4 Bitumen compound

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be approved manufacture and shall conform to the requirements of IS: 1834.

17.2.5 Isolation joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

17.3 Rubber Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer. The rubber shall have a unit weight of 1500 kg/m3, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

17.4 Barbed Wire Fencing

17.4.1 Materials

17.4.1.1 Galvanized barbed wire

Barbed wire shall be 2.24 mm dia 2 ply lines with 4 points barbes 7.5 cm apart and shall be properly galvanized and shall be obtained from the approved manufacturer.

17.4.1.2 Other materials

The specifications of materials, for angle iron posts, concrete works, plasters, if any, and for other works, shall conform to the requirements as specified in Part-I.

17.4.2 Workmanship

The work shall comprise of the following :

a) Excavation in ground of required dimensions with all sides vertical in any type of soil including soft rock and removing the soil dressing it neatly.

b) Filling the holes in full with cement concrete 1:3:6 mix, well packed, after erecting the posts in correct line, level and plumb. In case of any post coming at local depression, the hole may not be of full depth but the depth of concrete will always be made 60 cm raising it above ground level with necessary shuttering.

c) Where the angle iron posts are specified in the item these shall be 50 mm x 75 mm x 6 mm unless mentioned otherwise, 10 mm dia holes with saw cuts for inserting the wires shall be made as per the spacing of barbed wire shown in drawing or as directed by the Engineer. The foot of the post shall be provided with base plate for anchorage. The spacing shall be 2.5 m or as per drawing. After inserting the wire into holes the socket is to be pressed back.

d) Straining bolts are to be provided 15 m apart from each row of wire for maintaining proper tension in the wire and without any sag or looseness.

e) Posts are to be painted as directed by the Engineer.

f) Complete fenced length will not be measured for payment. Any gate openings will be deducted. There should not be any misunderstanding that each wire row will be paid separately.

PART-III

NORMS OF CEMENT CONSUMPTION

1.0 CONCRETE

. No.	Item	Cement requirement (kg/M3)
1.	Concrete Grade M5A	164
	M5B	196
2.	Concrete Grade M7.5A	194
	M7.5B	226
3.	Concrete Grade M10A M 10B M 10C	To be mutually agreed based on mix design to be prepared by the Contractor and approved by the Engineer
4.	Concrete Grade M15B M15C M15D	-do-
5.	Concrete Grade M20B M20C M20D	-do-
6.	Concrete Grade M25B M25C M25D	-do-
7.	Concrete Grade M30C M30D	-do-
8.	Grouting with Concrete Grade M15D	359
	M20D	422
	M25D	496
	M30D	591
9.	Grouting with 1:2 (by volume) Cement and sand 1:3 (by volume) mortar	718 540
10.	Jhama Brick Jelly Concrete 1:71/2	180

Note: A,B,C & D mentioned along with grade of concrete correspond to the maximum size of coarse aggregate being 75 mm, 40 mm, 20 mm, and 10 mm respectively

2.0 MASONRY

. No.	Item		Cement requirement (kg/M3)
1.	Random rubble masonry with cement sand mortar		
	(a)	1:4	125.40
	(b)	1:5	102.30
	(c)	1:6	82.50
2.	Brick work in Cement sand mortar		
	(a)	1:4	95.00
	(b)	1:5	77.50
	(c)	1:6	62.50
3.	Half brick thick brick work in cement sand mortar		
	(a)	1:3	14.30
	(b)	1:4	10.60
	(c)	1:5	8.70
4.	Half brick thick honey combed brick work in cement mortar		
	(a)	1:3	8.60
	(b)	1:4	6.40
	(c)	1:5	5.20

3.0 FLOORING

. No.	Item		Cement requirement (Kg/m2)
1.	(a)	25 mm thick granolithic layer with 10 mm down graded chips	
		i) 150 Grade	9.50
		ii) 200 Grade	11.50
	(b)	Extra for each additional thickness of 5 mm granolithic layer	
		i) 150 Grade	1.90
		ii) 200 Grade	2.30
2.	(a)	100 B Grade PCC rubbed smooth	
		i) 100 mm thick	26.00
		ii) 75 mm thick	19.50
	(b)	Extra over above for each additional 10 mm thickness	2.50
3.	(a)	75 mm thick with 20 mm stone RCC floor	
		i) 150 Grade	24.50
		ii) 200 Grade	28.00
	(b)	Extra over above for additional 25 mm thickness	
		i) 150 Grade	8.10
		ii) 200 Grade	9.20
4.		Cast in situ terrazzo floor 40 mm thick with top layer of 50% grey & 50% white cement	13.00
5.		Precast terrazzo tile floor 20 mm thick jointing with 50% white cement and under layer of 1:3 cement mortar 12 mm thick	11.50

4.0 FINISHING

. No.	Item		Cement requirement (Kg/m2)
1.	Cement plaster 10 mm thick		
	i)	1:6	3.00
	ii)	1:5	3.70
	iii)	1:4	4.30
	iv)	1:3	5.70
2.	Cement plaster 15 mm thick		
	i)	1:6	4.50
	ii)	1:5	5.40
	iii)	1:4	6.50
	iv)	1:3	8.80
3.	Ceiling plaster 6 mm thick		
	i)	1:4	2.80
	ii)	1:3	3.70
4.	Flush/Rule/Tuck/Weather Struck/Pointing		
	i)	1:3	1.50
	ii)	1:2	2.00

PART-IV

DIMENSIONAL TOLERANCE

1.0 GENERAL

The materials used in construction shall, besides conforming to the specifications and standards mentioned, be the best of the existing kinds obtainable. Where a particular 'Brand' or 'Make' of material is specified such 'Brand' or 'Make' of material alone shall be used.

A high standard of workmanship and accuracy shall be achieved in all sections and parts of the work. The workmanship shall be in accordance with the latest and the best civil engineering practice.

The Contractor shall ensure that all sections of the work are carried out with utmost care to achieve the dimensions shown in drawings or specifications. Where special and close tolerances are required in any particular section of work, these will be shown in the drawing and such tolerances shall be met. In the absence of such specific mention in drawings the following dimensional deviations may be tolerated, provided they do not impair the appearance or render the particular section of work unacceptable to the purpose for which it is intended.

Description		**Permissible tolerance**
Building bricks, in length width and height	:	As per IS 1077
Laterite stone, in length, width & height	:	Plus or minus 5 mm
Concrete and reinforced concrete pipes		
Length	:	Plus or minus 1% of standard length
Internal diameter, upto 300mm	:	Plus or minus 3 mm Minus 1.5 mm
Internal diameter, upto 400mm	:	Plus 6 mm Minus 3 mm
Over 400 mm	:	Plus 1.5% Minus 0.75%
Barrel wall thickness upto 25mm	:	Plus or minus 1.5mm
Over 25 to 35 mm	:	Plus or minus 2 mm
Over 35 to 50 mm	:	Plus or minus 3 mm
Over 50 mm	:	1 mm for every 15mm thickness over 50 mm, but limited to maximum of 5 mm
Cast iron pipes and fittings		
Length	:	Plus or minus 13mm
Thickness	:	Plus or minus 1 mm
Internal dia of socket	:	Plus or minus 3 mm

Depth of socket	:	Plus or minus 10mm
External dia, upto 75 mm	:	Plus or minus 3mm
100 mm to 125 mm	:	Plus or minus 3.5mm
150 mm	:	Plus or minus 4mm
Stoneware pipes, in lenth upto 75 cm	:	Plus or minus 10mm
Upto 90 cm	:	Plus or minus 15mm
Glazed tiles, length of all 4 sides	:	Plus or minus 0.8mm
Individual dimensions and thickness	:	Plus or minus 0.5mm
Metal doors, windows and ventilators In overall dimension	:	Plus or minus 1.5 mm
Wooden doors, windows, ventilators	:	Plus or minus 3 mm
Overall dimension of frame and shutter	:	Minus 0 mm

All components of shutter except glazing bar

Width	:	Plus or minus 3mm
Thickness	:	Plus or minus 1mm
Glazing bar, width & thickness	:	Plus or minus 1 mm

Earthwork

Finished level of site levelling except for hard rock	:	Plus or minus 50mm
Finished level of site levelling except for hard rock	:	Plus or minus 100mm
Level of pits, trenches foundations	:	Plus or minus 50mm

Concrete & Reinforced concrete

Footings, plan dimension	:	Plus or minus 50 mm\ Minus 12 mm
Eccentricity	:	0.02 times the dimension of footing in the direction limited to 50 mm
Thickness	:	Plus or minus 0.05 times the specified thickness

Foundations

Diviation of planes and lines of their intersection from vertical or inclination along full height	:	Plus or minus 20mm
Deviation of horizontal plane from horizontal linec for 1m of the plane in any direction	:	Plus or minus 5mm
For the whole plane	:	Plus or minus 20 mm
Sizes of cross section	:	Plus or minus 8 mm
Surfaces of inserts to support loads	:	Plus or minus 5 mm
Length of elements	:	Plus or minus 20 mm
Equipment foundations		
Top level of bolt	:	Plus 20 minus 0 mm
Top level of foundation before grouting	:	Minus 30 mm Plus 0 mm
Axes of anchor bolts in plan	:	Plus or minus 5 mm
Axis of foundation in either direction	:	Plus or minus 20 mm
Deviation in vertical line along height	:	Plus or minus 20 mm
Sizes of pits in plan	:	Plus or minus 20 mm
Sizes of steps in plan	:	Plus 0 mm Minus 20 mm
Levels of steps, benches and pits	:	Plus 0 mm Minus 20 mm
Axes of inserts in plan	:	Plus or minus 10 mm
Basic dimensions in plan	:	Plus or minus
Deviation of horizontal plan from horizontal line		
For 1 m of plane in any direction	:	Plus or minus 5 mm
For the whole plane	:	Plus or minus 20 mm
Local deviations of top surface when checked with a 2 m long straight edge	:	Plus or minus 8 mm
Buildings		
Surfaces when checked with a 2 m long straight edge	:	Plus or minus 8 mm
Sizes of cross section	:	Plus 8mm Minus 0 mm

Length of elements	:	Plus or minus 20 mm
Deviation from horizontal plane, for whole Building	:	Plus or minus 10 mm
Deviation of planes and lines of their intersection from vertical or design slope along height		
For columns supporting floor beams	:	Plus or minus 15mm
For framed columns linked with crane girders and beams	:	Plus or minus 10mm
Reinforced concrete walls		
Length	:	Plus or minus 20 mm
Flatness of surface when checked with a 2 m long straight edge	:	Plus or minus 20 mm
Level of top surface to support assembled elements	:	Plus or minus 5mm
Deviation in planes and lines of intersection from vertical	:	Plus or minus 15mm
Size of cross section	:	Plus or minus 8 mm
Placing of reinforcement		
Length of bar upto 75 cm long	:	Plus 3 mm Minus 5 mm
75 - 150 cm long	:	Plus 5 mm Minus 10 mm
150 - 250 cm long	:	Plus 6 mm Minus 15 mm
250 cm long	:	Plus 7 mm Minus 25 mm
Straight bars, all lengths	:	Plus or minus 25 mm
Spacing of bars	:	Plus or minus 5 mm
Anchor bolts		
Shift in location in plan	:	Plus or minus 5 mm
Same, when bolts are located outside of structural columns	:	Plus or minus 10 mm
Top level	:	Plus 20 mm Minus 0 mm
Threaded length	:	Plus 30 mm Minus 0 mm

For Walls	**For Pillars**	
	Masonry	
Width	Plus or minus 10 mm	Plus or minus 10 mm
Shift in axes	Plus or minus 10 mm	----
Deviation in row from Horizontal line for very 10m length	Plus or minus 15 mm	----
Flatness of surface when checked with a 2 m long straight edge	Plus or minus 10 mm	Plus or minus 5 mm
Deviation in lines Separating storeys	Plus or minus 15 mm	Plus or minus 15 mm
Deviation of surface from vertical and at angles and corners for 1 storey	Plus or minus 10 mm	Plus or minus 10 mm
For whole building	Plus or minus 30 mm	Plus or minus 30 mm
Dimensions of openings for doors, windows etc.	Plus 15 mm Minus 0 mm	
	Flooring, skirting, dado and plastering	
Insitu concrete floor	4 mm	
Concrete tile and mosaic,	3 mm	
in any 3 m length in large open area	15 mm	
Marble and such superior work,		
in any 2 m length	1.5 mm	
in any row	3 mm	
Plastered surfaces, flatness when checked		
with a 2 m long straight edge	3 mm	
Vertical surfaces, upto 1-storey Over full heights	10 mm	
	Metallic Inserts	
On assembled components length and width	Plus or minus 3 mm	

GAIL (India) Limited

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

SPECIFICATION NO. MEC/S/05/11/03

(CIVIL ENGINEERING SECTION)
MECON LIMITED
DELHI - 110 092

CONTENTS

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 to VIII)	:	Indian Standard Methods of Test for 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^3 and the compressive strength shall not be less than 350 kg/cm^2 in 28 days and 235 kg/cm^2 in 7 days.

CONTRACTOR shall be permitted to select any proportioning of materials to achieve the specified requirements of concrete density and weight by doing mix design and trial tests.

5.0 APPLICATION METHOD

Concrete coating shall be applied either using casting or guniting method. Any alteration or modifications to the methods described in this specification shall be submitted to the COMPANY for approval. The application method shall however ensure the basic characteristics of concrete coating in compliance with the minimum requirements of this specification.

CONTRACTOR shall submit to the COMPANY, prior to commencement of work, the procedure/ method of application for approval.
Wherever practical, the total thickness of coating shall be applied in a single pass.

6.0 EQUIPMENT

The equipment used for the concrete coating shall be capable of giving a reasonable degree of uniformity with respect to thickness, density and strength. The proportioning equipment and procedure shall be of the type to assure consistently proportioned materials by weight. Concrete shall be mixed in a mechanical mixer, which shall ensure thorough mixing of all materials. Any equipment that tends to separate the in gradients shall not be used.

7.0 MEASUREMENTS & RECORDS

7.1 All measurements as mentioned below shall be taken during the work stages and clearly recorded in a proper log-book. A special log-book shall be used for recording tests and trial results. A log-book shall refer to pipe lengths having the same nominal diameter, and steel wall thickness.

7.2 The following shall be subject to measurement and recording for each pipe length.

a) Line Pipe

1) Field identification number
2) Mill serial number
3) Length
4) Weight
5) Average outside diameter

b) Concrete Coating

6) Batch identification number
7) Date of placing of concrete coating
8) Average concrete coating thickness
9) "Dry weight" of concrete coated pipe
10) "Unit dry weight" of concrete coated pipe
11) "Negative buoyancy" (unit) of concrete coated pipe

7.3 No concrete placing shall be allowed before items 1 through 5 listed at clause 7.2, have been recorded and approved by COMPANY.

8.0 PROCEDURE QUALIFICATION

Before commencement of the work, CONTRACTOR shall perform all tests, either in laboratory or in field and trials necessary to properly select type of mix which meets the requirements of section 4.0 of this specification.

8.1 The type of mix, i.e. the correct combination of the cement, aggregates and water which results in the desired properties of concrete shall be at first determined. For each mix the following shall be accurately checked and recorded:

- proportions and weights of the respective materials used
- the water/ cement ratio;
- the grading of the aggregates.

8.2 Samples shall be prepared and tested in accordance with IS:456 to determine the dry specific gravity of the concrete.

Test for concrete specific gravity at intermediate time (7 days after coating) shall be performed.

8.3 When the results of the above tests do not meet the requirements, the mix shall be modified and concrete samples tested until a proper mix has been determined.

8.4 The mix so determined, shall then be used for sampling of concrete to be submitted to compressive strength tests as per IS:456.

8.5 Frequency of sampling for tests for density and compressive strength of concrete shall be as follows :

`Quantity' of Concrete in the Work(m^3)	**Number of Samples**
Upto 25	3
26 to 50	4
51 and above	4 plus one additional sample for each additional 50m^3 or part thereof.

`Quantity' means the volume of concrete to be used.

9.0 **APPLICATIONS OF REINFORCEMENT AND CONCRETE COATING**

9.1 Two test cubes each per day shall be obtained from batches and tested at the end of 7 days after coating, for compressive strength and specific gravity.

9.2 The moisture content of the aggregates used shall be such as to maintain a satisfactory control on the water/ cement ratio of the concrete mix.

To maintain the water/ cement ratio constant at its correct, value, determination of moisture contents in both fine and coarse (if used) aggregates shall be made as frequently as possible.

9.3 Pipe Length Preparation

Prior to placing of reinforcement, the protective coating of each pipe length shall be carefully inspected visually and by holiday detectors and, if damages are found, they shall be repaired before start of the work. Foreign materials, if any, shall be removed from the surface of the protective coating.

9.4. Reinforcement Application

9.4.1 Reinforcement shall be placed around the pipe in such a way as to cover the whole pipe length or sections to be concrete coated. The reinforcement shall protrude a minimum 5 cm from the finished concrete coating.

9.4.2 Reinforcement shall rest on PVC spacers forming a "Crown" whose number shall be such as to avoid any contact with the pipe's protective coating. Spacing between the two consecutive "crown" centers shall be 500 C/C and a minimum of 4 Nos. shall be provided at each `Crown' center.

9.4.3 Splices and attachments shall be done by binding with steel wire having 1.5 mm diameter. Circular and longitudinal joints of wire fabric in sheets shall be lapped at least for one mesh. When wire fabric in rolls (ribbon mesh) is used, the spiral lap shall be one mesh while the spliced lap shall be three meshes.

9.4.4 One layer of reinforcement steel shall be provided for concrete thickness less than 50mm and the same shall be embedded approximately midway in the concrete coating thickness. For concrete thickness 50mm and above two layers of reinforcing steel shall be provided. If application method requires more than one pass concrete, one reinforcement layer for each pass is to be applied independently from concrete coating thickness.

9.5 Concrete Placing

9.5.1 Concrete shall be placed within a maximum of 30 minutes from the time of mixing (adding water to mix) and shall be handled in such a way so as to prevent aggregate segregation and excessive moisture loss. Concrete containers shall continuously be kept clean and free from hardened or partially hardened concrete.

9.5.2 If casting method is used, once reinforcement and mould have been applied around the pipe, concrete mixture shall be poured through an opening on the upper section of the same mould. Concrete shall not be deposited from a height greater than 1 metro. During pouring of concrete, vibrator sets applied inside of pipe or outside the mould shall vibrate the mix so as to obtain the best possible compactness.

9.5.3 If guniting method is used, placement of concrete shall be upto the specified thickness in one continuous course, with allowance for splices of reinforcement and providing reinforcement in the right location.

9.5.4 No casting shall be interrupted or passes shall be stopped for more than 30 minutes. Before placing fresh concrete against the joint, the contact surfaces shall be carefully cleaned and wetted to obtain a good bond between the fresh material and the previously placed material.

9.5.5 Suitable means shall be provided to ensure that the temperature of the concrete, when placed, does not exceed 32°C.

9.5.6 All pipes shall be kept clean and free from cement concrete and grout either inside or outside of the uncoated sections.

9.5.7 Bevel protectors shall be kept in place throughout the coating application and after.

9.5.8 The coating at each end of the pipe shall be beveled to a slope of approximately two-to-one (2:1). It shall terminate about 50mm short of the end of the corrosion coating applied on the pipe surface.

9.6 **Curing**

9.6.1 Immediately after concreting, the exposed surfaces of the concrete shall be protected during `setting' from the effects of sunshine, drying winds, rain, etc. and then after the initial set has taken place, the concrete coating shall be properly cured. The coated pipe sections shall be handled gently by suitable means to prevent undue distortion.

9.6.2 Curing shall be done by sprinkling water at regular intervals on gunny cloth wound around the concrete coated pipes.

Alternatively, curing may be done by application of an approved curing membrane using sealing compounds and shall meet the basic requirements of IS:456 and shall generally be of very high quality of manufacture and approved make. The material shall be stored, prepared and applied in strict conformity with the instructions of the manufacturer. The ingredients of any such compound shall be non-toxic and non-inflammable and shall not react with any ingredient of the concrete, the reinforcement, the protective coating or pipe. The application of the curing compound shall take place immediately after the coating is completed and preferably before the pipe is removed from the concrete coating apparatus. The surface of the concrete shall be lightly sprayed with water before applying the curing compound. The membrane curing period shall not be less than 4 days, during which period the freshly coated pipes shall not be disturbed. The pipe surface shall be kept wet during daylight hours for seven days after application of the concrete coating. The concrete coating shall not be allowed to dehydrate.

9.6.3 Before handling and hauling the concrete coated pipes, a check shall be made to make sure that the concrete coating is properly cured. Stacking and shipment of the coated pipes shall be initiated only after seven days provided that the concrete coating suffers no damage.

10.0 TOLERANCES

10.1 CONTRACTOR shall maintain a surface tolerance of 8mm maximum for the radial distance between high and low areas of the surfaces. The diameter of each coated pipe shall be obtained at three (3) or more points, spaced at equal intervals between the end points.

10.2 The acceptance weight tolerance for any single pipe shall be limited to plus five (5) or minus two (2) percent of the calculated theoretical weight. The theoretical weight shall be calculated using total weight of the pipe with concrete and corrosion coating.

11.0 WEIGHING

11.1 The test specimen shall be selected at equal intervals during the course of production.

11.2 CONTRACTOR shall weigh each pipe when dry prior to shipment and 28 days after placing of concrete and mark the weight with paint on the inside of the pipe. The weight mark shall be followed with letters "DW" meaning Dry Weight.

12.0 INSPECTION AND TESTS

12.1 After curing, every length of concrete coated pipe shall be non-destructively tested by means such as "ringing" to determine if any suspected defects are present. In case this indicates faulty coating, cores shall be removed from coating and inspected. When defective coating appears from cores, the concrete coating shall be removed from the pipe lengths.

12.2 Every length of concrete coated pipe shall be checked to verify insulation between steel reinforcement and pipe by means of a megger or equivalent device. To this purpose provisions should be made during placing of concrete such as to leave at-least a point of exposed steel reinforcement whenever the latter shall terminate inside of concrete coating.

12.3 During the tests as per clause 12.2 above, and before transporting of concrete coated pipes, every pipe length shall be visually inspected to detect whether any damages and/ or defects are present. Possible damages and/ or defects with their allowable limits are described at following clause 13.0. Repairable concrete coatings shall be clearly marked while the non-repairable ones shall be removed from the pipe lengths.

13.0 THE COATING OF FIELD WELDS

13.1 The CONTRACTOR shall coat the uncoated pipe surface at field welds in accordance with methods approved by COMPANY. CONTRACTOR shall submit a detailed procedure for joint coating for COMPANY's approval.

13.2 The reinforcement for the field welds shall be same as that for line pipe coating with the same number of layers and the same space between layers as for the existing coating. The edges of this meeting must be carefully secured with galvanized wire to the reinforcement extending from the existing coating.

The reinforcement shall not make direct or electrical contact with the pipe.

Synthetic resin spacer blocks may be used to keep the reinforcement free from the pipe coating as mentioned in cl. 9.4.2.

The moulds used for applying the concrete coating shall be supplied by the CONTRACTOR.

13.3 The composition of the concrete shall be the same as that of the concrete coating of the pipe.

When using moulds, the CONTRACTOR shall prevent air being trapped by applying mechanical vibrators or by striking the outside of the moulds with sticks.

13.4 If the moulds remains around the pipe, e.g. in the case of submerged pipes floated into position, the CONTRACTOR shall take appropriate measures to prevent too much water entering the mould. This can be achieved by clamping strips of burlap between the ends of the mould and the existing concrete coating. After the mould has been filled with concrete the filling opening must also be closed off by clamping a strip on burlap under the sealing cover.

14.0 REPAIRS

The following are repairs that will be permitted to coating due to unavoidable damage in handling and in storage (This applies only to concrete that has set).

14.1 Spalling due to compression or shearing caused by impact against other objects. Spalling is defined as damage which causes a loss in concrete of more than 25 percent of the total thickness of the coating at the point of damage.

14.2 Damage due to spalling of a local area shall be repaired by removing loose concrete and exposing the reinforcing steel throughout the damaged area. Edges of the spalled area shall be undercut so as to provide a key lock for the repair material. A stiff mixture of cement, water and aggregate shall be trowelled into and through the reinforcement and built up until the surface is level with the coating around the repair. The pipe shall then be carefully laid with the repaired area at the top and shall be moist cured for a minimum of thirty six (36) hours before further handling.

14.3 Should the damaged area be more than 0.3m^2, coating shall be removed around the entire damaged area. A repair shall be made by satisfactorily restoring the reinforcement, forming the area with a metal form and pouring a complete replacement of materials similar to that from which the coating was made. The mixture shall be one (1) part of cement to three (3) parts of aggregate and the necessary water to produce a slump not to exceed 100mm. The resulting coating shall be equal in weight, density, uniformity, thickness, strength and characteristics to the originally applied coating. The pipe shall then be carefully laid in a position where it shall be moist cured for a minimum of 36 hours before further handling.

15.0 MARKING

15.1 Every concrete coated pipe length shall be clearly marked by a suitable type of paint (i.e. red and/ or white lead paint). Markings out of concrete coating shall be made inside of pipe close to bevel end, in such a way that the area involved by welding operations is not affected by paint.

15.2 For each concrete coated pipe length, at one of the two ends, the field identification number and the date of concrete placing shall be marked, while the dry as well as the net weight along with number of days after coating shall be marked at the other end.

16.0 UNLOADING, TRANSPORT, STORING AND HAULING

16.1 Once the pipe sections have been taken on charge, the CONTRACTOR, complying with provisions of the CONTRACT, shall execute their transport together with other material, either supplied by him or by the COMPANY, from the site of receipt to the coating yard and after concrete coating completion and acceptance, to delivery point at laying field or storage areas as previously established providing each time the necessary storage.

16.2 Materials other than pipes and which are susceptible of deteriorating or suffering from damages especially due to humidity or other adverse weather conditions, shall be suitably stored and protected.

16.3 During loading, transport, unloading and hauling of inert aggregates, any contact and mixing with mud, earth, grease and any other foreign material shall be carefully avoided. Precautions shall be taken to prevent contamination, to maintain the cleanliness and against effects of hot or cold weather.

16.4 During the operations of loading, unloading and stock-piling, the pipe sections shall be handled in such a way so as to avoid dents, cuts, cracks and other damages especially at beveled ends or damages to protective and/ or concrete coating.

16.5 Stacks shall consist of a limited number of layers such that the pressure exercised by the pipes own weight does not cause damages to coating. Stacking with more number of layers shall be agreed upon with the COMPANY provided that each pipe section is separated by means of spacers suitably spaced so as to avoid stresses and compressed points of contact on the coated surfaces.

17.0 PART-B : CONCRETE SADDLE WEIGHT

17.1 This specification deals with the work of supply, precasting, and placement of concrete saddle weights of specified design and construction. Refer Standard Drawing No. MEC/05/ 11/STD/TERMINAL/006, Rev-1.

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. MEC/S/05/11/01.

TECHNICAL SPECIFICATION FOR FABRICATION, ERECTION AND PAINTING OF STEEL STRUCTURES, GATES AND MISCELLANEOUS WORK

SPECIFICATION NO.: MEC/S/05/12/01 (Rev-0)

C O N T E N T S

LIST OF ANNEXURES

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

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, Boundary wall MS Gate 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 900ºC and 1100ºC. Cooling down of the heated item shall be done slowly.

6.0 DRILLING AND PUNCHING OF HOLES

6.1 Drilling and punching of holes for bolts shall be done as per clause no.11.2.4 of IS:800-1984, unless otherwise specified by CLIENT.

6.2 Drifting of holes for bolts during assembly shall not cause enlargement of holes beyond permissible limit or damage the metal.

6.3 Holes for bolted connection should match well to permit easy entry of bolts. Gross 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 carryout such orders failing which the rectification/redoing will be done by CLIENT through other agencies and the cost recovered from the Contractor.

v) Notwithstanding any inspection at the workshop, CLIENT/Inspector shall have the liberty to reject, without being liable for compensation any fabricated members or materials brought to site that do not conform to specifications/drawings.

vi) All rejected materials shall be removed from the site of fabrication by the Contractor at his own cost and within the time stipulated by CLIENT/Inspector.

10.0 CONTROL IN WELDING

10.1 The extent of quality control in respect of welds for structural elements shall be as follows and shall be conducted by the contractor at his own cost:

a) Visual Examination - All welds shall be 100% visually inspected to check the following:

i) Presence of undercuts
ii) Visually identifiable surface cracks in both welds and base metals
iii) Unfilled craters
iv) Improper weld profile and size
v) Excessive reinforcement in weld
vi) Surface porosity

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

b) Dye Penetration Test (DPT) - This shall be carried out for all important fillet welds and groove welds to check the following :

i) Surface cracks
ii) Surface porosity

Dye Penetration Test shall be carried out in accordance with American National Standard ASTM E165.

11.0 ACCEPTABLE LIMITS OF DEFECTS IN WELD

11.1 The limits of acceptability of defects detected during visual inspection and Dye Penetration Test shall be in accordance with clause 8.15.1 American National Standard ANSI/AWS D1.1-96.

12.0 RECTIFICATION OF DEFECTS IN WELDS

12.1 In case of detection of defects in welds , the rectification of the same shall be done as follows :

i) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld.

ii) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.

iii) 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/marking 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 mechanization 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 levelled using steel wedges and shims or by other approved methods. Plates shall be levelled 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 by-passed 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 Specification, 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 25μ/coat) of single pack type with 30-35% solids and covering capacity 12-13 m²/lit/coat.

c. Finishing paint: Two coats of synthetic enamel in alkyd medium with superior quality water and weather resistant pigments (DFT 25μ/coat) of single pack type with 30-40% solids and covering capacity 16-18 m²/lit/coat.

28.0 MEASUREMENTS

28.1 Structural Steel

Structural steelwork will be measured by the metric tonne and as per IS:1200(Part-8)-1993 and IS:1200(Part-9)-1973 subject to provisions outlined below:

a) The calculation of quantities shall be based on unit weights for structural sections as given in IS Handbooks. In the case of mild steel plates, the calculated weights shall be based on 78.5 kg/m^2/centimeter thick plate. The payments will be made on the basis of weights of members as per drawings. However, any changes on the above weights during fabrication erection, payment shall be based on sketches approved by CLIENT.

b) In the event the IS does not specify any mode of measurement for a particular item of work, the same shall be measured as per any other relevant international standard or as directed by CLIENT.

c) The weight of all plates and sections shall be calculated from the approved drawing using the minimum overall square or rectangular dimensions and theoretical weight, no deduction being made for skew cuts, holes etc. In the case of plates, other than gussets, the actual dimensions shown on approved drawings will apply unless approved otherwise by the purchaser based on cutting diagram of mother plates.

d) The weight of all welding runs, bolt, stanchion base packing, cuttings to waste and rolling margins, and coatings of paint, will be excluded from the measured weight and shall be deemed to have been allowed for in the rates for structural steelworks quoted by the Contractor.

e) Temporary works and all other materials not included in the permanent works shall be excluded from any measurement for payment.

f) Chain link fencing shall be measured in running meter basis, as specified and shown on the drawings.

28.2 GCS & AC Sheets

28.2.1 Asbestos Cement Corrugated sheets for roofing and side cladding shall be measured by the square meter of net laid area, as specified and shown on the drawings.

28.2.2 No allowance shall be made for wastage, cutouts, overlaps, etc., in the measurement.

28.2.3 The unit rate shall include all fasteners, flashing and fitting such as ridges corners, aprons and other accessories.

28.2.4 No deduction will be made for openings for area less than a single sheet. Also no extra payment will be made for making openings.

29.0 ACCEPTANCE OF WORKS

29.1 After completing the erection of a unit or portion thereof, the Contractor shall give a notice in writing stating that the job is complete in all respects and ready for preliminary acceptance.The job shall be jointly inspected visually by representatives of Contractor and CLIENT. All observed defects and omissions as per drawing and specification shall be noted down.

29.2 The Contractor shall make good all these defects, deficiencies and omissions and shall inform in advance CLIENT/Inspector for inspection. The Engineer-Incharge shall satisfy himself that all the defects, deficiencies and omissions noted down during preliminary acceptance have been rectified.

Annexure-A

Permissible deviations in pitch and gauge of holes for bolts of normal accuracy

Sl. No.	Description	Hole Diameter (mm.)	Permissible deviations in spacing (mm.)	Permissible deviations in each group of holes	
				Carbon steel	Low alloy steel
a.	Deviation in hole diameter.	Upto 17	+1.0	No limits	
		Above 17	+1.5		
b.	Ovality (Difference between the biggest and the smallest diameters).	Upto 17	+1.0	No limits	
		Above 17	+1.5		
c.	Curves exceeding 1mm. and cracks on the hole edges.	-	-	Not permissible	
d.	Non-coincidence of holes in separate details of the assembled unit:				
	Upto 1mm.	-	-	Upto 50%	Upto 50%
	Above 1mm. upto 1.5mm.	-	-	Upto 10%	Upto 10%
e.	Slope of axis.	-	Upto 30% the thickness of unit.	No limits	No limits

Annexure-B

Tolerance of Assembled Components of Structures

Sl. No.	Description of components in structures	Deviation (±) mm. for elements of structures						
		Upto 1m.	1m. to 5m.	5m. to 10m.	10m. to 15m.	15m. to 20m.	20m. to 25m.	Over 25m.
1.								
i.	Deviations from the dimensions assembled.							
	Length and width of the details cut:							
a.	Manual gas cutting as per marking	3.0	3.5	4.0	4.5	5.0	-	-
b.	With shears or with saw as per marking.	2.0	2.5	3.0	3.5	4.0	-	-
c.	With shears or with a saw with a stop.	1.5	2.0	2.5	3.0	3.5	-	-
d.	Machine gas cutting.	2.0	2.5	3.0	3.5	4.0	-	-
ii.	Length and width of planed processed on edge planing machine.	1.0	1.5	2.0	2.5	3.0	-	-
2.								
i.	Distance between centers of the end holes:							
a.	Drilled according to marking.	2.0	2.5	3.0	3.5	4.0	-	-
b.	Drilled according to a gauge with bushing.	1.0	1.5	2.0	2.5	3.0	-	-
ii.	Distance between centers of adjacent holes:							
a.	Drilled according to marking or a gauge..	1.5	-	-	-	-	-	-
b.	Drilled according to a gauge with bushing.	0.5	-	-	-	-	-	-

Annexure-C

Tolerances in Erected Steel Structures

Sl. No.	Description	Tolerance
1.	Deviation of structure at foundation top level w.r.t. true axis	
a.	in longitudinal direction.	± 5mm.
b.	In lateral direction.	± 5mm.
2.	Deviation in the level of bearing surface of structures at foundation top w.r.t. true level.	± 5mm.
3.	Out of plumb of structure from true vertical axis and measured from structure top.	$\pm H/1000$ or ±25mm. Whichever is less.
Note:	'H' above is the structure height in mm.	

Notes:

1. The tolerances do not apply to steel structures where deviations from true positions are intimately linked or directly influenced by technological processes. In such cases, tolerances on erected steel structures shall be as per recommendations of process technologists/equipment suppliers.
2. The observed or calculated values of deviations of steel structures from their true positions shall be rounded off in accordance with IS:2-1960 for comparison with permissible tolerances specified in this table. The number of significant places retained in the rounded off value shall be the same as that specified in this table.

Annexure-D

Material of construction (as applicable)

1.0 Unless otherwise specified in the drawing, all rolled sections and plates shall conform to Grade-A as per IS: 2062-1992.

2.0 Steel sheets shall conform to IS:1079-1988.

3.0 Steel tubes for structural purposes shall conform to IS: 1161-1979 (Grade YST-240).

4.0 ACC sheets shall be 6mm. thick with corrugation conforming to IS: 459-1992.

5.0 Gutters and down comers shall be of copper bearing steel conforming to IS: 2062-1992.

6.0 Crane rails shall conform to IS: 3443-1980.

7.0 All black hexagonal bolts, nuts and lock nuts shall conform to IS: 1363-1984 and IS: 1364-1983 (for precision and semi-precision hexagonal bolts). Washers shall conform to IS: 1148-1982.

8.0 Covered electrodes for arc welding shall conform to IS: 814-1991. Coding of electrodes shall be as follows:

a. ER 421 'C' x for mild steel of Grade A and Grade B as per IS: 2062-1992.

b. EB 542 'C' x H3X for:
mild steel of Grade B as per IS: 2062-1992 for dynamically loaded structures (arising out of crane, vibratory screen, equipment, etc.),
SAIL-MA micro alloyed steel 350 HYA/HYB and
when combined thickness (CT) for steel conforming to IS:2062-1992 exceeds 40mm.

where 'C' is the value of current as recommended by the electrode manufacturer.

9.0 Material for chain link fencing shall conform to IS:2721-1979. Mesh for chain link fencing shall be of 3.15mm hot dip galvanized steel mesh wire, the diameter being measured over zinc coating. The diameter of mesh wire shall not vary from the specified diameter by more than 0.05mm. The material for mesh wire and line wire of chain link fencing shall conform to IS:280-1978. Stretcher bar for erection of mesh shall consist of mild steel flats 25mmx4.75mm. The stirrup wire for securing the line wires to the intermediate post shall be of 2.5mm mild steel wire. Hairpin staples for fastening the bottom line wire to the foundation concrete shall be of 6mmÖ mild steel wire with ends of staples bent outwards for adequate anchorage. The cleats for eyebolts shall be of mild steel plate 10mm thick.

10.0 Material for barbed wire shall conform to IS:278-1978. Line wire for the barbed wire shall be made from two strands of galvanized steel wire of nominal dia 2.5mm twisted together. Barbs shall be made of point wire of galvanized steel of nominal dia 2.5mm in such a way that four points of the barbs are set and located or locked as far as possible at right angles to each other. Droppers for barbed wire shall be of mild steel flat 25mmx4.75mm with 38mmx4.85mm half round staples for fastening the barbed wire.

TECHNICAL / STANDARD SPECIFICATION

FOR

INSTRUMENTATION WORKS

Rev. : 0
Edition: 1

SPECIFICATION

FOR

INSTALLATION OF INSTRUMENTS

SPECIFICATION NO.: MEC/S/05/26/01

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

CONTENTS

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 MECON.

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 MECON.

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 galvanised 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 socket weld 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 equivalents make double ferrule and pressure seat type.

All tube fittings in impulse lines shall be rated to 5000 PSIG at 38^{o}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 socket weld to ANSI 16.11 and threaded to B2.1

2.5 Multibore tubing shall have a maximum 19 single polyethylene tubes, 6mmOD x 1mm 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 armoured, 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^2.

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^2 copper conductors 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^2.

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, masonary 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 don't 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.

3.2.1.23-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.

3.2.1.3Differential 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 tubing. The use of short lengths of tubing 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^2 (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 plates. 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^2

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 ½" pipe shall be run to the instrument with a ½" 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 manufacturer's standards.

3.4.2 All cables shall be rigidly supported on structural steel and masonary. 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 piping and tubing shall be tagged with slip-on or clip on wire marker at both ends.

3.4.9 Jointing of cables is 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 sage 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 vapours can be vented to a safe location and liquids shall be drained in a clean and orderly fashion to a safe place. Toxic vapours 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 vents 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., manufacturer's name, and 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^2 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^{2}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^2 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 magger 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 manufacturer's 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 calibration 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 bourdon 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 points 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 points 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 points calibrated using precision pneumatic calibrator 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 mechanism, 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 monitored 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. Declutch able 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 hydro testing.

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 hydorlic 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 RTD's. 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 traceability certificates shall be submitted to MECON 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 MECON for approval.

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

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Rev.: 0
Edition: 1

SPECIFICATION

FOR

INSTRUMENT TUBING

SPECIFICATION NO.: MEC/S/05/26/02

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

CONTENTS

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, type wise, 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 reproducible 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^2 at 38^{o}C for 1/2" OD Tube, unless otherwise specified and 80.0 kg/cm^2 at 38^o 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^2 at 38^o C for 1/2" tube and at 80.0 kg/cm^2 at 38^{o}C for 6mm tube, unless otherwise specified.

3.2 PVC jacketed copper tubes shall be tested at 7.0kg/cm^{2}g with dry air for leak check.

3.3 Bare copper tubes shall be hydrostatically tested at 80.0 kg/cm^{2}g at 38^{o}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.

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.

Rev.: 0
Edition: 1

SPECIFICATION

FOR

INLET / OUTLET SECTIONS AND FLOW STRAIGHTENER

SPECIFICATION NO.: MEC/S/05/26/03

ELECTRICAL & INSTRUMENTATION (OIL & GAS SBU) MECON LIMITED DELHI 110 092

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

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1.0 FLOW STRAIGHTNER

1.1 Flow straightener shall be installed in the inlet section upstream of flow meter.

1.2 Flow straightener shall consist of a bundle of tubes designed and assembled as per ISO 5167-1980 (E) or AGA Report no.3 or AGA Report no.7.

1.3 Tube diameter shall be 0.2 D or less where D is the diameter of Meter inlet section pipe. Tube shall be seamless quality of SS 316 material thickness 1.5 or 1 mm Tube shall be hydrostatically tested for 75kg/cm^2 pressure and then cut to the required length for assembly.

1.4 On both the sides of tube bundle a very thin retaining rings of SS316 shall be provided for avoiding the dislocation of pipes.

1.5 The tube bundle shall be kept in position by 6mm threaded bolt. After tightening the bolt shall seal welded.

1.6 Tube ends shall be tempered at 45^o angle.

2.0 INLET SECTION/OUTLET SECTION

2.1 Inlet/Outlet sections of pipe for flow meter shall be of same inside diameter (ID) as turbine meter.

2.2 The pipe used should be circular and with no ovality or any other deformation, the inside surface of pipe shall be smooth, welded portion shall be grinded to smooth finish.

Rev.: 0
Edition: 1

SPECIFICATION

FOR

INSTRUMENT TUBE FITTINGS

SPECIFICATION NO.: MEC/S/05/26/04

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

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1.0 GENERAL

1.1 Scope

1.1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, 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 hardnesss 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^2, 1/2" fittings at 153.0 kg/cm^2 at 38^{o}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^2, 3/8" at 80.0 Kg/cm^2 and all at 38^{o}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.

Rev.: 0
Edition: 1

SPECIFICATION

FOR

INSTRUMENT VALVES AND MANIFOLDS

SPECIFICATION NO.: MEC/S/05/26/05

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

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1.0 GENERAL

1.1 Scope

1.1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, 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 reproducible 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 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:

2.2.1.13 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.

2.2.1.25 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 packing unless otherwise specified.

2.2.1.5 The material of construction shall be 316 SS unless otherwise specified.

2.2.1.5 The material of construction shall be 316SS 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^2 g at 38^{o}C.

3.2 All manifolds (3 valves, 5 valves and 3 ways, 2 valves) shall be hydrostatically tested at 200 kg/cm2 at 38C.

3.3 The instrument air valves shall be hydrostatically tested at 15.0 kg/cm^{2}g at 38^{o}C and at 10.5 kg/cm^{2}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.: MEC/S/05/26/06

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

C O N T E N T S

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 millimetre.
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 number wise, 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 reproducible 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.

Rev.: 0
Edition: 1

SPECIFICATION

FOR

SIGNAL CABLES

SPECIFICATION NO.: MEC/S/05/26/07

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

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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 spec. 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± 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± 5% from the value indicated in the purchase order.

1.4.3 Tolerance over the total ordered length shall be as follows:
± 5% for total length less than 5 km
± 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 conductors. Each strand shall be 0.53 mm dia.

2.1.2 Primary insulation shall be 85^{o}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^{o}C PVC to IS 5831-Type ST2 Oxygen index of PVC shall be 30. Temp. Index shall be over 250^{o} 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 +_ 2mm over offered value for cables with OD less than 30mm and+3mm 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 Aluminium 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^{o}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^{o} C for cables with 1.5 sq.mm conductor and 39.7 ohms/km at 20^{o}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 concequency of 1 KHz.

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.

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GENERAL SPECIFICATIONS FOR INSTRUMENTATION

SPECIFICATION NO.: MEC/S/05/26/08

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

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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 salvageable 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 the 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 <u>INSTRUMENT PIPING</u>

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.

4.1.2.1 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 man-hour charges with cost of all materials, test 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.

4.1.3.1 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/Aluminium 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/Aluminium 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 multitubes, 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 masonary 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^2 upto the filter regulator. The down steam side of the filter regulator shall be tested for 1.5kg/cm^2. 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 hysterisis 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 hysterisis 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^2	- +/- 0.1%
4.12.7.5	Gauge comparator for pressure gauges Rating : upto 350 kg/cm^2	-
4.12.7.6	Oil bath for temperature calibrations max. Temp 350^{o}C.	Mfr's Std
4.12.8.7	Standard Mercury in glass thermometers Range : -50 to + 50^{o}C. 0 to 100^{o}C (NPL certified) 0-250^{o}C, 0-350^{o}C	$\pm$ 0.25%
4.12.7.8	Standard gauges for Ranges upto 350kg/cm^2	$\pm$0.25%
4.12.7.9	U-tube differential manometers/inclined	

	tube manometer Static pr. rating : 7 kg/cm^2	+_ 1mm
4.12.7.10	Single leg manometers Scale: -1500 mm water and 1500 mm hg. Static pr. rating : 7 kg/cm^2.	+_ 1mm
4.12.7.11	Decade resistance box	MFR' std.
4.12.7.12	Millimeters	±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.

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.

4.13.5.1 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 ad 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 and 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 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.

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Rev.: 0
Edition: 1

STANDARD SPECIFICATION

FOR

CABLING

SPECIFICATION NO.: MEC/S/05/26/021

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

CONTENTS

1.0 SCOPE

This is to define the requirements for supply, wherever applicable, the installation, testing and commissioning of the cabling system.

2.0 STANDARDS

The work shall be carried out in the best workman like manner in conformity with this specification, the relevant specifications, codes of practice of Indian Standards Institution, approved drawings and instructions of Engineer-in-Charge or his authorized representative issued from time to time. In case of any conflict between the standards, the instruction of Engineer-in-Charge shall be binding.

3.0 CABLE SPECIFICATIONS

3.1 Power Cables

Power cables for use on 415 V systems shall be of 1100 Volts grade, aluminium stranded conductor, PVC insulated, PVC sheathed, armoured and overall PVC sheathed. Power cables for 3.3 KV 6.6 KV and 11 KV system shall be aluminium conductor, XLPL insulated, screened, PVC bedded galvanized steel flat armoured and PVC sheathed cable. All L.T. Cables conform to standard specification and relevant sections of IS: 1554 Part-I and H.T. Cables shall conform to IS: 7098 (Part II). Unarmoured cables will be used wherever specified on the cable schedule.

3.2 Control Cables:

Control cables shall be 1100 Volt Grade, 2.5 mm^2 copper conductor PVC insulated PVC sheathed, single wire armoured with an overall PVC sheath, as per IS: 1554 Pt. Unarmoured cables shall be used wherever specified on the cable schedule.

3.3 Communication cables:

Communication cables shall comprise 1 pair unarmoured, 2-pair, 5-pair and multipair armoured cables of sizes as specified in the cable schedule. Minimum conductor size shall be 0.5 mm telephone system and 0.71 for plant communication system.

4.0 MISCELLANEOUS MATERIALS SPECIFICATIONS

4.1 Connectors:

Cable terminations shall be made with aluminium / tinned copper crimped type solder less lugs of M/s. Dowell's make or approved equivalent for all aluminium conductors and stud type terminals.

4.2 Cable Identification

Cable tags shall be of 2 mm thick, 20 mm wide aluminium strap of suitable length to contain cable number, equipment no., etc.

4.3 Ferrules

Ferrules shall be of approved type size to suit core size mentioned and shall be employed to designate the various cores of control cable by the terminal numbers to which the cores are connected for case in identification and maintenance.

4.4 Cable Glands:

Cable glands to be supplied shall be nickel-plated Brass double compression type of approved/ reputed make. Glands for classified hazardous areas shall be certified by CMRS.

4.5 Multi Cable transit

Multi Cable Transit shall be used for cable entry to all type of control room walls, Decks, Firewall etc. The MCT Block system should have only few components for facilitating simple, easy and quick assembly. The Multidiameter based cable transits shall be repeatedly re-openable and re-usable without the need of special tools and discarding the modules in normal operation.

Frame shall be G type galvanized or stainless steel. Block should be multi diameter blocks with center core in all the blocks / add blocks with plug / galvanized or stainless steel stay-plates / single piece compression wedge with galvanized or stainless steel bolts. Solid blocks and insert blocks should not be used. MCT should have 100% spare for each cable size / O.D. Spare blocks should be available on the frame as usable Multidiameter blocks / add blocks with center plug, so that these spare blocks in future can be used for wide range of cables also, solid blocks should not be used at all on frame. Apart form spare if there is any additional uncovered space left on frame then this uncovered space should also be filled only with usable Multidiameter

blocks with center plug only.

The Multi Cable & Pipe Transit penetrations should have been tested for Gas Tightness / water tightness & fire tests.

4.6 Cable Trays:

This shall be either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron trays as specified elsewhere. Prefabricated hot dip galvanized sheet steel cable trays shall be used for maximum support span of 2000 mm unless design is approved for larger span. For requirements of larger than 750 mm width two trays shall be run side by side. Cable trays shall be suitable for a cable weight of 50 kg/meter running length of tray. Minimum thickness of sheet steel/galvanizing shall be 2mm/86 microns respectively.

Cable trays fabricated from standard rolled sections shall use 50x50x6 /ISMC 100 Sections for runners for supporting spans limited to 2000 mm/more than 2000 mm respectively. Cross support shall be 32 x 6 mm flat/ 25x25x6 angle for width upto 500 mm/ more than 500 mm respectively.

Vertical supports for both the above type of trays shall be fabricated out of ISMC 100 and horizontal supports with 75 x 50 x 6 angle iron/ ISMC 75 as approved by Engineer-in-Charge.
If unit rate is not included in schedule of rates, then cable trays if required, shall be fabricated and installed at site as per tone rate for electrical structural supports etc.

5.0 CABLE LAYING

5.1 Cable network shall include power, control, lighting and communication cables, which shall be laid in trenches, cable trays or conduits as detailed in the relevant drawings and cable schedules. Erection of cable trays as required shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc. and minor adjustments shall be done to suit the field conditions wherever deemed necessary without any extra cost.

5.2 High voltage, medium voltage and other control cables shall be separated from each other by adequate spacing or running through independent pipes, trenches or cables trays, as applicable.

All communication cables (telephones, P.A.S.) RTD Cables shall run on instrument trays/ducts/trenches. Wherever these are not available, cables shall be taken in a separate trench with a minimum clearance of 300 mm away from electrical trench as per the direction of Engineer-in-Charge and Communication

cables shall cross power cables at right angles.

All cable routes shall be carefully measured and cables cut to the required lengths, leaving sufficient lengths for the final connection of the cable to the terminal of the equipment. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. The quantity indicated in the cable schedule is only approximate. The contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works. Before the start of cable lying, cable drum schedule; shall be prepared be electrician contractor and get that approved by Engineer-in-Charge to minimize/avoid straight through joints required. Contractor shall work out the actual number of straight through joints required.

5.4 Cables as far as possible shall be laid in complete, uncut lengths from one termination to the other.

5.5 Cables shall be neatly arranged in the trenches/trays in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the Contractor. Cable routing between lined cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 45^{o} to the trench wall. In case of larger dia cables, i.e., 50 mm and above, adequately sized pipe with larger bend radius shall be provided for ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Engineer-in-Charge.

5.6 All cables will be identified close to their termination point by cable numbers as per cable schedule. Cable numbers will be punched on aluminium straps (2 mm thick) securely fastened to the cable and wrapped around it. Alternatively cable tags shall be circular in construction to which cable numbers can be conveniently punched.

Each underground cable shall be provided with identity tags of lead securely fastened every 30 m of its underground length with at least one tag at each end before the cable enters the ground. In unpaved areas, cable trenches shall be identified by means of markers as per standard drawing. These posts shall be placed at location of changes in the direction of cables and at intervals of not more than 30 M and at cable joint locations.

5.7 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be taped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.

5.8 RCC cable trenches shall be with removable covers. Cables shall be laid in 3 or 4 tiers in these trenches as indicated on the sectional drawings. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases, RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. The electrical Contractor at no extra cost shall do removal of concrete covers for purpose of cable laying and reinstating them in their proper positions after the cables are laid.

Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving trenches shall be coiled and provided with a protective pipe or cover, until such times the final termination to the equipment is connected.

5.9 Directly buried cables shall be laid underground in excavated cable trenches where specified in layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables correctly spaced and arranged with a view of heat dissipation and economy of design.

Minimum depth of buried cable trench shall be 750 mm for low voltage and 900 mm for H.V. Cables, the depth and the width of the trench shall vary depending upon the number of layers of cables.

Cables shall be laid in trenches at depth as shown in the drawing. Before cables are placed, the trenches bottom shall be filled with a layer of sand. This sand shall be levelled and cables laid over it. These cables shall be covered with 150 mm of sand on top of the largest diameter cable and sand shall be lightly pressed. A protective covering of 75 mm thick second class red bricks shall then be laid flat. The remainder of the trench shall then be back-filled with soil, rammed and levelled.

5.10 As each row of cables is laid in place and before covering with sand every cable shall be given an insulation test in the presence of Engineer-in-Charge / Owner. Any cable, which proves defective, shall be replaced before the next group of cables is laid.

All wall openings / pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/-lined trench.

Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection upto a minimum of 300 mm above finished ground level.

Cable ends shall be carefully pulled through the conduits, to prevent damage to the cable. Where required, approved cable lubricant shall be used for this

purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

Following grade of the pipe fill shall be used for sizing the pipe size:

a) 1 cable in pipe - 53% full
b) 2 cables in pipe - 31% full
c) 3 or more cables - 43% full
d) Multiple cables - 40% full

After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/ `PUTTI' for sealing purpose. Alternatively G.I. Lidsor PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to have been included in the installation of G.I. Pipe and no separate payment shall be allowed.

5.11 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures, the electrical contractor shall determine their location and obtain approval of the Engineer-in-Charge before cutting is done.

5.12 At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.

5.13 Drum number of each cable from which it is taken shall be recorded against the cable number in the cable schedule.

5.14 Cables installed above grade shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel or at right angles to beams, walls or columns.

Cables shall be so routed that they will not be subjected to heat from adjacent hot piping or vessels.

5.15 Individual cables or small groups which run along structures/walls etc. will be clamped by means of 10 SWG GI saddles on 25x6 mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables and no separate payment shall be made on this account. Alternatively small group of cables can be taken through 100 mm slotted channel/ISMC 100.

They shall be rightly supported on structural steel and masonry, individual or in groups as required, if drilling of steel must be resorted to, approval must be secured and steel must be drilled where the minimum weakening of the structure will result.

Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300 mm for cables up to 25 mm diameter and maximum 450 mm for cables larger than 25 mm dia.

5.16 All G.I. Pipes shall be laid as per layout drawings and site requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the contractor), all the burrs from the pipes shall be removed. GI Pipes with bends shall be buried in soil/concrete in such way that the bends shall be totally concealed. For G.I. Pipes buried in soil, bitumen coating shall be applied on the buried lengths. Installation of G.I. Pipes shall be undertaken well before paving is completed and necessary co-ordination with paving agency shall be the responsibility of Electrical Contractor. The open ends of pipes shall be suitably plugged with G.I. Plugs after they are laid in final position. The Contractor at no extra cost shall supply G.I. Plugs.

5.17 Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable trays shall be suitably clamped by means of G.I. Saddles/Clamps, whereas cable in horizontal run of cable trays shall be tied by means of nylon cords.

5.18 Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint unless otherwise specified.

6.0 TERMINATION

6.1 All PVC cables up to 1.1 KV grade shall be terminated at the equipments by means of double compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.

All Cable entries shall be through bottom only and top entry terminations are made only after getting approval of Engineer-in-Charge.

6.2 Power cables wherever colour coding is not available shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections is made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.

6.3 In case of control cables all cables shall be identified at both ends by their terminal numbers by means of PVC ferrules or Self-sticking cable markers. Wire numbers shall be as per schematic/ wiring /inter- connection diagram. Bidders shall have the samples of PVC ferrules/cable markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends.

6.4 Where threaded cable gland is screwed into threaded opening of different size, suitable galvanized threaded reducing bushing shall be used of approved type, at no extra cost. All switchgear and control panels shall have undrilled gland plate.

Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables.

6.5 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom close fit hole should be drilled in the bottom plate for all the cables in one line, then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.

6.6 Cable leads shall be terminated at the equipment terminals, by means of crimped type solder less connector as manufactured by M/s. Dowell Electro works or approved equivalent.

Crimping shall be done by hand crimping hydraulically operated tool and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

6.7 <u>Cable accessories for H.V. Systems</u>

6.7.1 The 11, skilled and experienced jointers duly approved by the Engineer-in-Charge shall do 6.6 and 3.3 KV cables terminations joints. Termination including supplying of jointing kit shall be threaded in Contractor scope unless specified otherwise.

6.7.2 The termination and straight thro' joint kit. For use on high voltage system shall be suitable for the type of cables red by the contractor or the type of cables issued by owner for installation. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fitting and consumables items. An installation instruction shall be included in each sheet.

6.7.3 The termination kits shall be suitable for termination of the cables to indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer motor. The terminating kits shall preferably be of the following types:

a) TAPLEX' of M-seal make using non-linear resistance material fortress grading.

b) `PUSH-ON' type of CCI make using factory - moulded silicone rubber insulators.

c) `TROPOLINK' type of CCI makes.

d) Heat-shrinkable sleeve type of M/s. Raychem.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

6.7.4 The straight thro jointing kits shall be suitable for underground-buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types.

a) `TAPLEX' of M-seal make

b) `TROPOLINK' type of CCI make

c) Heat-shrinkable sleeve type of M/s. Raychem.

6.7.5 Makes of kits other than those specified in 6.7.3 and 6.7.4 may be considered provided the Contractor furnishes type test certificates, along with the offer.

6.7.6 Type tests are to be carried out at manufacturer's works to prove the general qualities and design of a given type of termination/jointing system. The type tests shall include the following tests conforming to the latest IEC 502.2, 466 and VDE 0278 specifications. The Contractor along with the offer for the jointing system considered shall submit the type test certificates.

a) A.C. Voltage withstand dry test for 1 minute

b) Partial discharge test - Discharge magnitude small be less than 20 p.c.

c) Impulse voltage withstand test with 10 impulses of each polarity.

d) A.C. high voltage test following load cycling test with conductor temperature at 95^{o}C.

e) Thermal short circuit test of 250^{o}C for 1 second.

f) DC Voltage withstand test for 30 minutes.

g) Humidity test.

h) Dynamic short circuit test.

i) Salt log test

j) Impact test

7.0 TESTING:

7.1 Before energizing, the insulation resistance of every circuit shall be measured from phase to phase and from phase to ground.

7.2 Where splices or termination are required in circuits rated above 600 volts, measure insulation resistance of each length of cable before splicing and or/ terminating. Repeat measurement after splices and/or terminations are completed.

7.3 Measure the insulation resistance of directly buried cable circuits before cable trenches are back-filled. Repeat measurement after back- filling.

For cables up to 1.1 KV grade, 1KV Megger and for H.V. Cables 2.5 KV/5 KV, 2.4 KV/4.9 KV Megger shall be used

7.4 D.C. High Voltage Test shall be conducted after installation on the following and test results are recorded.

a) All 1000volts grade cables in which straight through joints have been made.

b) All cables above 1100 V grade.

For record purposes test data shall include the measure values of leakage current versus time.

The D.C. High Voltage test shall be performed as detailed below in the presence of the Engineer-in- Charge or his authorized representative only.

Cables shall be installed in final position with the entire straight through joints complete. Terminations shall be kept unfinished so that motors, switchgears,

transformers etc. are not subjected to test voltage.

The test voltage shall be as under: -

i) For cables 3.3 KV grade 5.4 KV DC

ii) For cables 6.6 KV grade 10.8 KV DC

iii) For cables 11 KV grade 18 KV DC

7.5 All cables shall be tested as per standard test Performa available with site engineer.

7.6 Cable schedule and layout drawings must be marked for AS BUILT conditions during the installation work and shall be approved by Site Engineer.

SPECIFICATION FOR
EARTHING AND LIGHTNING PROTECTION

SPECIFICATION NO. MEC/S/05/26/23A

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

CONTENTS

1.0 SCOPE:

The intent of this specification is to define the requirements for the supply, installation, testing, and commissioning of the Earthing System.

2.0 STANDARDS:

The work shall be carried out in the best workmanlike manner in conformity with this specification, the relevant specifications/codes of practice of Indian Standard Institution, approved drawings and instructions of the Engineer-in-Charge or his authorized representative issued from time to time. In case of any conflict between the standards, the instructions of Engineer-in-Charge shall be binding.

3.0 CONDUCTOR ELECTRODE:

The main grid conductor shall be hot dip galvanized G.I. Flat or PVC insulated aluminum conductor/copper conductor. Sizes for main conductors shall be marked on the drawings. Thickness of hot dip galvanizing shall not be less than 75 microns.

4.0 EARTHING NETWORK:

4.1 The earthing installation shall be done in accordance with the earthing drawings, specifications and the standard drawings of reference attached with this document. The entire earthing system shall fully comply with the Indian Electricity Act and Rules framed thereunder. The contractor shall carry out any changes desired by the Electrical Inspector or the owner, in order to make the installation conform to the Indian Electricity Rules at no extra cost. The exact location on the equipment shall be determined in field, in consultation with the Engineer-in-Charge or his authorized representative. Any changes in the methods, routing, size of conductors etc. shall be subject to approval of the Owner/Engineer-in-Charge before execution.

Excavation and refilling of earth, necessary for laying underground earth bus loops shall be the responsibility of the contractor.

4.3 The earth loop impedance to any point in the electrical system shall have a value which will ensure satisfactory operation of protective devices.

4.4 The main earth loop shall be laid at a depth of 500 mm below grade level. Wherever cable trenches are available, the earth lead shall be laid in the trenches and shall be firmly cleared to the walls of concrete lined trenches. The earthing strip shall be protected against mechanical damage.

4.5 In process unit areas, the earthing cable shall be run along cable trays wherever specified in the layout drawings. The earthing cable shall be suitably cleated and electrically bonded to the cable tray at regular intervals.

4.6 Joints and tapping in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and suitably protected by giving two coats of bitumen and covering with Hessian tape. All joints above ground shall be by means of connectors/lugs as far as practicable. Tee connectors shall be used for tapping, earth leads from the main earth loop wherever it is installed above ground. Earthing plates shall be provided for earthing of two or more equipment at a place from earth grid. Where aluminum cable risers are to be connected to the underground GI earth bus, the aluminum cable riser shall be taken to the nearest earth pit and terminated through a bolted joint. If this is not practicable, then a G.I. risers shall be brought above grade and a bolted joint shall be made between this GI riser and the aluminum cable termination. This G.I. Riser shall be protected applying two coats of bituminous paint/bitumen on the exposed portion.

4.7 Conduits in which cables have been installed, shall be effectively bonded and earthed. Cable arm ours shall be earthed at both ends.

5.0 <u>EARTH ELECTRODES</u>:

5.1 Earth pipe electrodes shall be installed as shown in the earthing layout drawings and in accordance with the standard drawings of reference and IS:3043. Their location shall be marked to enable accurate location by permanent markers.

5.2 All earth electrodes shall preferably be driven to sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. Wherever practicable, the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes.

5.3 All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months, preferably after a protracted dry spell. If necessary, a number of electrodes shall be connected in parallel to reduce the earth resistance. The distance between two electrodes shall not be less than twice the length of electrode.

5.4 The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.

5.5 The exact location and number of earth electrodes required at each location shall be determined in the field in consultation with the owner/Engineer-in- Charge, depending on the soil strata and resistively, to meet the ohmic values prescribed in clause 5.3. Earth Electrodes shall be located avoiding interference with road, building foundation, column etc. Individual earth electrode shall be provided for each lightning arrestor and lightning mast. The electrodes shall be so placed that all lightning protective earths may be brought to earth electrode by a short and straight a path as possible to minimize surge impedance.

5.6 The disconnect facility shall be provided for the individual earth pits to check their earth resistance periodically. All the earth electrodes shall be suitably numbered and this should be indicated in as built drawings.

6.0 CONNECTION:

6.1 All electrical equipment is to be doubly earthed by connecting two points on equipment to a main earthing ring. The earthing ring will be connected via links to several earth electrodes. The earth grid formed shall be a closed loop as shown in the drawing with earth electrodes connected to the grid with double strip connection. The cable armour will be earthed through the cable glands.

6.2 In hazardous areas all major process equipments shall be connected to the earthing ring by means of anti- loosening connections and all pipelines will be bonded and earthed on entering the battery limit of the process area.

6.3 The following shall be earthed.

1. Transformer neutrals, CT/PT neutrals.

2. Neutral Grounding Resistors.

3. Transformer Housing.

4. Lightning Arrestors.

5. All switchgear and their earth buses, bus duct.

6. Motor Frames.

7. Non-current carrying metallic parts of electrical equipment such as switchgear, switch racks, panel boards, motor control centers, lighting, power and instrument panels, push button stations, cable trays, pipes, conduits, terminal boxes, etc.

8. All fences, gates/enclosures, housing electrical equipment

9. All steel structures, rails etc. including bonding between sections.

10. Shield Wire

11. Structural steel and Columns.

12. Loading racks.

13. Lighting Mast, poles.

14. Lighting rods (Mast).

15. Tanks and vessels containing flammable materials.

16. Rotating parts of the agitators, pumps etc. through spring loaded brushes of suitable grade.

17. Earth continuity conductor shall be provided for flanges.

Conductor size for connection to various equipments shall be as indicated on Earthing Layout Drawings.

6.4 Two distinct conductors directly connected to independent earth electrodes, which in turn, shall be connected to the earth too, shall earth system.

The earth connection shall be properly made. A small flexible aluminum cable loops to bridge the top cover of the transformer and the tank shall be provided to avoid earth fault current passing through fastening bolts when there is a lightning surge, high voltage surge or failure of the bushings.

6.5 Each Lightning Arrestor shall be connected to a separate electrode located as close as possible to it and within the fenced area for each set of arrestors. The three nos. electrodes for each set of arrestors shall be spaced about 5 meters apart so that they are all within the enclosing fence. Each of these electrodes shall be connected to the main earth grid.

6.6 The shield wire shall be connected with the main grid solidly and not through supporting steel structures.

6.7 All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.

6.8 All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground. In case of G.I. Earth Loop all underground "T" connections shall be of the same size as main loop however in case of PVC insulated aluminum conductor loops underground joints shall be completely avoided. Connections to motors from earth plate or main loop conductor brought above ground shall not be less than following:

i) No.8 SWG G.I. Wire upto 3.7 KW motors.

ii) 3/8" DIA G.I. FINE WIRE ROPE for all motors above 3.7 KW upto 30 KW with tinned copper lug at both ends or 35 mm^2 PVC insulated stranded aluminum conductor with crimped lug.

iii) 5/8" DIA G.I. FINE WIRE ROPE OR 70 mm^2 PVC insulated aluminum stranded conductor for motors above 30 KW upto 75 KW terminated as described above.

iv) For all motors above 75 KW conductor size shall be same as that of loop conductor with equivalent size flexible, if required.

Anchor bolts or fixing bolts shall not be used for earthing connection.

6.9 All hardware used for earthing installations shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections of equipment.

6.10 Lighting fixtures shall be earthed through the extra core provided in the lighting cable for this purpose.

7.0 TESTING:
Earthing systems/connections shall be tested as follows:

7.1 Resistance of individual electrodes shall be measured after disconnecting it from the grid.

7.2 Earthing resistance of the grid shall be measured after connecting all the electrodes to the grid. The resistance between any point on the metallic earth grid and the general mass of earth shall not exceed 1 ohm.

7.3 The resistance to earth shall be measured at the following:

a) At each electrical system earth or system neutral earth.

b) At each earth provided for structure lightning protections.

c) At one point on each earthing system used to earth electrical equipment enclosures.

d) At one point on each earthing system used to earth wiring system enclosures such as metal conduits and cable sheaths or armor.

e) At one point on each fence enclosing electrical equipment.

Measurement shall be made before connection is made between the ground and the object to be grounded.

8.0 LIGHTNING PROTECTION

8.1 Lightning protection system shall generally comprise lightning finials (air terminals), roof conductors, down conductors, test links, and earth electrodes. the number, types, materials and sizes shall be in accordance with the drawings.

8.2 Air terminals shall be mounted on top of buildings or structure as required. All air terminals shall be inter-connected with roof conductors,pipes,hands rails or any other metallic projection above the roofs shall also be bonded to the roof conductors.

8.3 Down conductors from air terminals or from roof conductors shall be routed as directly as possible to the test links on earth buses, with minimum bends.

8.4 All provisions regarding connections of conductors for equipment earthing system shall also apply to lightning protection system.

8.5 In corrosive atmospheres, plumbing metal for corrosion protection shall cover lightning finials or air terminals.

9.0 TEST PROFORMA

(INSTALLATION TESTING REPORT EARTHING INSTALLATIONS)

1. Earth system data

Type of electrode :

Total number of electrodes :

Main grid size :

Material :

2. General checks Put Tick √ if O.K.; otherwise give details.

Construction of earth electrodes as per Standard.

Size of earth conductor for various equipment O.K. as per Standard.

Minimum distance kept between two electrodes.

Cleanliness and tightness of connectors.
Inspect bolted & clamped connectors.

3. TESTS

3.1 Measured earth resistance of each electrode in ohms

No. 1

2

3

4

5

3.2 Measurement of earth grid resistance (with all electrodes connected to grid)

a) At each electrical system earth or system neutral earth. :

b) At each point provided for structure lightning protection :

c) At one point on each earthing systems used to earth electrical equipment enclosure :

d) At one point on each earthing systems used to earth wiring systems such as metal conduits etc. :

e) At one point on each fence enclosing electrical equipment. :

4. Remarks:

PROJECT:		UNIT:	
TESTED BY	WITNESSED BY		DATE
CONTRACTOR	MECON	OWNER	

TECHNICAL / STANDARD SPECIFICATION

FOR

ELECTRICAL WORKS

Rev.: 1
Edition: 1

SPECIFICATION
FOR
EARTHING AND LIGHTNING PROTECTION

SPECIFICATION NO: - MEC/S/05/E9/02, R-1

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

CONTENTS

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 SCOPE

The intent of this specification is to define the requirements for the supply, installation, testing, and commissioning of the complete Earthing & lightning protection System.

2.0 STANDARDS

The work shall be carried out in the best workmanlike manner in conformity with this specification, the relevant specifications/codes of practice of Indian Standard Institution, approved drawings and instructions of the Engineer-in-Charge or his authorized representative issued from time to time. In case of any conflict between the standards, the instructions of Engineer-in-Charge shall be binding.

IEC 60364 Electrical installations of buildings

IEC 61024 Protection of structures against lightning

IEC 61312 Protection against lightning electromagnetic impulse

IS 2309 Protection of building and allied structure against lightning

IS 3043 Code of practice for earthing

2.1 Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.2 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 TAGGING/MARKING

All components, equipment and installations shall receive the respective tagging plates, labels etc, which have to be of extremely durable material resistant against the environmental conditions. For further requirements, reference is made to the specification “Design Basis-Electrical”.

Contractor shall provide structure MS plate at each earth pit for indication of followings –

a) Year of installation of earth pit
b) Earth pit number
c) Resistance of pit (Individual & with grid)
d) Next due date

4.0 EARTHING SYSTEM

General

The stations shall be equipped with an equipotentially meshed grounding network. All exposed conductive parts or elements of the station systems will be connected to this network. The earthing systems of the various stations are part of the protection systems for electrical power supply, instrumentation, control and supervisory system. The earthing system consists of the main grounding grid, the grounding rods, the building foundation grounding and the equipment grounding.

Supply of all other erection/consumable required to complete the installation shall be the responsibility of the contractor. All hardware used for earthing shall be hot dip galvanized.

Any other items not specifically mentioned here but necessary for completeness of job shall be in the scope of contractor & shall be supplied by contractor without any extra cost.

For stations, which are to be extended, the existing earthing system shall be considered. The layout of new earthing system shall match to the existing installations. The new and the existing grounding network must be interconnected at two (2) locations, at least.

The grounding network system will be installed in different locations have different soil characteristics according to the location of the stations. Before design and installation of the grounding network the actual soil conditions in the station areas must be determined by adequate soil resistance measurements by the contractor & submit for review & approval.

Station earthing should have low earth resistance, low touch & step potential.

5.0 EARTHING CONDUCTOR

The main grid conductor shall be hot dip galvanized G.I. Flat or PVC insulated copper conductor. Size & type of conductor shall be as marked on the drawings. Thickness of hot dip galvanizing shall not be less than 75 microns.

6.0 DESIGN REQUIREMENTS

6.1 The earth resistance of the overall interconnected station grounding network shall not exceed 1 Ω.

6.2 All exposed metal part such as HT/LT switchgear, DP/FP structure, distribution board, metal clad switchgear enclosure, lamp brackets, lamp holder, plug sockets, lighting poles, junction boxes, high mast etc shall be properly earthed by connecting these to the earth electrode by means of GI wire/Flat or PVC insulated Cu conductor of approved size to pass the fault current safely to earth in case of any fault.

6.3 For the UPS, the SCADA and telecommunication systems with their equipment a separate grounding network with sufficient cross-section to avoid interference shall be installed. This grounding network shall be connected to the common station grounding

network on one (1) separable and indicated connection point, within the electrical building or equipment container/enclosure.

6.4 Before design and installation of the grounding network the actual soil conditions in the station areas must be determined by adequate soil resistance measurements.

6.5 The required conductor spacing, the total length of the grounding grid and the required grounding material cross-section shall be calculated under consideration of the maximum earth fault current, to maintain touch and step voltages within reasonable limits. The impedance of the fault current path and protective devices shall be chosen that the faulted circuit will be disconnected from the supply within the required time. A respective grounding calculation with report shall be performed for each station and is to be submitted to the Client/MECON for approval.

6.6 Multiple connections of grounding conductors shall only be carried out above ground. For these connections the respective grounding bars are to be installed. Extensions of single grounding conductors can be permitted below ground under use of compression connectors or welding connections, with repair painting and coating of the connection point.

6.7 All connections of conductors on equipment shall be performed with pressure type lugs or connectors and threaded bolts, screws, spring-washers and washers. Special care must be taken to avoid the arising of a chemical element. Connections between bare copper and iron parts must be protected in a special manner and shall only be executed on above-ground connection points (grounding bars) or inside of pits.

7.0 EARTHING NETWORK

7.1 The earthing installation shall be done in accordance with the earthing drawings and the standard drawings of reference attached with this document. The entire earthing system shall fully comply with the Indian Electricity Act and Rules. The contractor shall carry out any changes desired by the Electrical Inspector or the owner, in order to make the installation conform to the Indian Electricity Rules at no extra cost. The exact location on the equipment shall be determined in field, in consultation with the Engineer-in-Charge or his authorized representative. Any changes in the methods, routing, size of conductors etc shall be subject to approval of the Owner/ Engineer-in-Charge before execution.

7.2 Excavation and refilling of earth, necessary for laying underground earth bus loops shall be the responsibility of the contractor.

7.3 The main earth grid shall be laid at a depth of minimum 700 mm below grade level. Wherever RCC cable trenches are available, the earth lead shall be laid in the trenches and shall be firmly cleared to the walls of concrete lined trenches. The earthing strip shall be protected against mechanical damage.

7.4 **Interconnected earth pits for watering**

All earth pits of grounding system shall be interconnected by GI Pipe with valve for provision of watering all pits simultaneously. The tapping for water shall be terminated to nearby source of water as per drawing.

7.5 A common grounding system network (Main earthing grid) will be made underground by using 50 mm x 6 mm GI earthing strip connected to earth electrodes in loop-in & loop-out system and connecting the electrical equipment to network. In RCC cable trench one number earth strip of size 50 x 6 mm shall be run throughout the length of the trench.

7.6 Earthing system around each building shall be laid at distance approximately 1.5 meter from the building & at a depth of approximately 0.8m. The ring shall be bonded at intervals to the building steel structure, reinforcement of building columns & pipes wherever they are crossing. The earth ring shall further be connected to deep earthing electrodes to achieve a combined earth resistance of less than one ohm as specified earlier.

7.7 In process unit areas, the earthing cable shall be run along cable trays wherever specified in the layout drawings. The earthing cable shall be suitably cleated and electrically bonded to the cable tray at regular intervals.

7.8 Joints and tapping in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below ground shall be welded and suitably protected by giving two coats of bitumen and covering with Hessian tape. All joints above ground shall be by means of connectors/ lugs as far as practicable. Tee connectors shall be used for tapping, earth leads from the main earth loop wherever it is installed above ground. Earthing plates shall be provided for earthing of two or more equipment at a place from earth grid. Where aluminium cable risers are to be connected to the underground GI earth bus, the aluminium cable riser shall be taken to the nearest earth pit and terminated through a bolted joint. If this is not practicable, then G.I. risers shall be brought above grade and a bolted joint shall be made between this GI riser and the aluminium cable termination. This G.I. Riser shall be protected applying two coats of bituminous paint/bitumen on the exposed portion.

7.9 Conduits in which cables have been installed shall be effectively bonded and earthed. Cable armours shall be earthed at both ends.

8.0 INSTALLATION OF EARTH ELECTRODES

8.1 Earth pipe electrodes shall be installed at locations shown in the earthing layout drawings & earth electrode shall be in accordance with the standard drawings, specification and IS: 3043.

8.2 All earth electrodes shall preferably be driven to sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. Wherever practicable, the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes.

8.3 All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months. If necessary, a number of electrodes shall be connected in parallel to reduce the earth resistance, shall be in the scope of contractor. The distance between two electrodes shall not be less than twice the length of electrode.

8.4 The electrodes shall have a clean surface, not covered by paint, enamel, grease or other

materials of poor conductivity.

8.5 Tentative no of earth pits shown in drawing are only for reference to the contractor. The exact location and number of earth electrodes required at each location shall be determined in the field in consultation with the owner/Engineer-in- Charge, depending on the soil strata and resistivity, to meet the ohmic values prescribed in clause 6.1. The contactor shall design the earthing system accordingly & submit for review & approval.

8.6 Earth Electrodes shall be located avoiding interference with road, building foundation, column etc. Individual earth electrode shall be provided for each lightning arrestor and lightning mast. The electrodes shall be so placed that all lightning protective earths may be brought to earth electrode by a short and straight a path as possible to minimize surge impedance.

8.7 The disconnect facility shall be provided for the individual earth pits to check their earth resistance periodically. All the earth electrodes shall be suitably numbered and this should be indicated in as built drawings.

9.0 CONNECTION

9.1 All electrical equipment is to be doubly earthed by connecting two points on equipment to a main earthing ring. The earthing ring will be connected via links to several earth electrodes. The earth grid formed shall be a closed loop as shown in the drawing with earth electrodes connected to the grid with double strip connection. The cable armour will be earthed through the cable glands.

9.2 In hazardous areas all major process equipments shall be connected to the earthing ring by means of anti- loosening connections and all pipelines will be bonded and earthed on entering the battery limit of the process area.

9.3 The following shall be earthed.

1. Transformer neutrals & body
2. Double Pole & Four Pole structures
3. CT/PT neutrals
4. Neutral Grounding Resistors
5. Lightning Arrestors
6. All switchgear and their earth buses, bus duct
7. Motor Frames
8. UPS, Telecommunication system, RTU's, Control panels & other instruments etc.
9. Non-current carrying metallic parts of electrical equipment such as switchgear, switch racks, panel boards, motor control centres, lighting, power and instrument panels, push button stations, cable trays, pipes, conduits, terminal boxes, etc.
10. All fences, gates/enclosures, housing electrical equipment
11. All steel structures, rails etc. including bonding between sections
12. Shield Wire
13. Structural steel and Columns

14. Loading racks
15. Lighting Mast, poles etc
16. Tanks and vessels containing flammable materials.
17. Rotating parts of the agitators, pumps etc. through spring loaded brushes of suitable grade.
18. Earth continuity conductor shall be provided for flanges.

Conductor size for connection to various equipments shall be as indicated on Earthing Layout Drawings.

9.4 Two distinct conductors directly connected to independent earth electrodes, which in turn shall be connected to the earth and earth system. The earth connection shall be properly made. A small flexible aluminium cable loops to bridge the top cover of the transformer and the tank shall be provided to avoid earth fault current passing through fastening bolts when there is a Lightning surge, high voltage surge or failure of the bushings.

9.5 Each Lightning Arrestor shall be connected to a separate electrode located as close as possible to it and within the fenced area for each set of arrestors. The two nos. electrodes for each set of arrestors shall be spaced about 5 meters apart so that they are all within the enclosing fence. Each of these electrodes shall be connected to the main earth grid.

9.6 The shield wire shall be connected with the main grid solidly and not through supporting steel structures.

9.7 All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.

9.8 All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground. In case of G.I. Earth Loop all underground "T" connections shall be of the same size as main loop however in case of PVC insulated aluminium conductor loops underground joints shall be completely avoided. Connections to motors from earth plate or main loop conductor brought above ground shall not be less than following:

Equipments	**Earthing Conductor size**
Main earth Bus/Power transformer	As Calculated
Grid & equipment such as: PMCC/MCC, Silent D. G. Set HT switch board panel, DP/FP structure	50 x 6 mm GI Flat
EHV & HV substation	As Calculated
PDB/ MLDB/LDB Switch Socket DB, UPSDB etc	25 x 5 mm GI Flat
GI octagonal Pole/Street light pole/ Flood light/High mast pole	25 x 5 mm GI Flat

Motors up to 2.2kW	6mm2 stranded GI wire
Motors 3.7kW to 11kW	16mm2 stranded GI wire
Motors 15kW to 45kW	25mmx3mm GI strip
Motors 55kW to 90kW	25mmx3mm GI strip
Motors 110kW & above	40mmx6mm GI strip
FLP – WP lights/control station	6 sq mm solid GI Wire
Product pipe line	16 sq mm flexible copper wires
Mechanical equipment / Vessels, Tanks, Pipe/cable racks, structure, fencing	50 x 6 mm GI Flat
RTU, Telecom, UPS	25 x 5 mm copper
Field Instruments/Lighting fixture/ Power Socket/Switch socket	2.5 sq mm PVC Cu Wire
Jumper for flanges	50 x 2 mm Copper Strip

Anchor bolts or fixing bolts shall not be used for earthing connection.

9.9 All hardware used for earthing installations shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections of equipment.

9.10 Lighting fixtures shall be earthed through the extra core provided in the lighting cable for this purpose.

10.0 TESTING OF EARTHING SYSTEM

Earthing systems/connections shall be tested as follows:

10.1 Resistance of individual electrodes shall be measured after disconnecting it from the grid.

10.2 Earthing resistance of the grid shall be measured after connecting all the electrodes to the grid. The resistance between any point on the metallic earth grid and the general mass of earth shall not exceed 1 ohm.

10.3 The resistance to earth shall be measured at the following:

1) At each electrical system earth or system neutral earth.
2) At each earth provided for structure lightning protections.
3) At one point on each earthing system used to earth electrical equipment enclosure.

4) At one point on each earthing system used to earth wiring system enclosures such as metal conduits and cable sheaths or armour.

5) Each fencing shall be earthed as per construction drawings.

Measurement shall be made before connection is made between the ground and the object to be grounded.

11.0 LIGHTNING PROTECTION

All buildings and plant structures vulnerable to lightning strokes owing to their height or exposed situation shall be protected against atmospheric flash-overs and lightning strokes in such a manner as to eliminate any danger to the personnel employed therein.

The installation shall confirm to IS: 2309 as amended up to date.

11.1 Lightning protection system shall generally comprise lightning finials (air terminals or collector rods), roof conductors or collector lines, down conductors, test links, and earth electrodes. The number, types, materials and sizes shall be in accordance with the standard drawings, construction drawings etc issued to contractor.

11.2 Air terminals shall be mounted on top of buildings or structure as required. All air terminals shall be inter-connected with roof conductors, pipes, hands rails or any other metallic projection above the roofs shall also be bonded to the roof conductors.

11.3 Down conductors from air terminals or from roof conductors shall be routed as directly as possible to the test links on earth buses, with minimum bends.

11.4 All provisions regarding connections of conductors for equipment earthing system shall also apply to lightning protection system.

11.5 In corrosive atmospheres, plumbing metal for corrosion protection shall cover lightning finials or air terminals.

11.6 The layout and design of lightning protection systems for building extensions or new buildings and structures provided within existing station areas shall match the existing design.

11.7 All connections between the different parts of lightning protection systems and the connections to the earthing system must be performed in a manner such that the arising of chemical elements will be avoided.

12.0 COLLECTORS

Collectors shall be determined in accordance with the IS:2309. Collectors may comprise a combination of the following components:

- Collector lines/Parapet conductors
- Collector rods

12.1 Natural Components Of Collectors

Metal cladding, metal roof structures, metal components of roof Structures, gutters and railings may be considered as natural components of collectors.

The requirements of the standards, such as the following, have to be considered:

• Parts must be permanently conductively connected,

Protective coatings or insulation between metal parts shall be electrically bridged.

12.2 Mesh Type Collectors lines/Parapet conductors

Buildings shall be provided with mesh-type collector lines. The collectors have to be configured in a way such that no point of the roof is at a distance of more than 5 m from a collector.

The maximum permitted mesh size is as follows:

• Buildings with telecommunication or control rooms 10 x 10 m

• Other buildings 10 x 20 m

Protruding roof superstructures, such as ladders, chimney stacks, pipes, antenna mounting brackets, etc. and other metallic parts of buildings which are located near the roof (e.g. louvers of ventilation openings) must be directly connected to the collector lines.

12.3 Collector Rods

Collector rods shall be used for roof superstructures featuring mechanically or electrically operated equipment, such as ventilators and non-conductive parts projecting from the mesh plane by 0.3 m. The angle of protection and a certain minimum distance have to be observed.

Outdoor electrical facilities for HVAC or other purposes not located in the protective area of earthed structures, installations or buildings, including exposed electrical equipment shall be protected by collectors.

Buildings with sheet metal roofs where the thickness of the sheet is smaller as the required value, the collector mesh must be equipped with collector rods of sufficient quantity and length to avoid lightning strokes in the sheet metal.

12.4 Down Conductors

Down conductors shall be selected in a manner such that there are several parallel current paths between the collector and the earthing system. The length of each down conductor is to be kept as short as possible.

Steel structures and steel columns of buildings may be used as down conductor, if the minimum sizes according to the standards are guaranteed. In each case the connections with the earthing system and collectors respectively must be visible and removable.

Starting from the corners of the structure involved, conductors should be distributed

around the exterior as evenly as possible. They must be configured in such a way as to constitute the direct continuation of the collector. The minimum distance between conductors and doors, windows and other apertures must be 0.5 m.

If not already connected with the collectors or with the internal potential equalisation, larger metal parts mounted in/on the building outer walls (e.g. frames of doors, ventilation louvers) shall be terminated on the down conductors. The number of down conductors and the minimum distance between the conductors is given as follows:

a) Buildings containing telecommunication and control systems
- Minimum number of conductors: 4
- Maximum distance between conductors: 10 m

b) Other buildings
- Minimum number of conductors: 2
- Maximum distance between conductors: 20 m

All down conductors which are connected to the earthing system must be provided with an accessible isolating point for measuring purposes. For termination the grounding bars of grounding loops shall be used, preferably. No conductors are required for outdoor metal structures of adequate size.

12.5 Inadmissibly Short Distances

Inadmissibly short distances between the lightning protection system and metal installations or electrical equipment shall be prevented. In the event of potential hazard due to flash-over or disruptive discharge caused by lightning, appropriate measures shall be taken.

Admissible distances between lightning protection systems and metal installations, electrical wiring and equipment shall be determined in compliance with the relevant Indian & International standards. This also applies to the use of special roof-mounted collectors.

13.0 TESTS OF LIGHTNING PROTECTION SYSTEM

After erection of the earthing and lightning protection system all installations shall be tested in accordance with applicable regulations

The following tests shall be carried out, at least:

- Measures against corrosion protection and arising of chemical elements,
- Check of all connections,
- Measurements of earthing system resistance,
- Measurements of lightning protection system conductivity,
- Check of mechanical details,
- Compliance with specifications.

The aim of the tests is to ensure the proper function of the complete scope. The measuring results and the locations of the measuring points have to be indicated in respective drawings as a basis for future measurements.

14.0 DOCUMENTATION

Complete documentation shall be provided for the design, construction, testing, maintenance and repair of the earthing and lightning protection systems and their components.

The documentation shall be in English language.

The following drawings/documents shall be submitted for approval within 3 weeks of award of contract.

a) Soil resistivity report
b) Technical data sheets
c) Complete Earthing design calculations
d) Lightning protection design calculations
e) Earthing grid layouts
f) Construction drawings
g) Spare parts list
h) Operation and maintenance manuals
i) Test reports

The documents listed above shall be handed over for approval. Special attention has to be given to the fact, that documentation must be submitted with sufficient time allocated for approval prior to manufacturing / assembly. The documentation has to be prepared in accordance with the relevant ISO standards. The final documentation shall be delivered on paper in sufficient number and with exception of the signed protocols in electronic form, also. The type of the electronic files and the number of copies shall be agreed with the Client.

After commissioning & testing of earthing system contractor shall submit the following document to Client/MECON for As-Built status in hard copy (5 set) plus one soft copy.

a) Soil resistivity report
b) As built earthing grid layouts & earth electrode installations
c) Construction drawings

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TECHNICAL / STANDARD SPECIFICATION

FOR

CATHODIC PROTECTION WORKS

Rev. : 1
Edition : 1

SPECIFICATION
FOR
CORROSION SURVEY

SPECIFICATION NO.: MEC/S/05/21/016C

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Rev.	Date	By		Verified	
					Name	Sig.	Name	Sig.
1	Revised & Issued as standard specification	-	1	May-2011	AM		QA	

1.0 SCOPE

The specification covers the corrosion survey including measurement of soil resistivity, chemical analysis of soil/ water and other cathodic protection related data collection along right of way of the pipelines.

2.0 CODES AND STANDARDS

Equipment and measurement techniques shall unless otherwise specified, conform to the requirement of following latest applicable standards:-

BIS Specifications
BS Specifications and Codes of Practice
NACE Publications

3.0 GENERAL

This specification defines the basic guidelines for carrying out the corrosion survey. Contractor shall be responsible for providing necessary data interpretation based on corrosion survey measurement which is intended to form a basis for design of cathodic protection system for the pipeline to be burried along ROW.

4.0 SOIL RESISTIVITY SURVEY

4.1 Unless otherwise specified the soil resistivity measurements shall be carried out at intervals of approximately 500 mtr. along the ROW. Where soil resistivity is less than 100 ohm mtr and two successive readings differ by more than 2:1 then additional soil resistivity readings in between the two locations shall be taken.

4.2 To carryout the soil resistivity measurement Wenner's 4 pin method or approved equal shall be used. The depth of resistivity measurement shall be around the burial depth of the pipeline or 1.5 mtr & additional depth of 2.5 mtr (approx.) & 3.5 mtr (approx.) or more shall be taken for Temprory CP design & shallow bed design for Permanent CP design. 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 totography and strata at the area.

4.3 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

4.4 For design of Permanent CP deep well anode ground bed Two or more ground bed plots may be required to be selected for soil resistivity survey at proposed anodebed location. Depth of soil resistivity shall be as per type of anode ground bed.

For shallow type-1, 2.5 & 3.5 meter depth

For Deepwell anode bed-1, 3, 5, 7, 10, 15, 20, 25, 30, 35, 40, 45, 50...Meter as per depth of anode ground bed

4.5 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.

4.6 Observations shall be made enclosing the soils adjoining the trench wherever pipeline trenching has already been done.

4.7 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.

4.8 All measurement shall be taken at right angles to the right of way unless otherwise asked by Owner or his representative at site.

4.9 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.

4.10 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.

4.11 Wherever possible/ advised by Owner or his representative depth of water table shall be determined by resistivity observations.

4.12 All measurements shall be made and recorded in metric units. While recording the data reference to the nearest point shall be made. To 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, 2 mtr & 3 mtr depth at each location for Temorory CP system & for shallow type anodebed location for Permanent CP system.

For Deep well anode groundbed Soil sample shall be collected at 1, 3, 5, 7, 10, 15, 20, 25, 30, 35, 40, 45, 50...Meter depth or as per depth of anode deep ground bed @ time of installation of deep anodebed.

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, running parallel or crossing the right of way.

6.2 Diameter, wall thickness, pressure, soil cover etc. of the foreign pipeline.

6.3 Foreign pipeline coating details.

6.4 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.

6.5 Interference remedial measures existing on foreign pipelines/ services/ shall be collected from the owner of the foreign pipeline/ services.

6.6 Graphical representation of existing structure/ pipe to soil potential records, Transformer Rectifier Unit/ CP Power source voltage/ current readings.

6.7 Possibilities of integration / isolation of the proposed pipeline CP System with foreign pipeline / structure CP System, which may involve negotiation with Owner's of foreign services.

6.8 Crossings or parallel running of any H.T. AC/ DC overhead line with in approximately 25 mtr from ROW along with details of voltage rating, fault level etc.

6.9 Voltage rating, phases and sheathing details of parallel running or crossing of under ground cables with ROW.

6.10 Crossing and parallel running of electrified and non-electrified railway tracks along with details of operating voltage and type (AC/ DC) as well as abandoned tracks near ROW having electrical continuity with track in use.

6.11 Information on existing and proposed DC / AC power sources and system such as electric substations / earthing stations, fabrication yards with electric welding in the vicinity of the entire right of way.

6.12 Major river / canal crossings.

6.13 Major cased crossings.

6.14 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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Rev. : 1
Edition : 1

SPECIFICATION
FOR
TEMPORARY CATHODIC PROTECTION SYSTEM

SPECIFICATION NO.:- MEC/TS/05/E9/016A

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)
1	Cl. No. 4.1 & 4.3 (Protection current density & Anode utilization factor)	-	1	05.06.11	AM	SS

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 contractor of 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

2.1 The system design, performance and materials to be supplied shall unless otherwise specified, conform to the requirements of latest relevant applicable standards of :-

- NACE Standard RP-0169 : Standard Recommended Practice Control of External Corrosion on Underground or Submerged Metallic Piping systems.

- NACE Publication 10A190 : Measurement technique related to criteria for CP of Underground or Submerged Steel Piping System (as defined in NACE Standard

RPO169-83).

- NACE Standard RP-0177 : Standard Recommended Practice Mitigation of Alternating Current and Lighting Effects on Metallic Structures and Corrosion Control Systems.
- NACE Standard RP-0286 : Standard Recommended Practice The Electrical isolation of Cathodically Protected Pipelines.
- NACE Publication No. 54276 : Cathodic Protection Monitoring for Buried Pipelines.
- BS 7361 Part I : Code of Practice for Cathodic Protection for land and Marine applications.
- VDE 0150 : Protection against Corrosion due to Stray Current from DC Installations.
- IS : 7098 Part I : XLPE insulated cables.

In case of conflicting requirements amongst any of the above standards the publication having most stringent requirement shall be governing.

2.2 The equipment shall also confirm to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

2.3 In case of any contradiction between various referred standards / specifications / data sheet and statutory regulations the following order of priority shall govern:

- Statutory Regulations
- Data Sheets
- Design Basis
- Job Specification/Scope of work
- This Specification
- Codes and Standards.

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 anode 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.

Care shall be taken to ensure that the resistivity observations are not influenced by the presence of foreign pipelines / structures, and earth currents in the vicinity of EHV / HV lines and installations using earth return in their power system etc.

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. Details of Existing Pipelne including 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. CP unit current/ voltage readings.

v. Remedial measures existing on foreign pipeline/services to prevent interaction.

vi. Possibility of integration/isolation of CP system, which may involve negotiations with owners of other services.

vii. River crossing with detail of location/chainage, Name of river, Length of river.

viii. 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.

ix. Crossing and parallel running of any HT/AC/DC overhead line (existing/proposed) along with details of voltage, type AC/DC etc.

x. Voltage rating, number of cores and sheathing details of under ground power cables, running in parallel or crossing ROW.

xi. 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.

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 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.

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 FBE Coatings

Pipeline surrounding Resistivity	Minimum Protection current density*
	Temporary CP ($\mu A/m^2$)
Normal Soil (10-100 Ohm-Mtr)	50
Marshy Area/ HDD (<10 Ohm-Mtr)	70
High Resistivity Area (more than 100 ohm-mtr. Resistivity)	25

(ii) Pipe lines having polyethylene coatings

Pipeline surrounding Resistivity	Minimum Protection current density*
	Temporary CP ($\mu A/m^2$)
Normal Soil (10-100 Ohm-Mtr)	25
Marshy Area/ HDD (<10 Ohm-Mtr)	50
High Resistivity Area (more than 100 ohm-mtr. Resistivity)	15

Pipe to soil "ON" potential shall not be more negative than (-) 1.5V.

* Actual current density to be adopted shall be decided based upon soil and other environmental conditions, proximity of foreign pipelines and structures affecting interference. Where considered necessary for satisfactory protection of pipeline the current density shall be suitably increased by contractor.

4.2 Safety factor for current density : 1.3

4.3 Anode utilization factor : 0.88 for Centre Connected Mg Anodes
0.6 for End Connected Mg Anodes &

0.85 for Centre Connected Zn Anodes
0.5 for End Connected Zn Anodes
0.6 for Ribbon anodes

4.4 Pipeline natural potential : (-) 0.45 V

4.5 Unless otherwise specified in project specification the design life of temporary CP shall be as mentioned in Scope of work and that of permanent CP shall be 35 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 (-) 0.95 V (ON) or more negative as measured between pipe surface and saturated Cu-CuS04, reference electrode containing electrolyte when cathodic protection is applied but on potential measurement shall not go more negative than (-)1.50 V (ON).

b) To prevent damage to the coating the limiting Pipe to Soil Potential should not be more negative than (-) 1200 mV to avoid the detrimental effect of Hydrogen production and/or a high Ph at material surroundings.

c) 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.

d) 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
- CP System at cased crossings
- Electrical resistance probes & Reader
- Polarisation Coupons

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 or equivalent international standard for gas groups IIA & IIB and temp. Class T3. Indigenous equipment shall be certified by CMRI or any other recognized testing body and shall be approved by the concerned statutory authority. All flameproof equipment shall carry the BIS license marking as per the requirement of statutory authorities.

All imported equipment for hazardous area may be tested and certified by an independent certifying agency of country of equipment origin and shall be approved by the concerned statutory authority in India.

6.1 Anode Ground Beds

6.1.1 The pipeline shall be protected by prepacked zinc/ magnesium anodes.

6.1.2 Along ROW where soil resistivity predominantly remains low, ranges from 0-10 ohm. m and pH value is within 9, zinc anodes may be provided. Anodes of type I as per ASTM-B 418 standard shall be used for seawater, brackish water or saline electrolyte application and anode of type II as per ASTM-B 418 standard shall be used for fresh water, back fill and soil applications.

6.1.3 Along ROW where soil resistivity predominantly in the range of 10 ohm. m to 30 ohm. m low potential (1.55V) magnesium anodes may be provided.

6.1.4 At saline soil Ag/Agcl reference electrode should be used and not Zinc electrode.

6.1.5 Along ROW where soil resistivity is predominantly in the range of 30 ohm.m to 50 ohm.m high potential (1.75V) magnesium anodes may be provided.

6.1.6 At high resistivity area where resistivity is of the order of 50 ohm-m and above magnesium ribbon anodes may be provided.

6.1.7 Where magnesium anodes are used for protection of polyethylene coated pipelines, the anodes shall be preferably of low potential (1.55 V) type.

6.1.8 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 1 (one) km of the pipeline. At high resistivity area the magnesium ribbon anodes shall be installed all along the pipeline by the side of the pipeline in the pipeline trench.

6.1.9 Each electrically continuous section of pipeline shall preferably be protected totally by one type (material) of anodes to avoid inter-anode circulation currents.

6.1.10 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 magnesium ribbon abode shall be separated from the pipeline by at least ½ meter. The anode connections to pipeline shall be routed through test stations.

6.1.11 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, the leads of all the anodes shall be brought up to the test station and shall be terminated individually.

6.1.12 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.

6.1.13 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. Any deficiency in the protection system if noticed during commissioning or during monitoring shall be corrected by the CP contractor by suitably augmenting the system with additional anodes without any cost / schedule implications.

6.1.14 For the portion of the pipeline for which for CP system has been specified based on the permanent CP system parameters, the contractor shall ascertain the requirement of the cathodic protection current density indicated in Cl. No. 4.1 above. Where specified in the project specification / datasheet the requisite current density test /survey shall be conducted by the contractor to establish the adequacy of the CP current requirement & number of anode ground beds.

6.2.1 Magnesium anode

The anode shall confirm to the requirements of ASTM-B 418 standard. The anode shall be of high

manganese, magnesium alloy packed with special back fill. The metallurgical composition, potential and consumption rate of anode shall be as below:

(i) Composition:

Element	Weight (Low Potential type)	Weight (High Potential type)
Manganese	0.15 – 0.7%	0.5 – 1.3%
Copper	0.02% max.	0.02% max.
Silicon	0.1% max.	0.05% max.
Zinc	2.5% - 3.5%	-
Aluminium	5.3% - 6.7%	0.01% max.
Iron	0.003% max.	0.03% max.
Nickel	0.002% max.	0.001% max.
Other metallic elements		
- Each	-	0.05% max.
- Total	0.3% max.	0.3% Max.
Magnesium	Balance	Balance

(ii)	Anode closed circuit potential	1.55 volts	1.75 volts
(iii)	Anode consumption rate	7.9 kg/(A yr)Max.	7.9 kg/(A yr) Max.

6.2 Zinc Anode

The anode shall confirm to the requirements of ASTM-B 418 standard. The anode (other than ribbon anode) shall be packaged with special back fill. The metallurgical composition of anode, potential and consumption rate shall be as below. Anodes of Type-I shall be used for seawater, brackish water or saline electrolyte application and anodes of Type-II shall be used for fresh water, back fill and soil applications.

(i) Composition:

Element	Weight Type-I	Weight Type-II
Aluminum	0.1% to 0.5%	0.005% max.
Cadmium	0.025 – 0.07%	0.003% max.
Copper	0.005% max.	0.002% max.
Iron	0.005% max.	0.0014% max.
Lead	0.006% max.	0.003% max.
Others	0.01% max.	-
Zinc	Remainder	Remainder

(ii)	Anode closed circuit potential	1.1 volts	1.1 volts
(iii)	Anode consumption Rate	11.24 kg/(A yr) max.	11.24 kg/(A yr) max.

6.2.1 Contractor shall furnish spectrographic analysis from each heat both for zinc and magnesium anodes along with electrochemical test results.

6.2.2 The anodes for grounding of cathodically protected above ground pipelines at intermediate SV station, pigging stations, etc., grounding of motor operated valves on cathodically protected portion of the pipeline, grounding of pipeline through polarization cell at EHV / HV line crossings or running in parallel, etc. shall be of minimum 20 kg net weight each. The anode and cable terminations shall be suitable for the anticipated fault current at the location of installation. For pipelines protected by sacrificial anodes, for directly grounding the pipeline shall be of the same type as the one provided for the protection of the pipeline.

6.3 Special Backfill

The composition of special back fill for anodes shall be as below. In any case, the thickness of back fill shall not be less than 50 mm on all sides of the anode.

Gypsum	75%
Bentonite	20%
Sodium Sulphate	5%

6.3.1 The anodes shall be provided with cable tail of sufficient length to reach junction box test station as applicable without tension.

6.3.2 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	± 2.5%
Width/thickness	± 5%

6.4 Test Stations

6.4.1 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 the locations of anode ground beds
b. At both sides of metalled road crossings
c. At all insulating joints
d. At vulnerable locations with drastic changes in soil resistivity
e. At connections of surge diverters, grounding cells and polarisation cells
f. At HV AC/DC overhead line crossings and selected locations where HT overhead line is in the vicinity of the pipeline.
g. At both sides of railway line crossings.
h. At both sides of major river crossings.
i. At high voltage cable crossings or along routes where HV cables are running in parallel.
j. In the vicinity of DC net works or grounding system where interference problems are suspected.
k. At crossings/parallel running of other pipeline / structures
l. At the locations of reference cell and Electrical Resistance probe installation.
m. At both sides of cased crossings
n. At any other locations considered vulnerable locations where interference is expected
o. At location of CTSU.
p. At the locations of reference cell, Polarisation coupons Installation and ER probe installation.
q. At locations of Sectionalising Valve (SV) stations & IP (Intermediate Pigging Stations).
r. At any other locations considered necessary by owner/owner's representative

6.4.2 Bond stations shall be provided with shunt & resistor 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.

6.4.3 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 & anode disconnecting link.

6.4.4 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 minimum one for every 10 km (max.) alongwith pipeline.

6.4.5 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.

6.4.6 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

6.4.7 Terminal blocks and different scheme of wiring as required shall be provided in the test station as per the test station connection scheme sketch. Minimum 20% spare terminals shall be provided in each TLP.

6.4.8 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.

6.5 Surge diverter, Grounding cell and Polarisation cell

6.5.1 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 wt. each. Grounding shall be done at regular intervals of maximum 1 km 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.

6.5.2 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 transmission line or other system 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. The polarisation cell shall be installed in test station.

6.5.3 Explosion proof Surge Diverter (Spark Gap Arrester) shall be connected across each insulating joint to protect it from high voltage surges as per drawing.

6.5.4 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.

6.5.5 The total system including cables, cable termination, anodes/ surge diverters, polarization cells shall be suitable for the anticipated fault current at the location of installation.

6.5.6 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 Min 10kA surge

(ii) Polarisation cell

- Type : Solid state or Electrolytic type (As per PJS)
- Rating : Suitable to pass Min 5KA or more surge

(iii) Surge Diverter (Spark Gap Arrester)

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

6.5.7 The grounding cell, Surge Diverter (Spark Gap Arrester), 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 / VDE criteria but shall not exceed 5 ohms. The anodes shall be pre packed with special backfill adequately so that the performance of the anode is not affected by the carbonates, bicarbonates, nitrates, etc. present in the soil. In any case, the thickness of back fill shall not be less than 50 mm on all the sides of the anode.

6.5.8 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. The pipeline shall be grounded through polarization cell to earth system of HV tower causing the voltage induction or to a separate earthing system of zinc anodes through polarization cell.

6.5.9 Motor operated valves where located on the cathodically protected portion of the pipeline shall be grounded by a zinc or magnesium anode of 20 kg net where the type of anode provided for the CP system of the pipeline is zinc or magnesium respectively. The MOV power supply cable armour shall be insulated (by cutting and taping with insulation tape) at MOV end to avoid armour carrying CP current.

6.5.10 The above ground cathodically unprotected pipeline at intermediate SV stations, pigging stations, etc. and terminals shall be earthed with GI earth electrodes. The resistance to earth of grounding shall be limited to 5 ohms max.

6.6 Polarisation Coupons

The coupon shall have one side exposed area of 100 mm x 100 mm unless other wise specified in project specification/data sheet. The Polarisation Coupons shall be made from the material of the pipeline. Cable connection of 10 mm2 and 4 mm2 shall be provided to the coupon for connecting it to pipeline for cathodic protection and potential measurements respectively. Connection of coupon to pipeline shall be through a vacuum sealed magnetic reed switch housed inside the test station. The magnetic reed switch shall be rated to carry and break minimum 50 mA at 50 V DC. Magnet for operation of reed switches shall be provided as specified in Scope of work/SOR.

6.7 Electrical Resistance Probe

6.7.1 Where specified in project specifications, electrical resistance probes utilising the electrical resistance technique shall be provided along the pipeline at marshy areas and at vulnerable locations to monitor the external corrosion activity on the pipeline. The lead wires of the probe shall be connected to pipeline and terminated inside test station enabling periodic resistance measurement with the probe using a portable measuring instrument.

6.7.2 The material of the E/R probe element shall be of the same alloy as of the pipeline material. The E/R probes shall be provided preferably at the bottom portion of pipeline. The locations of E/R probes shall be got approved. Portable E/R probe reading instrument shall be supplied by contractor as per SOR/Data Sheet. The probe reading instrument have IP-55 protection & digital display.

6.8 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. At cased crossings where casing is painted or uncoated, additional protection for casing pipes may not be provided.

The carrier pipe inside the casing shall be protected by zinc ribbon anodes weld 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 calculations with minimum one number of anodes installed between every two supports provided between carrier & casing and sized based on the permanent CP design parameters for marshy area and design life of permanent CP system.

For Bare Casing (Uncoated or Un-Painted) protection for carrier pipe by Ribbon anodes may not be provided.

6.9 Reference Cell Access Points

Reference cell access points shall be provided near insulating joint locations and at SV stations,

where the ground is paved, for measurement of pipe to soil potentials. A perforated PVC pipe filled with native soil and buried at the location shall be provided for the purpose. The length of the PVC pipe shall be adequate to reach the native soil below the paving.

6.10 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.

6.11 Cables

Cables shall be annealed high conductivity, tinned, stranded copper conductor, XLPE insulated 650/1100 V grade, armoured, PVC sheathed. The size of the copper conductor shall be 6 sq mm for anode cable from anode to buried junction box, 10 sq mm from junction box to test station, 10mm² from test station to pipeline. The size of the conductor shall be 6 sq mm for potential measurement, 10 sq.mm for current measurement and 25mm² for bonding, polarisation cell/grounding cell and surge diverter connection purpose. The anode cable from anode to junction box (buried) shall be unarmoured. The length of anode tail cable shall be sufficient enough to reach junction box (buried) in case of temporary CP anodes and up to test station in case of permanent CP sacrificial anodes. PE Sleeves shall be provided for unarmoured cables.

7.0 INSTALLATION

7.1 Cable Laying

7.1.1 Cables shall be laid in accordance with approved layout drawings to be prepared by the contractor. No straight through joint shall be permitted in a single run of cable. Cable route shall be carefully measured and cables cut to required length. Minimum ½ metre cable slack shall be provided near anodes, pipeline and test stations to account for any settling.

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 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.

7.1.6 In case of above ground cable, all unarmoured CP cables shall be laid in GI conduits of sufficiently large size, up to accessible height for protecting against the mechanical damage.

7.1.7 The armour of all the cables from pipeline to test station (potential measurement, reference cell cables, cathode cables, etc.) and test station to ground bed (anode cable) shall be earthed only at test station end of the cable to avoid armour carrying CP current. The cable armour shall be insulated by cutting and taping with insulation tape.

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. The resistance of cable to pipe at the connection point shall not exceed 0.1 ohm. Coating shall be repaired after connection of cable conductor to pipeline. The coating repair material shall be compatible with the original coating and shall prevent ingress of water along the cable surface and at the interface of coating repair with the original pipe coating.

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.

10.0 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

11.2 Contractor shall furnish the detailed field testing and commissioning procedure for approval. Field tests as per the approved procedures shall be carried out on the equipment/systems before being put into service. the acceptance of the complete installation shall be contingent upon inspection and field test results.

11.3 Before the CP facilities are placed in operation all necessary tests shall be carried out to establish that all equipment, devices, wiring and connection, etc., have been correctly installed, connected and are in good working condition as required for intended operation.

11.4 Owner/owner's representative may witness all the tests. At least one week's notice shall be given before commencing the tests.

11.5 All tools, equipments and instruments required for testing shall be provided by CONTRACTOR.

11.6 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.

Cables

- Cable no.
- Voltage grade
- Conductor cross-section
- Continuity check
- Voltage test
- Insulation resistance values between core to earth and between cores

- All cables shall be tested by 500 V megger

Insulating joint

Checking of insulating joint for leakage, before and after energisation of C.P. by means of insulating joint tester. Pipe to soil potential of both protected and non-protected sides of insulating joint shall be checked before and after energistaion of CP system.

Polarisation cell

- Location/identification number
- Rating
- Check for wiring
- Check for standby current drain with CP energisation (current drain with respect to voltage across the cell shall be recorded)
- Details of grounding provided for polarization cell.

Grounding cell

- Location
- Type (no. of anodes)
- Ratings

Surge diverter

- Location/identification no.
- Ratings
- Check for healthiness
- Explosion proof enclosure
- Check for proper connection.

E/R Probe

- Location / Identification number
- Checking of wiring as per schematics
- Resistance reading of probe

Anode ground beds

- Location/test station number
- Current output of the ground bed
- Vertical / horizontal
- Check for actual layout and compliance with drawings.

11.7 Commissioning

11.7.1 Natural pipe to soil potential shall be measured at each test station location and casing pipeline at the locations of cased crossings prior to connecting anodes to pipeline. The pipe to soil potential

observation shall be repeated after connecting the anodes after 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. In case pipe to soil potential exceeds the specified value, suitable resistance shall be inserted in the anode circuit to limit the potential.

Each anode installation shall become individually operational as above.

11.7.2 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.

11.7.3 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 OWNER / OWNER's Representative.

11.7.4 Resistance readings of the probe shall be taken at all the locations of electrical resistance probes.

11.8 Interference Mitigation

11.8.1 Investigation shall be made for stray current electrolysis of the pipeline, mutual interface between the pipeline and foreign pipelines / structures, interference on foreign pipeline / structures due to the CP of the pipeline and ground bed. AC induction on pipeline due to overhead high voltage line, interference due to high voltage DC lines & grounding, electric traction, etc.

11.8.2 Where transmission lines cross the pipeline or run in parallel within or more than 25m from the pipeline, AC voltage measurements shall also be made on the pipeline to find out continuous induction of voltage. In case of induced voltage being beyond safe limits, the pipeline shall be grounded in line with clause no. 6.4 above.

11.8.3 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.

11.8.4 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.

11.8.5 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.

11.8.6 Mitigation measured shall be provided depending on type of interference. These shall include installation of bond with variable resistor and diodes, installation of galvanic anodes for auxiliary drainage of current, adjustment/relocation (if possible) of offending interference source, provision of electric shield etc., depending on the type of interference.

11.8.7 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	4
b.	Drawings issued for execution construction	5+1
c.	Final / As built drawings execution/construction	5+1
d.	Operation/Maintenance manual, vendor data	5+1

13.2 Contract drawings and documents

13.2.1 As a part of the contract, drawings and documents shall be furnished which shall include but not be limited to the following:

a. Report on corrosion survey
b. Basis of system design calculations, equipment selection criteria and sizing calculations.
c. Bill of material, material requisitions, purchase requisitions

13.2.2 Detailed construction drawings (including as built drawings)

a. Sacrificial anode fabrication drawings
b. Typical layout drawing for anode ground bed installation and connection
c. Equipment layout, cable layout and schedules
d. Fabrication, installation and connection scheme drawing for different types of test stations.
e. Fabrication and installation details of surge diverter, grounding cell and polarisation cell with its enclosure and housing
f. Cable-to-pipe joint details for charged and non-charged pipelines.
g. Incorporation of anode beds, polarisation cell, surge diverters, test stations, etc., and other relevant features of CP system design in Pipeline alignment sheet and other related drawings
h. Identification of section of pipeline affected by interference, source of interference and details of interference mitigation arrangements provided. various measurement data at all relevant test stations with and without mitigation measures provided.

i. Detailed commissioning report including various measurement data at all test stations, etc.

j. Vendor drawings and catalogues, test certificates

k. Operation and maintenance manual

l. Miscellaneous

- Equipment inspection and testing procedure
- Construction, installation procedures
- Field testing and commissioning procedures
- Procedure for monitoring of cathodic protection after commissioning
- Quality control procedures

14.0 INSTRUMENT, TOOLS AND SPARES

14.1 CONTRACTOR shall supply all instruments, tools and tackles necessary for proper operation and maintenance of complete cathodic protection system and associated equipment.

14.2 CONTRACTOR shall provide a list of spares and consumables required for proper operation and maintenance of part of cathodic protection system to be integrated with permanent CP system designed on the basis of permanent CP design parameters and associated equipment, for two years operation of the system.

15.0 INFORMATION REQUIRED WITH THE BID

Bidders are advised in their own interest to provide the following information along with the bid without which the bids are liable for summary rejection.

a. Basis and calculations for preliminary system design for cathodic protection system.
b. List of formulas to be used for detailed system design calculations.
c. Basis of system design, design calculations, equipment selection criteria, sizing

TECHNICAL SPECIFICATION
FOR
MDPE

TECHNICAL SPECIFICATION

FOR

LAYING OF MDPE MAIN PIPELINES

AND SERVICE PIPELINES

MECON LIMITED

(A Govt. of India Undertaking)

15th Floor, SCOPE Minar, North Tower

Laxmi Nagar District Centre,

DELHI - 110 092

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TECHNICAL SPECIFICATION

1.0 GENERAL INFORMATION

1.1 INTRODUCTION

1.2

The project is to provide CNG (Compressed Natural Gas) as fuel to commercial & private vehicles through filling stations and PNG (piped Natural Gas) to Industrial, household and commercial sector.

1.2 Nature of Contract

The contractor shall be paid on a Schedule of Rates basis. He shall execute the work and perform his obligations under the contract, and PURCHASER shall pay the contractor for measured quantity of each item of work actually carried out under the contract. Payment shall be at the rate for the work set out in the agreed Schedule of Rates.

2.0 SCOPE OF WORK

Generally the following shall constitute the Contractor's scope of work :

2.1 Plan and prepare a schedule for execution and work implementation as per QA/QC plans to be issued by PURCHASER /MECON. Contractor has to submit the Construction/ Execution procedures before commencement of work.

2.2 Assist in obtaining permissions from land owing agencies for road cutting for laying of pipelines. Liaisoning with concerned authorities during execution of the job.

2.3 Prior to start of Construction activities , Contractor shall carry out area and crossings survey and prepare drawings for proposed gas pipe line laying and submit to PURCHASER /MECON for approval.

2.4 Receipt of free issue items from PURCHASER 's designated stores, loading, transportation, unloading at Contractor's stores near project sites.

2.5 Proper storing, stacking, identification, providing security, and insurance, during storage, laying and upto handing over of pipelines.

2.6 Making trial pits to determine the underground utilities /services such as existing pipelines, Cables (Electrical/Communication), Conduits, U/G drainage, Sewers, tunnels, Subways foundations etc, and deciding optimum routes and depths for laying the pipelines based on the route plans provided in the tender.

2.7 Obtaining the approval for optimum route and ROU from the concerned authority and EIC. Grading the ROU as per requirement for proper movement of workmen, equipment and QA/QC personnel.

2.8 Wherever required the grass/ turfing, pavement, linings, drains roads and other such 'pucca' area shall be locally removed to facilitate trenching and pipe laying works. The same is to be reinstated as original.

2.9 Supply & Installation of Safety/ Warning Signs, barricading of the entire route to be trenched. Pits to be similarly barricaded along the warning sign.

2.10 To make trenches with stable slopes but restricting minimum disturbance to above ground/underground services/ installation as per specifications and approved route plans; keep the trenches free from water and soil till placement of pipes;

2.11 Supplying, Uncoiling/ stringing the PE pipes of required sizes (i.e. 20, 32, 63, 90, 125 & 180 mm) pipes into trenches as per specification.

2.12 Joining the pipe ends with fittings and valves by approved electrofusion techniques as per specification.

2.13 Installation of pipe fittings/installation like elbow, tee, reducers, tapping saddles, joints, connectors, transition fittings, valves, sleeves etc. including construction of supports, valves pits, inspection chambers etc. as per specification.

2.14 Laying pipeline using trench less technology methods with or without casing pipes as per specification and as directed by EIC.

2.15 Supply & Laying of HDPE duct as casing pipe wherever applicable, alongwith MDPE Pipe.

2.16 Supply of good quality GI sleeves, MS enamel coated sleeves, concrete casing pipes, sand and other material, fittings to be supplied by the Contractor as per provisions of tender.

2.17 Back filling and compaction by jumping jack compactor using approved 'good' soil or using excavated earth or borrow earth as per requirement and specification and replacement of tiles, slabs removed during the excavation. Cleaning all unserviceable material, debris, excess earth near trenches etc to designated disposal area.

2.18 Carrying out pneumatic testing and purging as per specifications and approved procedures; providing all tools, tackles, instruments, manpower and other related accessories for carrying out the testing of pipes.

2.19 Nitrogen purging (including supply), commissioning & gas charging of tested pipeline as per approved procedure.

2.20 Restoration of existing ground features such as grass/ turfing, paving, roads, drains, concrete, floral beds, fencing, titles, flooring masonry etc. to original

condition and to match with adjoining conditions- functionally and aesthetically upto the entire satisfaction of PURCHASER /MECON/ any other third party agency designated by PURCHASER and local authorities, failing which, it will be done at the risk and cost of the contractor. Obtaining satisfactory completion certificates for the restoration work done from the concerned authorities.

2.21 Installing of permanent site markers, warning signs, valve chamber etc.

2.22 Returning surplus material to PURCHASER stores, reconciliation of free issue material/ consumables if supplied by PURCHASER and obtaining 'no objection certificates' from PURCHASER /MECON.

2.23 Handing over the completed works to PURCHASER for their operation / use purposes.

2.24 Maintaining the completed pipelines/installation for any defect, failures during defect liability period.

2.25 Preparation and submission of As-built drawings, details of crossings, utility graphs, measurement sheets and deviation statements on completion / commissioning of work by way of drawing, sketches and tables.

2.26 Any other activity(ies) not mentioned/ covered explicitly above, but otherwise required for satisfactory completion/ operation/ safety/ statutory/ maintenance of the works shall also be covered under the Scope of work and has to be completed by the Contractor within specified schedule at no extra cost to PURCHASER

3.0 MATERIAL, LABOUR, PLANT AND EQUIPMENT

3.1 Owner's Scope of Supply (Free Issue Item)

In order to speed up the profit Free Issue Materials on replacement basis shall be issued to the Contractor from the designated store(s) of Gas Ltd.. Contractor shall be responsible for lifting the free issue materials from Owner's storage point(s) and transporting the same to work site(s) at his own cost.

3.2 Supplied by the Contractor

Contractor will supply all size of MDPE Pipe ,HDPE casing pipe, GI fittings, Meters, Regulators and other materials as per SOR & scope of supply necessary to complete the laying of gas main pipelines and service pipelines.

The contractor is to procure all bought out items from approved vendors and accordingly keep PURCHASER / MECON informed. The inspection of bought out items would be carried out by PURCHASER / MECON / Third Party Inspection or as instruction by EIC.

In general PE pipe shall be of the following lengths indicated.

20 mm/32 mm	100 to 300 Mtrs. coils
63 mm	100 Mtrs. Coils
90 mm	50 Mtrs Coils
125 mm	50 Mtrs. Coils
180 mm	12 Mtrs

The Contractor shall provide the skilled labour, tools, material and equipment necessary for the proper execution of the Work. This will include but not be limited to list of specialized items included in the enclosure furnished herewith.

3.2.1 Equipment & Machinery

All vehicular type machinery shall be in good working order and shall not cause spillage of oil or grease. To avoid damage to paved surfaces the Contractor will provide pads of timber or thick rubber under the hydraulic feet or outriggers of machinery.

In addition to above, the contractor must have dedicated bar coded electro-fusion (Automatically readable) machine with power generator (at any point of time minimum 2 nos.), Pipe Cutters (like circular guillotine), End Scrapers, Pipe Straightener, approved Top loading clamp for fusing saddle tapping tee, clamps of all sizes for Electro-fusion fittings, re-rounding tools and test ends etc. for pipes of following diameters 180mm, 125mm, 90mm, 63mm, 32mm & 20mm for this project. Contractor has to arrange his own all equipments for trenchless crossings such as HDD, Moling & rock cutting equipment, HDPE fusion equipment at the site whenever required.

Contractor must also have to arrange his own equipment for restoration work like water tanker and jumping jack compactor for compaction of backfilled trenches and roller and other required equipment/ machinery for asphalting/ road works.

3.2.2 Imported Backfill and Material

The Contractor shall be responsible to arrange the supply of any imported backfill including approved Sweet earth/ Coarse Sand and aggregate etc. Payment for the supply of sand only is included in Schedule of Rates. The other soils shall be supplied without any cost implication to Owner.

In case specified trench depths are not achieved & if directed by Engineer-in-charge Contractor to provide concrete casing pipes/ slabs or cement concrete, without any cost implication to Owner.

3.2.3 Other Materials

The Contractor shall supply the following items where required.

- All materials required for form work, trench support, temporary trench crossings.
- All sign boards, barricades, tin sheets, lights and protective equipment.
- All minor items not expressly mentioned in the Contract but which are necessary for the satisfactory completion and performance of the Work under this Contract.
- Permanent markers as shown in the drawings enclosed in the tender.

3.2.4 Manpower

The contractor shall provide the skilled labour, tools, materials , and equipment necessary for the proper execution.

3.2.5 Acquisition, Receipt, & Storage Of Materials

In case of material supplied by owner than the contractor shall collect all materials from Gas store between working hours following all documentation procedures laid down and as directed by EIC. The contractor shall at the time of receipt of material physically examine all materials and notify the EIC immediately of any damage . Any damage not recorded at the time of inspection done by contractor will be deemed not to have existed at the time of receipt of material . Cost of repair , rectification , replacement will be borne by the contractor. Any defective material found during the time of installation will noted and forwarded to stores for replacement immediately with P.O reference and only wit written approval of EIC. The contractor shall ensure that no defective material shall be returned to store at the time of closure of contract .

The contractor shall maintain permanent locked store preferably near site in so that all the material are stored in such a manner so as to prevent and damage to the materials from scratching , gouging , indentation , excessive heat or by contact with any sharp objects and chemicals.

The contractor shall maintain log book at their respective stores stating issue and availability of free issue material as a given day. Further the contractor is required to undertake and submit an inventory of materials every month to Owners/Owners Representative (mandatory) .

4.0 PROGRESS OF WORK

The Contractor shall proceed with the Work under the Contract with due expedition and without delay.

The EIC may direct in what order and at what time the various stages or parts of the work under the Contract shall be performed.

Contractor has to regularly submit daily progress reports, weekly progress reports, graphs with utilities, testing reports, material consumption and inventory reports, deviation statements etc.

5.0 APPROVALS

Contractor has to assist in getting permissions, obtain statutory approval/ clearances for laying of pipelines. However, PURCHASER will pay the departmental charges and Bank Guarantees for getting the clearance s. It is the contractor's responsibility to inform and co-ordinate the concerned local authorities and also other utility agencies before commencement of work at site. To ensure smooth execution of the work on a day to day basis, the contractor has to liaison with respective authorities and obtains necessary approvals.

6.0 REFERENCE SPECIFICATION, CODES AND STANDARDS

The contractor shall carry out the work in accordance with the requirement of latest relevant applicable standards, this specification, GAS LTD's Engineering Standards; relevant Oil India Safety Directorate (OISD) norms, ASME B31.8 - Gas Transmission and Distribution Piping Systems; Australian Standard 3723 - Installation and Maintenance of Plastics Pipe Systems for Gas; and the American Gas Association Document - Purging Principles and Practice. ISO:4437/ IS:14885 for underground polyethylene pipes and PURCHASER 's approved procedures

Should the contractor find any discrepancy, ambiguity or conflict in or between any of the Standards and the contract documents, then this should be promptly referred to the Engineer-in-Charge (EIC) for his decision, which shall be considered binding on the contractor.

7.0 **SAFETY**

The Contractor shall conform to the requirements outlined elsewhere in the tender document. In addition, the Contractor shall observe safe working practices in the storage and handling of cleaning fluids, flammable fluids, etc, and ensure smoking or naked flames are not permitted in the vicinity when these materials are being used.

Trench walls shall be battered with sufficient slope in order to minimize a trench collapse. Where there is a danger of an earth slide or collapse, the trench shall remain open for the minimum time possible with proper barricading. The Contractor is to ensure that no person enters a trench, which is of a depth of 1.5 meters or greater, unless the trench has adequate shoring or the sides are battered to such an extent as to prevent a trench collapse

The Contractor shall also protect all work sites with warning signs, barricades and night lighting. The Contractor shall inspect all fenced excavations daily, and maintain them in good order.

The trenches/ pits shall not be kept open in night times. However in case the same is essential the same shall be properly barricaded with proper lighting arrangements & manned.

The Contractor shall provide all safety equipments like helmets, books, etc. to the labour which are necessary for safe working practice.

Any accident causing injury to any person or damage to property or equipment shall be reported to the EIC.

Where the EIC determines that the work is being performed by the Contractor in an unsafe manner, he may suspend the Work until corrective action is taken by the Contractor.

For further details refer Attached HSE technical specification.

8.0 ROUTE SURVEY

8.1 Plans detailing the size, operating pressure and approximate location of the proposed mains, connections and associated regulator installations will be issued to the contractor at the start of the works.

8.2 The final alignment of mains will be worked out at site in consultations with the site engineers after route survey and trial pits, at his cost, have been carried out. Any change in routing from the issued drawings due to site constraint will be notified to EIC & his specific written approval shall be obtained before carrying out the job.

8.3 **Service Lines**

8.3.1 A survey will be conducted jointly by MECON/ third party inspection and the contractor at each premises or housing colony to be supplied. The survey

record will note customer details, the potential gas supply points and proposed regulator positions and estimates of material quantities. The contractor's representatives will make as sketch of the agreed pipe routes if necessary.

8.3.2 The contractor will be responsible for contacting the customer and making the necessary arrangements for access, and appointments to carry out the work. Contractor shall maintain job card and complaint books at site. GAS LTD will not be responsible for any time lost due to broken appointments or disputes with customers.

9.0 ORGANIZATION OF WORK

9.1 All construction work will be carried out as per direction of EIC, and this will be the primary point of contact between the contractor and PURCHASER on site. All work will be issued and sanctioned through the EIC and site control exercised by Site Engineer PURCHASER /MECON. The contractor shall ensure that technical quality standards are maintained, that construction is carried out cost effectively and that a good customer and public image of PURCHASER is maintained.

9.2 Contractor shall designate RCM who will be the single point coordinator to interact with EIC/Consultant/TPIA and authorized to attend review meetings, receive materials, authorized to sign documents, claims and receive payments etc. . Contractor shall submit the organization chart stating that in charge of projects ,store, QA/QC and take approval from the owner.

9.3 The contractor will appoint his own supervisors of minimum number instructed by EIC. These personnel will be responsible to the SE for monitoring construction standards and for ensuring that all detailed technical requirements are met on each and every job which is undertaken. The contractor's supervisor(s) will have day to day liaison with the SE, and will provide the SE with technical reports and audits, and other management information as is required on work progress and construction quality standards.

9.4 The contractor's supervisor shall have mobile telephones or pagers to ensure that they can be contacted at all times. The contractor will also nominate one person who can be contacted if necessary out of hours, for the duration of the works. The contractor's supervisor will have access to transport at all times to allow them to visit sites and attend meetings with MECON/ PURCHASER as is required. The normal day to day issue of work instructions, communication between MECON/ PURCHASER and the contractor 's supervisor and the SE.No deviation from the approved technical specification / issued construction drawings shall be undertaken without written approval of EIC.

9.5 Contractor shall maintain a Project site office, Material store with following facilities:

Telephone, Mobile phones, Fax machine, printers/Scanning/Xerox machines, Computer with e-mail facilty

1 No. four wheeler with driver for suit survey , meetings etc, with Owner/Owners representative. Also it shall be well equipped with tools and tackles for attending any emergency complaints and ongoing execution work.

On award of the contract , The contractor shall establish and submit documentary evidence for above Which will be verified by owner before of the work order .Any delay and non-compliance of above may result into the termination of contract

10.0 STRUCTURES, SERVICES AND OTHER PROPERTY

10.1 Location of Underground Utilities

The contractor shall locate all buried utility pipes, underground cables, water mains and other obstructions intersecting or adjacent to the Works, and shall make available the necessary labour to expose and record the depth of cover over all obstructions in advance of excavation. This shall be done far enough in advance of excavation to facilitate gradual change in grade or position found necessary to clear any obstructions.

In addition, the contractor shall excavate trial pits as necessary to determine the pipe route. The number of trial pits will be agreed with the EIC in advance of any excavation. In any event, trial pits shall be made at intervals of a maximum of 30 meters. Restoration of the abandoned trial pits and trenches shall be the contractor's responsibility. No payments shall be made for such type of jobs.

There will be no additional payments in respect of abandoned trenches incurred because of insufficient or inadequate trial pits, or any associated lost time or delays.

10.2 Protection of Structures and Utilities

The Contractor shall at his own cost, support and protect all buildings, walls, fences or other structures and all utilities e.g. Electrical cables, Telephone Cables, Water pipelines, Sewer pipelines etc., and property which may, unless so protected, be damaged as a result of the execution of the works. He shall also comply with the requirements in the specification relating to protective measures applicable to particular operations or kind of work. Special care shall be taken while laying Pipelines near the trees.

10.3 Interference with Traffic, Street Drainage and General Public

The Work shall be executed in such a manner as to cause a minimum of inconvenience to persons requiring to use public or private roads, lanes, thoroughfares, walkways, rights-of use or passages through which the Works

are to be executed. The trench shall be back filled, compacted, leveled and extra earth shall be removed immediately after laying of pipeline to avoid public inconvenience. Closure of roads, etc, shall not be permitted without the approval of the EIC.

The Contractor shall comply with all local Authorities requirements to traffic, and keep roads open to traffic, and maintain access to and within any private property.

Wherever the pipe route crosses driveways, access tracks or entrances to private properties, the Contractor shall give the owner, occupier or relevant authority at least 24 hours prior notice of intended commencement of excavation and shall be restricted to pass through.

The Contractor shall not, in any circumstance, use a private driveway, access track or entrance without the prior approval of the EIC.

The Contractor shall provide suitable access where necessary in the form of temporary bridges, culverts, flumes, etc, of a size and type approved by the EIC.

The Contractor shall comply with all relevant road Laws. Where limits and/or speed limits have been placed in the vicinity of the Works, the Contractor shall provide for the necessary movement of plant and equipment in accordance with the requirements of the relevant authority.

The Contractor shall not obstruct any drainage pipes or channels in any road but shall deviate them where necessary and use all proper measures to provide for the free passage of water.

The Contractor shall deliver the completed works after proper cleaning of the site.

The contractor shall conduct his operations at all times, with a view to minimizing as far as practicable noise from plant and other objectionable nuisance (e.g. oil leakage).

11.0 TRENCHING

The schematic diagram with the detail of trench is enclosed as Annexure.

The Contractor shall perform the excavation works so as to enable the pipe to be laid in conformity with the levels, depths, slopes, curves, dimensions and instructions shown on the Drawings, Specifications or as otherwise directed by the EIC.

Contractor shall excavate and maintain the pipeline trench on staked centerline as per approved alignment sheets taking into account the horizontal curves of the pipelines.

While trenching care shall be taken to ensure that all underground structures and utilities are disturbed to the minimum. Suitable crossing shall be provided

and maintained over the ROU wherever necessary to permit general public, property owners or his tenants to cross or move stock or equipment from side of the trench or another.

Trenching shall be made with sufficient slopes on sides in order to minimize collapsing of the trench. On slopes wherever there is danger of land slides, the pipeline trench shall be maintained open only for the time strictly necessary. PURCHASER may require excavation by hand tools, local rerouting and limiting the period of executing of the works. Before trench cuts through water table, proper drainage shall be ensured, both near the ditch and ROU in order to guarantee the soil stability.

The Contractor shall ensure that trench bottom is maintained in the square form as far as possible, with equipment, so as to avoid/ minimize the hand grading at the bottom of the trench. The Contractor shall do all such handwork in the trench as required to free the bottom of trench from loose rock, pebbles and to trim protruding roots from the bottom and sidewalls of the trench.

11.1 Depth of Trench

The minimum depth of cover shall be measured from top of pipe to the top of undisturbed surface of the soil or top of the graded working strip or top of road or top of rail, whichever is lower.

The depth of the trench will be such as to provided minimum cover as stipulated below :

a) For Distribution Main and Service Lines

i)	Minor Water Crossing/ Canal	1.5 meter
ii)	Uncased/ Cased Road Crossing	1.5 meter
iii)	Rail/ Road Cased Crossing	1.5 meter
iv)	Normal Areas	1.0 meter

The minimum depth as mentioned above may be greater than as may be required by Government/ Public authorities under jurisdictions. The Contractor shall perform such work without extra compensation, according to the requirement of concerned authorities.

In cases of Drain/ Culvert crossing through open cut where excavation cut is more than 1.5m, the extra excavation shall be paid in quantity basis. The rate shall include backfilling as specified. No separate payment is chargeable for extra excavation and includes backfilling as well.

In case the depth could not be achieved due to practical problems and the same is demonstrated, EIC after examining thoroughly and considering the codes and standards may allow the contractor to provide suitable protection by way of concrete casing pipes or slabs without extra cost to PURCHASER

11.2 Width of Trench

The width of the trench shall be wide enough to provide bedding around the pipe and to prevent damage to the pipe inside the trench. Unless otherwise directed by the EIC and where ground conditions permit, the minimum distance from the inside edge of the trench wall to the outside of the pipe shall be as per drawing enclosed herewith.

11.3 Trench Base

The trench bottom shall be cut or trimmed to provide a uniform bedding for the pipe, and shall be free of stones, metal, wood, vegetation, clods of earth or other debris before placement of the pipe.

Hard rock is defined as trench material with a single piece dimension exceeding 1.5 m in length which cannot be removed other than by the use of pneumatic chisel/drill or sledge hammer and chisel.

Excavation through soil mixed with boulders that have been used for a road base will not be considered as hard rock for the purposes of payment.

1.4 Clearances

Unless otherwise approved, the following clearances shall be maintained between the external wall of the gas pipe and the external surface of other underground assets in the vicinity of the Works.

- 150mm where the gas pipe crosses other assets, other than electric cables, whereupon the clearance shall be 300 mm.

- 300mm where the gas pipe is on a similar alignment to the other assets.

Where the above clearances cannot be achieved, or in other special circumstances, the EIC may approve/specify protection with concrete/MS coated pipe, etc. The protective material shall be supplied and installed by the Contractor at his cost.

11.5 Under Ground Interferences

The Contractor shall locate and expose manually all underground facilities if any during trenching. Safety barriers, if required shall be erected to prevent any damages or accident. On locations where pipeline is laid under the existing facilities and near the approaches to the crossing, the trench shall be gradually deepened to avoid sharp bends.

All sewers, drains, ditches and other natural waterways encountered while trenching shall be maintained open and functional by providing proper temporary installations if required. Suitable dewatering pumps shall be deployed to dewater, if required.

Whenever it is permitted by Authorities and/ or PURCHASER to open cut paved road crossing, or where line is routed within the road pavement, the Contractor shall remove the paving in accordance with the restrictions and

requirements of the authorities having jurisdiction thereof as directed by PURCHASER After laying the pipeline, backfilling shall be immediately performed
and all the areas connected with the works shall be temporarily restored.

In case of damage to any of above referred structures/ utilities the contractor shall be responsible for repairs/ replacement at his own cost, which shall be carried out to satisfaction of concerned authorities, resident and MECON/ PURCHASER

11.6 **Others**

Throughout the period of execution of such work, the Contractor shall provide and use warning signs, traffic lights or lanterns, barricades, fencing, watchman etc. as required by the local authorities having jurisdiction and/ or GAS LTD.

For all roads, paths, walkways etc. that are open-cut, the Contractor shall provided temporary diversions properly constructed to allow the passage of normal traffic with the minimum of inconvenience and interruptions.

The paving shall be restored to its original condition after the pipeline is installed.

The Contractor shall excavate to additional depth at all the points where the contour of the earth may require extra depth, or where as deep trench is required at the approaches to crossings of roadways, railroads, rivers, streams, drainage ditches without any extra cost implication to PURCHASER

The Contractor shall excavate all such aforesaid depths as may be required at no extra cost of PURCHASER

The trench shall be cut to a grade that will provide a firm, uniform and continuous support for the pipe.

The Contractor shall take conducive measures to ensure the protection of underground utilities as per the instructions of PURCHASER or relevant authorities.

Where the pipeline crosses underground utilities/ structures, Contractor shall first manually excavate to a depth and in a such a manner that the utilities/ structures are located, then proceed with the conventional methods.

The locations, where the pipeline has to be laid more or less parallel to an existing pipeline cable and/ or other utilities in the Right-of-way the Contractor shall maintain proper distances and perform the work to the satisfaction of PURCHASER and other utility agencies. In such locations, the Contractor shall
perform work in such a way that even under the worst weather and flooding conditions, the existing pipeline/ utilities remain stable and shall neither become undermined nor have the tendency to slide towards the trench.

11.7 **Bedding**

The contractor shall ensure that the pipe when placed in the trench is supported and surrounded by a bed of screened excavated soil, which shall be stone free and have a maximum grit size of 5mm in order to ensure no damage occurs to the pipe.

However in case of rocky soil, the bedding shall be done with approved/ good quality packing sand, subject to the approval of the EIC, the size distribution of the sand/ shall be the same as per soil. The packing sand shall be placed to a minimum thickness of 150mm around the pipe in case of rocky terrain.

Unless directed by the EIC the quantity of bedding & surrounding sand shall confirm to specifications. There shall be no void space in packing sand around the pipe.

12.0 LAYING

Laying of MDPE pipelines shall commence only after ensuring proper dimensions and clean surface of the trench. The trench bottom shall be free from the presence of cuts, stones, roots, debris, stakes, rock projections upto 150mm below underside of pipe and any other material which could lead of perforation/ tearing of the pipe wall. After ensuring above the MDPE pipe coil shall be uncoiled smoothly through proper equipment's/ care inside the trench ensuring no damage to pipe coil during laying. The Contractor must ensure that pipe caps are provided before lowering of pipeline. The trench after this can be released for back filling leaving adequate lengths open at the ends, for jointing.

Where given specific approval by the EIC a pipe may pass through an open drain or nallah. Where this is permitted the pipe shall be installed inside a concrete or steel sleeve for protection. The sleeve material shall be procured and laid by the Contractor. In general the GI Sleeve and MS sleeves material specification shall be confirming to IS 1239 (Heavy Duty) specification of reputed make. The payment for the length of pipe in the sleeve will be made as per SOR. All other work necessary to break through the walls of the obstruction, and to seal the annulus between the pipe and the sleeve and the sleeve and the wall, shall be deemed to be included in the rates.

Open ends of pipe placed in the trench shall be securely capped or plugged to prevent the ingress of water or other matter. The Contractor is to ensure that nothing enters the inside of the pipe during the laying process as this could cause a future blockage or regulator malfunction due to dust, etc.

Service lines shall be installed in accordance with the drawing enclosed. Note that the service pipe rises out of the ground at the customer's premises within a GI sleeve pipe. The vertical portion of the sleeve shall be fixed to the wall of the premises in a secure manner. A bending tool shall be used to bend the GI sleeve pipe so that it has the appropriate curvature and is free of kinks. The bending of the sleeve, its fitting and clamping, and the installation of the transition fitting excluding service-isolating valve, is all included in the service connection rate. A rate is included in the SOR for the provision of sleeves for PE laying. Any installation without inspection and approval may lead to penalties as Special condition of contract

A bending tool shall be used to bend the GI sleeve pipe so that it has the appropriate curvature and is free of Kinks. The installation of the GI sleeve for service lines shall be done by sealing the annulus, firm fixing of the GI sleeves with concrete mix, breaking through any obstructions & their subsequent restoration to the satisfaction of the EIC.

The contractor shall supply the GI sleeves (Heavy duty OF IS:1239 reputed make) respectively for domestic & commercial / Industrial installation. The vertical portion of the sleeves shall be fixed to the wall of the premises in a secure manner. The service line shall be installed in accordance with drawing enclosed. The material test certificates / inspection reports shall be inspected by TPIA/PMC before installation.

Valves shall be installed at locations shown on the Design Plan or as directed by the EIC and joined with PE pipes by electro-fusion techniques. The valves shall be supported on a bed of fine fill of grit size not greater than 5mm to achieve equivalent support as the incoming and outgoing pipe work.

Laying graphs with details of depth, length, offsets from fixed references, other utility crossings, fittings, size of casing pipe used for the pipeline shall be prepared on daily basis and submitted to Site Engineers of the Owner for approval. These details will be further incorporated into As-Built Drawings.

14.0 JOINTING OF POLYETHYLENE PIPE

The procedure for jointing of PE pipe and fittings is enclosed. Only Bar coded electro-fusion machine (Automatically Readable) that can read the bar code of the fittings automatically shall be used for jointing of MDPE pipe / fittings. Manual feeding electro-fusion machines are not acceptable for jointing purpose. The Contractor has to submit the certificate of calibration of Fusion machine at the time of start of work and at fixed intervals as per the instruction of owner. Contractor shall ensure that the machine are always available at site, no stoppage of work due to the non availability of machines.

The contractor shall flush the Pipeline with air to remove dust, water, mud etc. before fusing the joints.

Before jointing, the Contractor shall place packing sand under the pipes on both sides of the joint to keep the pipes in line and at the correct alignment during the jointing process. Alignment clamps with the correct size shells should be used to align the pipe during the electro-fusion cycle.

The Contractor shall ensure that polyethylene pipe is only cut with an approved plastic pipe cutting tool. Before fusion is attempted he shall remove the oxidized surface of the pipe to be inserted into the electro-fusion coupling. The tool must remove a layer of 0.1 mm to 0.4 mm from the outer surface of the polyethylene pipe. It may also be noted that no fusion will be allowed without clamping device and only the approved cutting tools (Hack Saw shall not be allowed for cutting the Pipe) shall be used.

The contractor has to supply all the consumables required for carrying fusion of the joints (like cloth/ paper napkin, acetone etc.).

If, upon inspection, the EIC determines a joint is defective, Contractor shall remove the joint by an approved method. The cost of this work shall be borne by the Contractor.

For electro-fusion jointing, the contractor must bring own tools, tackles and equipments.

Contractor shall arrange generator for power supply for fusion machine. Taking power connection from electric poles ,connections without written permission from concerned authorities or residential premises is strictly not permitted.

Only, Approved Jointers shall carry out fusion of all joints. Contractors shall provide the list of jointers to be used on the job and make arrangements for qualification Testing of the jointers in presence of Owner / Owner's representative . All approved Jointers shall bear Identity cards signed by Owner/Owner's representative..

Taking power connection from electric poles , connection without written permission from the concerned authorities or residential premises is strictly prohibited

15.0 BACKFILLING

Backfilling shall be done after ensuring that appurtenance have been properly fitted and the pipe is following the ditch profile at the required depth that will provide the required cover and has a bed which is free of extraneous material and which allows the pipe to rest smoothly and evenly. Dewatering shall be carried out prior to backfilling. No backfilling shall be allowed if the trench is not completely dewatered.
Prior to backfilling it should be ensured that the post padding where required of compacted thickness 150mm is put over and around the pipe immediately after lowering.

Backfilling shall be carried out immediately after the post padding where required has been completed in the trench, inspected and approved by PURCHASER / MECON, so as to provide a natural anchorage for the pipe, avoiding,
sliding down of trench sides and pipe moment in the trench. If immediate backfilling is not possible, a padding of at least 200mm of earth, free of rock and hard lumps shall be placed over and around the pipe and coating.

The backfill material shall contain no extraneous material and/ or hard lumps of soil, which could damage the pipe and/ or coating or leave voids in the backfilled trench. In case, it is required and directed by EIC, screening of the backfill material shall be carried out with specified equipment before backfilling the trench.

The surplus material shall be neatly crowned directly over the trench and the adjacent excavated areas on both sides of the trench to such a height which will, in PURCHASER / MECON opinion of provide adequately for future

settlement of the trench backfill during the maintenance period and thereafter. The down shall be high enough to prevent the formation of the depression in the soil when backfill has settled into its permanent position should depression occur after backfill, Contractor shall be responsible for remedial work at no extra cost to Company. Surplus material, including rock, left from this operation shall be disposed off to the satisfaction of land owner or authority having jurisdiction at no extra cost to PURCHASER

Where small pieces of rock, gravel, lumps of hard soil or like materials are encountered at the time of trench excavation, sufficient earth or select backfill materials shall be placed around and over the pipe to form a protective cushion extending at least to a height of 150mm above the top of the pipe. Select backfill materials for padding that are acceptable shall be screened soil, containing no gravel. All these works shall be carried out by Contractor at no extra cost to PURCHASER Loose rock may be returned to the trench after the required selected backfill material has been placed, provided the rock placed in the ditch will not interfere with the use of the land by landowner, or tenant.

In case where hard rock is encountered or as desired by EIC sand padding is to be provided upto height of 150mm around the pipe.

When the trench has been dug through drive ways or roads, all backfilling shall be executed with suitable material in layers as approved by MECON/ GAS LTD and shall be thoroughly compacted. Special compaction methods as specified may be adopted. All costs incurred there upon shall be borne by the Contractor.

Trenches excavated in dikes which are the properties of railways or which are parts of main roads shall be graded and backfilled in their original profile and condition. If necessary, new and/ or special backfill materials shall be supplied and worked-upto.

PE Warning Grid/Mat 1mm thick and 300mm wide will be placed on distribution main and on service lines inside premises, after backfill of the trench upto a height of 300mm on the top of the carrier pipes. The warning grid is to be unrolled centrally over the pipe section and thereafter further backfilling will commence.

Backfilling activity shall include proper compaction by jumping jack compactor and watering in layers of 150mm above the warning mat.
Proper crowning of not more than 150mm shall be done. All the excavated material required to be used during the Restoration process shall be stacked and kept separately and properly. Wherever Road cutting/ Tiles removal/ PCC cutting has been done during excavation for laying, the area shall be back filled and compacted immediately so that no inconvenience is caused to the general public.

Electro-fusion of joints is to be undertaken immediately after lowering and the activity shall not be kept pending for lack of Electro-fusion jointing. The backfilling shall be considered complete only after the joint in completed.

Debris and other surplus material shall be removed immediately after the back filling.

The contractor shall not be entitled for 30% payment on laying & backfilling till the above activities are completed.

16.0 MOLING:

The Moling shall be carried out as per the requirement specified by PURCHASER / MECON, and approved procedures. The contractor has to carry out thorough survey of the under ground utilities before going for the Moling, to avoid the damage to the other utilities.

No extra payment will be made for any trial/ abandoned pits made during the survey. The supply of all equipment, power required for carrying out moling work, is in contractor's scope. The type of moling to be carried out i.e., Manual/ Machine with or without casing shall be at the discretion of MECON / PURCHASER A prior approval is to be taken before starting the Moling.

For manual Moling the contractor shall ensure that the size of the hole shall not be more than 20% of the size of the casing / carrier pipe which ever is applicable. After completion of Manual Moling the hole shall be properly compacted / filled with soil by watering and by approved procedures, the pits shall be backfilled, compacted & restored . The rate for such crossing work by using casing pipe & carrier pipe or only carrier pipe shall be payable as per Schedule of Rates. **No separate payment shall be made for pulling the carrier pipe.**

In case of Machine Moling a standard procedure is attached herewith in **Annexure** for reference.

The rate for such crossing work by using casing pipe shall be provided in appropriate item of Schedule of Rates. **No separate payment shall be made for pulling the carrier pipe.** In case Casing pipe is not laid during Moling then rates payable shall be as per appropriate item of Schedule of Rates.

The rates for Moling, as indicated in SOR, are payable as per the size of the casing/ carrier pipe and are inclusive of excavation of pits, backfilling, compaction, restoration, jointing and insertion of carrier pie.

Any damages occurred to other utilities during the Moling operation shall be immediately notified and rectified by the contractor without any cost implication to PURCHASER

The length of the Hole (excluding the sizes of the pits on both ends) shall be considered for the measurement of Moling length. However, intermediate pits will consider in the moling length.

17.0 BORING/RAMMING/DIRECTIONAL DRILLING

One of the above techniques is required to be carried out by the Contractor where conventional trenching/Moling is not possible viz. railways, major

waterways, highways, roads etc. Details of such crossings shall be obtained by the Contractor, and construction drawings shall be prepared by the Contractor in consultation with MECON/ PURCHASER Execution of the work shall be based on the MECON/ PURCHASER approved drawings. The contractor has do the thorough survey of the under ground utilities before commencement of BORING/ RAMMING/ DIRECTIONAL DRILLING to avoid the damage to the other utilities. No extra payment will be made for any trail/ abandoned pits made during the survey. The supply of all equipments is in Contractors scope. Work to be carried out in accordance with API - 1102.

Once the work is allotted, Any delay in mobilizing / non - availability of HDD machines as per site requirement and conditions shall result in levying of penalties on daily basis as per SCC.

The type of HDD to be carried out i.e. conventional (with or without casing) shall be at the discretion of PURCHASER / MECON. And prior approval is to be taken before starting the HDD.

The rates for HDD, as indicated in SOR, are payable as per the size of the carrier pipe and are inclusive of excavation of pits, backfilling, compaction, jointing and insertion of carrier pipe and restoration of pits. For HDD with casing pipe no separate payment shall be made for pulling of the carrier pipe, the rate quoted by the Contractor shall be inclusive of pulling carrier pipe.

Any damages occurred to other utilities during the HDD operation shall be immediately notified and rectified by the Contractor without any cost implications to PURCHASER

The length of the HOLE (excluding the sizes of the pits on both ends) shall be considered of HDD length.
Once the work allotted , any delay in mobilizing / Non availability of HDD machines as per site requirement and conditions shall result in levying of penalties on daily basis as per SCC.

18.0 CASING PIPE

The tentative sizes of the HDPE casing pipe for Moling/ HDD shall be as follows:-

Size of MDPE pipe	**Size of HDPE pipe**
20 mm	50mm
32 mm	75 mm
63 mm	125 mm
90mm	180mm
125mm	250mm
180 mm	315 mm

However, size of the casing pipe may vary according to length of the carrier pipe and requirement of laying of OFC Duct.

19.0 RESTORATION

Wherever the restoration is required, the roads, footpaths (including roads and footpaths inside colonies) shall be restored to original condition, and the same shall be done as per concerned local authorities norms and to the satisfaction of the concerned local Authority. To retard curing of the installed concrete, wet sack cloth is to be placed on the finished surface and kept damp for a period of 36 hours.

Where slabs and blocks are to be restored, the level of the compacted subbase is to be adjusted according to the slab/block thickness. The slabs or blocks should be laid on moist bedding material, which should be graded sand, mortar or mortar mix. The slabs or blocks should be tapped into position to ensure they do not rock after laying.

The restored slabs or blocks should match the surrounding surface levels. Joint widths should match the existing conditions, and be filled with a dry or wet mix of mortar.

The sketch for restoration of Road, Footpath, Channel is enclosed herewith and is indicative. However, the restoration shall be done in accordance with the norms of concerned land owning agencies.

Turf shall be replaced in highly developed grassed area. In lesser-developed grassed areas topsoil should be replaced during the restoration process.

Where permanent surface restorations cannot be completed immediately, the Contractor shall provide and maintain a suitable temporary running surface for vehicular traffic and pedestrians. The Contractor will be responsible for the maintenance of all restoration carried out, for the duration of the Contract guarantee period.

The Contractor is to ensure the restoration work is properly supervised, and that the material used is suitable for the purpose and properly compacted. Where the required standards are not achieved the Contractor will be required to replace the defective restoration work.

Note that Payment for pipe laying will only be authorized on initialsatisfactory restoration, and where the sites has been cleared of all surplus materials, etc.

Contractor has to obtain the clearance certificate from the concerned local authorities after completion of the restoration work. The restoration specification specified in the tender is only a typical specification and the contractor has to carry out restoration as per latest version of the (PWD/ IRC) specification to its original condition and also to the entire satisfaction of land owner (Private/Public).

The expenditure incurred towards testing of the material used for restoration as per applicable standards, shall be born by the contractor.

20.0 TESTING

Pressure testing will be carried out with compressed air. Compressed air will be provided by Contractor for testing purposes and is to be included in the rates.

For main pipelines work the Contractor shall perform progressive pressure testing to avoid having to find leaks in long lengths of pipe. The test pressure shall be 10.5 bar(g), and there shall be no unaccountable pressure loss during the test period.

Test procedure with sketches showing the pipeline to be tested, vent points, gauge location, and inlet pressure print is to prepared & got approved by EIC.

For main line the test duration shall be 24 hrs . With these tests the pressure should be allowed to stabilize for a period of 30 minutes after pressurization. The holding period may then commence and continue for 24 hours. Measuring instruments shall have been calibrated and their accuracy and sensitivity confirmed. For testing of Network, calibrated pressure gauges of suitable range shall be supplied by the contractor. The pressure gauges shall be calibrated from time to time as desired by Engineer-in-Charge. All testing shall be witnessed and approved by the EIC or his delegated representative. Tie-in joints may be tested at working pressure following commissioning.

For service lines in some cases testing will be carried out independently of the testing of the mains for which the test duration may be reduced to 4 hrs. The service testing in this case will be performed after the service installation is complete but before the service tee has been tapped. Also in some cases the tapping of the service tee will be delayed pending the completion and purging of the main pipelines.

21.0 PURGING

Purging shall be carried out in accordance with the principles defined in the American Gas Association publication 'Purging Principles and Practice".

Nitrogen required for purging will also be provided by the Contractor. Nitrogen shall be supplied in labeled, tested and certified cylinders, and completed with all necessary regulators, hoses and connections, which will be in good condition and working order.

In addition the Contractor shall submit and get approved a Purging Plan before commencing any purging work. The Plan shall include, but not be limited to, the provision of the following materials and equipment: Personal safety equipment, Fire extinguisher, Purging adapter, Purge stack with flame trap and gas sampling point, Gas sampling equipment (may be gas leak detector), squash-off tool, Polyethylene connecting pipe work.

The Plan shall also include the purging process along with detail on the sequence of events. The process is to also specifically mention the need to lay a wet cloth over the PE main and in contact with the ground, to disperse static electricity during the purging work.

A purge stack with flame trap shall be used when purging services. Care shall be taken to ensure that the purge outlet is so located that vent gas cannot drift into buildings.

22.0 VALVE PIT

The valve pit shall be constructed in accordance with enclosed drawing & payment shall be as per appropriate item of SOR.

The construction of valve chambers shall be taken up immediately after installation of valve pit. Drawing No. : MEC/23N0/05/25/M/000/016 - 20

22.1 Workmanship

The excavation work shall be done at a location given by Engineer-in-Charge. All care shall be taken not to damage existing facilities and surface of construction shall be restored to its original state.

Sandbags to be placed below pipeline without disturbing the layed pipe. Gunny bags and Sand should be of approved quality.

Precast RC slab shall be placed as indicated in the drawing issued to the contractor. PCC to be placed below the pipe as indicated. Once PCC is set sand is to be filled and properly rammed so that pipe and precast concrete blocks are firmly placed.

Valve will be supplied without the operating stem. Contractor has to supply the operating stem with a handle for the valves of the different sizes. The Contractor has to take prior approval for design and material specification of the stem for installation. Approved quality sand is to be placed in between area.

Surrounding area to be properly cleared and PCC to be placed around the location where precast slab with CI Manhole cover is placed. The RC precast slab to be laid in level and finished smooth.

23.0 PERMANENT MARKERS

23.1 Permanent Marker (As per typical Drawings Placed at Tender) shall be installed on the ROU at regular intervals as per the instructions of the EIC immediately after laying of the pipeline. The installation of the type of the Permanent Marker shall be decided by the EIC depending on the site condition. The Markers shall be painted before installation as per the approved procedure. The supply of the paint and painting as per the specification is in contractor's scope. Separate payment for installation of the markers shall be paid to the Contractor as per the appropriate item of SOR.

23.2 The artwork shown in the drawing is typical for all the markers. The contractor must take prior approval for the artwork from EIC before installation of Markers. The artwork must have PURCHASER 's logo and specify the location of the pipeline from the marker.

Guidelines :

- The installation of these markers shall be such that in between two pole markers two RCC markers are installed with spacing of 50 Mtrs on either side. However , Pole markers shall be installed at all the tapping / Branching points in the mainline.

- Interval between any two RCC markers for mainline (180mm to 63mm) shall not be more than 50 m .

- Pole marker or RCC marker shall be installed near to valve chambers on mainline & inside the pockets respectively for indication.

- Pole marker with foundation shall be installed after two RCC marker as per drawings.

- The entry and exit pits for laying of pipeline by HDD/ Moiling for road crossings shall be marked by pole markers or RCC markers depending upon the site condition .

- In addition to the above , pole markers with foundation (As per drawings) shall be installed outside societies / Areas as per the instruction of the site in charge.

- For the distribution network 32 mm & 20 mm pipe , plate markers shall be installed as per the site condition and direction of the site in charge.

24.0 ASSISTANCE IN COMMISSIONING

Contractor shall provide the required personnel, Vehicles, labour, supervision, tools, equipment, instruments and technical assistance for performance tests and commissioning activities as per requirement of PURCHASER /MECON.

25.0 STANDARD OF WORK

25.1 All work carried out under this contract shall be to standards, codes of practice, construction procedures and other technical requirements as defined in the technical specifications.

25.2 The manpower deployed on the respective work shall be adequately trained & shall have necessary skills to executive / supervise the work. However, the assessment on the qualification of the personal shall be at the discretion of EIC.

25.3 Fusion operators and other skilled personnel shall be approved by GAS LTD/ MECON and identification cards duly signed by EIC shall be issued to them. Only those personnel who are approved by EIC shall be allowed to execute the critical activities like joining of PE Pipes.

26.0 RECORDING (AS-BUILT DRAWINGS)

The Contractor will be required to submit computerized as-built drawings duly certified by EIC in A0/ A1 sheet form at 1:200 scale with six sets of prints plus soft copy. The as-built drawing shall be submitted on area wise as specified. The bill of materials used for the particular area shall be specified on the drawings. The Contractor shall use the area and crossing survey drawings prepared by them as reference. On-site sketches, picking up key reference points, shall be made during the installation of services. The lengths, depths of installed pipe work, changes in direction, major fittings, etc, shall be recorded together with appropriate references to other services crossed and in the proximity of the gas pipe .

Distance of pipeline from permanent property /structure should be provided at least every 20 meters. If there is any chance in alignment/orientation and offset distance etc. of the pipeline in between the above said 20 meters, the same shall be dearly mentioned in the as laid.
Gas objects (off valve, tees, elbows, couplers , T.F, etc shall be shown as block objects (which from a single node to connect) with respect owners symbol and legend. The as laid drawing shall be as per the legends provided by EIC.
Details & offset distances from other utilities present should be given in as laid drawing. If there is any change in the depth of pipeline , the same shall be clearly marked with details in the as laid drawings. The details of additional protection provided must be mentioned.

Details of the PE stop off valve and other fittings used should be shown with adequate information and orientation. Technical deviation (if any) should be provided with reference to the buildings and permanent structure around , and the same should be cited clearly with all relevant details.
Complete details of nallah crossings should be shown in a separate sketch

Name of roads , major landmarks and buildings should be mentioned appropriately for reference.

Proper Chainage shall be mentioned on all the drawings to be referred with continuation reference.

Direction of gas flow should be indicated in each drawing.

Land based features shown on the drawing shall match the exact distance as they were on real ground with respect to scale ratio (1:200)

The details shall be prepared in standard format using Map Info/AUTOCAD Map and submitted in CD ROM. Contractor shall also make the item wise material consumption report for the respective areas in a soft copy and to be submitted along with the as-built drawings.

27.0 Civil Works

The contractor has to supply the adequate materials and skilled manpower for the completion of all the civil works . The contractors shall also insure that the work carried out as per the detail mentioned in the schedule of rates .

Special care should be taken at the time of labours working in depths/lifting of the skids by hydras/ cranes considering all the safety guidelines.

The contractors has to ensure that sample of all the material shall be inspected and approved by EIC before carrying out installation or erection work. The contractor has to submit the test certificates for all the materials to be used at the site . the construction shall be carried out strictly as per the drawings provided by the PURCHASER The party shall ensure extra / Surplus / malba shall be immediately removed from the site after completion of the job. Separate payment shall be made as per the SOR.

TECHNICAL SPECIFICATION

FOR

MEDIUM DENSITY

POLYETHYLENE FITTINGS

AND

ELECTRO-FUSION

MECON LIMITED

(A Govt. of India Undertaking)

15th Floor, SCOPE Minar, North Tower

Laxmi Nagar District Centre,

DELHI – 110 092

CONTENTS

1.0 SCOPE AND FIELD OF APPLICATION

This specification elaborates the requirements for Electrofusion fittings in the nominal size range 16 to 180 mm made from PE compound used with PE pipes for supply of natural gas and to be used at operating temperature not more than 40°C.

The material grades to be used are PE 100. The fittings shall be yellow or black in colour.

Electro Fusion Fitting Jointing

1.1 For Electro Fusion fitting jointing an electrical resistance element is incorporated in the socket of fitting which when connected to an appropriate power supply, melts and fuses the materials of the pipe and fitting together.

1.2 The effectiveness of this technique depends on attention to the preparation of the jointing surfaces , in particular the removal of the oxidized surface of the pipe over the socket depth and ensuring the jointing surface are clean. If ovality causes gap between concentrically located pipe and the fitting to exceed 1% of the pipe OD after re-rounding to ensure correct welding . If the gap still exceeds 1% of the pipe OD after re-rounding then a check should be made of the pipe OD dimensions to determine if it meets specification.

1.3 The maximum gap between eccentrically located pipe and fitting i.e. pipe touching fitting at one point must not exceed 2% of the pipe OD.

1.4 Sometimes coiled pipes may be too oval to fit into couplers, or the end of the pipe may make the alignment of the ends impossible. In such circumstances the use of a mechanical pipe straightener or rounding tool is necessary.

2. EQUIPMENT

2.1 The control box input supply is to be from a nominal 240V generator, which is normally of approximately 5kVA capacity. The Nominal output of the generator is to be 240V + 15%, -10% between no load and full load .

Control box are to include safety devices to prevent excessive voltages being present at the control box output. The safety devices shall operate in less than 0.5 s

Note that extension leads are not to be used on the control box outlet connections.

Warning : Control boxes are not intrinsically safe and must therefore not be taken to trench.

A mechanical pipe surface preparation tool is to be used before fusion is attempted. The tool is capable of removing the oxidized surface of the pipe in excess of the insertion depth. The tool is to remove a layer of surface material 0.2-0.4 mm thick form outer surface of the pipe preferably in a continuous strip of swarf over that length and round of the pipe.

Pipe clamps for restraining, aligning and re-rounding the pipes in the fusion process are to be used.

Pipe cutters with saw and saw guide

Protection against adverse weather conditions.

2.2 Electro Fusion Jointing Method / Procedure

Preparation

- Ensure there is sufficient space permit access to the jointing area . In a trench a minimum clearance of 150 mm is required.
- Check that the pipe ends to be jointed are cut square to the axis of the pipe and any burrs removed.
- Wipe pipe ends clean lint free material to remove traces of dirt or mud
- Mark the area over which the oxidized pipe surface is to be removed I.e. by placing the socket of the bagged fitting along side the pipe end. Trace a line round the circumference at the appropriate distance from the end of the pipe using a felt tip pen or similar.

Note that the fitting should not to be removed from the packaging at this stage.

- Connect the electro fusion control box input leads to the generator

- Check that the reset stop button, if fitted on the control box is in the correct mode.

- Check that reset stop button if fitted on the control box is in the correct mode
- Using the pipe end preparation tool, remove the entire surface of the pipe uniformly, preferably in continuous swarf over the area identified. i.e. in excess of insertion depth.

- A mechanical scraper could be used however there is a considerable risk that the end preparation will not be adequate with the use of such a tool.

Note that the prepared pipe surface should not be touched by hand.

- Remove the fitting from its packing and clean the scrapped area of the pipe surface and the bore of the fitting with a disposable wipe impregnated with Iso-propanol / Acetone. Ensure the prepared surfaces are completely dry before proceeding

Note that while Iso-propanol is a suitable cleaner , its use is subject to local health and safety regulation.

Check that the pipe clamps are of the correct size for the pipes to be jointed .
Insert the pipe ends into the fitting so that they are in contact with centre stop
Using the pipe clamps , secure the pipes so that they cannot move during the fusion cycle . Check that the pipes ends and the fitting are correctly aligned.
Connect the control box and check that they have been fully inserted.
If required by the control box enter the fusion jointing time into the control box timer. The jointing time is indicated on the fitting . Check the correct time as shown on the control box display.

Note 1 : Automatic control box are available which obviate the need to enter the fusion time
Note 2 : Gloves and goggles should be worn during the fusion process

Note 3 : If the fusion cycle terminates before completion of the countdown , check for faults as indicated by the control box warning lights and check that there is adequate fuel in the generator. DO NOT attempt a second fusion cycle within one hour / cooling of joint at Ambient temperature of the first attempt.

2.3 **Records** : Records of appropriate servicing and calibration shall be kept.

2.4 **Training** : It is necessary that operators , inspection and supervisory personnel acquire the skills of Electro-fusion fitting .The necessary training should be carried out by qualified instructor with the objective of enabling participants to

- Understand the principles of electro-fusion fitting jointing
- Identify pipe and appropriate fitting markings
- Carry out pre jointing machine and equipment checks
- Make satisfactory Electro-fusion joints from pipes and fittings of different sizes
- Inspect for and identify joints of acceptable

Note that some form of assessment and certification should be associated with the training . The certificate should detail the pipe and fitting size range and the equipment used. A register of successful participants should be kept.

2.5 Electro-Fusion Saddle Jointing

For Electro Fusion fitting jointing an electrical resistance element is incorporated in the socket of fitting which when connected to an appropriate power supply, melts and fuses the materials of the pipe and fitting together.

The effectiveness of this technique depends on attention to the preparation of the jointing surfaces , in particular the removal of the oxidized surface of the pipe over the socket depth and ensuring the jointing surface are clean.

Method of holding the tapping tee saddle during the fusion cycle are used namely top loading and under clamping space around the pipe . In a trench a minimum clearance of 150 mm is required.

2.6 Electro-Fusion Saddle Jointing Method / Procedure.

Preparation

Expose the pipe onto which the aping tee is to be assembled , ensuring there is

sufficient clear space around the pipe . In a trench a minimum clearance of 150mm is required.

Clean the pipe over the general area on which the saddle is to be assembled using clean , disposable lint free material

Without removing the fitting from its packaging , place over the required position on the main . Mark the pipe surface all around and clear of the saddle base area using a felt tip pen or similar.

Remove the surface of the pipe to a depth of 0.2 to 0.4mm over the full area marked using a suitable tool , remove the swarf.

Connect the electro fusion control box input leads to the generator
Check that the reset stop button, if fitted on the control box is in the correct mode.

Check that reset stop button if fitted on the control box is in the correct mode.

Remove the fitting from its packing and clean the scrapped area of the pipe surface and the bore of the fitting with a disposable wipe impregnated with Iso-propanol / Acetone. Ensure the prepared surfaces are completely dry before proceeding

Note that while Iso-propanol is a suitable cleaner , its use is subject to local health and safety regulation.

Position the fitting base onto the prepared pipe surface , and bring the lower saddle into position then gradually and evenly tighten the nuts until the upper saddle makes firm contact with scrapped pipe.

Check that there is sufficient fuel for the generator to complete the joint .
Start the generator and check that it is functioning correctly

Switch on the control box if applicable

Connect the control box output leads to the fitting terminals and check that have they have been fully inserted.

If required by the control box enter the fusion jointing time into the control box timer. The jointing time is indicated on the fitting . Check the correct time as shown on the control box display.

Note 1 : Automatic control box are available which obviate the need to enter the fusion time
Note 2 : Gloves and goggles should be worn during the fusion process

Press the start button on the control box and check that the heating cycle is proceedings as indicated on the display.

On completion of the heating cycle , the melt indicators where incorporated should have risen . If there is no apparent move in the melt indicators a new saddle joint should be made. Cut the tee of the faulty joints from its base.

If a satisfactory joint has been made , the joint is to be left in the clamps for the cooling time specified on the fitting label or any the automatic control box

Note 3 : If the fusion cycle terminates before completion of the countdown , check for faults as indicated by the control box warning lights and check that there is adequate fuel in the

The connection of the service pipe to the fitting outlet should be carried out in accordance with the procedure of the appropriate section of this item

Do Not attempt to tap the main with the integral cutter for at least 10 minutes after the completion of cooling cycle .

Records

Records of appropriate and calibration of electro fusion machines and joint shall be kept.

Trainings

AS PER 2.4

Note that some form of assessment and certification should be associated with the training. The certificate should detail the pipe and fitting size range and the equipment used. A register of successful participants should be kept.

2.7 STOPPING THE GAS FLOW

In the operation of a distribution system there is a periodic need to stop the gas flow for either routine or emergency maintenance. The flow may be stopped through the use of installed fitting such as valves. Where installed fittings are not available or the use of such would cause significant supply disruption, then one of the following methods may be employed.

2.8 SQUEEZE - OFF

a. To control the gas flow a special tool may be used to squeeze the pipe walls together. Hydraulic jacks are used to supply the necessary force to compress the pipe walls for sizes 90 mm and above.

b. As will be seen the squeeze-off equipment comprises two bars to apply pressure to outside of the pipe. The bars are bars are brought together either manually or hydraulically, squeezing the pipe material together until a seal is formed where the upper and lower walls meet.

c. The hydraulic machines should have a spring return for the jack and locking to prevent accidental release of pressure during operation. All squeeze – off machines should be fitted with check plate or stops to avoid over compression of the pipe.

d. Where the pipe walls are compressed the polyethylene pipe will be severely deformed in the regions of maximum compression. The pipe will eventually regain its original shape after squeezing but there will be reduction in some pressure bearing properties.

e. A complete stop may not always be obtainable because of wrinkling of the inside of the pipe. If a complete stop is required than a second squeeze can be used, with an intermediate vent to remove the gas which passes the first squeeze from say the trench of three pipe diameters area. A second squeeze

– off procedure should be a minimum of three pipe diameters and right angles to the squeeze.

f. While not essential it would be good practice to fit a reinforcing stainless steel band / do not squeeze again adhesive tape around the pipe upon the completion of squeezing operation.

2.9 BENDING – BACK

Bending back of the pipe may be performed where the pipe has been served damaged and stopping they gas flow is imperative. Its application is of a temporary nature and will provide a relief until a permanent repair can be affected. The section of pipe, which has been bent back, will to be replaced because of the damage caused by the serve ness of the band back operation. The need of any bend back operation is most likely to occur as a consequence of damage caused to a PE service pipe.

While it is not the prime function of a saddle tee , controlling the flow in the service may be achieved by opening upon an installed saddle tee and winding down the internal tapping tool to shut off the flow to the service pipe.

3. SYMBOLS & DEFINITIONS

3.1 Symbols for Electro fusion Fittings

3.1.1 Symbols for Electro fusion Socket Fittings

The dimensions and main symbols used in this part of ISO 8085 are shown in figure 1, where

D1 is the mean inside diameter in the fusion zone comprising the mean inside diameter measured in a plane parallel to the plane of the mouth at a distance of L3 + 0.5 L2 from the plane at the mouth.

D2 is the minimum bore comprising the minimum diameter of the flow channel through the body of the fitting.

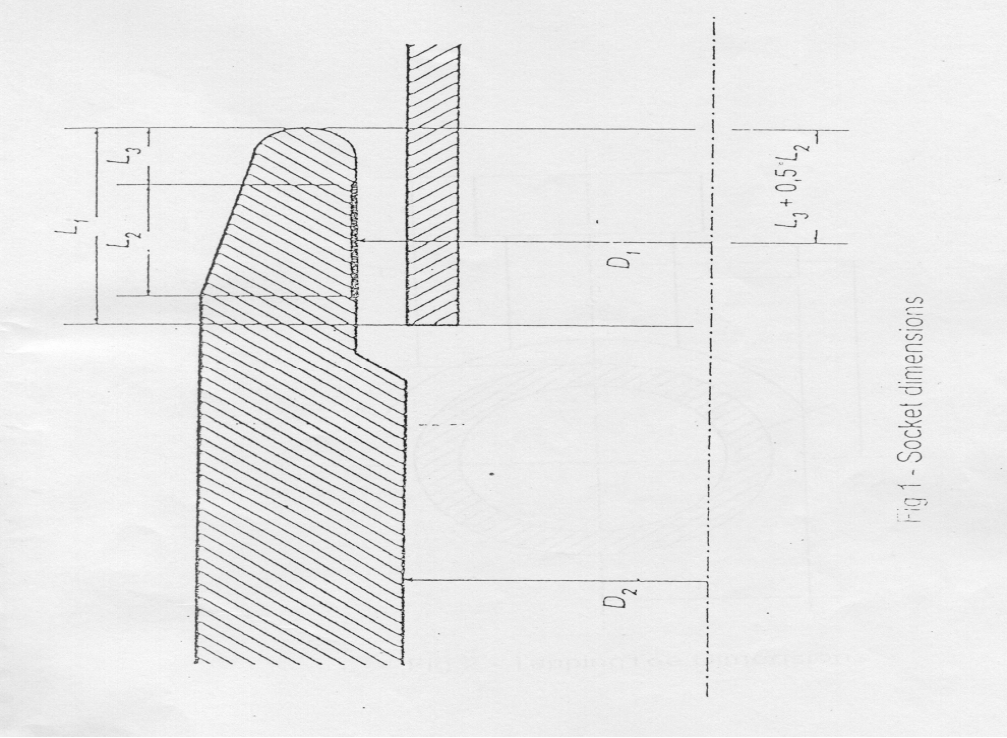
L1 is the depth of penetration of the pipe or of the male end of a spigot fittings.

L2 is the nominal length of the fusion zone corresponding to the heated length.

L3 is the nominal unheated entrance length of the fitting comprising the distance between the mouth of the fittings and the near end of the fusion zone.

3.1.2. Symbols for Electrofusion Tapping Tees

The main symbols used for tapping tees are shown in Figure 2, where. **h** is the height of the service pipe and comprising the distance between the axis of the main pipe and the axis of the service pipe.



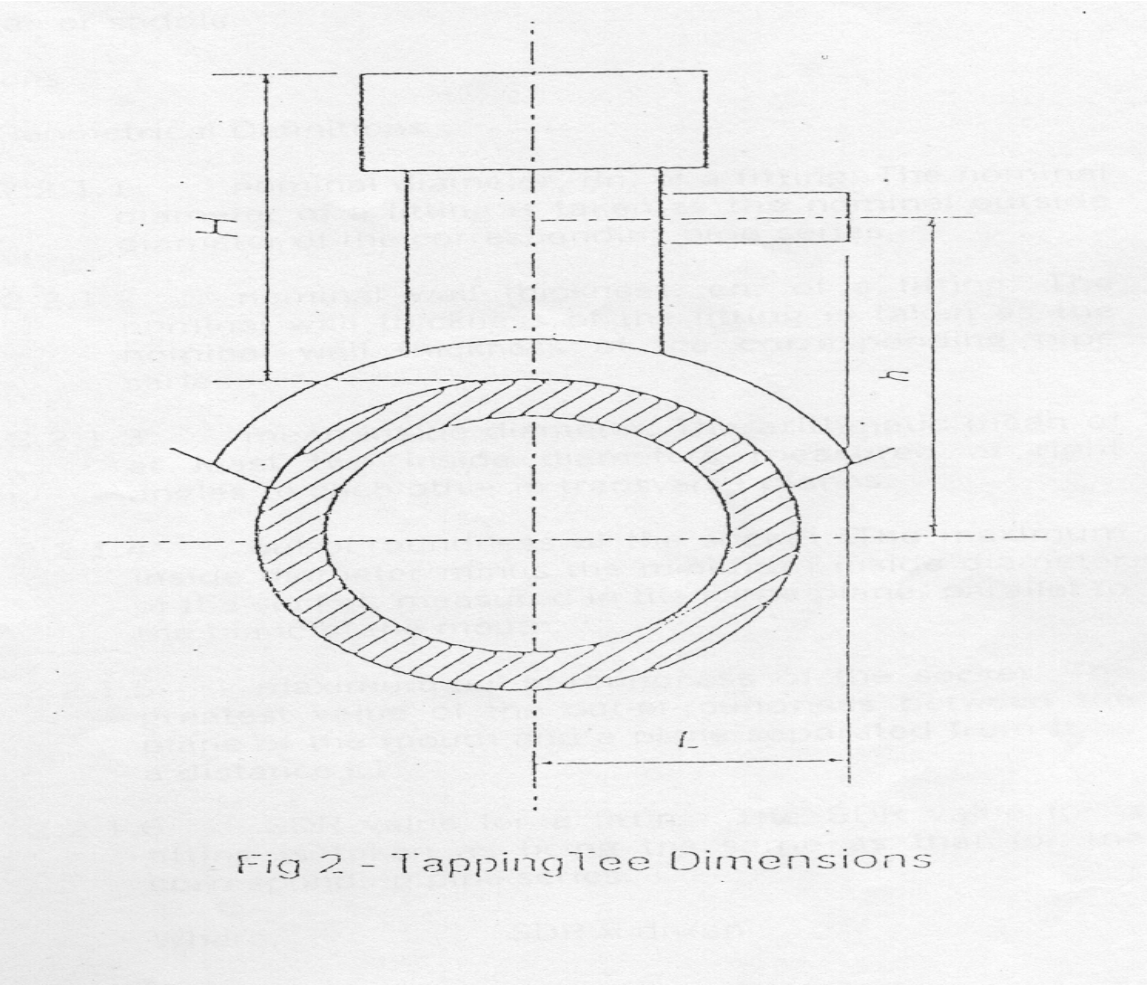


Fig 2 - TappingTee Dimensions

L is the width of the tapping tee and comprising the distance between the axis of the main pipe and the plane of the mouth of the service pipe.

H is the height of the saddle which comprises the distance from the top of the main to the top of the tapping tee or saddle.

3.2 Definitions

3.2.1. Geometrical Definitions

3.2.1.1 Nominal diameter, dn, of a fitting:

The nominal diameter of a fitting is taken as the nominal outside diameter of the corresponding pipe series

3.2.1.2 Nominal wall thickness. en, of a fitting:

The nominal wall thickness of the fittings is taken as the nominal wall thickness of the corresponding pipe series.

3.2.1.3 Mean inside diameter:

The arithmetic mean of at least two inside diameter measured at right angles to each other in transverse planes.

3.2.1.4 Out of roundness of the Socket:

The maximum inside diameter minus the minimum inside diameter of the socket, measured in the same plane, parallel to the plane of the mouth.

3.2.1.5 Maximum out of roundness of the socket:

The greatest value of the out of roundness between the plane of the mouth and a plane separated from it by a distance L1.

3.2.1.6 SDR value for a fitting:

The SDR value for a fittings is taken as being the same as that for the corresponding pipe series.

Where, SDR = dn/en

3.2.1.7 Wall thickness, E of a fitting:

The wall thickness of a fittings at any point of the body of the fitting which could be submitted to a stress inducted by the pressure of the gas in the piping system.

3.2.2 Material Definition

3.2.2.1 Virgin Material :

Materials in form such as granules or powder that has not been subjected to use or processing other than that required for its manufacturer and to which no re-processable or recyclable materials have been added.

3.2.2.2 Own Reprocessable Material :

Material prepared from rejected unused pipes, fittings or valves, including trimmings from the production of pipes, fittings or valve, that will be reprocessed in a manufacturer's plant after having been previously processed by the same manufacturer by a process such as injection moulding or extrusion.

3.2.2.3 Compound:

A homogenous mix of base polymer (PE) and additives, i.e. antioxidants, pigments, UV-stabilisers and others…, at a dosage level necessary for the processing and of components of this standards. The additives shall not have a negative influence on the performance with respect to feasibility. All additives shall be uniformly dispersed.

3.2.3 Definition related to Material Characteristics

3.2.3.1 Lower Confidence Limit (LCL):

A quantity with the unit in mega Pascals (MPs), which can be considered as a property of the material representing the 97.5% lower confidence limit of the predicted long-term hydrostatic strength at a temperature 20° C for 50 years in water.

3.2.3.2 Overall Service (Design) Coefficient (C):

An over all coefficient with a value larger than 1.0 which takes into consideration service conditions as well properties of the components of a piping system other than those represented in lcl. For gas applications, C can have any value equal to or greater than 2.0.

3.2.3.3 Minimum Required Strength (MRS):

The value of the lcl rounded down to the next lower value of the R 10 series when the lcl is less than 10 Mpa, or to the next lower value of the R 20 series when the lcl is greater than or equal to 10 Mpa.

Note: R10 and R 20 series are the Renard number series according the ISO 3 and ISO 497

3.2.3.4 Melt Mass Flow Rate (MFR):

A value relating to the viscosity of the molten material at a specified temperature and rate of shear.

3.2.4 Definitions Related to Service Conditions

3.2.4.1 Gaseous Fuel:

Any fuel which is in the gaseous state at a temperature of + 15° C and a pressure of 1 bar.

3.2.4.2 Maximum Operating Pressure (MOP)

The maximum effective pressure of the gas in the piping system, expressed in bar, which is allowed in continuos use. It takes into account the physical and the mechanic characteristics of the components of a piping system.

Note : It is given by the equation : $MOP = \frac{20 * MRS}{C*(SDR-1)}$

3.2.5 Definition on Design of Electrofusion Fittings:

3.2.5.1 Electrofusion Socket Fitting:

A polyethylene (PE) fittings which contains one or more integral heating elements, that are capable of transforming electrical energy into head to realise a fusion joint with a spigot – end or a pipe.

3.2.5.2 Electrofusion Saddle Fitting:

A polyethylene (PE) fitting (top loading or wrap around) which contains one or more integral heating elements, that are capable of transforming electrical energy into head to realise a fusion joint onto a pipe.

3.2.5.3 Tapping Tee:

An Electrofusion saddle fitting which contains an integral cutter, to cut through the pipe wall. The cutter remains in the body of the saddle after installation.

3.2.5.4 Branch Saddle:

An Electrofusion saddle fitting which requires an ancillary cutting tool for drilling a hole in the adjoining main pipe.

3.2.5.5 U Regulation :

Control of the energy supplied during the fusion process of an Electrofusion fitting, by means of the voltage parameter.

3.2.5.6 I Regulation:

Control of the energy supplied, during the fusion process of an electrofusion fitting by means of the current parameter.

4. DESIGNATION

4.1 Fittings shall be designed according to the grade of material, nominal diameter and Standard Dimension Ratio (SDR).

4.2 **Grade of Material:**

4.2.1. Fittings shall be classified according to the grade of material as given in following table:

Table–1

Material	M.R.S. Mpa	1 cl (20° C, 50 Yrs 97.5%) Mpa	Maximum Allowable Operating Pressure
PE 80	8.0	8.00 ≤ 1 cl ≤ 9.99	5.5 Bar
PE 100	10.0	10.00 ≤ 1 cl ≤ 11.19	7.0 Bar

4.3 **Nominal Diameter**

The Nominal Diameter for fittings covered in this standard are 16, 20, 25, 32, 40, 63, 75, 90, 110, 125, 140, 160 ,180 mm.

4.4 **Material**

4.4.1 Polyethylene Compound:

The Polyethylene compound used in the manufacture of fitting shall be a cadmium free compound. It shall be free from visible water, shall comply with the requirements as specified in Table – 2.

Table-2 : Characteristics of PE Compound

Characteristics	Units	Requirements	Test Parameters	Test Method
Conventional Density	Kg/m^3	≥ 930 (base polymer)	23 °C	ISO 1183 - ISO 1872/1
Melt Mass-flow Rate	g/10 min	± 20% of value nominated by compound producer	190 °C condition 18	ISO 1133
Thermal Stability	Minutes	> 20	200 °C (2)	ISO TR 10837
Volatile Content at Extrusion	mg/kg	≤ 350		ISO 4437 Annex. A
Water Content (3)	mg/kg	≤ 300		ASTM D 4019
Carbon Black Content	% (m/m)	2,0 ≤.....≤ 2,5		ISO 6964
Carbon Black Dispersion (4)	Grade	≤ 3		ISO DIS 11420
Pigment Dispersion (5)	Grade	≤ 3		ISO DIS 13949
Resistance to Gas Constituents	h	≥ 20	80 °C 2 Mpa	ISO 4437 Annex. B
Resistance to rapid crack propagation (RCP) (6)	Mpa	The critical pressure in the FS test shall be greater than or equal to the value of the MOP of the system multiplied by 1:5	0°C	ISO DIS 13478
Full Scale (FS) test : d ≥ 250mm				
Or		The critical pressure in the S4 test shall be equal to or greater than the value of the MOP of the system divided by 2,4 (8)	0°C	ISO DIS 13477
S4 Test : in principle according to all diameters (7)	Mpa			
Resistance to slow crack growth en > 5mm	h	165	80 °C, 8,0 bar (f) (9) 80 °C, 9,2 bar (f) (10)	ISO DIS 13479

1) Non black compound shall conform to the weathering requirements to ISO 4437

2) Test may be carried out at 210°C providing that there is a clear correlation to the results at 200°C, in case of dispute the reference temperature shall be 200°C

3) Only applicable if the compound does not conform to the requirement for volatile content. In case of dispute the requirements for water content shall apply

4) Carbon black dispersion for black compounds only.

5) Pigment dispersion method for non-black compounds only.

6) Only applicable for fittings which incorporate extruded pipe elements.

7) Shall be performed on pipe with a wall thickness of ≥15 mm.

8) This factor 2.4 is still under study and may be subject to change. If the requirement is not met, then retesting by using the Full Scale (FS) test shall be performed

9) Test parameter for PE 80.

10) Test parameter for PE 100.

5.0 DESIGN

- Fittings shall be designed for system operation at the pressures given in Table – I
- Fittings shall be free from cracks, voids, blisters, distortion, dent or other defects.
- Fittings shall be capable of being fusion jointed to pipes using control boxes. The fittings shall exhibit the strengths and fusion compatibility with, pipes of respective sizes.
- Each fitting shall be bar coated and shall have a permanent fusion indicator.
- Heating coil design shall be such that it should not be damaged during assembly leading to short circuit of heating coil.

5.1 Electrofusion Socket Fittings

Electrofusion Socket Fittings shall incorporate a method of controlling pipe penetration within each socket. The inner cold zone of each socket shall not be less than (0.1 d + 5) mm for sizes upto 125 mm & 0.1 d for sizes greater than 125 mm.

5.2 Tapping Tees

Tapping tees shall be capable of installation by a force between 1 kN and 1.5 kN applied from above and on the centre line of the tapping tees stack. The tapping tees shall provide a means of cutting through the pressurised main pipe and allowing the gas flow into the outlet pipe.

5.3 Transition Pieces

To make connection between steel pipe and MDPE pipe specially fabricated transition pieces consisting of steel and MDPE pipes should conform to the requirements mentioned herein.

5.3.1 MDPE Pipe:

The MDPE pipe with one end plain should conform to the specification (IS:14885/ SDR 11)

5.3.2 Steel Pipe:

Black ERW steel pipe should conform to the specifications as laid in API STD 5L (latest revision)

5.3.2.1 Pipe End:

One end of the pipe should be bevelled for welding angle of bevel should be 30° + 5°.

5.3.3 Jointing between Steel and MDPE Pipes:

Steel and MDPE pipes should be so jointed in the factory so as to have a monolithic joint which is leak free and should be mechanically as strong or stronger than the PE Pipe.

5.4 **Transition Fittings (MDPE Pipes to threaded G.I. Fitting):**

Transition fitting for jointing of MDPE Pipes confirming to specification IS:14855/ SDR 11 to threaded G.I. tubing confirming to specification. The MDPE end of the transition fitting shall be jointed with MDPE Pipe with the electrofusion method.

6.0 ELECTRICAL CHARACTERISTICS

For each size and type of fitting, the manufacturer shall declare the nominal resistance of the heating element and specify the production tolerances.

The manufacturer shall demonstrate that satisfactory joint can be made using the extremes of these tolerances.

All fittings shall have mechanically shrouded malo electrical terminals. The fittings terminals connections shall be suitable for use with voltage less than or equal to 48 volts. Considerations should be given to the design of the shroud with respect to impact damage. When hollow terminal pins are used, the hole at the top of the pin shall be less than 1 mm diameter. The terminal pin material shall be corrosion resistant and the surface finish shall be N7.

Fittings incorporation two electrofusion sockets shall have both sockets fused in a single operation.

The heating elements shall be suitable designed to prevent short circuiting or local overheating/ under heating during the fusion operation. Protective coating applied to the heating element shall not have a detrimental effect on the joint.

The heating element wire shall not be disturbed during assembly.

7.0 DIMENSIONS

7.1 Measuring Temperature

Fittings shall not be measured within 24 hrs. of manufacturer to allow for normalization. The fittings shall be measured at an ambient temperature of 23 ± 2°C, after a conditioning period of 5 Hrs.

Methods of measurements shall provided the appropriate degree of accuracy, and the reference conditions specified in this clause 6 apply in case of disputes in dimensional measurement.

7.2 Dimensional Stability

7.2.1 Couplers (Including all forms of socket fittings)

All coupler dimensions shall conform to their specified value when the fitting has been stored for a period of 12 months at a temperature of 30 ± 2°C.

7.2.2 Tapping Tees and Branch Saddles:

All tapping tee and branch saddle dimensions shall conform to their specified agreed values when the fitting has been stored for a period of 12 month at a temperature of 30 ± 2°C.

TABLE 3 : SOCKET DIMENSIONS

Pipe Size d mm	Limits for average diameter d on each fitting measured over apparent fusion length L mm		Apparent fusion length L mm	Penetration depth L mm
	Maximum	Minimum	Minimum	Maximum
16	16.6	16.4	15	41
20	20.6	20.4	16	41
25	25.6	25.4	18	41
32	32.9	32.5	18	41
40	41.0	40.6	18	49
50	51.1	50.7	20	55
55	56.1	55.7	21	63
63	64.1	63.7	23	63
75	76.3	75.9	25	70
90	91.5	91.1	28	79
110	111.3	111.1	32	82
125	126.7	126.2	35	87
140	141.7	141.2	38	92
160	162.1	161.4	42	98
180	182.1	181.5	46	105

Notes:

1. The apparent fusion length, L, is the length of the integral heating elements, from the first regular section of the element to the end of the regular section, on one side of the fitting. This dimension to be measured from outside edge to outside edge of wire.

2. Any protrusions into the bore of the fitting (e.g. centralization ribs) shall not prevent easy assembly in the field.

3. The overall length of a straight coupler is equal to twice the quoted maximum penetration depth L.

TABLE 4: OVERALL LENGTH OF REDUCERS

Major Diameter mm	Maximum Length mm
25	90
32	90
63	120
90	180
125	215
180	280
200	245
225	260
250	280
280	300
315	320

TABLE 5: BRANCH SADDLE ASSEMBLY OUTLET LENGTH

Off-take Size mm	Shut-off method	Dimension from flange face to crown of main		Dimension from pipe end to crown of main	
		Class B fitting mm	Class B fitting mm	Class B fitting mm	Class B fitting mm
63	Valve	-	-	-	-
63	Squeeze	-	260*	-	-
90	Valve	-	-	400	-
90	Squeeze	400	180**	-	-
125	Valve	-	-	550	-
125	Squeeze	360	180***	-	-
180	Valve	-	-	750	-
180	Squeeze	360	180+	-	-
250	Valve	-	-	-	-
250	Squeeze	360	180++	-	-

* Flange size DN 50
** Flange size DN 100
*** Flange size DN 150
\+ Flange size DN 250
++ Flange size DN 250

8 PERFORMANCE REQUIREMENTS

8.1 Mechanical Characteristics

Fittings shall be tested using pipes, which conform to ISO 4437, Test samples shall be assembled in accordance with ISO DIS 11413, following the technical instruction of the manufacturer and using fusion equipment conforming ISO DIS 12176.2.

When tested in accordance with the test methods as specified in table – 6 using the indicated parameters, the fittings have mechanical characteristics confirming to the requirements given in Table 6.

TABLE 6: MECHANICAL PROPERTIES

Characteristics	Units	Requirements I	Test	Parameters	Test Method
Hydrostatic strength at 20°C	H	Failure time ≥ 100	End caps orientation conditioning time. Type of test circumferential (hoop) stress pipe PE 80, PE 100, Test temperature.	Type a) free 1 h 9 Mpa, 12.4 Mpa, 20°C	ISO DIS 9356
Hydrostatic strength at 80°C	H	Failure time ≥ 165	End caps orientation conditioning time. Type of test circumferential (hoop) stress pipe PE 80, PE 100, Test temperature.	Type a) free 12 h water-in-water 4.6 Mpa 5.5 Mpa 80°C	ISO DIS 9356
Hydrostatic strength at 80°C	H	Failure time ≥ 1000	End caps orientation conditioning time. Type of test circumferential (hoop) stress pipe PE 80, PE 100, Test temperature.	Type a) free 12 h water-in-water 4 Mpa, 5 Mpa, 80°C	ISO DIS 9356
Cohesive resistance	mm	Length of initiation of brittle fracture L/3	Test temperature choice of method	23°C	ISO 13954 (A) ISO 13955 (A) ISO 13956 (B)
Impact strength (B)		No failure No leakage	Test temperature Falling height Mass of the striker	20°C 23°C 5m 5kg	ISO DIS 13957

Characteristics	Units	Requirements I	Test	Parameters	Test Method
Pressure drop (B)	M^3/h	0.5 mbar : dn ≤ 63 0.1 mbar : dn^2 > 63	Air flow rate Test medium Test pressure	Indicated by the manufacturer Air source 25 mbar	PrEN 12117

(A) Electrofusion Socket Fittings

(B) Tapping Tees

For hydrostatic strength test at 80°C only brittle failure shall be taken into account. If ductile failure occurs before the required time, a lower stress shall be selected and the minimum test time will be obtained from the line through the stress/ time points given in Table – 7.

TABLE 7
Hydrostatic strength (80°C) – Stress/ Minimum Failure Time Correlation

PE-80		PE-100	
Stress Mpa	Minimum Failure Time h	Stress Mpa	Minimum Failures Time h
4.6	165	5.5	165
4.5	219	5.4	233
4.4	293	5.3	332
4.3	394	5.2	476
4.2	533	5.1	688
4.1	727	5.0	1000
4.0	100	-	-

8.2 Physical Characteristics

When tested in accordance with the test methods as specified in Table 8 using the indicated parameters, the fittings shall have physical characteristics conforming to the requirements given in Table 8.

TABLE 8 : Physical Characteristics of Fittings

Property	Units	Requirements	Test Parameters	Test Method
Thermal Stability	Minutes	> 20	200 °C (1)	ISO TR 10837

Property	Units	Requirements	Test Parameters	Test Method
Melt Mass-flow Rate (MFR)	g/10 min	$0.2 \leq MFR \leq 1.4$ and after processing maximum deviation of $\pm$ 20% of the value measured on the batch compound	Condition 18	ISO 4440.1

(1) Test may be carried out at 210 °C providing that there is a clear correlation to the results at 200 °C, in case of dispute the reference temperature shall be 200 °C.

8.3 **Technical File**

The manufacturer of the fittings shall make availability of a technical file (generally confidential) with all relevant data to prove the conformity of the fittings to this specification. It shall include all results of the type testing and shall conform to the specification relevant technical brochure (e.g. ISO 12093 for electro fusion fittings).

The technical description of the manufacturer shall include the following information:

1. Field of appliance (pipe and fitting temperature limits SDR's and out of roundness):
2. Assembly instructions:
3. Fusion instruction (fusion parameters with limits)
4. For saddles and tapping tee:

   - The means of attachment (tools and/ or under clamp).
   - The need to maintain the under clamp in position in order to ensure the performances of the assembly.

For electrofusion fitting, the format of the technical brochure shall conform to ISO DIS 12093.

In the event of modification of the fusion parameters, the manufacturer shall ensure that the joint conforms to this standard.

9. MARKING

Following information shall be embossed upto height of 0.15 mm onto the fitting and also in the form of bar code:

a) The manufacturer's identity
b) The size of the fitting in mm
c) Material and Designation
d) The date of manufacturer (code may be used)
e) Fusion time in seconds
f) Cooling time in minutes
g) Fusion parameters in BAR code
h) Lot Number.

The information may be printed on a label associated with the fitting.

10 . PACKING

The fittings shall be packaged in bulk or individually protected where necessary in order to prevent deterioration. Whenever possible, they shall be placed in airtight plastic bags in card board boxes or cartons.

The cartons and/or individual bags shall bear at least one label with the manufacturer's name, date of manufacturer, type and dimensions of the part, number of units in the box, and any special storage conditions and storage time limits.

Note:

All the fittings required shall be bar coded electrofusion fitting type. In case bidder is quoting for spigot fittings, the necessary electrofusion coupler for all non electrofusion ends shall be included in the complete package

The transition fittings shall also be bar coded electrofusion type for PE connection, NPT Female threading confirming to ANSI B 20.1 for G.I connection & butt welded for carbon steel end.

The carbon steel material of transition fittings shall be confirming to APL 5L x 42 and thickness shall be of 4.8 mm.

All the fittings shall be used for the network operating at 4.0 Bar(g) Pressure.

TECHNICAL SPECIFICATION

FOR

POLYETHYLENE PIPES

MECON LIMITED
(A Govt. of India Undertaking)
15th Floor, SCOPE Minar, North Tower
Laxmi Nagar District Centre,
DELHI – 110 092

C O N T E N T S

1.0 INTENT OF SPECIFICATION

The intent of this specification is to establish minimum requirements to manufacture and supply of Polyethylene Pipes used for supply of natural gas.

2.0 INSTRUCTION TO THE TENDERER

2.1 The PE pipes are to be supplied as per IS:14885.

2.2 The length of the Pipes and their supply will be as per following :-

- 20mm OD – In each Coils of 100 mtrs. length
- 32mm OD – In each Coils of 100 mtrs. length
- 63mm OD – In each Coils of 100 mtrs. Length
- 90mm OD – In each Coils of 50 mtrs, Length
- 125mm OD – In each Coils of 50 mtrs. length
- 180mm OD – Each pipe of 12 mtrs. length minimum & above

2.3 **PROTECTION**

i) The ends shall be protected by proper end caps to prevent from shocks and ingress of the foreign body.

ii) Coils shall be covered by black PVC/ PE Film to prevent exposure to direct sun light.

2.4 The successful bidder shall submit following for approval of Purchaser/ Consultant after placement of order

a) The Quality Assurance Plan (QAP & Sampling Plan)

b) Certified test result of PE Compound (clause 5 of IS:14885)

c) Performance Requirements (clause 8 of IS:14885)

d) Type Test (clause 9.1.2 of IS:14885).

2.5 The bidder shall submit following documents at the time of bidding,

a) BIS/ ISO Certification if obtained already, or documentary evidence of applying for the same

b) List of current orders in hand for similar items with full details such as specification, name of purchaser etc.

c) Details of the largest supply executed

d) Name and address of proposed test laboratories alongwith their credentials/ past records for carrying out all required tests.

e) The names of standards/ codes being followed in manufacture and supply

f) Any accreditation certificates obtained or applied for.

2.6 **MARKING**

The pipe shall be marked in continues length in addition to the requirement of the applicable code.

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.

-X-X-X-

TECHNICAL SPECIFICATION

FOR

WARNING MATS

MECON LIMITED

(A Govt. of India Enterprise)

BENGALURU

SPECIFICATION FOR THE WARNING MATS

Purpose	:	For using as a warning sign for Under Ground Natural Gas Pipeline
Width	:	250 mm +/- 2 mm for Under ground Gas Pipeline
Thickness	:	0.5 mm thk.(500 microns +/- 8 %)
Tracer Wire		: Double copper wire-with anti-corrosive coating, in sinusoidal wave pattern.
Material of the mat	:	The material shall be of high density Polyethylene
Colour of the mat	:	Yellow colour + black text
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 2weeksat a temperature of 15°C for colour intactness of the strip. Art work would be finalized after placement of order.

Mechanical Properties of HDPE:

1. Tensile strength - Min. 1.8 kg/cm2
2. Elongation at break – Min.125%

Bundle length:
0.5 mm thick warning mat shall be 50 m

Test certificates:
Vendor has to submit all test certificates

Inspection:
Manufacturer has to submit QAP

ELECTRICAL & INSTRUMENTATION SECTION

TECHNICAL SPECIFICATION

PERMANENTLY LUBRICATED TELECOM HDPE DUCT & ACCESSORIES
TS No. : MEC / TS / 05 / E5 / T / 037

Prepared & Issued By

MECON LIMITED
DELHI

Revision	Date	Description	Prepared by	Checked by	Approved by
1	11.11.2006	Modified as reqd.			
0	11.07.2005	First Issue	Vikas Jain	Rakesh Shukla	Pankaj Shrivastava

Contents

1.0 **SCOPE**

This specification covers the minimum generic requirement of permanently self-lubricated high Density Polyethylene ducts (PLB HDPE ducts) for use as underground conduits for optical fibre cables and associated accessories, suitable for installation of OFC by blowing technique.

The scope of work shall include supply of PLB HDPE ducts and the accessories as per the specification/ requirements given in this document.

However Optical Fibre Cable shall be laid in a permanently lubricated HDPE pipe using blowing technique.

1.1 Supply of special tools and tackles as mentioned in the bills of quantity.

1.2 Supply of complete technical literature and documentation as defined in Section 10.

1.3 Quality Assurance and testing as described at section 9, to the complete satisfactory of the Owner/ Consultant and/or third appointed agency.

2.0 **REFERENCE DOCUMENTS**

Unless otherwise specified, this document requires references to the latest standards of the following:

IS 2530	Methods for test for Polyethylene Molding Materials and Polyethylene Compounds
IS 4984	High Density Polyethylene Pipes for water supply
IS 7328	High Density Polyethylene materials for molding and extrusion
IS 9938	Recommended colours for PVC insulation for LF wires and cables
IS 12235 (Part – 9)	Methods of test for unplasticized PVC pipes for potable water supplies – Impact strength at 0°C
IS 14151 (Part – 1)	Ployethylene pipes for sprinkler irrigation systems (Part – I Pipes)
ASTMD 1693	Test method for environmental stress cracking of ethylene plastics.

3.0 **PLB HDPE Duct Specification :**

3.1 The PLB HDPE duct shall consist of two concentric layers, the outer layer being HDPE, co-extruded with an inner layer of solid permanent lubricant, to reduce the internal co-efficient of Friction (ICF). The lubricant shall be of a solid layer of uniform thickness so formulated to provide a permanent, low friction boundary layer between the inner surface

of the duct and Optical Fiber cable. The lubricant layer shall be clearly visible in cross-section, concentric with the outer layer.

3.2 Alternatively the duct can be of a homogenous construction (without a separate inner layer) meting all the requirements of this specification.

3.3 The PLB HDPE duct shall be supplied in a continuous length in coil form, suitable for shipping and handing purposes.

3.4 **MATERIAL**

3.4.1 **Two Layer Construction**

3.4.2 Outer Layer

The base HDPE rein used for the outer layer of the PLB HDPE duct shall conform to any designation of IS – 7328 or to any equivalent standard meeting the following requirements, when tested as per IS – 2530. However, the manufacturers shall furnish the designation for the HDPE resin as permanently IS – 7328 as applicable.

a)	Density	:	0.940 TO 0.958 g/cc AT 27°C
B)	Melt Flow Rate (MFR)	:	0.2 to 1.1 g/10 minutes at 190°C & 5 kg load.

3.4.3 Inner Layer

The inner lubrication material shall be of friction reducing, polymeric material which shall be integral with HDPE layer. The lubricant materials shall have no toxic or dermatic hazards for safe handling. In the finished PLB HDPE duct, the co-extruded layer of solid permanent lubricant shall be integral part with HDPE and shall be white in colour and clearly visible in cross-section of duct.

3.4.4 The inner layer of solid permanent lubricant shall be continuous all through and shall not come out during storage, usage and throughout the life of the duct.

3.5 **Homogenous Construction:**

The HDPE material used for this construction shall meet the requirements listed in clause 4.1.1, such that the finished duct shall satisfy the internal Co-efficient of friction (ICF) and all other requirements of this specification.

3.6 The raw material (s) used for the duct shall meet the following requirements :

i) The anti-oxidants used shall be physiologically harmless.

ii) None of the additives shall be used separately or together in quantities as to impair long term physical and chemical properties of the duct.

iii) Single pass rework material of the same composition produced from the manufacturer's own production shall be used and it shall not exceed 10% in any case.

iv) The raw material used for extrusion shall be dried the moisture content to less than 0.1%.

v) Suitable UV stabilizers shall be used for manufacturer of the duct to protect against ultra violet degradation, when stored in open for a minimum period of 8 months.

vi) The raw material used in the manufacturer of the duct shall be such that the service life of the duct and all its accessories can be expected to be more than 50 years including the life of permanent lubricant.

4.0 PLB HDPE DUCT ACCESSORIES

4.1 The following accessories are required for jointing the ducts and shall be supplied along with the ducts. The manufacturers shall provide complete design details, procedure for method of installation and type/ grade of the material used for the accessories. The qty. will be as per material requisition (MR).

a) ***Plastic Coupler***

It is used to couple two ducts. The design of this shall be simple, easy to install and shall provide airtight and water tight joint between the two ducts. The coupler shall ensure that the two ducts are butted smoothly without any step formation in the inner surface. The jointing shall meet the air pressure test of 10 kg/cm^2 for a minimum period of 2 hours without any leakage.

b) ***End Plug.***

This is for sealing the ends of the empty ducts, prior to installation of the Optical Fiber Cable and shall be fitted immediately after laying of the duct, to prevent the entry of any dirt, water, moisture, insects/ rodents etc.

c) ***Cable Sealing Plug***

This is used to seal the ends of the ducts perfectly, after the cable is installed in the duct, to prevent the entry of dirt, water, moisture, insects/ rodents etc. This is required at all places where cable has come out of the duct either for jointing or entry into the building as required. The sealing plug shall be capable of accommodating standard sizes of optical fibre cable taking into account the variation in diameter due to tolerance limits, etc.

d) ***End Cap***

This cap is made of hard rubber, shall be fitted into both ends of duct coil after manufacturing the duct. This shall avoid entry of duct, mud and rainwater into the duct during the transit and storage.

Note: The Accessories in clause 6.1 (b) and (c) shall be tested for air tightness with a pressure of 1 bar for 30 minutes. For carrying out the tests for the above accessories suitable length of duct shall be taken.

4.2 The following additional tools are required for jointing for the ducts and installation for optical fibre cable. These items can be procured as per the Manufacturer/ Supplier's specification, as and when required by the Owner.(This is required if exclusively mention in the Material Requisition).

a) ***Duct Cutter***

This is required to cut the duct ends squarely without any burr or notch.

b) ***C-Spanner***

This is required to tighten Plastic Coupler properly so as to ensure air/water tightness as specified above.

c) ***Blowing Equipment***

The equipment used for installing optical fibre cable by blowing technology shall be capable of pushing 1 km (minimum) cable into the duct with powerful air stream generated by a compressor. The compressor shall have the following characteristics:

Pressure	:	Min 8 bar Max. 12 bar
Flow rate	:	10 m^3/ minute

The mechanical feeder of the equipment shall not cause any damage to the sheath/ jacket of the optical fibre cable.

5.0 **INSPECTION AND TESTS:**

The manufacturer shall perform all inspection and test as per the requirements of this specification and the relevant codes, prior to shipment at this works. Such inspection and test shall be, but not limited to the following:

5.1 **Visual Inspection**

The ducts shall be checked visually for ensuring good workmanship that the ducts shall be free from blisters, shirks hole, flaking, chips, scratches, roughness, break and other defects. the ducts shall be smooth, clean, round. The ends shall be cleanly cut and shall be square with axis of the duct.

5.2 The colour of the duct shall be green and uniform throughout. Each duct shall contain 4 approximately equi-spaced continuous longitudinal stripes of width 3-mm minimum in white colour. These stripes shall be co-extruded during manufacturing. The material of the stripes shall be same as that of base compound for the duct.

5.2.1 In the case of two layer construction the inner layer (Soil Lubricant) shall be white in colour.

5.2.2 The colours of the duct, stripe and inner layer (in the case of two layer construction) shall be identifiable under normal lighting conditions and generally conform to IS-9938.

5.3 **Dimension of Ducts**

The nominal size of the ducts shall be 40/33 mm & 32/26 mm and shall meet the following requirements.

		40 mm/ 33 mm	**32 mm/ 26 mm**
a)	Outside diameter	40 mm + 0.4 mm	32 mm + 0.3 mm
b)	Wall thickness	3.5 mm ± 0.2 mm	3.0 mm ± 0.2 mm
c)	Standard length	1000 ± 100 mtr.	1000 ± 100 mtr.
d)	Maximum Outer Diameter of Optical Fiber Cable (OFC) that can be Installed by air blowing Technique	16 mm	12 mm

Note: Selection of duct size will depend on the outside diameter of the Optical Fiber Cable (OFC) to be installed.

5.4.1 Tensile Strength and Elongation

The samples removed from the PLB HDPE ducts when tested as permanently IS-14151 (Part – I) shall meet the following requirements.

Tensile Strength : Min 20 N/mm^2

Elongation : Min. 350%

5.4.2 Reversion Test:

The test shall be carried out as per IS-4984. For this purpose, a duct length of 200 mm shall be placed horizontally in an air-oven or a suitable liquid bath on a support at 110 ± 2°C for 60 minutes so that the dimensional change in duct section are not impeded. After cooling to room temperature the dimensional change of the duct section shall be measured in the longitudinal direction and the deviation from the initial length shall be calculated and stated in percentage. The dimensions shall not changes by more than 3% in the longitudinal direction.

5.4.3 Environmental Stress Crack Resistance Test:

The specimen cut from the PLB HDPE ducts shall meet the environmental stress cracking as described in ASTM D-1693, when tested with 10% Igepal (CO 630) solution at 50 ±1°C for 96 hours. There shall be no failure.

5.4.4 Impact Strength Test:

The test has to be carried as per IS-12235 (Part – 9). A sample duct 150 mm in length shall be placed on heavy rigid block whose faces are at an angle of 120°. A striker with a hemispherical nose of 13 mm radius and loaded to a total weight of 10 kg shall be allowed to fall freely in a suitable vertical guides through a height of 1.5 m before striking the duct. The line of fall of the striker shall coincide with the diameter of the duct. The duct shall not crack or split.

5.4.5 Crush Resistance Test :

Samples of duct of 150 mm ± 2 mm in length shall be subjected to a dead load of not less than 50 kg for one minute and shall be allowed to recover for 5 minutes. The deflection with load on and after recovery period shall not exceed 10% and 2% respectively.

5.4.6 Mandrel Test:

A 150 mm long mandrel of diameter, 3 mm less than the internal diameter of the duct shall be passed through a 5 meter length of duct, freely throughout the length, when the duct is bent to a radius of 5 meters.

5.4.7 Ovality Test:

Ovality is the difference between maximum outside diameter and the minimum outside diameter at the same cross-section of the duct, at 300 mm away from the end. The ovality for 40/33 mm and 32/26 mm ducts, when measured as per IS_4984 shall not exceed 1.4 mm and 1.3 mm respectively.

5.4.8 Coil Set Test :

The PLB HDPE duct shall unroll of the drums without snaking or waving having zero coil set. Thus the duct shall lay straight into the trench without re-coiling. For this purpose, when a minimum length of 50 meters duct taken from the coil and laid on the ground, it shall be straight without any bends or kinks and without deformation, except 5 meters from each end.

5.4.9 Oxidation Induction Test:

The induction time in oxygen when tested with a copper pan as per method in Annexure – I, shall not be less than 30 minutes.

5.4.10 Hydraulic Characteristics :

The duct shall be tested for internal pressure creep rupture test as per IS-4984. For this purpose, a sample length of 10 times the outside diameter of the duct shall be taken. At the end of the test, the sample shall not shown signs of localised swelling or leakage and shall not burst during the test duration. The test showing failure within a distance equivalent to the length of end cap from the end shall be disregarded and the test repeated. The test temperature and the duration of the test shall be as follows:

Test	Test Temp °C	Test Duration (Hrs.) (Min, holding time)	Induced Stress (Mpa)
Type Test	80	165	3.5
Acceptance test	80	48	3.8

5.4.11 Internal Co-efficient of Friction:

The internal Co-efficient of Friction when tested as permanently method in Annxurer – II, shall not exceed 0.06, when tested with respect to Nylon jacketted unarmored Optical Fiber Cable i.e., 24 F Fiber or 12 F as required.

5.4.12 Optical Fiber Cable Blowing Test:

For this test an Optical fiber Cable of a diameter nearest to the diameter indicated in this specification, relevant to the size of duct under test shall be installed by blowing of the cable in a length of 1 km of the duct. The duct shall be laid with bends in the horizontal

and vertical planes and a raise in the middle. The 1 km section shall include two couplings at suitable locations.

The OFC shall then be blown out. It shall be inspected for any visual damage. The OFC shall then be blown in again.

It shall be possible to blow in the Optical Fiber Cable through the 1 km duct, each time in not more then 30 minutes. There shall be no visible damage to OFC.

The test will be conducted on two samples out of the five submitted for Type Approval.

5.4.13 Owner/ Consultant reserves the right to perform stage – wise inspection and witness tests as indicated above at manufacturer's works prior to shipment. Manufacturer shall give reasonable access and facilities required for inspection to the Owner / Consultant Inspector.

Owner/ Consultant reserved- the right to require additional testing at any time to confirm or further investigation a suspected fault. The cost incurred shall be to manufacturer's account. In no case shall any action Owner/ Consultant or his Inspector relive the manufacturer of his responsibility for material, design, quality etc. Inspection and test performed / withered by the Owner/ Consultant Inspector shall in no way relieve the manufacturer's obligation to perform the required inspection and test.

5.4.14 Test Certificate

Manufacturer shall submit all the test report of the test performed as per above requirement.

The certificates shall be valid only when signed by Owner/ Consultant Inspector. Only the certificate material shall be dispatched from manufacturer works.

6.0 IDENTIFICATION MARKINGS

The duct shall be prominently marked with indelible link, with the following information at intervals every meter to enable identification of the pipe. The size of ink markings shall be distinct, clearly and easily visible.

- Client Name
- Client Logo
- Manufacturer's Name (Also can be abbreviated form)
- Name of the duct with size
- Machine number/ specific serial number of the duct
- Date of manufacturing
- Sequential length marking at every meter.

7.0 **TYPE APPROVAL AND ACCEPTANCE TEST :**

7.1 All the tests mentioned in this document shall be carried out on the 5 standard lengths of ducts and the samples must pass these tests before according the type approval. The supplier shall furnish 5 standard length for carrying out these tests for according type approval. Bulk manufacturer and supply shall start only after issue of type approval. The type approval certificate shall clearly indicated the type/ grade/ source of high-density polyethylene raw material, the size of the duct and the construction of the duct i.e., Two layer of Homogenous.

7.2 Fresh type approval shall be obtained whenever grade/ source of raw material HDPE resin or Solid Lubricant is changed.

7.3 **Acceptance Tests**

7.3.1 The acceptance tests shall be carried out on samples from the lot as per Table – 1 for Dimensional and Visual requirements. The requirements for Tensile Strength & Elongation, Reversion Test, Environmental Stress Crack resistance, Impact Strength, Crush resistance, Oxidation Induction Test, Hydraulic Characteristics and internal Co-efficient of Friction shall be carried out as per Table – 2.

7.3.2 The Owner at his discretion at any point of time can modify the acceptance tests and the sampling plan.

8.0 **STORAGE**

All the material shall be stores in the manufacturer's premises in such a manner that it will not affect the performance of the product.

9.0 **QUALITY ASSURANCE PROGRAM & TESTING**

9.1 **Quality Assurance Program**

a) Vendor shall submit the details for Quality Assurance Program followed by him beginning with raw materials, fabricated components, assemblies, etc., to finished product (AS Applicable). Vendor shall obtain and forward the Quality Assurance Program for equipment supplied by Sub-contractor.

b) The Owner/ Consultant and/ or third appointed agency reserves the right to inspect and test duct and accessories etc. at all stages of production and testing. The inspection and testing shall include but not be limited to materials, sub-assemblies, prototypes, produced units, guaranteed, performance specifications etc.

c) For factory inspection and testing, vendor shall arrange all the is required e.g., quality assurance personnel spaces, test gear etc., for successful carrying out of

the job by the Owner's respectively at vendor's cost at the vendor's/ Manufacturer 's works.

d) Owner's representatives shall have free entry and access to any and all parts of the Vendor's facilities associated with manufacturing and testing of the system at any given time.

e) It shall be explicitly understood that under no circumstances shall any approval of the Owner or his representatives relieve the vendor of his responsibility of material, design, quantity assurance and the guaranteed performance of the system and its constants.

f) Vendor shall invite the Owner/ Consultant, at least 30 days in advance, of the date on which material shall be ready for inspection and testing. All relevant documents and manuals approved engineering drawings, etc shall be provided to the Owner's / consultant's representative's well in advance of the start of inspection and Testing.

g) Owner/ Consultant shall, after completion of inspection and testing to their satisfactory, issues factory acceptance certificate to release duct / accessories for shipment. No. Duct / accessories shall be shipped under any circumstances unless a factory acceptance certificate has been issued for it, unless agreed otherwise by Owner/ Consultant.

h) **PLB HDPE Duct Testing**

Factory testing shall be conducted for acceptance of the duct at the manufacturing facility, wherefrom duct is offered for this project before final acceptance, as per the approval test plan

i) **Accessories Testing :**

Accessories shall be tested before final acceptance, as per the approved test plan.

j) **Test Instruments :**

i) Vendor shall arrange all test equipment's/ instruments, manpower, test-gear, accessories etc. necessary for testing.

ii) All technical personnel assigned by vendor shall be fully conversant with the system specifications and requirements. They shall have the specific capability to make the system operative quickly and efficiently and shall not interface or be interfered by other concurrent construction and commissioning activities in progress. They shall also have the capability to incorporate any minor modification/ suggestions put forward by Owner/ Consultant.

iii) Power supply required for testing shall be arranged by the vendor

iv) *Test Plane*

Vendor shall submit to owner and consultant 'Test Plans' well in advance of commencement of actual testing.

The plans shall include:

- Functional and performance description (in short) and tests to be conducted and purpose of test.
- Test procedures (including time schedule for the tests) and identification of test inputs details and desired test results.

v) *Test report*

The observation and test results obtained during various tests conducted shall be complied and documented to produce test reports by vendor. The test reports shall be given for each equipment / items and system as a whole. The report contain the following information to a minimum/

vi) *Test Results*

- Comparison of tests results with anticipated test result as given in test plans and reasons for deviations if any,
- The data furnished shall prove convincingly that:
- The system meets the Guaranteed performance objective.
- Mechanical/ Optical/ Electrical limits were not exceeded.
- Failure profiles during the tests are well within the specified limits.

10.0 VENDOR DATA REQUIREMENTS AND DOCUMENTATION

10.1 All the documents shall be is English language only.

10.2 Six sets of documents shall be supplied with final submission.

10.3 With the initial bid, the following documents shall be submitted

i) Duct Construction Details and Duct Life.
ii) Accessories Details.
iii) Technical Literature etc.

10.4 Following documents shall be supplied to Owner/ Consultant in order to start Factory Acceptance Testing

a) For Review Approval

i) Detailed Testing procedure for Duct.
ii) Detailed test procedure for accessories
iii) Quality assurance program
iv) Any other data/ documents not specifically mentioned but required for the satisfactory completion of the work

b) For Information

i) Detail technical Literature and manuals for duct & accessories
ii) Installation, Maintenance & Operation Instruction Manual for all the supply items

11.0 PACKAGE AND DELIVERY

The store shall be supplied in coils of suitable size for delivery in such a manner that they arrive at their distribution in a safe and undamaged condition and will permit the loading, unloading and handing the stores using standard moving equipment. The minimum inner bending diameter of technical coiled duct shall be 25 times the outer diameter of the cut. The material used for packaging wrapping sealing, moisture, resistant, corrosion prevents etc. as per applicable shall be of recognized brands and shall conform to best standards for packaging. The packing shall protect the material from impact vibration rough handling rain, dust, damp, insects, rodents etc., Each packing should have packing slip and test dispatch clearance documents.

Table – 1

SCALE OF SAMPLING FOR VISUAL AND DIMENSIONAL, REQUIREMENTS

No. of coils (Duct) in the Lot	Sample No.	Sample Size	Cumulative Sample Size	Acceptance No.	Rejection No.
(1)	(2)	(3)	(4)	(5)	(6)
Up to 150	First	13	13	0	2
	Second	13	26	1	2
151 to 280	First	20	20	0	3
	Second	20	40	3	4
281 to 500	First	32	32	1	4
	Second	32	64	4	5
501 to 1200	First	50	50	2	5
	Second	50	100	6	7
1201 to 3200	First	80	80	3	7
	Second	80	160	8	9
3201 to 10000	First	125	125	5	9
	Second	125	250	12	13
10001 to 35000	First	200	200	7	11
	Second	200	400	18	19

Criteria:

The number of ducts given for the first sample in Column 3 shall be examined for dimension and visual requirements. A duct failing to satisfy any of these requirements shall be considered as defective. The lot shall be deemed to have satisfied these requirements, if the number of defectives found in the first sample are less than or equal to the corresponding acceptance number given in Column 5. The lot shall be deemed not to have met these requirements of the number of defectives found in the first sample is greater than or equal to the corresponding rejection number given in Column 6. If, however, the number of defectives found in the first sample, lies between the corresponding acceptance and rejection numbers given in Column 5 and 6, the second sample of the size given in Column 3 shall be taken and examined for these requirements. The lot shall be considered to have satisfied these requirements, if the number of defectives found in the cumulative sample is less than or equal to the corresponding acceptance number given in Column 5 otherwise not.

TABLE – 2

SAMPLING FOR ACCEPTANCE TESTS

A separate sample size for each of the tests shall be taken as stipulated at random from the samples already examined for dimensions and visual inspection. All the ducts in each of the sample size shall be tested for compliance for the requirements for as per clause no. 5.4 of technical specification:

(a) Tensile Strength & Elongation
(b) Reversion Test
(c) Environmental Stress Crack Resistance
(d) Impact Strength
(e) Crush Resistance
(f) Oxidation Induction Test
(g) Hydraulic Characteristics
(h) Internal Co-efficient of Friction

The lot shall be considered to have met the requirements of these tests, if none of samples tested fails.

No. of Coils	Sample Size
Up to 150	3
151 to 1200	5
1201 to 35000	8

Annexure – I

OXIDATION INDUCTION TEST FOR PLB HDPE DUCT

1.0 A short length of completed duct (approximately 30 cm) shall be sealed at the ends and placed in an oven at temperature of 68 ± 1°C for 8 hours. The sample shall then be allowed to cool at room temperature for at least 16 hours. The sample shall be clean and dry. The sample shall then by tested by means of a Differential Scanning Calorimeter (DSC) or by Differential Thermal Analyser (DTA).

2.0 **INSTRUMENT TEST PROCEDURE :**

2.1 **Cell cleaning**: The cell shall be held at approximately 400 °C for 10 minutes in Nitrogen. The cell shall be cleaned after standing over night and between testing of different formulations.

2.2 **Temperature Calibration**: This has to be done according to the instrument manual. The temperature scale should be adjusted until the determined melting point of pure Indium metal is 156.6 °C at a heat rate of 5 °C per minute or any other heat rate as indicated in the manual of the equipment is permitted.

2.3 **Copper Pan Preparation**: Prepare fresh oxide coatings by holding the pan in the flame of Fisher burner until it begins to glow (about 3 seconds). Remove the pan from the flame and immediately cool in a gentle stream of air. A fresh pan shall be used for each test, and the copper shall be of electrolyte grade.

2.4 **Sample Preparation**: Take the sample weighing about 5 mg from the duct conditioned as indicated above. Position the sample in the center of the copper pan. Cover with clean 316 stainless steel screen (40 mesh) and crimp the pan.

2.5 **Nitrogen Purge**: Place the sample pan and reference pan in instrument cell. Flush for 5 minutes with cylinder of nitrogen (99.6% extra dry grade) at 60 ± 10 cc per minute.

2.6 **Oxidation Test**: Rapidly increase the temperature of the sample (20 °C /min or greater) from 100 °C or lower initial temperature to 199 ± 1°C. After thermal equilibrium is obtained (steady recorder signal) switch to 80 ± 20 cc per minute oxygen flow and simultaneously start time-base recording. The oxygen used for the test should be equivalent to or better than 99.9% extra dry grade.

2.7 **Induction Period**: The oxygen induction point shall be recorded as time zero, and the chart speed shall be sufficient to provide a clearly discernible slope at the start of the exothermic reaction. The test in the pure dry oxygen atmosphere shall continue until the exothermic peak is produced. The intersection of the tangent of the exothermic sloped line with the extended base line will be drawn. The time form time zero to this intersection point is read from the base line and recorded as the oxidative induction time.

Anenxure – 2

INTERNAL CO-EFFICIENT OF FRICTION TEST FOR PLB HDPE DUCT

1. **SCOPE:**

These procedure details the method employed to determine internal friction properties of the duct.

2. **APPARATUS :**

Extensometer machine, circular test fixture of diameter 750 mm (capable of having secured to it), 25 kg weight, optical fibre cable and pulley wheel.

3. **METHOD:**

a) A suitable length of the duct, per-conditioned at 23 $\pm$ 2°C for 2 hours, shall be secured to the text fixture such that the sample completes a 450°C wrap. With one end extending vertically 200 mm towards the floor.

b) A suitable length of optical fibre cable shall be inserted into the sample.

c) The extensometer and the test fixture shall be aligned and secured from movement.

d) The 25 kg tail weight shall be attached to the optical fibre cable extending from the 200 mm vertical extension of the sample such that there is a minimum free travel of 150 mm for the weight.

e) The other end of the optical fibre cable shall be attached via a pulley, to the extensometer such that the planes of travel are in no direction diagonal and there shall be slack remaining in the optical fibre cable.

f) The extensometer shall be operated, and the maximum load applied, in lifting the 25 kg weight to a minimum travel of 150 mm shall be noted.

g) Extensometer conditions
Load : kg or Newtons
Speed : 500 mm / minute
Mode : Tension

4. The co-efficient of friction shall be calculated by the following equation:

Internal Co-efficient of Friction (ICF) = $\log_e$ (T1/T2) / Q

Where, T1 = Pulling force in kg;

T2 = 25 kg

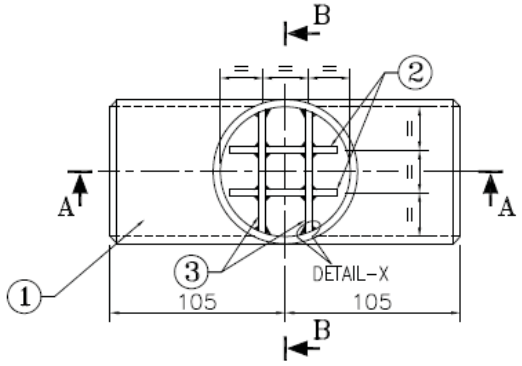
Q = Angle of the subtending are between T1 & T2 in radians (i.e. 450 ° = 7.85398 radians)

****

DATA SHEETS

DRG. NO. MEC/U999/05/25/M/001/028

ITEM NO.	DESCRIPTION	QTY.	MATERIAL
1	TEE B.W. END AS PER ASME16.9 SIZE 4"x4"x4"	1	MSS-SP 75 Gr.WPHY 42/ A860 WPHY 42
2	GUIDE BAR	2	ASTMA – 36 / ASTMA – 516 Gr. 70
3	CONNECTING PLATE	2	ASTMA – 36 / ASTMA – 516 Gr. 70



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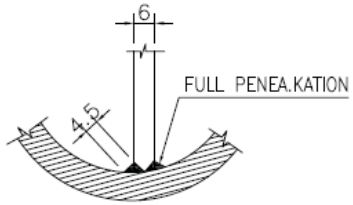


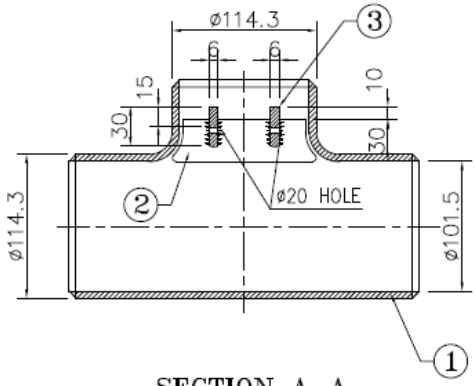
DETAIL–X

DESIGN DATA

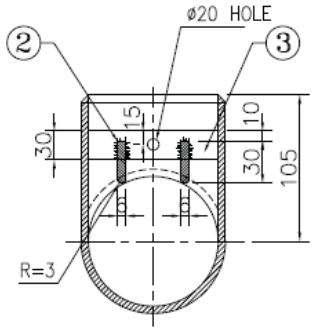
1. SERVICE	:	NATURAL GAS
2. DESIGN PRESSURE	:	49 Kg/cm^2
3. DESIGN TEMP.	:	–29 TO 65°C
4. CORROSION ALLOWANCE	:	1.5mm
5. HYDRO–TEST PRESSURE	:	73.5 Kg/cm^2

CONNECTING PIPE DETAILS

1. RUN PIPE	:	ø4"(114.3) x WT 6.4 mm, API 5L GR. X–42
2. BRANCH PIPE	:	ø4"(114.3) x WT 6.4 mm, API 5L GR. X–42



SECTION A–A



SECTION B–B

NOTES:–

1. THE BARRED TEE IS INTENDED TO BE SUITABLE FOR SCRAPPER PIGS AND USE IN LINE FOR BIRDIRECTIONAL GAS FLOW.
2. THE GUIDE BARS SHALL BE EXTENDED INTO THE RUN SO THAT THEY GET FLUSHED WITH THE INSIDE DIAMETER OF THE SAME.
3. THE CONTOUR OF THE GUIDE BARS SHALL BE SUCH THAT THEY GO ALONG THE INTERNAL SHAPE OF THE BRANCH.
4. THE CONNECTING PLATE SHALL BE WELED WITH THE STRAIGHT PORTION OF THE BRANCH.
5. READ THIS DRAWING TOGETHER WITH MECON'S TECHNICAL SPECIFICATION NO MEC/TS/05/62/025, REV–1 FOR BARRED TEES
6. THE BARRED TEE IS INTENDED TO BE SUITABLE FOR UNDER GROUND INSTALLATION.
7. BUTT–WELD ENDS SHALL BE BEVELED IN ACCORDENCE WITH MSS–SP–75 / B 16.25 AND SHOULD MATCH WITH RUN PIPE AND BRANCH PIPE'S WALL THICKNESS AS INDICATED IN CONNECTING PIPE DETAILS.
8. FOR UNDER GROUND INSTALLATION, THREE COATS OF CORROSION RESISTANCE PAINT/COATING SUITABLE FOR BURRIED APPLICATION SHALL BE APPLIED WITH MINIMUM THICKNESS OF 1000 MICRON. COLOUR OF PAINTING/COATING SHALL BE BLACK HOWEVER ANY CHANGE IN COLOUR SHALL BE FINALISED DURING APPROVAL STAGE.

QUANTITY – AS PER

FOR TENDER PURPOSE

मेकॉन लिमिटेड

MECON LIMITED

CITY GAS DISTRIBUTION NETWORK

BARRED TEES (4"x4"x4")

SECTION	OIL & GAS
LOCATION	NEW DELHI
DESIGNED	PS
DRAWN	SUNIL
CHECKED AND VERIFIED	SUNIL KUMAR
APPROVED	SKI
DATE	21.02.2012
SCALE : NTS	SHEET 1 OF 1
DRG. NO. MEC/U999/05/25/M/001/028	REV 0

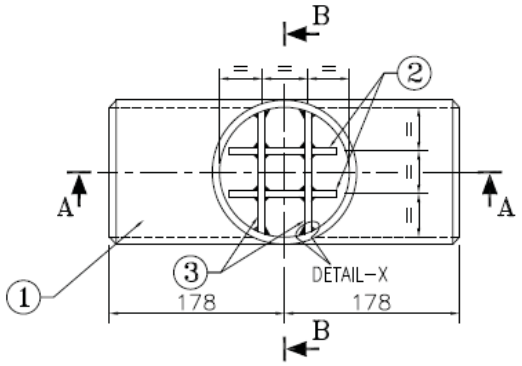
REV NOS | INST. | CONCURRED BY

REV.NO | DATE | ZONE | DESCRIPTION | BY | VERIFIED — REVISION

REFERENCES | DRG.NO.

DRG. NO. MEC/U999/05/25/M/001/028

ITEM NO.	DESCRIPTION	QTY.	MATERIAL
1	TEE B.W. END AS PER ASME16.9 SIZE 8"x8"x8"	1	MSS-SP 75 Gr.WPHY 42/ A860 WPHY 42
2	GUIDE BAR	2	ASTMA - 36 / ASTMA - 516 Gr. 70
3	CONNECTING PLATE	2	ASTMA - 36 / ASTMA - 516 Gr. 70



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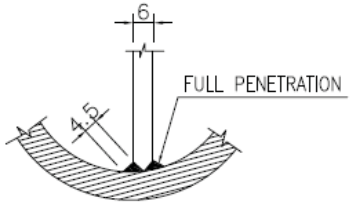


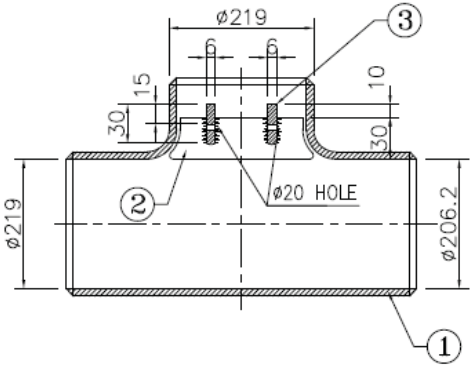
DETAIL-X

DESIGN DATA

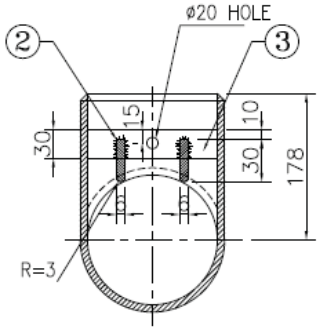
1. SERVICE	:	NATURAL GAS
2. DESIGN PRESSURE	:	49 Kg/cm^2
3. DESIGN TEMP.	:	-29 TO 65°C
4. CORROSION ALLOWANCE	:	1.5mm
5. HYDRO-TEST PRESSURE	:	73.5 Kg/cm^2

CONNECTING PIPE DETAILS

1. RUN PIPE	:	ø8"(219) x WT 6.4 mm, API 5L GR. X-42
2. BRANCH PIPE	:	ø8"(219) x WT 6.4 mm, API 5L GR. X-42



SECTION A-A



SECTION B-B

NOTES:-

1. THE BARRED TEE IS INTENDED TO BE SUITABLE FOR SCRAPPER PIGS AND USE IN LINE FOR BIRDIRECTIONAL GAS FLOW.
2. THE GUIDE BARS SHALL BE EXTENDED INTO THE RUN SO THAT THEY GET FLUSHED WITH THE INSIDE DIAMETER OF THE SAME.
3. THE CONTOUR OF THE GUIDE BARS SHALL BE SUCH THAT THEY GO ALONG THE INTERNAL SHAPE OF THE BRANCH.
4. THE CONNECTING PLATE SHALL BE WELED WITH THE STRAIGHT PORTION OF THE BRANCH.
5. READ THIS DRAWING TOGETHER WITH MECON'S TECHNICAL SPECIFICATION NO MEC/TS/05/62/025, REV-1 FOR BARRED TEES
6. THE BARRED TEE IS INTENDED TO BE SUTABLE FOR UNDER GROUND INSTALLATION.
7. BUTT-WELD ENDS SHALL BE BEVELED IN ACCORDENCE WITH MSS-SP-75 / B 16.25 AND SHOULD MATCH WITH RUN PIPE AND BRANCH PIPE'S WALL THICKNESS AS INDICATED IN CONNECTING PIPE DETAILS.
8. FOR UNDER GROUND INSTALLATION, THREE COATS OF CORROSION RESISTANCE PAINT/COATING SUITABLE FOR BURRIED APPLICATION SHALL BE APPLIED WITH MINIMUM THICKNESS OF 1000 MICRON. COLOUR OF PAINTING/COATING SHALL BE BLACK HOWEVER ANY CHANGE IN COLOUR SHALL BE FINALISED DURING APPROVAL STAGE.

QUANTITY - AS PER

FOR TENDER PURPOSE

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MECON LIMITED

CITY GAS DISTRIBUTION NETWORK

BARRED TEES (8"x8"x8")

SECTION	OIL & GAS
LOCATION	NEW DELHI
DESIGNED	PS
DRAWN	SUNIL
CHECKED AND VERIFIED	SUNIL KUMAR
APPROVED	SKS (A.K.SAXENA)
DATE	21.02.2012
SCALE : NTS	SHEET 1 OF 1
DRG. NO. MEC/U999/05/25/M/001/028	REV. 0

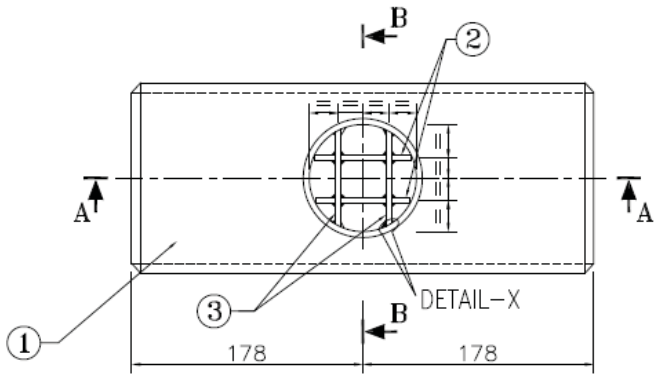
REV. NO. | DATE | ZONE | DESCRIPTION OF REVISION | BY | VERIFIED

REFERENCES | DRG.NO.

INST. | CONCURRED BY

DRG. NO. MEC/U999/05/25/M/001/028

ITEM NO.	DESCRIPTION	QTY.	MATERIAL
1	TEE B.W. END AS PER ASME16.9 SIZE 8"x8"x6"	1	MSS-SP 75 Gr.WPHY 42/ A860 WPHY 42
2	GUIDE BAR	3	ASTMA - 36 / ASTMA - 516 Gr. 60
3	CONNECTING PLATE	2	ASTMA - 36 / ASTMA - 516 Gr. 60



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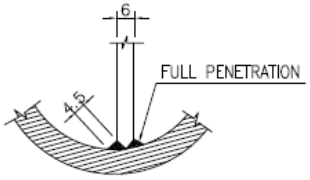


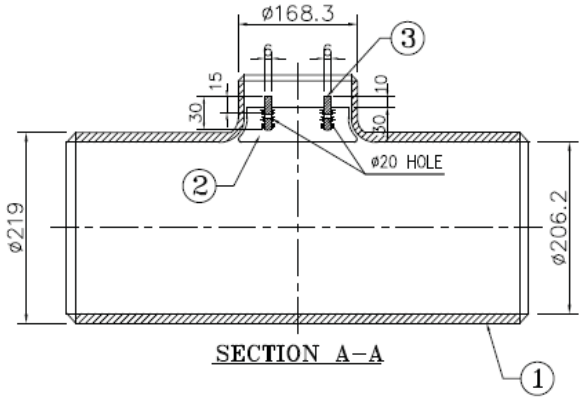
DETAIL-X

DESIGN DATA

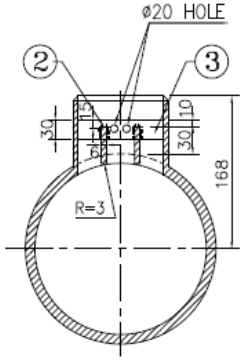
1. SERVICE : NATURAL GAS
2. DESIGN PRESSURE : 49 Kg/cm^2
3. DESIGN TEMP. : -29 TO 65°C
4. CORROSION ALLOWANCE : 1.5mm
5. HYDRO-TEST PRESSURE : 73.5 Kg/cm^2

CONNECTING PIPE DETAILS

1. RUN PIPE : ø8"(219) x WT 6.4 mm. API 5L Gr. X-42
2. BRANCH PIPE : ø6"(168.3) x WT 6.4 mm. API 5L Gr. X-42



SECTION A-A



SECTION B-B

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8. FOR UNDER GROUND INSTALLATION, THREE COATS OF CORROSION RESISTANCE PAINT/COATING SUITABLE FOR BURRIED APPLICATION SHALL BE APPLIED WITH MINIMUM THICKNESS OF 1000 MICRON. COLOUR OF PAINTING/COATING SHALL BE BLACK HOWEVER ANY CHANGE IN COLOUR SHALL BE FINALISED DURING APPROVAL STAGE.

QUANTITY - AS PER

FOR TENDER PURPOSE

मेकॉन लिमिटेड

MECON LIMITED

SECTION	OIL & GAS
LOCATION	NEW DELHI
DESIGNED	PS
DRAWN	SUNIL
CHECKED AND VERIFIED	SUNIL KUMAR
APPROVED	SKS (A.K.SAXENA)
DATE	21.02.2012

CITY GAS DISTRIBUTION NETWORK

BARRED TEES (8"x8"x6")

SCALE : NTS | SHEET 1 OF 1 | REV. 0

DRG. NO. MEC/U999/05/25/M/001/028

REFERENCES DRG.NO.

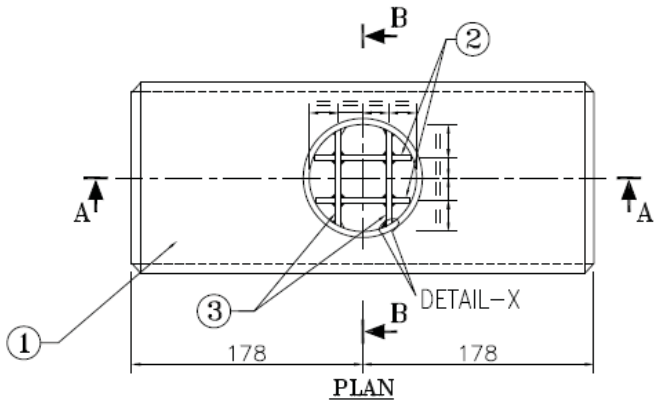
REV. NO. | DATE | ZONE | DESCRIPTION | BY | VERIFIED

REVISION

INST. CONCURRED BY

DRG. NO. MEC/U999/05/25/M/001/028

ITEM NO.	DESCRIPTION	QTY.	MATERIAL
1	TEE B.W. END AS PER ASME16.9 SIZE 8"x8"x4"	1	MSS-SP 75 Gr.WPHY 42/ A860 WPHY 42
2	GUIDE BAR	3	ASTMA - 36 / ASTMA - 516 Gr. 60
3	CONNECTING PLATE	2	ASTMA - 36 / ASTMA - 516 Gr. 60



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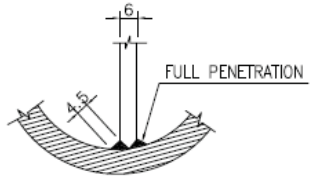

DETAIL-X

DESIGN DATA

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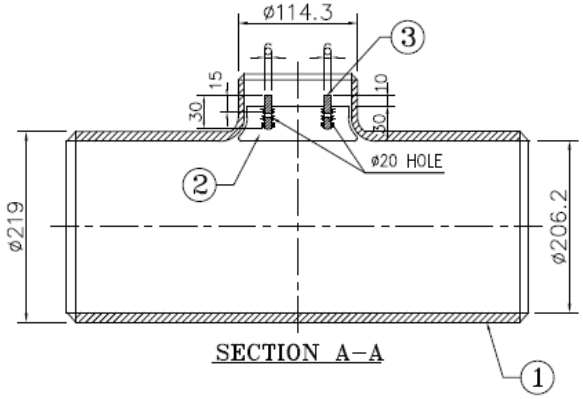
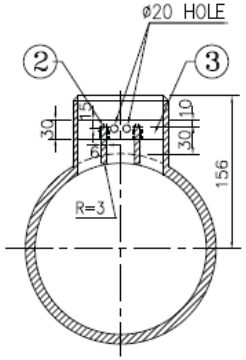
4. CORROSION ALLOWANCE : 1.5mm
5. HYDRO-TEST PRESSURE : 73.5 Kg/cm^2

CONNECTING PIPE DETAILS

1. RUN PIPE : ø8"(219) x WT 6.4 mm. API 5L Gr. X-42
2. BRANCH PIPE : ø4"(114.3) x WT 6.4 mm. API 5L Gr. X-42



SECTION A-A



SECTION B-B

NOTES:-

1. THE BARRED TEE IS INTENDED TO BE SUITABLE FOR SCRAPPER PIGS AND USE IN LINE FOR BIRDIRECTIONAL GAS FLOW.
2. THE GUIDE BARS SHALL BE EXTENDED INTO THE RUN SO THAT THEY GET FLUSHED WITH THE INSIDE DIAMETER OF THE SAME.
3. THE CONTOUR OF THE GUIDE BARS SHALL BE SUCH THAT THEY GO ALONG THE INTERNAL SHAPE OF THE BRANCH.
4. THE CONNECTING PLATE SHALL BE WELED WITH THE STRAIGHT PORTION OF THE BRANCH.
5. READ THIS DRAWING TOGETHER WITH MECON'S TECHNICAL SPECIFICATION NO MEC/TS/05/62/025, REV-1 FOR BARRED TEES
6. THE BARRED TEE IS INTENDED TO BE SUTABLE FOR UNDER GROUND INSTALLATION.
7. BUTT-WELD ENDS SHALL BE BEVELED IN ACCORDENCE WITH MSS-SP-75 / B 16.25 AND SHOULD MATCH WITH RUN PIPE AND BRANCH PIPE'S WALL THICKNESS AS INDICATED IN CONNECTING PIPE DETAILS.
8. FOR UNDER GROUND INSTALLATION, THREE COATS OF CORROSION RESISTANCE PAINT/COATING SUITABLE FOR BURRIED APPLICATION SHALL BE APPLIED WITH MINIMUM THICKNESS OF 1000 MICRON. COLOUR OF PAINTING/COATING SHALL BE BLACK HOWEVER ANY CHANGE IN COLOUR SHALL BE FINALISED DURING APPROVAL STAGE.

QUANTITY - AS PER

FOR TENDER PURPOSE

मेकॉन लिमिटेड

MECON LIMITED

CITY GAS DISTRIBUTION NETWORK

BARRED TEES (8"x8"x4")

SECTION: OIL & GAS | LOCATION: NEW DELHI | DESIGNED: PS | DRAWN: SUNIL | CHECKED AND VERIFIED: SUNIL KUMAR | APPROVED: SIG (A.K.SAHNAY) | DATE: 21.02.2012

SCALE : NTS | SHEET 1 OF 1 | REV. 0

DRG. NO. MEC/U999/05/25/M/001/028

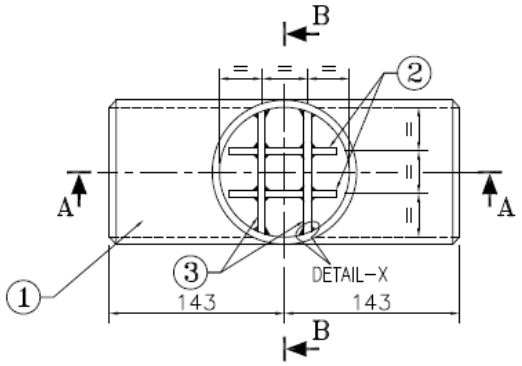
REV. NOS | INST. | CONCURRED BY

REVNO | DATE | ZONE | DESCRIPTION | BY | VERIFIED | REVISION

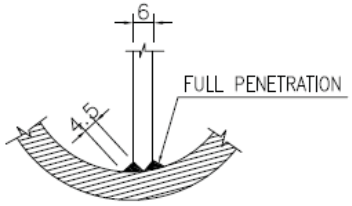
REFERENCES | DRG.NO.

DRG. NO. MEC/U999/05/25/M/001/028

ITEM NO.	DESCRIPTION	QTY.	MATERIAL
1	TEE B.W. END AS PER ASME16.9 SIZE 6"x6"x6"	1	MSS-SP 75 Gr.WPHY 42/ A860 WPHY 42
2	GUIDE BAR	2	ASTMA - 36 / ASTMA - 516 Gr. 70
3	CONNECTING PLATE	2	ASTMA - 36 / ASTMA - 516 Gr. 70



PLAN



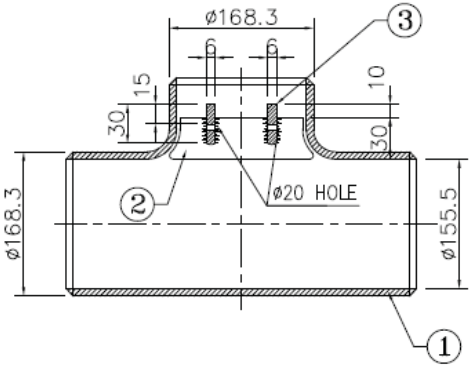
DETAIL-X

DESIGN DATA

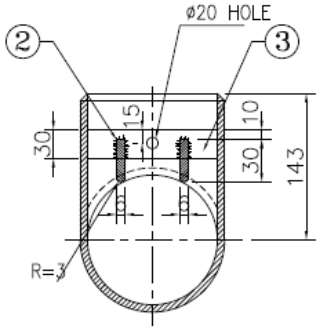
1. SERVICE	:	NATURAL GAS
2. DESIGN PRESSURE	:	49 Kg/cm^2
3. DESIGN TEMP.	:	-29 TO 65°C
4. CORROSION ALLOWANCE	:	1.5mm
5. HYDRO-TEST PRESSURE	:	73.5 Kg/cm^2

CONNECTING PIPE DETAILS

1. RUN PIPE	:	ø6"(168.3) x WT 6.4 mm, API 5L GR. X-42
2. BRANCH PIPE	:	ø6"(168.3) x WT 6.4 mm, API 5L GR. X-42



SECTION A-A



SECTION B-B

NOTES:-

1. THE BARRED TEE IS INTENDED TO BE SUITABLE FOR SCRAPPER PIGS AND USE IN LINE FOR BIRDIRECTIONAL GAS FLOW.
2. THE GUIDE BARS SHALL BE EXTENDED INTO THE RUN SO THAT THEY GET FLUSHED WITH THE INSIDE DIAMETER OF THE SAME.
3. THE CONTOUR OF THE GUIDE BARS SHALL BE SUCH THAT THEY GO ALONG THE INTERNAL SHAPE OF THE BRANCH.
4. THE CONNECTING PLATE SHALL BE WELED WITH THE STRAIGHT PORTION OF THE BRANCH.
5. READ THIS DRAWING TOGETHER WITH MECON'S TECHNICAL SPECIFICATION NO MEC/TS/05/62/025, REV-1 FOR BARRED TEES
6. THE BARRED TEE IS INTENDED TO BE SUTABLE FOR UNDER GROUND INSTALLATION.
7. BUTT-WELD ENDS SHALL BE BEVELED IN ACCORDENCE WITH MSS-SP-75 / B 16.25 AND SHOULD MATCH WITH RUN PIPE AND BRANCH PIPE'S WALL THICKNESS AS INDICATED IN CONNECTING PIPE DETAILS.
8. FOR UNDERGROUND INSTALLATION THREE COATS OF CORROSION RESISTANCE PAINT/COATING SUITABLE FOR BURRIED APPLICATION SHALL BE APPLIED WITH MINIMUM THICKNESS OF 1000 MICRON. COLOUR OF PAINTING/COATING SHALL BE BLACK HOWEVER ANY CHANGE IN COLOUR SHALL BE FINALISED DURING APPROVAL STAGE.

QUANTITY - AS PER

FOR TENDER PURPOSE

मेकॉन लिमिटेड

MECON LIMITED

CITY GAS DISTRIBUTION NETWORK

BARRED TEES (6"x6"x6")

SECTION: OIL & GAS | LOCATION: NEW DELHI | DESIGNED: PS | DRAWN: SUNIL | CHECKED AND VERIFIED: SUNIL KUMAR | APPROVED: SKS (A.K.SAXENA) | DATE: 21.02.2012

SCALE : NTS | SHEET 1 OF 1 | REV. 0

DRG. NO. MEC/U999/05/25/M/001/028

REV. NOS. | INST. | CONCURRED BY

REVNO | DATE | ZONE | DESCRIPTION | BY | VERIFIED — REVISION

REFERENCES | DRG.NO.

ORG. NO. MEC/U999/05/25/M/001/028

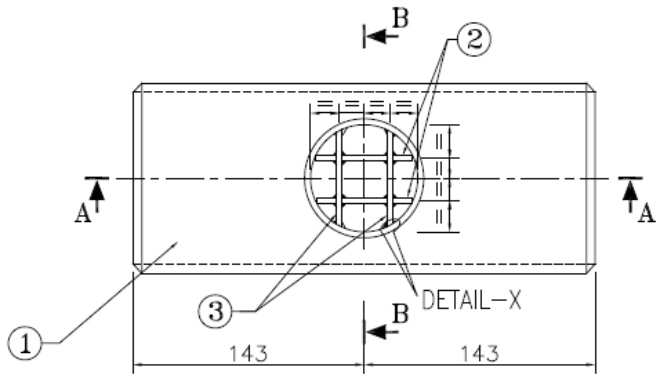
ITEM NO.	DESCRIPTION	QTY.	MATERIAL
1	TEE B.W. END AS PER ASME16.9 SIZE 6"x6"x4"	1	MSS-SP 75 Gr.WPHY 42/ A860 WPHY 42
2	GUIDE BAR	3	ASTMA - 36 / ASTMA - 516 Gr. 60
3	CONNECTING PLATE	2	ASTMA - 36 / ASTMA - 516 Gr. 60

DESIGN DATA

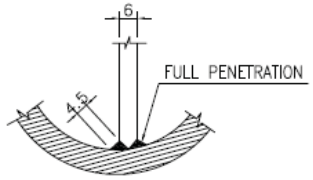
1. SERVICE : NATURAL GAS
2. DESIGN PRESSURE : 49 Kg/cm^2
3. DESIGN TEMP. : -29 TO 65°C
4. CORROSION ALLOWANCE : 1.5mm
5. HYDRO-TEST PRESSURE : 73.5 Kg/cm^2

CONNECTING PIPE DETAILS

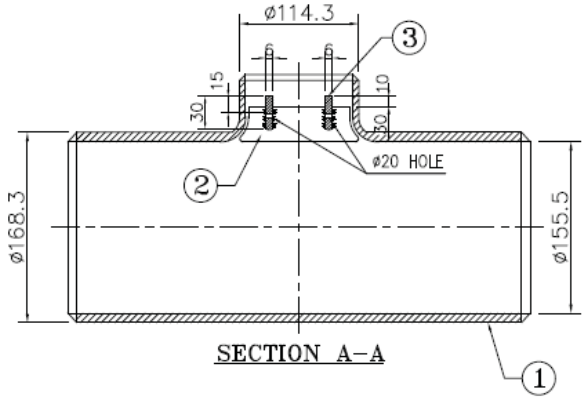
1. RUN PIPE : ø6"(168.3) x WT 6.4 mm. API 5L Gr. X-42
2. BRANCH PIPE : ø4"(114.3) x WT 6.4 mm. API 5L Gr. X-42



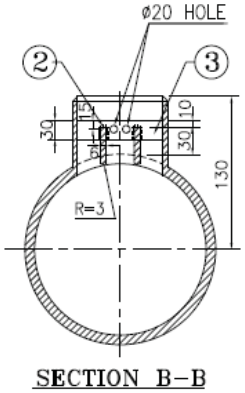
PLAN



DETAIL-X



SECTION A-A



SECTION B-B

NOTES:-

1. THE BARRED TEE IS INTENDED TO BE SUITABLE FOR SCRAPPER PIGS AND USE IN LINE FOR BIRDIRECTIONAL GAS FLOW.
2. THE GUIDE BARS SHALL BE EXTENDED INTO THE RUN SO THAT THEY GET FLUSHED WITH THE INSIDE DIAMETER OF THE SAME.
3. THE CONTOUR OF THE GUIDE BARS SHALL BE SUCH THAT THEY GO ALONG THE INTERNAL SHAPE OF THE BRANCH.
4. THE CONNECTING PLATE SHALL BE WELED WITH THE STRAIGHT PORTION OF THE BRANCH.
5. READ THIS DRAWING TOGETHER WITH MECON'S TECHNICAL SPECIFICATION NO MEC/TS/05/62/025, REV-1 FOR BARRED TEES
6. THE BARRED TEE IS INTENDED TO BE SUTABLE FOR UNDER GROUND INSTALLATION.
7. BUTT-WELD ENDS SHALL BE BEVELED IN ACCORDENCE WITH MSS-SP-75 / B 16.25 AND SHOULD MATCH WITH RUN PIPE AND BRANCH PIPE'S WALL THICKNESS AS INDICATED IN CONNECTING PIPE DETAILS.
8. FOR UNDER GROUND INSTALLATION, THREE COATS OF CORROSION RESISTANCE PAINT/COATING SUITABLE FOR BURRIED APPLICATION SHALL BE APPLIED WITH MINIMUM THICKNESS OF 1000 MICRON. COLOUR OF PAINTING/COATING SHALL BE BLACK HOWEVER ANY CHANGE IN COLOUR SHALL BE FINALISED DURING APPROVAL STAGE.
9. FOR ABOVE GROUND INSTALLATION, THREE COATS OF CORROSION RESISTANCE PAINT APPLICATION SHALL BE APPLIED WITH MINIMUM THICKNESS OF 1000 MICRON (PERMISSIBLE THICKNESS IN EACH COAT SHALL BE 80 TO 120 MICRON) COLOUR OF PAINTING SHALL BE RAL-7038, HOWEVER ANY CHANGE IN COLOUR SHALL BE FINALISED DURING APPROVAL STAGE.

QUANTITY - AS PER

FOR TENDER PURPOSE

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MECON LIMITED

CITY GAS DISTRIBUTION NETWORK

BARRED TEES (6"x6"x4")

REV.	DATE	ZONE	DESCRIPTION	BY	VERIFIED
			REVISION		

REFERENCES DRG.NO.

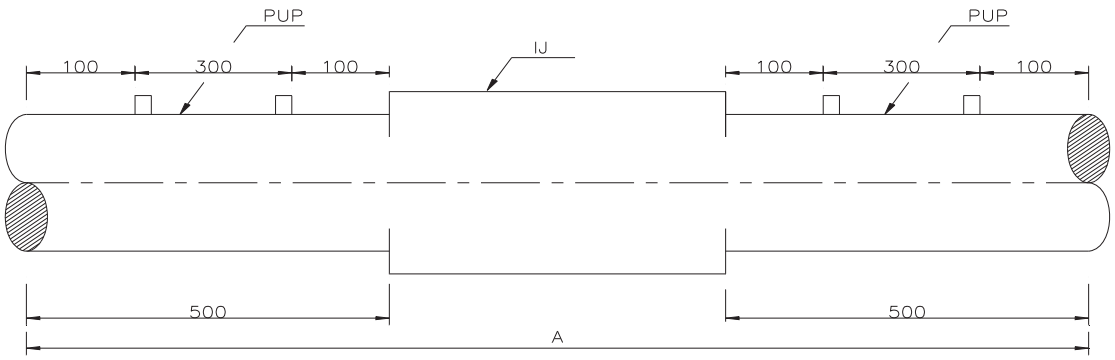
SECTION	OIL & GAS
LOCATION	NEW DELHI
DESIGNED	PS
DRAWN	SUNIL
CHECKED AND VERIFIED	SUNIL KUMAR
APPROVED	(A.K.SARKAR)
DATE	21.02.2012

SCALE : NTS SHEET 1 OF 1 REV.

DRG. NO. MEC/U999/05/25/M/001/028 0

REV. / INST. / MEC CONCURRED BY

DATA SHEET FOR INSULATING JOINTS



A = OVERALL LENGTH OF IJ TO BE CONFIRMED BY MANUFACTURER.

1. INSULATING JOINTS MFR. :
2. PURCHASER'S SPECIFICATION NO. : MEC/TS/05/21/009
3. RATING : 300#
4. DESIGN PRESSURE : 49 KG/CM^2(G)
5. DESIGN TEMPERATURE :(-)29°C to (+)65°C
6. SERVICE : Natural Gas
7. CORROSION ALLOWANCE : 1.5 MM
8. SIZE NB MM(INCHES) : 101.6(4")
9. END CONNECTION : BUTT-WELD AT BOTH ENDS
10. DESIGN CODE : ASME SECTION-VIII DIV-I
11. DESIGN FACTOR : 0.5
12. HYDROSTATIC TEST PRESSURE : 73.5 KG/CM2(G)
13. CHARPY TEST : REQUIRED AS PER SPEC.
14. HARDNESS TEST : REQUIRED AS PER SPEC.
15. MATERIALS SPECIFICATION (EQUIVALENT OR SUPERIOR)
    A) BODY : ASTM A-105
    B) PUPS : ASTM A 106 Gr.B(Charpy) , 6.4mm THK(Min.)
    C) INSULATING MATERIAL : AS PER MANUFACTURER'S STANDARD
16. CONNECTING PIPE SPECIFICATION

SIZE, NB MM (INCHES)	101.6(4")
WALL THICKNESS, MM	6.4 (Min.)
GRADE	X-42

17. SPECIAL REQUIREMENTS : INSULATION JOINT SHALL BE SUITABLE FOR ABOVE GROUND INSTALLATION
18. QUANTITY : as per SOR.
19. TAG NOS. :

REV. NO.	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS					

SECTION PROCESS & PIPING					STANDARAD DRAWING	
	NAME	DATE	CHKD	DATE		
DSGN					PROJECT : CITY GAS Distribution Project	
DRWN						
APPROVED					DATA SHEET FOR INSULATING JOINTS	

REFERENCES | DRG. NO.

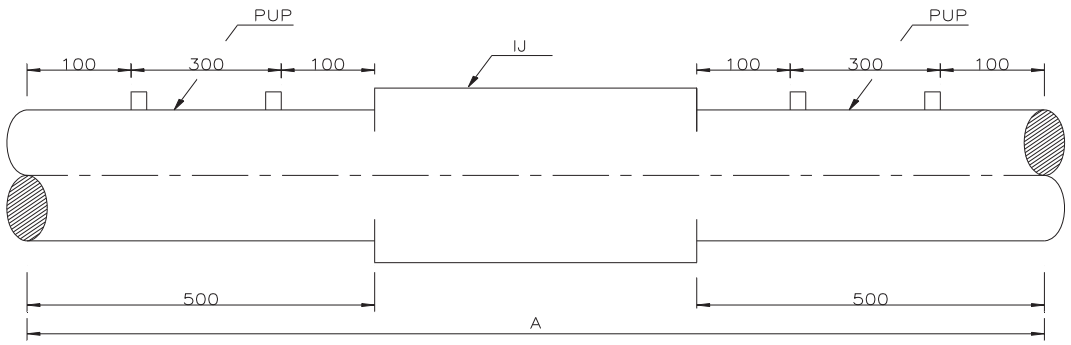
MECON LIMITED

SCALE :

DATA SHEET NO.: MEC/U999/05/21/M/001/DS-009-01

REV 0

DATA SHEET FOR INSULATING JOINTS



A = OVERALL LENGTH OF IJ TO BE CONFIRMED BY MANUFACTURER.

1. INSULATING JOINTS MFR. :
2. PURCHASER'S SPECIFICATION NO. : MEC/TS/05/21/009
3. RATING : 300#
4. DESIGN PRESSURE : 49 Kg/cm2(g)
5. DESIGN TEMPERATURE : (-)29°C to 65°C
6. SERVICE : NATURAL GAS / RLNG
7. CORROSION ALLOWANCE : 1.5 MM
8. SIZE NB MM (INCHES) : 200(8")
9. END CONNECTION : BUTT-WELD AT BOTH ENDS
10. DESIGN CODE : ASME SECTION-VIII DIV-I
11. DESIGN FACTOR : 0.5
12. HYDROSTATIC TEST PRESSURE : 73.5 Kg/cm2(g)
13. CHARPY TEST(BODY, WELDING ENDS) : REQUIRED AT (-) 20^0C, CV (Avg.) - 35 J/cm^2 / CV (Min.) - 28 J/cm^2 (Min. 3 Samples)
14. HARDNESS TEST : REQUIRED AS PER SPEC.
15. MATERIALS SPECIFICATION (EQUIVALENT OR SUPERIOR)
    - A) BODY : ASTM A-694, F-42
    - B) PUPS : API 5L X-42 ,6.4 mm THK.(MIN.)
    - C) INSULATING MATERIAL : AS PER MANUFACTURER'S STANDARD
16. CONNECTING PIPE SPECIFICATION

SIZE, NB, MM (INCHES)	200 (8")
WALL THICKNESS, MM(MIN.)	6.4
GRADE	API 5L Gr. X42

17. SPECIAL REQUIREMENTS : INSULATION JOINT SHALL BE SUITABLE FOR ABOVE GROUND INSTALLATION
18. QUANTITY : as per SOR
19. TAG NOS. :

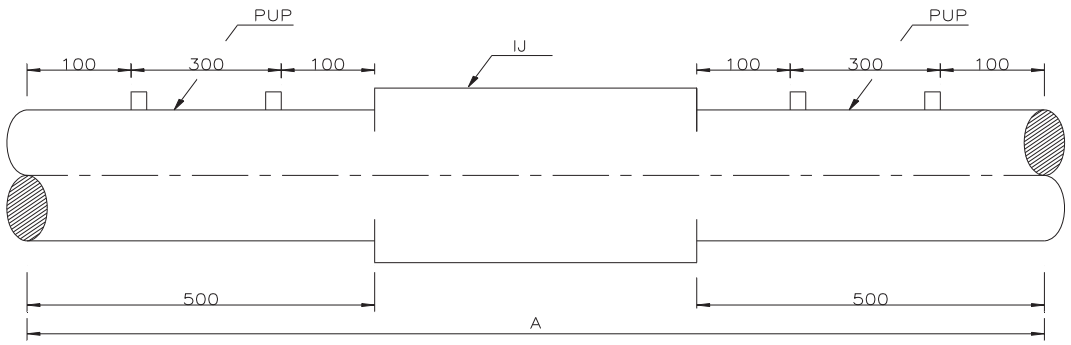
Note: Manufacturer shall ensure that the wall thickness (W.T.) of all parts of insulating joint shall be adequate to sustain design pressure and selected W.T. shall be suitable for welding with W.T. of connected pipeline.

REV. NO.	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS					

REFERENCES			DRG. NO.				
SECTION OIL & GAS			STANDARD DRAWING				
	NAME	DATE	CHKD	DATE		MECON LIMITED	
DSGN	Ssinghal		RKN		PROJECT : CITY GAS Distribution Project		
DRWN	Ssinghal		RKN				
APPROVED			DATA SHEET FOR INSULATING JOINTS		SCALE :		REV
					DATA SHEET NO.: MEC/U999/05/21/M/000/DS-009-03		0

d:\BNPL\IJ\Data Sheet - IJ - 01-8 inches-300 #

DATA SHEET FOR INSULATING JOINTS



A = OVERALL LENGTH OF IJ TO BE CONFIRMED BY MANUFACTURER.

1. INSULATING JOINTS MFR. :
2. PURCHASER'S SPECIFICATION NO. : MEC/TS/05/21/009
3. RATING : 300#
4. DESIGN PRESSURE : 49 Kg/cm2(g)
5. DESIGN TEMPERATURE : (-)29°C to 65°C
6. SERVICE : NATURAL GAS / RLNG
7. CORROSION ALLOWANCE : 1.5 MM
8. SIZE NB MM (INCHES) : 150(6")
9. END CONNECTION : BUTT-WELD AT BOTH ENDS
10. DESIGN CODE : ASME SECTION-VIII DIV-I
11. DESIGN FACTOR : 0.5
12. HYDROSTATIC TEST PRESSURE : 73.5 Kg/cm2(g)
13. CHARPY TEST(BODY, WELDING ENDS) : REQUIRED AT (-) 20^0C, CV (Avg.) - 35 J/cm^2 / CV (Min.) - 28 J/cm^2 (Min. 3 Samples)
14. HARDNESS TEST : REQUIRED AS PER SPEC.
15. MATERIALS SPECIFICATION (EQUIVALENT OR SUPERIOR)
    - A) BODY : ASTM A-694, F-42
    - B) PUPS : API 5L X-42 ,6.4 mm THK.(MIN.)
    - C) INSULATING MATERIAL : AS PER MANUFACTURER'S STANDARD
16. CONNECTING PIPE SPECIFICATION

SIZE, NB, MM (INCHES)	200 (8")
WALL THICKNESS, MM(MIN.)	6.4
GRADE	API 5L Gr. X42

17. SPECIAL REQUIREMENTS : INSULATION JOINT SHALL BE SUITABLE FOR ABOVE GROUND INSTALLATION
18. QUANTITY : as per SOR
19. TAG NOS. :

Note: Manufacturer shall ensure that the wall thickness (W.T.) of all parts of insulating joint shall be adequate to sustain design pressure and selected W.T. shall be suitable for welding with W.T. of connected pipeline.

REV. NO.	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS					

SECTION OIL & GAS					**STANDARD DRAWING**	REFERENCES / DRG. NO.
	NAME	DATE	CHKD	DATE		**MECON LIMITED**
DSGN	Ssinghal		RKN		**PROJECT : CITY GAS Distribution Project**	
DRWN	Ssinghal		RKN			
APPROVED					**DATA SHEET FOR INSULATING JOINTS**	SCALE : / DATA SHEET NO.: MEC/U999/05/21/M/000/DS-009-02 / REV 0

d:\BNPL\IJ\Data Sheet - IJ - 01-6 inches-300 #

DATA SHEET FOR SOCKET WELED PLUG VALVE

1.0 Valve Manufacturer :

2.0 Valve Size (NB), mm (inch) : **1" NB & 1½" NB** ANSI Rating : **800#** Design Standard : **BS:5353**

3.0 MECON's Technical Specification No. :

4.0 Connecting Pipeline Design Pressure, Bar : 49 Design Temperature, °C : **-29°C to +65°C**

5.0 **Connecting Pipe Specification**

5.1 Material : A106 Gr. B

5.2 Diameter (OD), mm (inch) : 33.4mm(1") & 48.3mm (1½")

5.3 Thickness, mm : 4.5mm (for 1") & 5.1mm (for 1½")

6.0 **Valve Construction Design**

6.1. Pattern : Short [√] Regular [ ] Venturi [ ]

6.2. End Connections : **Flanged both ends** [ ] **Flanged as per ASME B 16.5**

: **Butt Weld both ends** [ ] **Butt Weld as per ASME B16.25**

: **Socket Weld both ends** [√] Socket Welded 3000# (as per ASME B16.11)

100 mm Extension Pups in ASTM A106 Gr. B (Sch. 160 for 1/2" & 3/4" & Sch.80 for 1" & 1½") at both ends

6.3. Flanges (wherever applicable) : a) RF [ ] FF [ ] RTJ [ ] NA [√]

b) Serrated [ ] Smooth (125 to 200 microinches AARH) [ ] NA [√]

7.0 **Valve Material Specification**

	Part	Specified Material	Material Offered (Equivalent or Superior)
7.1	Body	**ASTM A105**	
7.2	Plug (Lubricated)	**ASTM A105 + 75 microns ENP**	
7.3	Stem (No Casting)	**(AISI 4140 + 75 microns ENP Coating)/ AISI 410**	
7.4	Gland	**ASTM A105**	
7.5	Gland Packing	**Graphite/ PTFE**	
7.6	Gasket	**N.A.**	
7.7	Body Studs/Nuts	**ASTM A193 Gr. B7/ A194 Gr. 2H**	
7.8	Lubricant Screw	**Manufacturer's Standard**	

8.0 Corrosion Allowance : **1.5 mm** Service : **Natural Gas**

9.0 Location : Above Ground [√] Buried [ ]

10.0 Stem Extension Requirement : Yes [ ] No [√]

11.0 Gear Operator Requirement : Yes [ ] No [√]

12.0 Gas Powered Actuator Requirement : Yes [ ] No [√]

13.0 Fire Resistant Design Requirement : **Type-Test as per Standard API 607/BS EN: 10497**

14.0 **Valve Testing Requirement**

			Test Pressure (min.), kg/cm2(g)	Minimum Duration, minutes
14.1	Hydrostatic Test	Body	**210**	**2**
		Seat	**155**	**2**
14.2	Air Test		**5.6 - 7**	**15**

15.0 **Valve Painting Specification**

15.1 Surface preparation by Short Blasting as per grade SA 2 1/2, Swedish Standard SIS-055 909.

15.2 For above ground installation-Three coats of corrosion resistant paint shall be applied with minimum thickness of 300 micron (Permissible thickness in each coat shall be within 80 to 120 micron). Colour of paint shade shall be RAL-7038, however any change in colour shall be finalized during drawing approval stage.

16. Lock Open/Lock Close Requirement: **As indicated in P&ID / Schedule of Rates (SOR)**

Notes:

1. Valves shall have an inherent feature using the line pressure to ensure that the line pressure cannot cause taper locking of the plug/ plug movement into the taper, i.e., valves shall be of "pressure-balanced design".
2. Painting procedure of valves shall be as per Manufacturer's standard.
3. Material test certificates and hydrostatic test reports shall be furnished prior to despatch.
4. Charpy V-notch test for body, plug, stem & studs/nuts will be conducted as per relevant material code.
5. Detailed dimensional drawings showing cross-section with part numbers and materials shall be submitted for Purchaser's approval prior to manufacture of the valves.
6. Valves shall have valve position indicator.
7. Stops shall be provided to ensure positive alignment of plug with ports and ensure proper installation of handle.
8. Each valve shall be provided with a wrench.
9. Valves shall be inspected and approved by Purchaser before despatch.
10. Gland packing assembly shall permit repair of gland packing under full line pressure.
11. Inspection and Testing shall be done as per data sheet, specification & BS:12266 (Part-I).
12. Minimum all pressure containing and controlling parts of the valve shall be provided with EN 10204-3.2 certificate.
13. Attached generic QAP shall be admitted for approval after making necessary changes considering 3.2 certification aspect.
14. Minimum port area for regular pattern shall be 55%.
15. Bidder shall clearly write valves material (equivalent or superior) offered by them against each part/material of the valve in the space provided for. Wherever bidder agrees with valves material as mentioned above in Mecon's datasheet, bidder shall clearly indicate **"Agreed".**

REV. NO.	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS					

REFERENCES DRG. NO.

SECTION OIL & GAS

STANDARD DRAWING

SUPPLIER :

SUB SUPPLIER :

PROJECT : City Gas Distribution Project

	NAME	DATE	CHKD	DATE
DSGN	Sachin	21.02.15	Harsh	21.02.15
DRWN				

MECON LIMITED

APPROVED Anil Kumar DGM

DATA SHEET FOR PLUG VALVES (NB < 2")

SCALE :

Data Sheet No.: MEC/U999/05/28/M/001/DS/PV/78

REV 0

DATA SHEET FOR BUTT WELDED PLUG VALVE

1.0 Valve Manufacturer :

2.0 Valve Size (NB), mm (inch) **: 2"** **ANSI Rating : 300** Design Standard : **API 6D**

3.0 MECON's Technical Specification No. : **MEC/TS/05/62/003, Rev-2**

4.0 Connecting Pipeline Design Pressure, Bar : 49 **Design Temperature, C : -29 C to 65 C**

5.0 **Connecting Pipe Specification**

5.1 Material **: ASTM A106 Gr. B (Charpy)**

5.2 Diameter (OD), mm (inch) **: 60.3 mm**

5.3 Thickness, mm **: 5.54 mm**

6.0 **Valve Construction Design**

6.1. Pattern : Short [√] Regular [ ] Venturi [ ]

6.2. End Connections : **Flanged both ends** [ ] Flanged as per ASME B 16.5

: **Butt Weld both ends** [√] Butt Weld as per ASME B16.25

: **Flanged one end, butt weld other end** [ ]

6.3. Flanges (wherever applicable) : a) RF [ ] FF [ ] RTJ [ ] NA [√]

b) Serrated [ ] Smooth (125 to 200 microinches AARH) [ ] NA [√]

7.0 **Valve Material Specification**

	Part	Material	Material Offered (Equivalent or Superior)
7.1	Body	**ASTM A216 Gr. WCB/ A234 Gr. WPB**	
7.2	Plug	**(ASTM A216 Gr. WCB/ A234 Gr. WPB) 75 microns ENP Coating**	
7.3	Cover	**ASTM A216 Gr. WCB/ A234 Gr. WPB**	
7.4	Stem (No Casting)	**(AISI 4140 75 microns ENP Coating)/ AISI 410**	
7.5	Stem Seal	**PTFE/Graphite**	
7.6	Stud Bolts/ Nuts	**ASTM A193 Gr. B7/ A194 Gr. 2H**	

8.0 Corrosion Allowance : **1.5 mm** Service : **Natural Gas**

9.0 Location : Above Ground [√] Buried [ ]

10.0 Stem Extension Requirement : Yes [ ] No [√]

11.0 Gear Operator Requirement : Yes [ ] No [√]

12.0 Gas Powered Actuator Requirement : Yes [ ] No [√]

13.0 Fire Resistant Design Requirement : **Type-Test as per Standard API 6FA/ BS EN: 10497**

14.0 **Valve Testing Requirement**

			Test Pressure (min.), kg/cm2(g)	Minimum Duration, minutes
14.1	Hydrostatic Test	Body	**76**	**As per API 6D**
		Seat	**57**	**As per API 6D**
14.2	Air Test		**5.6 - 7**	**As per API 6D**

15.0 **Valve Painting Specification**

15.1 Surface preparation by Short Blasting as per grade SA 2 1/2, Swedish Standard SIS-055 909.

15.2 For above ground installation-Three coats of corrosion resistant paint shall be applied with minimum thickness of 300 micron (Permissible thickness in each coat shall be within 80 to 120 micron). Colour of paint shade shall be RAL-7038, however any change in colour shall be finalized during drawing approval stage.

16.0 Lock Open/ Lock Close Requirement : **As indicated in P&ID./ Schedule of Rates (SOR)**

Notes:

1. This Valve Data Sheet shall be read in conjunction with MECON's Technical Specification No. MEC/TS/05/62/003, Rev2
2. Inspection and Testing shall be as per attached QAP, this Data Sheet, MECON's T.S., API 6D and other relevant standards.
3. Stops shall be provided for positive alignment of plug with ports and ensure proper installation of handle.
4. Charpy V- notch & Hardness test for body, plug, cover, stem & studs/nuts shall be conducted as per Clause No.: 3.4 & 3.5 of TS respectively.
5. Minimum all pressure containing and controlling parts of the valve shall be provided with EN 10204-3.2 certificate.
6. Attached generic QAP shall be submitted for approval after making necessary changes considering 3.2 certification aspect.
7. Material for body shall have a guaranteed minimum yield strength of 35000 psi. In case the same cannot be guaranteed, valves shall be provided with a 500 mm pup piece (integrally welded to the valve on each side) with strength equivalent to that of the connecting pipe.
8. For welding end, the out of roundness (i. e. difference between maximum and minimum ID at pipe end) shall not be more than 0.5% of pipe OD.
9. Bidder shall clearly write valves material (equivalent or superior) offered by them against each part/material of valve in the space provided for. Wherever bidder agrees with valves material as mentioned above in MECON's data sheet, bidder shall clearly indicate **"AGREED".**

REV. NO.	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS					

REFERENCES	DRG. NO.

SECTION OIL & GAS					STANDARD DRAWING
	NAME	DATE	CHKD	DATE	SUPPLIER :
DSGN	Sachin	21.02.15	Harsh	21.02.15	SUB SUPPLIER :
DRWN					PROJECT : City Gas Distribution Project

MECON LIMITED

APPROVED	Anil Kumar DGM	**DATA SHEET FOR BWE PLUG VALVES (NB ≥ 2")**	SCALE :	REV
			DATA SHEET NO.:MEC/U999/05/28/M/001/DS/PV/76	0

DATA SHEET FOR FLANGE END PLUG VALVE

1.0 Valve Manufacturer :

2.0 Valve Size (NB), mm (inch) **: 2"** **ANSI Rating : 300** Design Standard : **API 6D**

3.0 MECON's Technical Specification No. : **MEC/TS/05/62/003, Rev-2**

4.0 Connecting Pipeline Design Pressure, Bar : 49 **Design Temperature, C : -29 C to 65 C**

5.0 **Connecting Pipe Specification**
5.1 Material **Not applicable**
5.2 Diameter (OD), mm (inch) **:**
5.3 Thickness, mm **:**

6.0 **Valve Construction Design**
6.1. Pattern : Short [√] Regular [ ] Venturi [ ]
6.2. End Connections : **Flanged both ends** [√] Flanged as per ASME B 16.5
: **Butt Weld both ends** [ ] Butt Weld as per ASME B16.25
: **Flanged one end, butt weld other end** [ ]
6.3. Flanges (wherever applicable) : a) RF [√] FF [ ] RTJ [ ] NA [ ]
b) Serrated [ ] Smooth (125 to 200 microinches AARH) [√] NA [ ]

7.0 **Valve Material Specification**

	Part	Material	Material Offered (Equivalent or Superior)
7.1	Body	**ASTM A216 Gr. WCB/ A234 Gr. WPB**	
7.2	Plug	**(ASTM A216 Gr. WCB/ A234 Gr. WPB) 75 microns ENP Coating**	
7.3	Cover	**ASTM A216 Gr. WCB/ A234 Gr. WPB**	
7.4	Stem (No Casting)	**(AISI 4140 75 microns ENP Coating)/ AISI 410**	
7.5	Stem Seal	**PTFE/Graphite**	
7.6	Stud Bolts/ Nuts	**ASTM A193 Gr. B7/ A194 Gr. 2H**	

8.0 Corrosion Allowance : **1.5 mm** Service : **Natural Gas**

9.0 Location : Above Ground [√] Buried [ ]

10.0 Stem Extension Requirement : Yes [ ] No [√]

11.0 Gear Operator Requirement : Yes [ ] No [√]

12.0 Gas Powered Actuator Requirement : Yes [ ] No [√]

13.0 Fire Resistant Design Requirement : **Type-Test as per Standard API 6FA/ BS EN: 10497**

14.0 **Valve Testing Requirement**

			Test Pressure (min.), kg/cm2(g)	Minimum Duration, minutes
14.1	Hydrostatic Test	Body	**76**	**As per API 6D**
		Seat	**57**	**As per API 6D**
14.2	Air Test		**5.6 - 7**	**As per API 6D**

15.0 **Valve Painting Specification**
15.1 Surface preparation by Short Blasting as per grade SA 2 1/2, Swedish Standard SIS-055 909.
15.2 For above ground installation-Three coats of corrosion resistant paint shall be applied with minimum thickness of 300 micron (Permissible thickness in each coat shall be within 80 to 120 micron). Colour of paint shade shall be RAL-7038, however any change in colour shall be finalized during drawing approval stage.

16.0 Lock Open/ Lock Close Requirement : **As indicated in P&ID / Schedule of Rates (SOR).**

Notes:
1. This Valve Data Sheet shall be read in conjunction with MECON's Technical Specification No. MEC/TS/05/62/003, Rev2
2. Inspection and Testing shall be as per attached QAP, this Data Sheet, MECON's T.S., API 6D and other relevant standards.
3. Stops shall be provided for positive alignment of plug with ports and ensure proper installation of handle.
4. Charpy V- notch & Hardness test for body, plug, cover, stem & studs/nuts shall be conducted as per Clause No.: 3.4 & 3.5 of TS respectively.
5. Minimum all pressure containing and controlling parts of the valve shall be provided with EN 10204-3.2 certificate.
6. Attached generic QAP shall be submitted for approval after making necessary changes considering 3.2 certification aspect.
7. Material for body shall have a guaranteed minimum yield strength of 35000 psi. In case the same cannot be guaranteed, valves shall be provided with a 500 mm pup piece (integrally welded to the valve on each side) with strength equivalent to that of the connecting pipe. **- N.A.**
8. For welding end, the out of roundness (i. e. difference between maximum and minimum ID at pipe end) shall not be more than 0.5% of pipe OD. **- N.A.**
9. Bidder shall clearly write valves material (equivalent or superior) offered by them against each part/material of valve in the space provided for. Wherever bidder agrees with valves material as mentioned above in MECON's data sheet, bidder shall clearly indicate **"AGREED".**

REV. NO.	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS				REFERENCES	DRG. NO.

SECTION OIL & GAS					STANDARD DRAWING		
	NAME	DATE	CHKD	DATE	SUPPLIER :		
DSGN	Sachin	21.02.15	Harsh	21.02.15	SUB SUPPLIER :		**MECON LIMITED**
DRWN					PROJECT : City Gas Distribution Project		
APPROVED		Anil Kumar DGM			**DATA SHEET FOR FLANGED PLUG VALVES (NB ≥ 2")**	SCALE : DATA SHEET NO.:MEC/U999/05/28/M/001/DS/PV/77	REV 0

DATA SHEET FOR BUTT WELDED END BALL VALVES

1.0 Valve Manufacturer :

2.0 Valve Size (NB), mm (inch) : 2"NB ANSI Rating : **300** Design Standard : **API 6D**

3.0 MECON's Technical Specification No. : **MEC/TS/05/21/002, Rev-1, Ed-1**

4.0 Connecting Pipeline Design Pressure, bar **: 49** Design Temperature, °C : **-29 C to 65 C**

5.0 **Connecting Pipe Specification** :
5.1 Material **ASTM A106 Gr. B**
5.2 Diameter (OD), mm (inch) : 60.3 mm
5.3 Thickness, mm : 5.54 mm

6.0 **Valve Construction Design**
6.1. Configuration : Reduced Bore [ ] Full Bore [√]
6.2. End Connections : Flanged as per ASME B16.5 [ ] Butt Welded as per ASME B16.25 [√]
6.3. Flanges (wherever applicable) : a) RF [ ] [ ] RT [ ] NA [√]
b) Serrated [ ] Smooth (125 to 200 microinches AARH) [ ] NA [√]
6.4 Ball Mounting **: Floating upto 4 and Trunnion Mounted 6 and above**
6.5 Valve body type : Fully Welded [ ] Two/Three Piece Bolted [ ] Either [√]

7.0 **Valve Material Specification**

	Part	Specified Material	Material Offered (Equivalent or superior)
7.1	Body	**A 216 Gr. WCB/A 234 Gr. WPB**	
7.2	Ball	**(A 216 Gr.WCB/A 234 Gr.WPB) 75 ENP coating/AISI410**	
7.3	Body Seat Rings (No Casting)	**AISI 4140 75 micron ENP coating/AISI 410**	
7.4	Seat Seal	**VITON/DEVLON**	
7.5	Stem (No casting)	**AISI 4140 75 micron ENP coating/AISI 410**	
7.6	Stem Seals	**VITON/PTFE**	
7.7	Stud Bolts/ Nuts	**ASTM A 193 Gr. B7/ A194 Gr. 2H**	

8.0 Corrosion Allowance : **1.5 mm** Service : **Natural Gas**

9.0 Location : Above Ground [√] Buried [ ]

10.0 Stem Extension Requirement : Yes [ ] No [√] Length of Stem Extension, m : N.A

11.0 Gear Operator Requirement : Yes [ ] No [√]

12.0 Actuator Requirement : Yes [ ] No [√]

13.0 Fire Resistant Design Requirement **: Type test as per API 607 for Floating Ball valve.**

14.0 **Valve Testing Requirement**

			Test Pressure (min.), kg/cm^2(g)	Minimum Duration, minutes
14.1	Hydrostatic Test	Body	**76**	**As per API 6D**
		Seat	**57**	**As per API 6D**
14.2	Air Test		**5.6-7**	**As per API 6D**

15.0 Anti-Static Testing Requirement : **As per Standard API 6D (Latest Ed.)**

16.0 **Valve Painting Specification**
16.1 Surface preparation by Short Blasting as per grade SA 2 1/2, Swedish Standard SIS-055 909.
16.2 For above ground installation-Three coats of corrosion resistant paint shall be applied with minimum thickness of 300 micron (Permissible thickness in each coat shall be within 80 to 120 micron). Colour of paint shade shall be RAL-7038, however any change in colour shall be finalized during drawing approval stage.
17.0 Lock Open/ Lock Close/Normally Close Requirement : **As indicated in P&ID./ Schedule of Rates (SOR)**

Notes:
1. This Valve Data Sheet shall be read in conjunction with MECON's Technical Specification No. MEC/TS/05/21/002,Rev 1 ,Ed. 1
2. Inspection and Testing shall be as per attached QAP, this Data Sheet, MECON's T.S., API 6D and other relevant standards.
3. Stops shall be provided for positive alignment of ball with ports and ensure proper installation of handle.
4. Short pattern valves (as per API 6D or otherwise) are not permitted. Only long pattern valves are to be supplied.
5. Charpy V-notch & Hardness test for body, body adaptor, end flanges, ball, body seat rings, stem & studs / nuts shall be conducted as per Cl. 3.4 & 3.6 of TS respectively or as per relevant material code.
6. Compressed asbestos fibre (CAF) shall not be used for body sealing / gasket materials.
7. Material for body shall have a guaranteed minimum yield strength of 35000 psi. In case the same cannot be guaranteed, valves shall be provided with a 500 mm pup piece (integrally welded to the valve on each side) with strength equivalent to that of the connecting pipe.
8. For welding end, the out of roundness (i. e. difference between maximum and minimum ID at pipe end) shall not be more than 0.5% of pipe OD.
9. Valves shall be inspected and approved by Purchaser before despatch.

REV. NO.	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS					

REFERENCES DRG. NO.

SECTION PROCESS & PIPING				
	NAME	DATE	CHKD	DATE
DSGN	Sachin	21.02.15	Harsh	21.02.15
DRWN				

STANDARD DRAWING
SUPPLIER :
SUB SUPPLIER :
PROJECT : City Gas Distribution Project

MECON LIMITED

APPROVED Anil Kumar DGM

DATA SHEET FOR BW END BALL VALVES (NB ≥ 2")

SCALE :
DATA SHEET NO.: MEC/U999/05/28/M/001/DS/BV/76
REV 0

DATA SHEET FOR FLANGED END BALL VALVES

1.0 Valve Manufacturer :

2.0 Valve Size (NB), mm (inch) : 2" NB ANSI Rating : **300** Design Standard : **API 6D**

3.0 MECON's Technical Specification No. : **MEC/TS/05/21/002, Rev-1, Ed-1**

4.0 Connecting Pipeline Design Pressure, bar **: 49** Design Temperature, °C : **-29 C to 65 C**

5.0 **Connecting Pipe Specification** : NA
5.1 Material :
5.2 Diameter (OD), mm (inch) :
5.3 Thickness, mm :

6.0 **Valve Construction Design**
6.1. Configuration : Reduced Bore [ ] Full Bore [√]
6.2. End Connections : Flanged as per ASME B16.5 [√] Butt Welded as per ASME B16.25 [ ]
6.3. Flanges (wherever applicable) : a) RF [√] [ ] RT [ ] NA [ ]
b) Serrated [ ] Smooth (125 to 200 microinches AARH) √ [ ] NA [ ]
6.4 Ball Mounting **: Floating upto 4 and Trunnion Mounted 6 and above**
6.5 Valve body type : Fully Welded [ ] Two/Three Piece Bolted [ ] Either [√]

7.0 **Valve Material Specification**

	Part	Specified Material	Material Offered (Equivalent or superior)
7.1	Body	**A 216 Gr. WCB/A 234 Gr. WPB**	
7.2	Ball	**(A 216 Gr.WCB/A 234 Gr.WPB) 75 ENP coating/AISI410**	
7.3	Body Seat Rings (No casting)	**AISI 4140 75 micron ENP coating/AISI 410**	
7.4	Seat Seal	**VITON/DEVLON**	
7.5	Stem (No casting)	**AISI 4140 75 micron ENP coating/AISI 410**	
7.6	Stem Seals	**VITON/PTFE**	
7.7	Stud Bolts/ Nuts	**ASTM A 193 Gr. B7/ A194 Gr. 2H**	

8.0 Corrosion Allowance : **1.5 mm** Service : **Natural Gas**

9.0 Location : Above Ground [√] Buried [ ]

10.0 Stem Extension Requirement : Yes [ ] No [√]

11.0 Gear Operator Requirement : Yes [ ] No [√]

12.0 Actuator Requirement : Yes [ ] No [√]

13.0 Fire Resistant Design Requirement **: Type test as per API 607 for Floating Ball valveFA**
: Type test as per API 6FA for Trunnion Mounted Ball Valve

14.0 **Valve Testing Requirement**

			Test Pressure (min.), kg/cm^2(g)	Minimum Duration, minutes
14.1	Hydrostatic Test	Body	**76**	**As per API 6D**
		Seat	**57**	**As per API 6D**
14.2	Air Test		**5.6-7**	**As per API 6D**

15.0 Anti-Static Testing Requirement : **As per Standard API 6D (Latest Ed.)**

16.0 **Valve Painting Specification**
16.1 Surface preparation by Short Blasting as per grade SA 2 1/2, Swedish Standard SIS-055 909.
16.2 For above ground installation-Three coats of corrosion resistant paint shall be applied with minimum thickness of 300 micron (Permissible thickness in each coat shall be within 80 to 120 micron). Colour of paint shade shall be RAL-7038, however any change in colour shall be finalized during drawing approval stage.
17.0 Lock Open/ Lock Close/Normally Close Requirement : **As indicated in P&ID./ Schedule of Rates (SOR)**

Notes:
1. This Valve Data Sheet shall be read in conjunction with MECON's Technical Specification No. MEC/TS/05/21/002,Rev 1 ,Ed. 1
2. Inspection and Testing shall be as per attached QAP, this Data Sheet, MECON's T.S., API 6D and other relevant standards.
3. Stops shall be provided for positive alignment of ball with ports and ensure proper installation of handle.
4. Short pattern valves (as per API 6D or otherwise) are not permitted. Only long pattern valves are to be supplied.
5. Charpy V-notch & Hardness test for body, body adaptor, end flanges, ball, body seat rings, stem & studs / nuts shall be conducted as per Cl. 3.4 & 3.6 of TS respectively or as per relevant material code.
6. Compressed asbestos fibre (CAF) shall not be used for body sealing / gasket materials.
7. Material for body shall have a guaranteed minimum yield strength of ……..psi. In case the same cannot be guaranteed, valves shall be provided with a 500 mm pup piece (integrally welded to the valve on each side) with strength equivalent to that of the connecting pipe - **N.A**.
8. For welding end, the out of roundness (i. e. difference between maximum and minimum ID at pipe end) shall not be more than 0.5% of pipe OD. - **N.A**
9. Valves shall be inspected and approved by Purchaser before despatch.

REV. NO.	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS					

REFERENCES DRG. NO.

SECTION PROCESS & PIPING

	NAME	DATE	CHKD	DATE
DSGN	Sachin	21.02.15	Harsh	21.02.15
DRWN				

STANDARD DRAWING
SUPPLIER :
SUB SUPPLIER :
PROJECT : City Gas Distribution Project

MECON LIMITED

APPROVED Anil Kumar DGM

DATA SHEET FOR FLANGED BALL VALVES (NB ≥ 2")

SCALE :
DATA SHEET NO.: MEC/U999/05/28/M/001/DS/BV/77

REV 0

	CONTRACTOR		QUALITY ASSURANCE PLAN FOR STRUCTURAL AND MECHANICAL EQUIPMENT	PROJECT : **CNG & CITY GAS DISTRIBUTION**
	ORDER NO. & DATE			PACKAGE NO. :
	SUB-CONTRACTOR			PACKAGE NAME : **Flanges & Fittings ≤16"**
	ORDER NO. & DATE			MR NO. : TS No.: MEC/TS/05/21/025

INSTRUCTIONS FOR FILLING UP :

1. QAP shall be submitted for each of the equipment separately with break up of assembly/sub-assembly & part/component or for group of equipment having same specification.
2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant and equipment
3. Separate identification number with quantity for equipment shall be indicated wherever equipment having same specifications belonging to different facilities are grouped together.
4. Weight in kilograms must be indicated under Column-5 for each item. Estimated weights may be indicated wherever actual weights are not available.

ABBREVIATIONS USED :

CONTR : CONTRACTOR
MFR : MANUFACTURER
H : HOLD
R : REVIEW
W : WITNESS

KEY TO SYMBOLS :

* : MFR/ CONTRACTOR - AS APPLICABLE
** : TEST TO BE PERFORMED, IF APPLICABLE

CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS :

Code Description

1. Visual
2. Dimensional
3. Fitment & Alignment
4. Physical Test (Sample)
5. Chemical Test (Sample)
6. Ultrasonic Test
7. Magnetic Particle Test (MPI)
8. Radiography Test
9. Dye Penetration Test
10. Metallographic Exam.
11. Welder's Qualification & Weld Procedure Test
12. Approval of Test and Repair Procedure
13. Heat Treatment
14. Pressure Test
15. Leakage Test
16. Balancing
17. Vibration Test
18. Amplitude Test
19. Sponge Test
20. Dust/ Water Ingress Test
21. Friction Factor Test
22. Adhesion Test
23. Performance Test/Characteristic Curve
24. No Load/ Free Running Test
25. Load/ Overload Test
26. Measurement of Speeds
27. Accoustical Test
28. Geometrical Accuracy
29. Repeatability and Positioning Accuracy
30. Proving Test
31. Surface Preparation
32. Manufacturer's Test Certificates for bought-out items
33. IBR/ Other Statutory agencies compliance certificate
34. Internal Inspection Report by Contractor
35. Hardness Test
36. Spark Test for Lining
37. Calibration
38. Safety Device Test
39. Ease of Maintenance
40. Fire Test (Type Test)
41. Charpy V-Notch Test
42. Operational Torque Test
43. ENP (Electroless Nickel Plating) Execution
44. Painting
45. Anti-Static Test
46. Hydrostatic Double Block & Bleed Test
47. Functional Test
48. Pneumatic Double Block & Bleed Test
49. Proof Test (Type Test)
50. Dielectric Test

Code DOCUMENTS:

D1. Approved GA drawings
D2. Information and other reference drg/ stamped drgs released for mfg.
D3. Relevant catalogues
D4. Bill of matl./Item no./ Identification
D5. Matchmarks details
D6. Line/ Layout diagram
D7. Approved erection procedures
D8. Unpriced sub P.O. with specification and amend-ments, if any
D9. Calibration Certificate of all measuring instruments and gauges
D10. X-Ray Reports

EQUIPMENT DETAILS							INSPECTION AND TESTS						Test Certificates & Documents to be submitted to MECON	Acceptance Criteria Standards/ IS/ BS/ ASME/ Norms and Documents	REMARKS/ SAMPLING PLAN
Sl. No.	Description (with equipment heading, place of use and brief specifications)	Identification No. (MR Item No.)	Quantity No./M	Unit Weight (Kg)	Manufacturer's Name and Address	Expected Schedule of Final Inspn.	Raw Material and In-Process Stage Inspection			Final Inspection/ Test by					
							MFR	CONTR	MECON	MFR	CONTR	MECON			
1		3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.0	Flanges & Fittings ≤ 16"		As per SOR				1,2,4,5, 13,35,41**	-	-	1,2,6	*	1,2,6	1,2,4,5,6,13,35,41**, D9	MECON's T.S. & Relevant Standards mentioned therein	100%

For MECON (Stamp & Signature)

For CONTRACTOR/ SUB-CONTRACTOR (Stamp & Signature)

QAP NO. MEC/23N0/05/28/M/001/QAP-025 REV

SHEET **1 OF 1**

	CONTRACTOR		QUALITY ASSURANCE PLAN FOR STRUCTURAL AND MECHANICAL EQUIPMENT	PROJECT : **City Gas Distribution Project**
	ORDER NO. & DATE			PACKAGE NO. : **05/51/U999/GGPL/001 (i)**
	SUB CONTRACTOR			PACKAGE NAME : **PIPELINE LAYING WORKS** ITEM : **BALL & PLUG VALVES**
	ORDER NO. & DATE			TS NO. : **MEC/TS/05/21/002 Rev 1,Ed 1, MEC/TS/05/62/003, Rev-2 & Additional Notes to TS for Ball Valves.**

INSTRUCTIONS FOR FILLING UP :

1. QAP shall be submitted for each of the equipment separately with break up of assembly/sub-assembly & part/component or for group of equipment having same specification.
2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & tests may be added as applicable for the plant and equipment
3. Separate identification number with quantity for equipment shall be indicated wherever equipment having same specifications belonging to different facilities are grouped together.
4. Weight in kilograms must be indicated under Column-5 for each item. Estimated weights may be indicated wherever actual weights are not available.

ABBREVIATIONS USED :

SV : SUB VENDOR
MFR : MANUFACTURER
TPI : DESIGNATED THIRD PARTY INSPECTION AGENCY
CONTR : CONTRACTOR
H : HOLD
R : REVIEW
W : WITNESS

KEY TO SYMBOLS :

* : TO BE FILLED BY VENDOR
** : TEST TO BE PERFORMED, IF APPLICABLE

CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS :

Code	*Description*	*Code*	*Description*	*Code*	*Description*	*Code*	*DOCUMENTS:*
1.	Visual	18.	Amplitude Test	34.	Internal Inspection Report by Contractor	D1.	Approved GA drawings
2.	Dimensional	19.	Sponge Test	35.	Hardness Test	D2.	Information and other reference drg/ stamped drgs released for mfg.
3.	Fitment & Alignment	20.	Dust/ Water Ingress Test	36.	Spark Test for Lining	D3.	Relevant catalogues
4.	Physical Test (Sample)	21.	Friction Factor Test	37.	Calibration	D4.	Bill of matl./Item no./ Identification
5.	Chemical Test (Sample)	22.	Adhesion Test	38.	Safety Device Test	D5.	Matchmarks details
6.	Ultrasonic Test	23.	Performance Test/Characteristic Curve	39.	Ease of Maintenance	D6.	Line/ Layout diagram
7.	Magnetic Particle Test (MPI)	24.	No Load/ Free Running Test	40.	Fire Test (Type Test)	D7.	Approved erection procedures
8.	Radiography Test	25.	Load/ Overload Test	41.	Charpy V-Notch Test	D8.	Unpriced sub P.O. with specification and amend-ments, if any
9.	Dye Penetration Test	26.	Measurement of Speeds	42.	Operational Torque Test	D9.	Calibration Certificate of all measuring instruments and gauges
10.	Metallographic Exam.	27.	Accoustical Test	43.	ENP (Electroless Nickel Plating) Execution	D10.	X-Ray Reports
11.	Welder's Qualification & Weld Procedure Test	28.	Geometrical Accuracy	44.	Painting		
12.	Approval of Test and Repair Procedure	29.	Repeatability and Positioning Accuracy	45.	Anti-Static Test		
13.	Heat Treatment	30.	Proving Test	46.	Hydrostatic Double Block & Bleed Test		
14.	Pressure Test	31.	Surface Preparation	47.	Functional Test		
15.	Leakage Test	32.	Manufacturer's Test Certificates for bought-out items	48.	Pneumatic Double Block & Bleed Test		
16.	Balancing	33.	IBR/ Other Statutory agencies compliance certificate	49.	Cyclic Test		
17.	Vibration Test						

EQUIPMENT DETAILS							INSPECTION AND TESTS								Test Certificates & Documents to be submitted to MECON	Acceptance Criteria Standards/ IS/ BS/ ASME/ Norms and Documents	REMARKS/ SAMPLING PLAN
Sl. No.	Description (with equipment heading, place of use and brief specifications)	Identification No. (MR Item No.)	Quantity No./M	Unit Weight (Kg)	Manufacturer's Name and Address	Expected Schedule of Final Inspn.	Raw Material and In-Process Stage Inspection				Final Inspection/ Test by						
							MFR/SV	TPI	CONTR	MECON	MFR/SV	TPI	CONTR	MECON			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1.0	Ball Valves & Plug Valves	----	As per SOR/ P&ID	*	*	*	As per attached sheet 2 to 10										

For MECON (Stamp & Signature)

For CONTRACTOR/ SUB-CONTRACTOR (Stamp & Signature)

QAP No. : MEC/U999/05/28/M/001/QAP-002/C&M

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SHEET 1 OF 10

EQUIPMENT DETAILS					INSPECTION AND TESTS								Test Certificates & Documents to be submitted to MECON	Acceptance Criteria Standards/ IS/ BS/ ASME/ Norms and Documents	Inspection Codes & Sampling Plan				REMARKS
					Raw Material and In-Process stage inspection				Final Inspection/ Test by										
Sl. No.	Description (with equipment heading, place of use and brief specifications)	Identification No.	Quantity No./M	Unit Weight (Kg)	MFR/SV	TPI	CONTR	MECON	MFR/SV	TPI	CONTR	MECON			MFR/SV	TPI	CONTR	MECON	
1	2	3	4	5	8	9	10	11	12	13	14	15	16	17	18A	18B	18C	18D	
1.01	Body	Material As per approved Datasheet			1,2	-	-	-	-	-	-	-	1. D1 2. Report	1. D1 2. Relevant Material Standard 3. Manufacturer's Specification	H	R	R	R	
					4	4	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's D.S.	H	H	R	R	
					5	5	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					6 **	6 **	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-IV 2. MECON's T.S.	H	W	R	R	Forgings, welds, wrought weld ends
					7 **	7 **	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-II 2. MECON's T.S.	H	W	R	R	Wet MPI for 100% of internal surfaces of all castings & forgings & bevel surfaces (MPI/ DP)
					8 **	8 **	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-I 2. MECON's T.S.	H	W	R	R	All castings as per clause 5.1.4 b) of T.S., all welds, weld ends of all cast valves
					9**	9**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-III 2. MECON's T.S.	H	W	R	R	Bevel Surfaces (by MPI/ DP)
					13	13	-	-	-	-	-	-	Report/ Material Test Certificates	1. Relevant Material Standard	H	R	R	R	
					35	35	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					41	41	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	

EQUIPMENT DETAILS					INSPECTION AND TESTS								Test Certificates & Documents to be submitted to MECON	Acceptance Criteria Standards/ IS/ BS/ ASME/ Norms and Documents	Inspection Codes & Sampling Plan				REMARKS
					Raw Material and In-Process stage inspection				Final Inspection/ Test by										
Sl. No.	Description (with equipment heading, place of use and brief specifications)	Identification No.	Quantity No./M	Unit Weight (Kg)	MFR/SV	TPI	CONTR	MECON	MFR/SV	TPI	CONTR	MECON			MFR/SV	TPI	CONTR	MECON	
1	2	3	4	5	8	9	10	11	12	13	14	15	16	17	18A	18B	18C	18D	
1.02	Closure/ Body Adapter/ Tail Piece	Material As per approved Datasheet			1,2	-	-	-	-	-	-	-	1. D1 2. Report	1. D1 2. Relevant Material Standard 3. Manufacturer's Specification	H	R	R	R	
					4	4	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's D.S.	H	H	R	R	
					5	5	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					6**	6**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-IV 2. MECON's T.S.	H	W	R	R	Forgings, welds, wrought weld ends
					7**	7**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-II 2. MECON's T.S.	H	W	R	R	Wet MPI for 100% of internal surfaces of all castings & forgings & bevel surfaces (MPI/ DP)
					8**	8**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-I 2. MECON's T.S.	H	W	R	R	All castings as per clause 5.1.4 b) of T.S., all welds, weld ends of all cast valves
					9**	9**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-III 2. MECON's T.S.	H	W	R	R	Bevel Surfaces (by MPI/ DP)
					13	13	-	-	-	-	-	-	Report/ Material Test Certificates	1. Relevant Material Standard	H	R	R	R	
					35	35	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					41	41	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	

EQUIPMENT DETAILS					INSPECTION AND TESTS								Test Certificates & Documents to be submitted to MECON	Acceptance Criteria Standards/ IS/ BS/ ASME/ Norms and Documents	Inspection Codes & Sampling Plan				REMARKS
					Raw Material and In-Process stage inspection				Final Inspection/ Test by										
Sl. No.	Description (with equipment heading, place of use and brief specifications)	Identification No.	Quantity No./M	Unit Weight (Kg)	MFR/SV	TPI	CONTR	MECON	MFR/SV	TPI	CONTR	MECON			MFR/SV	TPI	CONTR	MECON	
1	2	3	4	5	8	9	10	11	12	13	14	15	16	17	18A	18B	18C	18D	
1.03	Top Cover	Material Manufacturer to indicate (to be approved by MECON)			1,2	-	-	-	-	-	-	-	1. D1 2. Report	1. D1 2. Relevant Material Standard 3. Manufacturer's Specification	H	R	R	R	
					4	4	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's D.S.	H	H	R	R	
					5	5	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					6 **	6 **	-	-	-	-	-	-	Test Report	1. ASME B16.34, Annex-E 2. MECON's T.S.	H	W	R	R	Forgings, welds, wrought weld ends
					7 **	7 **	-	-	-	-	-	-	Test Report	1. ASME B16.34, Annex-C 2. MECON's T.S.	H	W	R	R	Wet MPI for 100% of internal surfaces of all castings & forgings & bevel surfaces (MPI/ DP)
					8 **	8 **	-	-	-	-	-	-	Test Report	1. ASME B16.34 Annex-B 2. MECON's T.S.	H	W	R	R	All castings as per clause 5.1.4 b) of T.S., all welds, weld ends of all cast valves
					13	13	-	-	-	-	-	-	Report/ Material Test Certificates	1. Relevant Material Standard	R	R	R	R	
					35	35	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					41	41	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	R	H	R	R	

EQUIPMENT DETAILS					INSPECTION AND TESTS													
					Raw Material and In-Process stage inspection				Final Inspection/ Test by				Test Certificates & Documents to be submitted to MECON	Acceptance Criteria Standards/ IS/ BS/ ASME/ Norms and Documents	Inspection Codes & Sampling Plan				REMARKS
Sl. No.	Description (with equipment heading, place of use and brief specifications)	Identification No.	Quantity No./M	Unit Weight (Kg)	MFR/SV	TPI	CONTR	MECON	MFR/SV	TPI	CONTR	MECON			MFR/SV	TPI	CONTR	MECON	
1	2	3	4	5	8	9	10	11	12	13	14	15	16	17	18A	18B	18C	18D	
1.04	Trunnion (for Trunnion Mounted Valves)	Material Manufacturer to indicate (to be approved by MECON)			1,2	1,2	-	-	-	-	-	-	1. D1 2. Report	1. D1 2. Relevant Material Standard 3. Manufacturer's Specification	H	R	R	R	
					4	4	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's D.S.	H	H	R	R	
					5	5	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					13	13	-	-	-	-	-	-	Report/ Material Test Certificates	1. Relevant Material Standard	H	R	R	R	
					43 **	43 **	-	-	-	-	-	-	1. Test Report 2. Material Test Certificates for composition, hardness, thickness & integrity	1. MECON's T.S. 2. MECON's D.S. 3. ASTM B733 Std. 4. Manufacturer's Specification	H	H	R	R	
1.05	Ball / Plug / Disc	Material As per approved Datasheet			1,2	1,2	-	-	-	-	-	-	1. D1 2. Report	1. D1 2. Relevant Material Standard 3. Manufacturer's Specification	H	R	R	R	
					4	4	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's D.S.	H	H	R	R	
					5	5	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					6**	6**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-IV 2. MECON's T.S.	H	W	R	R	Forgings, welds, wrought weld ends
					7**	7**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-II 2. MECON's T.S.	H	W	R	R	Wet MPI for 100% of internal surfaces of all castings & forgings & bevel surfaces (MPI/ DP)
					8**	8**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-I 2. MECON's T.S.	H	W	R	R	All castings as per clause 5.1.4 b) of T.S., all welds, weld ends of all cast valves

EQUIPMENT DETAILS					INSPECTION AND TESTS								Test Certificates & Documents to be submitted to MECON	Acceptance Criteria Standards/ IS/ BS/ ASME/ Norms and Documents	Inspection Codes & Sampling Plan				REMARKS
					Raw Material and In-Process stage inspection				Final Inspection/ Test by										
Sl. No.	Description (with equipment heading, place of use and brief specifications)	Identification No.	Quantity No./M	Unit Weight (Kg)	MFR/SV	TPI	CONTR	MECON	MFR/SV	TPI	CONTR	MECON			MFR/SV	TPI	CONTR	MECON	
1	2	3	4	5	8	9	10	11	12	13	14	15	16	17	18A	18B	18C	18D	
					9**	9**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-III 2. MECON's T.S.	H	W	R	R	Bevel Surfaces (by MPI/ DP)
					13	13	-	-	-	-	-	-	Report/ Material Test Certificates	1. Relevant Material Standard	H	R	R	R	
					35	35	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					41	41	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					43	43	-	-	-	-	-	-	1. Test Report 2. Material Test Certificates for composition, hardness, thickness & integrity	1. MECON's T.S. 2. MECON's D.S. 3. ASTM B733 Std. 4. Manufacturer's Specification	H	H	R	R	
1.06	Stem	Material As per approved Datasheet			1,2	1,2	-	-	-	-	-	-	1. D1 2. Report	1. D1 2. Relevant Material Standard 3. Manufacturer's Specification	H	R	R	R	
					4	4	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's D.S.	H	H	R	R	
					5	5	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					6**	6**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-IV 2. MECON's T.S.	H	W	R	R	Forgings, welds, wrought weld ends
					7**	7**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-II 2. MECON's T.S.	H	W	R	R	Wet MPI for 100% of internal surfaces of all castings & forgings & bevel surfaces (MPI/ DP)
					8**	8**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-I 2. MECON's T.S.	H	W	R	R	All castings as per clause 5.1.4 b) of T.S., all welds, weld ends of all cast valves

EQUIPMENT DETAILS					INSPECTION AND TESTS								Test Certificates & Documents to be submitted to MECON	Acceptance Criteria Standards/ IS/ BS/ ASME/ Norms and Documents	Inspection Codes & Sampling Plan				REMARKS
					Raw Material and In-Process stage inspection				Final Inspection/ Test by										
Sl. No.	Description (with equipment heading, place of use and brief specifications)	Identification No.	Quantity No./M	Unit Weight (Kg)	MFR/SV	TPI	CONTR	MECON	MFR/SV	TPI	CONTR	MECON			MFR/SV	TPI	CONTR	MECON	
1	2	3	4	5	8	9	10	11	12	13	14	15	16	17	18A	18B	18C	18D	
					9**	9**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-III 2. MECON's T.S.	H	W	R	R	Bevel Surfaces (by MPI/ DP)
					13	13	-	-	-	-	-	-	Report/ Material Test Certificates	1. Relevant Material Standard	H	R	R	R	
					35	35	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					41	41	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					43	43	-	-	-	-	-	-	1. Test Report 2. Material Test Certificates for composition, hardness, thickness & integrity	1. MECON's T.S. 2. MECON's D.S. 3. ASTM B733 Std. 4. Manufacturer's Specification	H	H	R	R	
1.07	Seats	Material As per approved Datasheet			1,2	1,2	-	-	-	-	-	-	1. D1 2. Report	1. D1 2. Relevant Material Standard 3. Manufacturer's Specification	H	R	R	R	
					4	4	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's D.S.	H	H	R	R	
					5	5	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					6**	6**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-IV 2. MECON's T.S.	H	W	R	R	Forgings, welds, wrought weld ends
					7**	7**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-II 2. MECON's T.S.	H	W	R	R	Wet MPI for 100% of internal surfaces of all castings & forgings & bevel surfaces (MPI/ DP)

EQUIPMENT DETAILS					INSPECTION AND TESTS								Test Certificates & Documents to be submitted to MECON	Acceptance Criteria Standards/ IS/ BS/ ASME/ Norms and Documents	Inspection Codes & Sampling Plan				REMARKS
					Raw Material and In-Process stage inspection				Final Inspection/ Test by										
Sl. No.	Description (with equipment heading, place of use and brief specifications)	Identification No.	Quantity No./M	Unit Weight (Kg)	MFR/SV	TPI	CONTR	MECON	MFR/SV	TPI	CONTR	MECON			MFR/SV	TPI	CONTR	MECON	
1	2	3	4	5	8	9	10	11	12	13	14	15	16	17	18A	18B	18C	18D	
					8**	8**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-I 2. MECON's T.S.	H	W	R	R	All castings as per clause 5.1.4 b) of T.S., all welds, weld ends of all cast valves
					9**	9**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-III 2. MECON's T.S.	H	W	R	R	Bevel Surfaces (by MPI/ DP)
					13	13	-	-	-	-	-	-	Report/ Material Test Certificates	1. Relevant Material Standard	H	R	R	R	
					35	35	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					41	41	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					43	43	-	-	-	-	-	-	1. Test Report 2. Material Test Certificates for composition, hardness, thickness & integrity	1. MECON's T.S. 2. MECON's D.S. 3. ASTM B733 Std. 4. Manufacturer's Specification	H	H	R	R	
1.08	Bolting Material (Studs & Nuts)	Material As per approved Datasheet			1,2	1,2	-	-	-	-	-	-	1. D1 2. Report	1. D1 2. Relevant Material Standard 3. Manufacturer's Specification	H	R	R	R	Alongwith thickness measurement for ENP Coating.
					4	4	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's D.S.	H	H	R	R	
					5	5	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
					6**	6**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-IV 2. MECON's T.S.	H	W	R	R	Forgings, welds, wrought weld ends

EQUIPMENT DETAILS					INSPECTION AND TESTS								Test Certificates & Documents to be submitted to MECON	Acceptance Criteria Standards/ IS/ BS/ ASME/ Norms and Documents	Inspection Codes & Sampling Plan				REMARKS
					Raw Material and In-Process stage inspection				Final Inspection/ Test by										
Sl. No.	Description (with equipment heading, place of use and brief specifications)	Identification No.	Quantity No./M	Unit Weight (Kg)	MFR/SV	TPI	CONTR	MECON	MFR/SV	TPI	CONTR	MECON			MFR/SV	TPI	CONTR	MECON	
1	2	3	4	5	8	9	10	11	12	13	14	15	16	17	18A	18B	18C	18D	
					7**	7**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-II 2. MECON's T.S.	H	W	R	R	Wet MPI for 100% of internal surfaces of all castings & forgings & bevel surfaces (MPI/ DP)
					8**	8**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-I 2. MECON's T.S.	H	W	R	R	All castings as per clause 5.1.4 b) of T.S., all welds, weld ends of all cast valves
					9**	9**	-	-	-	-	-	-	Test Report	1. ASME B16.34, Appendix-III 2. MECON's T.S.	H	W	R	R	Bevel Surfaces (by MPI/ DP)
					13	13	-	-	-	-	-	-	Report/ Material Test Certificates	1. Relevant Material Standard	H	R	R	R	
					41	41	-	-	-	-	-	-	Material Test Certificates	1. Relevant Material Standard 2. MECON's T.S. 3. MECON's D.S.	H	H	R	R	
1.09	Assembled Valves				-	-	-	-	1,2	1,2	1,2	1,2	Report	1. D1 2. MECON's T.S.	H	H	W	W/R	
					-	-	-	-	3	3	3	3	Report		H	H	W	W/R	
					-	-	-	-	14	14	14	14	1. Report 2. Test Certificates	1. D1 2. MECON's T.S. 3. MECON's D.S. 4. API 6D Std./ BS EN 12266 (as applicable)	H	H	W	W/R	
					-	-	-	-	15	15	15	15	1. Report 2. Test Certificates	1. D1 2. MECON's T.S. 3. MECON's D.S. 4. API 6D Std./ BS EN 12266 (as applicable)	H	H	W	W/R	
									40	40	40	40	1. Report 2. Test Certificates	1. API 607/ API 6FA / BS EN ISO 10497 (as applicable) 2. MECON's T.S. 3. MECON's D.S.	R	R	R	R	
									42	42	42	42	1. Report 2. Test Certificates	1. MECON's T.S. 2. MECON's D.S. 3. API 6D Std. (as applicable)	H	H	W	W/R	
					-	-	-	-	37	37	37	37	Certificates		-	R	R	R	
					-	-	-	-	44	44	44	44	1. Report 2. Test Certificates	1. MECON's T.S. 2. MECON's D.S. 3. Manufacturer's Specification	H	W	W	W/R	Inspection & test to be witnessed by MECON for buried valve surface paint integrity & thickness

EQUIPMENT DETAILS					INSPECTION AND TESTS								Test Certificates & Documents to be submitted to MECON	Acceptance Criteria Standards/ IS/ BS/ ASME/ Norms and Documents	Inspection Codes & Sampling Plan				REMARKS
					Raw Material and In-Process stage inspection				Final Inspection/ Test by										
Sl. No.	Description (with equipment heading, place of use and brief specifications)	Identification No.	Quantity No./M	Unit Weight (Kg)	MFR/SV	TPI	CONTR	MECON	MFR/SV	TPI	CONTR	MECON			MFR/SV	TPI	CONTR	MECON	
1	2	3	4	5	8	9	10	11	12	13	14	15	16	17	18A	18B	18C	18D	
					-	-	-	-	45	45	45	45	1. Report 2. Test Certificates	1. MECON's T.S. 2. MECON's D.S. 3. API 6D Std. / BS EN ISO 17292 (as applicable)	H	H	W	W/R	
					-	-	-	-	46	46	46	46	1. Report 2. Test Certificates	1. MECON's T.S. 2. API 6D Std. (as applicable)	H	H	W	W/R	
					-	-	-	-	47	47	47	47	1. Report 2. Test Certificates	1. MECON's T.S. 2. API 6D Std. / BS EN ISO 17292 (as applicable)	H	H	W	W/R	
					-	-	-	-	48	48	48	48	1. Report 2. Test Certificates	1. MECON's T.S. 2. API 6D Std. (as applicable)	H	H	W	W/R	
					-	-	-	-	49	49	49	49	1. Report 2. Test Certificates	1. MECON's T.S. 2. MECON's D.S.	H	H	W	W/R	
1.10	Complete documentation check and compilation								√	√	√	√	1. Final Report 2. Final Certificates	1. MECON's T.S. 2. API 6D Std. / BS EN ISO 17292 (as applicable)	H	H	H	-	
1.11	Complete and compiled documentation check and despatch clearance				-	-	-	-	√	√	√	√	1. Final Report 2. Final Certificates	1. MECON's T.S. 2. API 6D Std. / BS EN ISO 17292 (as applicable)	H	-	-	H	

For MECON (Stamp & Signature)

For CONTRACTOR/ SUB-CONTRACTOR

QAP No. : MEC/U999/05/28/M/001/QAP-002/C&M REV **0**

QUALITY ASSURANCE PLAN
FOR
INSULATING JOINTS

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
0	20.02.2015	ISSUED FOR IMPLEMENTATION	Sachin Singhal	Anil Kumar	A.K.Sarkar

APPLICABLE CODES AND SPECIFICATIONS : MEC/TS/05/21/009, R-0 WITH AMENDMENTS									SCOPE OF INSPECTION			
S. NO.	**STAGE**	**COMPONENT**	**CHARACTERISTICS**	**METHOD OF CHECK**	**QUANTUM OF CHECK**	**REFERENCE DOCUMENTS**	**ACCEPTANCE NORMS**	**RECORD**	**Sub Vendor**	**Vendor**	**Contractor**	**MECON**
1.	Raw Material Identification	Forged Ring, Pipe	1. Visual 2. Dimensions 3. Finish 4. Bore 5. Marking 6. Mechanical properties (Tensile, Impact, Hardness and others) 7. Chemical properties (CE Value) 8. Supply Condition (Heat treatment). 9. Deoxidation practice / refining (killed / calcium treated / vacuum degassed etc.) (as per applicable spec.)	Visual Dimensions Verification of markings with TC, TC verification	100%	Material Specification	Technical Specification as per TS and Data Sheet	Mill, Manufact-urer's TC	-	W	W	R
2.	Raw Material Identification	Seal Gasket, Filling Material Insulating Ring	Electrical Resistance & Thickness	Die Electric Test	100%	Material Specification / Data Sheet	Technical Specification as per TS and Data Sheet	Inspection Report	-	W	W	R
3.	Manufacturing Welding	-	Approved WPS, PQR, WQT	Welding Parameters	100%	ASME Section-IX	ASME Section IX	WPS, PQR, WPS	-	P	R	R

APPLICABLE CODES AND SPECIFICATIONS : MEC/TS/05/21/009, R-0 WITH AMENDMENTS									SCOPE OF INSPECTION			
S. NO.	**STAGE**	**COMPONENT**	**CHARACTERISTICS**	**METHOD OF CHECK**	**QUANTUM OF CHECK**	**REFERENCE DOCUMENTS**	**ACCEPTANCE NORMS**	**RECORD**	**Sub Vendor**	**Vendor**	**Contractor**	**MECON**
4.	Manufacturing Welding	-	New WPS, PQR, WQT	Welding Parameters	100%	ASME Section-IX	ASME Section IX	WPS, PQR, WPS	-	P	W	R
5.	Manufacturing Welding	Forged Ring to pipe (Butt & Fillet)	Welding	Welding Parameters	At random	Approved WPS	Approved WPS	Inspection Report	-	P	W	R
6.	Non Destructive Testing	Pipe to Ring (Other than butt welds) Forgings (surface), Finished weld ends for lamination, Fillet welds greater 7 mm and above.	Surface & Internal Imperfections	UT, MPI or other as specified	PO, Material Specification	PO, Material Specification	PO, Technical Specification	Inspection Report, Graphical record	-	P	W	R
7.	Non Destructive Testing	Pipe to Ring (Butt Welds & Repairs)	Surface & Internal Imperfections	Radiography	PO, Material Specification	API-1104 ASME SEC V	API-1104 PO, Technical Specification	Inspection Report Film	-	P	R (100% of films)	R
8.	Hydro testing Air Leak Test, Vacuum Test	Insulating Joint Assembly	Leak Check	Visual	100%	Material Specification	Technical Specification and relevant standards mentioned therein.	Inspection Report, Hydro graph	-	P	W	W
9.	Final Inspection	Pipe	Surface condition, Bevel angle, Root	Visual Dimensional	100% by vendor, At	Material Specification	Technical Specification	Inspection Report	-	P	W	W

APPLICABLE CODES AND SPECIFICATIONS : MEC/TS/05/21/009, R-0 WITH AMENDMENTS									SCOPE OF INSPECTION			
S. NO.	**STAGE**	**COMPONENT**	**CHARACTERISTICS**	**METHOD OF CHECK**	**QUANTUM OF CHECK**	**REFERENCE DOCUMENTS**	**ACCEPTANCE NORMS**	**RECORD**	**Sub Vendor**	**Vendor**	**Contractor**	**MECON**
			face, Outer dia., Thickness Length, End finish, Coating, Marking, Colour coding.		random by MECON / TPI		and relevant standards mentioned therein.					
10.	Final Inspection	Assembly	Insulating Resistance	Die Electric Test	All Joints	Technical Specification and relevant standards mentioned therein.	No Break down of flash over	Inspection Report	-	P	W	W

NOTE: 1..**One week advance intimation to be given to the Owner/consultant by the vendor for activity marked at Sl. No. 8,9 & 10**

LEGENDS: H – Hold (Offer for Witness & obtain clearance), W – Witness, R – Review, A – Approval, I – Information, X – Submit, PO – Purchase Order, PR – Purchase Requisition, SR – Stress Relieving, MPI – Magnetic Particle Inspection, DI-Dye Penetrant Test , UT – Ultrasonic examination, TS – Technical Specification, WPS – Welding Procedure Specification, PQR – Procedure Qualification Record, WQT – Welder Qualification Test.

All the NDT / Leak Testing / Heat Treatment / Special manufacturing procedures have to be specially approved or only previously approved procedures have to be used. In case of conflict between purchase specification, contract documents and ITP more stringent conditions shall be applicable. The document describes generally the requirements pertaining to all types of Insulating Joints. Requirements specific to the item are only applicable.

For CONTRACTOR/ SUB-CONTRACTOR

(Stamp & Signature)

PART-III
SECTION-IV

PERTICULAR JOB SPECIFIATION

3.0 PARTICULAR JOB SPECIFICATION (PJS)

3a) PARTICULAR JOB SPECIFICATION FOR MAINLINE, MECHANICAL & ASSOCIATED WORKS

CONTENTS

1.0 PROJECT DESCRIPTION

M/s Godavari Gas Private Limited (GGPL) a Joint Venture of APGDC & HPCL have been authorized by PNGRB for implementation of CGD Project in East and West Godavari Districts excluding Kakinada Geographical Area (GA). M/s GGPL is implementing CNG & City Gas Distribution Network (CGDN) to supply Natural Gas to domestic, commercial, industrial and automobile Consumers in the Geographical Area (GA) of East & West Godavari Districts.

MECON Ltd. on behalf of M/s GGPL, invites bids for supply & laying of underground steel pipelines through Open Domestic Competitive Bidding basis under single stage two e-envelopes system from contractor meeting the Bid Evaluation Criteria as detailed herein.

The work tendered in this bid package consists of supply/procurement of materials for underground pipelines (linepipe, LR bends etc.) including valves,above ground piping (assorted pipes, assorted valves, fittings & flanges etc) , survey, grading, stringing, bending, welding, trenching, Joint Coating, lowering, crossings (incl crossings by HDD, cased etc), tie-ins, NDT and destructive testing, , laying of OFC & HDPE ducts, backfilling, site restoration, hydro-testing, dewatering, swabbing, drying, pre-commissioning & commissioning of the 149 km pipeline in various stretches (east & West Godavari districts) along with associated facilities like sectionalizing valve stations, Tap-off station, etc. including associated Mechanical, Temporary Cathodic Protection (TCP), Civil, Structural, Electrical, Instrumentation works. However, Permanent Cathodic Protection Works (PCP works), SCADA & telecom and Terminal/ station works shall be carried out by different agency under separate contract. Coated steel pipes, valves & Insulation Joints of size 8", 6" & 4" NB. and MDPE pipes will be issued as a free issue items.

The salient feature of the pipeline Sections are as under:

Laying of 3 layer PE coated Steel line pipes (WT-6.4mm, API 5L, X-52, 2mm 3LPE coating, ERW/Seamless pipes), Double random conforming to MECON's Technical Specification No. MEC/TS/05/21/012 or 012A & MEC/S/05/21/014 for 3 layer PE coated Steel line pipes of following sizes, grades & specifications as indicated below :

S.NO	AREAS/TOWNS/DESSTINATIONS		PIPE QTY (Km)		
EAST GODAVARI			8" pipe	6" pipe	4" pipe
1	PART-A	GAIL'S RT AT JEGURUPADU TO RAJAHMUNDRY	23	11	
2		MANDAPETA GAIL RT TO MANDAPETA JUNCTION			
3		MANDAPETA JUNCTION TO ANAPARTHY			
4		ADDITIONAL QUANTITIES (FOR CNGS STATIONS & WITHIN TOWNS)	1	1	2
5	PART-B	MANDAPETA JUNCTION TO RAMACHANDRAPURAM	7	20	4
6		GAIL'S GUDALA TR TO AMALAPURAM			
7		GAILS'S KGPL/DCU TO RAVULAPALEM			
8		TUNI (FROM APGDC P/L TAPOFF)			

9		ADDITIONAL QUANTITIES (FOR CNGS STATIONS & WITHIN TOWNS)	1	1	2
WEST GODAVARI					
10	PART-C	ANDHRA SUGARS TO TANUKU	-	18	12
11		CHINCHUNADA GAIL RT TO CHINCHUNADA TRI-JUNCTION POINT (ON NH-214)			
12		CHINCHUNADA TRI-JUNCTION POINT (ON NH-214) TO NARSAPUR			
13		CHINCHUNADA TRI-JUNCTION POINT (ON NH-214) TO PALAKOLLU			
14		DDPL VENDRA TO BHIMAVARAM			
15		ADDITIONAL QUANTITIES (FOR CNGS STATIONS & WITHIN TOWNS)	1	1	2
16	PART-D	GAIL, VIJJESWARAM to NIDADAVOLU	10	13	17
17		GAIL'S SV-4, TADEPALLIGUDEM to TADEPALLIGUDEM TOWN			
18		GAIL'S SV-5 TO BHIMADOLE			
19		GAIL'S SV-6, KOPPAKA TO ELURU			
20		TRIVENI GLASS TO IKYA CERAMICS			
21		TRIVENI GLASS TO DEVARAPALLI			
22		ADDITIONAL QUANTITIES (FOR CNGS STATIONS & WITHIN TOWNS)	1	1	0
		TOTAL LENGTH (Km)	**44**	**66**	**39**

The brief scope of work includes the following :

- Supply of bulk materials , pipe laying work including but not limited to Construction Management, HSE & Quality Management.
- Supply of L.R.bends, IJs, assorted piping, fittings, elbows, valves etc. to complete the entire works as per SOR
- Laying, testing and commissioning of underground Steel pipeline of DN 300/ DN 150 / DN 100 size in the above mentioned locations
- Laying of 125 mm MDPE pipe along with Steel Pipeline in same pipeline trench.
- Survey, grading, stringing, bending, welding, trenching, lowering, crossings. Tie-ins, NDT and destructive testing and backfilling.
- Crossing by HDD/ moling / boring, (wherever approved) – Type of crossing i.e., HDD / Moling / Boring / cased / Uncased / Open-cut and the length of the crossing shall be as per prior written approval of EIC.

- Installation of facilities like MRS / DRS.

- Tap-off provision of all sizes made on proposed DN 300 / DN 150 / DN 100 pipeline network shall be kept underground.

- Installation of sectionalizing valves (SVs) including Valve pits shall be made at various locations on proposed steel pipeline network. All SVs shall be installed buried, without any stem extension, on the pipeline alignment itself with-in RCC chambers with covers. The steel pipeline to be taken to a lower depth by use of bends to accommodate the above. The GPS co-ordinates of the valve location shall be provided for all the SVs.

- Entire buried pipeline network system shall be cathodically protected by providing TCP system including design & engineering, resistivity data collection.

- Fabrication & erection of aboveground piping system, but not limited to the associated works including installation of MRS / DRS / CNG at outlet connections.

- Hook-up with existing facilities like CNG station / DRS / PRS and laying of associated piping for the same as required.

- Line cleaning, flushing, Hydro testing, drying, nitrogen purging, pre-commissioning & assistance in commissioning of entire pipeline and piping system.

- Nitrogen purging and retaining pipeline at 2 kg/cm^2 pressure where required for preservation purpose.

- Associated Mechanical, Civil, Structural, Electrical, and Instrumentation & Pipeline Safety System Works at stations.

- Commissioning of pipelines shall be carried out segment-wise in phases even as laying is in progress elsewhere.

GGPL reserves the right to lay pipeline in any surrounding areas mentioned above in East & west Godavari distrcits towns Geographical Area.

1.2 Description of the facilities covered in the above are described in following clauses.

1.2.1 **Main Pipeline for all sections**

•	Line Size	:	DN 200/DN 150 / DN 100
•	Line Length	:	149 km approx. including all pipeline sizes
•	Class	:	300 #
•	Design Pressure	:	49 kg/cm^2(g)
•	Material of Pipe & Grade	:	API 5L Gr. X-52
•	Wall Thickness	:	6.4 mm
•	Coating Material	:	3 Layer PE
•	Location Classification	:	Zone IV as per OISD 141
•	Design Code	:	ANSI / ASME B31.8 (Latest Edition)
•	Corrosion Allowance	:	0.5mm
•	Road Crossings	:	As per SOR
•	Rail Crossings	:	As per SOR
•	Drain Crossings	:	As per SOR
•	Gas Temperature (Design)		
	- Buried	:	45°C
	- Over ground	:	65°C
•	Cathodic Protection Works	:	As per PJS & SOR
•	Pipeline Safety System Works	:	As per PJS & SOR

Associated underground piping works alongwith installation of Barred Tees, Insulating Joints, all type & sizes of valves; Civil Works, Structural Works and Instrumentation Works.

1.2.2 **Terminals / Stations**

i) **Aboveground Piping Works inside proposed various MRS at Industrial Consumer's Stations / DRS etc.**

- Gear & hand operated valves of different sizes and types of all ratings.
- Provision shall be kept for future tap-off, wherever required.
- Local mounted instrument such as PG, TG at CGS.
- Installation of aboveground Insulating Joints, wherever required.
- Associated civil, structural and instrumentation works.

ii) **SV Stations**

- Buried installation of full bore ball valves, Buried installation of ball / plug valves of different sizes with underground gas venting facilities shall be provided at specified SV Station as per drawing.
- Buried installation of future tap-off provision.
- Buried installation of Insulating Joints at all tap-off points, wherever required in-addition to SV stations.
- Buried installation of all types and sizes of valves on mainline & branch line.
- Associated piping, civil, structural & instrumentation works.
- Installation of Tees / Barred Tees.

1.3 **Construction Fronts**

The contractor shall mobilize equipments and deploy manpower as per the instruction of owner to work on multiple fronts / spreads as per PMC / owner's instructions

2.0 **WORK TENDERED**

2.1 The work tendered in this bid package consists of supply (in CONTRACTOR's scope), fabrication, installation, testing and commissioning of the mainline, tap-off stations, various MRS at Industrial Consumer's Stations / DRS and SV stations including all associated mechanical, civil, structural, instrumentation works.

2.2 All works of the section & terminals included in the scope will be done simultaneously from the date of issue of FOA. Bidder will organize equipment and manpower accordingly to meet this requirement as per instruction of Engineer-in-charge.

3.0 **SCOPE OF WORK**

The scope of work shall generally be, but not limited to the following:-

3.1 **Procurement**

3.1.1 CONTRACTOR shall procure and supply all the materials other than OWNER supplied materials, required for permanent installation of main pipeline and terminals in sequence and at appropriate time. All equipment, materials, components etc. shall be suitable for the intended service. Approved vendor list has been indicated in the bid package for various items. For items which are not covered in the vendor list, CONTRACTOR shall obtain Owner's prior approval for the vendor. Equipment requiring specialized maintenance or operation shall be avoided as far as possible. Equipment offered shall be field proven.

3.1.2 CONTRACTOR shall procure all materials, components, equipment,

consumable etc. required for successful completion of the pipeline system. CONTRACTOR shall also procure and supply spares required for pre-commissioning and commissioning/ start up as recommended for all items supplied by him as per specifications provided in the bid package. Where no specification is available in the contract, the same shall be prepared by the CONTRACTOR based on the piping material specification and shall be subject to Owner's approval.

3.1.3 Material take-off with complete description of size, rating material and thickness.

3.1.4 Only single offer shall be provided by the bidder fully complying with specifications/ drawings/ requirements for Owner's review and approval. CONTRACTOR shall provide for inspection of the items at vendor's works by the OWNER/ Owner's REPRESENTATIVE or by a reputed inspection agency and shall submit inspection reports for Owner's clearance.

3.1.5 Stores management including receipt, warehousing, preserving the material in good condition, issue of material to construction site, reconciling/ handing over surplus material to OWNER for OWNER supplied items.

3.1.6 Carryout proper documentation of inspection and quality assurance programs for all equipment and bulk materials duly approved by OWNER. CONTRACTOR shall maintain an accurate and traceable listing of procurement records for the location, quality and character of all permanent materials in the Project.

3.1.7 CONTRACTOR shall immediately report to the OWNER of all changes which will affect material quality, and recommend any necessary corrective actions to be taken.

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

3.1.9 Interact with authorities such as Sales Tax, Octroi, Excise, Customs etc. as necessary and arrange for transportation of the materials under his scope of supply to site.

3.1.10 All purchase requisitions including purchase orders shall be approved by OWNER/ Owner's REPRESENTATIVE.

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

3.2 **Construction**

3.2.1 **General**

3.2.1.1 All construction works shall be carried out as per "Approved for Construction" drawings, procedures, specification and applicable codes and standards. Any changes at site shall also need prior approval from the OWNER and revision of

drawings. Construction drawings will be submitted by the Contractor in a phased manner for owner's approval in accordance with the procurement and construction plan prepared and furnished by contractor & agreed by Owner.

Owner will take minimum 7 working days from the date of submission of the documents / drawings submitted by the contractor for owner's comments / approval.

3.2.1.2 **Statutory Approvals**

GGPL will arrange the in-principle clearance/ permission for ROU for laying the pipeline and other facilities from the concerned land / road owning authority, in the proposed route. Necessary liasoning for the same shall be in the scope of the bidder.

All the liaisoning during the pipeline laying execution with any authorities and any other utility companies / agencies such OFC operators etc are in the scope of the contractor. Repairing/replacement of all damaged utilities if any, and payment of any compensation (if claimed by owner/other utility agencies) is in scope of the contractor. The Liaisoning shall be treated as part of laying works & no extra payment shall be made for it.

3.2.1.3 The Contractor shall comply with all the conditions and requirements issued by Authorities having jurisdiction in the area where the work is to be performed.

It shall be the Contractor's sole responsibility to make arrangements for land for setting up of its string fabrication yards, all storage areas for line pipe and other materials, wherever required, and all other work areas.

The Contractor shall make all arrangements for access to his work site at his own cost and responsibility. If no public road exists Contractor shall arrange on his own for access to his work area at no extra cost to the COMPANY.

The CONTRACTOR shall be responsible for claims if any arising out of damage/ obstruction to public utilities like lines of BSNL / HMWSSB / utility operators etc. where the claims will cover the restoration costs as well as loss of revenue due to down time.

3.2.1.4 Providing schedules, progress reporting, organization chart at construction site, quality assurance plan and developing quality control procedures, as per requirements indicated elsewhere in the bid package.

3.2.1.5 Coordination and supervising the work of sub-contractors.

3.2.1.6 Transportation of appropriate materials and taking delivery of Company supply materials, store, worksite, intermediate storage points, maintaining and operating an adequate material control procedure at worksite.

3.2.1.7 Fabrication of all piping, structural components as per approved drawings.

3.2.1.8 All civil / structural works, laying and preservation / commissioning of pipeline works shall be performed in accordance with relevant specifications and requirements enclosed elsewhere in the bid package.

3.2.1.9 CONTRACTOR shall provide complete details of manpower, equipment etc. to be deployed. Mobilizing and providing all equipments, manpower (skilled and unskilled), consumable and other resources etc. as required for the execution of the complete job defined herein and thereafter demobilizing the same upon completion of work.

3.2.1.10 Provide, maintain and operate all temporary facilities required for the construction related works and remove after completion of work. Providing barricading at trench in city area as per instruction of engineer in charge for safety

3.2.1.11 Hook up/ tie-in with GGPL's existing facilities, wherever required and tie-in of pipeline and SV stations buried / aboveground piping system.

3.2.1.12 All works related to testing, dewatering, swabbing, drying, pre-commissioning and preservation / commissioning of the work tendered.

3.2.1.13 Idle time preservation of pipeline, if required.

3.2.1.14 All incidental and associated works and any other works not specifically listed therein but are required to be carried out to complete entire work related to pipelines and terminals.

3.2.2 **Main Pipeline**

3.2.2.1 **Topographic Survey**

The contractor shall be deemed to have to familiarized themselves with route prior to quoting and take care of all the eventualities. No extra cost shall be admissible in any form at a later date. The survey drawings & details to the extent available are being furnished to the successful bidder. Any additional survey/ route survey and their details required either for local detours during execution or for which the survey data / drawings are not available shall be carried out by contractor in similar manner without any extra cost to the owner. However, laying and construction of entire pipeline including detoured portion and pipeline section/ sections of pipeline for which survey data / drawings are not available shall be within the scope of contractor without any cost implication. **Contractor shall be deemed to have considered such survey works in his bid.**

The drawings available are indicative & tender purpose only and are furnished to enable Bidder to estimate the quantum of work and to quote a firm price for the work. Final construction drawings of all type shall be

prepared and submitted for approval to Owner by successful bidder / contractor at or before project execution stage. Approved for Construction drawings may vary to some extent from the drawings included in the Bid Package. Contractor shall carry out all works in accordance with the construction drawings duly approved by Owner without any extra time & cost implication to the Owner.

3.2.2.2 **Familiarization of Pipeline Route**

Bidders are advised to arrange to carry out survey and preparation of Alignment sheets, make site visits to familiarise themselves with all the salient features of terrain and available infrastructure along the pipeline route. Contractor shall be deemed to have considered all constraints and eventualities on account of site conditions along pipeline route while formulating his bid. Contractor shall not be eligible for any compensation in terms of cost and/ or time, on account of site conditions along pipeline route varying to any extent from whatever described in the Bid Package and the drawings furnished along with the Package.

3.2.2.3 **Soil Investigation and Soil Resistivity survey**

COMPANY has carried out soil investigation (visual classification/ stratification) and resistivity survey along the pipeline route in some segments. Data collected from such surveys will be furnished to successful bidder. It shall be Contractor's responsibility to verify the data and satisfy himself with regard to accuracy and utility of data. CONTRACTOR may carry out soil data/ investigation required for installation in the already surveyed and un-surveyed localities. CONTRACTOR shall not be entitled for any compensation in terms of time or cost in case of any variation in actual site conditions from the data furnished in the bid package. It shall be Contractor's responsibility to familiarize himself with sub-soil conditions along the pipeline route and workout the lengths of pipeline to be laid in different subsoil conditions including the quantum of rock excavation that would be necessary.

3.2.2.4 The city condition field / other fields may have lots of PVC, PE & utility pipelines or other pipelines & cables being used for city utility / other utilities purposes. CONTRACTOR shall ensure that these lines shall not be damaged/ cut affecting the water / power / communication / other supply to concerned Users / Owners / Authorities. Wherever required temporary necessary precautions had to be maintained for uninterrupted supply.

3.2.2.5 Carrying out physical inspection of OWNER supplied line pipes and pipe corrosion coating at the time of receiving and taking-over. Carrying out all repairs, to pipe and pipe coating, including supply of all materials. All handling, lifting, stacking of coated/ bare pipes required during inspection.

3.2.2.6 Carrying out repairs (including supply of all materials) of line pipe and pipe coating which will include repair of all defects/ damages occurring during transportation and / or handling after receiving and taking over.

3.2.2.7 Loading, unloading, handling, stacking, storing and transportation to workshop/ work site of all materials that may be used for the construction of pipeline system either supplied by OWNER at their designated stack yard/ dump site/ store and/ or by CONTRACTOR as the case may be.

3.2.2.8 Obtaining all necessary approvals, work permits and liaisoning / coordination works for laying of pipeline and its all crossing from concerned local authorities and respective OWNER's having jurisdiction, as applicable for performing the work including shifting/ relocation and restoration of telephone/ electrical poles and underground pipes and other utilities etc. as required by local authorities and as directed by OWNER shall be responsibility of contractor.

3.2.2.9 Stacking, clearing, grading, trenching to all depths in all types of soil including soft & hard rock, by special techniques, chiseling or otherwise cutting etc. to a width to also accommodate the HDPE duct as per relevant standards, drawings, specification etc. transportation of coated pipes to along the route, stringing, aligning, bending, welding, NDT including radiography by X-ray (Gamma ray will only be permitted in inaccessible area like tie-in pit etc., where Engineer-in-charge feels necessary and decision of Engineer-in-charge shall be final & binding to the contractor) and ultrasonic (if required), inspection, field weld joint coating including supply of all materials, protective coating of long radius including supply of materials as per specifications, sand padding, laying and lowering of the pipeline, back filling, slope breakers as required, carrying out road, canal, utility on pipeline as shown in approved drawings and as directed by OWNER, installation of supports wherever required, supply of select backfill material as required, clean-up, flushing, hydrostatic testing with the quantity of inhibitor as required, dewatering with the additive, at required dosage, swabbing, pre-commissioning and commissioning of complete pipeline system, including all associated works as per relevant specifications, standards and approved drawings.

3.2.2.10 Welding of all tie-in joints including tie-in joints and bends on either side of major river crossings/ with adjoining pipeline installed by others/ other facilities as required, cutting of test header, re-bevelling and tie-in with adjacent pipeline segments.

3.2.2.11 Field weld joint coating shall be by heat shrink sleeve (Covalence / Canussa / Seal-for-life) / other suitable material as per specification enclosed with bid package compatible of pipe coating material.

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

3.2.2.13 Installation of casing pipes (by open cut/ trenchless method) assembly, including supply of all materials viz. casing pipe, casing insulators and end seals, vents and drains etc. complete, at cased crossings as per the drawings/ specifications

enclosed with bid package.

Cased crossings shall be installed at locations indicated in alignment sheets or as per SOR or as per instruction of owner. The number of crossings indicated in alignment sheets or as in SOR is subject to change based on engineering, construction and statutory requirements or the requirements of the authority having jurisdiction over a utility crossing.

Crossing by HDD/ moling / boring, (wherever approved) – Type of crossing i.e., HDD / Moling / Boring / cased / Uncased / Open-cut and the length of the crossing shall be as per prior written approval of EIC.

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

3.2.2.15 Sand/ soft soil padding around pipe wherever required in areas where trenching has been done in hard soil area / rocky area including supply of sand/ soft soil. The thickness of sand/ soft soil padding at the top of coated pipe shall be minimum 150 mm and bottom of coated pipe shall be minimum 150 mm or as per standard drawing, whichever is more.

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

3.2.2.17 **Crossings**

List of crossings shall be provided to successful Bidder

All crossings shall be crossed by heaviest wall thickness carrier pipe among available pipes at site or as per approved drawings/ as decided by Engineer-in-charge.

3.2.2.17.1 **Railway Crossings**

The general arrangement drawings for railway crossings shall be approved by Indian Railways and construction shall be carried out accordingly. These drawings shall be made available to the Contractor at appropriate time during the execution of the project. Pipeline at railway crossings shall be provided with a casing pipe. The casing pipe shall be as specified or at least three nominal pipe sizes larger than carrier and shall be installed by boring/ jacking. It should be noted that the extent of casing pipe generally specified by Railways, is 15.0m beyond centrelines of the outermost tracks on either side or 0.6 meter beyond the pipe line alignment limits of railways on either side, whichever is more. All railway crossings shall be cased crossings. The railway crossing shall comply with the requirements of API 1102 and Indian Railway regulations. The crossing angle shall be as close to 90° as possible.

3.2.2.17.2 **Road Crossings**

i) Contractor shall firm the method of crossing of roads such as open cut/

boring up in consultation with concerned authorities and Company. The Contractor shall also take due care to identify and take due precautions so as not to disturb or damage the utilities like cables, water lines and other structures.

ii) After laying the pipeline in a road crossing by open cut method, the Contractor shall either completely backfill the road & make ready for restoration or completely restore the road to its original condition depending upon instructions of Owner / EIC.

iii) While laying the pipeline in road crossings by open cut method the Contractor should ensure that the traffic is not stopped during the execution of work. This may be done by cutting half of the road at a time so as to enable the traffic to pass on the remaining half of the road. Alternatively, the Contractor can provide diversion roads to maintain the flow of traffic.

iv) The Contractor shall provide proper caution boards during day time and danger lights during night time when the cutting operation of the road is going on.

For cased crossings, the pipeline should be taken through the casing pipe which should be at least 1.9 metres below the road top as specified or as per the requirements of local authorities, whichever is higher. All national highway and state highway as indicated in relevant drawings/ alignment sheets/ or as directed by Engineer-in-charge shall be cased crossing.

3.2.2.17.3 **Crossings by Horizontal Directional Drilling (HDD)**

Contractor shall cross the roads / water crossings by HDD method at various depth in different locations as directed by Owner / Consultant either as per site conditions or as per instruction received from concerned authorities, whichever will be higher / stringent and decision of Owner / Consultant in this regard shall be final & binding to the contractor. Before start of HDD, the contractor shall ascertain by pre-construction survey all underground obstacles namely electrical/ PSS cable, foreign pipeline, water line, drain/ sewerage line etc. and prepare crossing profile drawings showing all elevations & levels. The contractor shall also ascertain, the type of soil & their terrain whether rocky or normal by way of trial pit or by geo-technical survey in case of river etc. before start of job. The contractor shall submit procedure, profile drawing with complete design calculations of HDD as per requirement of ASME B31.8/ OISD norms and safety requirement that pipe is not under stress during and after crossing for Owner/ Consultant's approval prior to start the execution of works.

Contractor shall determine the minimum allowable elastic bend radius for pipe from the following considerations :

i) 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.

ii) Maximum equivalent stress during final hydrostatic test

After installation the pipeline shall be hydrostatically tested (for 4 hours) at a pressure stipulated in the Special Conditions of Contract / relevant Particular Job Specification. 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.

iii) Maximum equivalent stress during service

Permissible values of maximum equivalent stress during service shall be governed by the requirements of ASME B31.8. The details of pipeline operating parameters are provided in the Special Conditions of Contract.

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 no. i), ii) & iii) 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.

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

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

3.2.2.18 **Hydrostatic Testing, Dewatering, Swabbing and Drying of Pipeline**

Contractor shall hydro test the pipeline as per specification enclosed with tender. The test duration shall be minimum 24 hours. After successful completion of hydrostatic testing of the pipeline, Contractor shall dewater the pipeline. As a minimum, Contractor shall continue the dewatering operation until the volume of water removed is less than volume of 2 metres of full pipe length.

After completion of dewatering operations, Contractor shall carry out swabbing of pipeline by running high/ medium/ low density foam pigs propelled by compressed air through the pipeline. Prior to their launching, Contractor shall weigh the pigs. On arrival of the pigs at the receiving end they shall be re-weighed. The swabbing operation shall be repeated till the weight of the last received foam pig does not increase by more than 50% or 10 runs of foam pigs whichever is earlier.

The pipeline/ section(s) of pipeline shall never be left empty (filled with air) after dewatering/ swabbing. Contractor shall take up dewatering and swabbing of pipeline after hydro testing only when Contractor is ready for carrying out the drying operation immediately following pipeline swabbing. Till such time Contractor is ready to start drying of pipeline, the pipeline/ section(s) of pipeline after hydro testing shall be kept filled with inhibited water or the pipeline/ section(s) of pipeline shall not be dewatered. Preservation of pipeline using inhibited water from the time of completion of hydro testing till Contractor is ready for drying of pipeline, shall be carried out by Contractor as part of his scope of work at no extra cost to Owner.

After the results of swabbing operation has been accepted by Owner, nitrogen purging of line may be started for pre-commissioning activities as per specification.

Pre-hydro testing of aboveground mainline section shall be carried out separately and test duration shall be minimum 4 (four) hours.

3.2.2.20(A) **Leak Detection**

a) Contractor shall submit a detailed procedure for detection of anticipated/ probable leak which is likely to be found during hydro test. Such method of detection shall consume minimum possible time to complete the hydrotest activity within contractual completion schedules. This procedure needs prior approval.

b) For Major Leak/ Burst (attributable to Owner) which can be traced visually by re-excavation – rates for locating and rectification shall be paid as per item included in mainline SOR for each Leak/ Burst.

c) For Minor suspected Leak (attributable to Owner) which can not be visually located and which requires sectionalising of pipeline or any other suitable means, rates of activities for leak detection shall be derived from rates of equipments and manpower available in the Contract. However for the pipe which needs to be replaced after the leak has been located, the payment will be made as per SOR item i.e. same as (b) above.

In case after sectionalisation/ other method no leak is detected, for such eventuality no payment will be made for efforts made for sectionalising/ other means.

3.2.2.19 **Hydrostatic Test Pressure**

The pipeline shall be hydrostatically tested to a minimum test pressure 1.4 times the design internal pressure and in no case test pressure of the pipeline shall exceeds 1.5 times the design internal pressure.

3.2.2.20 All tie-in joints including tie-ins with existing facilities, if any. All tie-ins shall be welded tie-ins.

3.2.2.21 **Markers**

Installation of all types of markers including all associated civil works. Any other work not specifically mentioned above but required for making the entire pipeline system ready for operation.

3.2.2.22 **CATHODIC PROTECTION – Scope of Work as per respective PJS 3(d), SOR & technical specification**

3.2.2.23 **Priorities**

The Contractor shall start the execution work for entire length of mainline simultaneously and shall deploy adequate manpower, machinery, tool & tackles etc. accordingly.

However, Owner may, at its sole option, assign priority of construction of any section of total pipeline length or to any part/ segment of the work. Contractor shall comply with such priority of execution and their deployment without any time and cost implication to the Owner.

3.2.2.24 **Deleted**

3.2.2.25 **Forest/ Plantation Areas**

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

3.2.2.26 **Restoration**

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

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

cost.

3.2.2.27 Preparation and submission of as built drawings, pipe books, documents, photographs of major activities, and project records as per specification and instructions of the OWNER including furnishing of all Test Certificates/ Inspection Reports for all materials used for permanent installation in requisite numbers as mentioned elsewhere in this document.

3.2.2.28 **Idle Time Preservation of the Pipeline – (if required)**

3.2.2.29 **Route Clearing**

During Route clearing, the vegetation shall be cut off at ground level leaving the roots intact. Only stumps and roots directly over the trench shall be removed for pipeline installation.

3.2.2.30 **Pre-commissioning and Commissioning Assistance**

3.2.2.30.1 Dewatering, swabbing, Drying and pre-commissioning including supply of all materials, consumables and manpower of the complete pipeline system and terminal piping work.

3.2.2.30.2 Making the entire system ready for commissioning and providing assistance during the complete duration of commissioning operations.

3.2.2.30.3 Completion of all mainline activities as detailed in SOR.

3.2.2.30.4 Complete N_2 purging before the start of welding at all hook up works as indicated/ shown in schematic drawing enclosed in Tender Document.

3.2.3 **Terminals (Tap-off Point, various MRS at Industrial Consumer's Stations / DRS)**

3.2.3.1 **Piping Works**

- Supply of assorted pipe, fasteners, gaskets, fittings, flanges, utility piping & piping supports and other supply wherever specified as per SOR.
- Taking delivery of free issue materials from GGPL designated stores and its transportation to site.
- All fabrication, erection, testing and commissioning of piping above ground at all elevations and below ground at all depths including provision shall be kept for installation of temporary flanged end header for Pig Launching, all valves, insulating joints, barred tee and other fittings and associated piping works as per drawings and specifications.

  All mechanical works of under ground and above ground, complete piping including fabrication, welding, all non destructive testing of welds repairs/ pretesting, hydrostatic testing, cleaning/ flushing, functional testing, cutting of mainline and bevelling (if required), excavation in all types of soil for installation of piping and pipe supports.
- Installation of all inline/ online instruments.
- Obtaining all necessary approvals and work permits from concerned local authorities having jurisdiction including hot work permit as applicable for performing the work.
- Carrying out welding including cutting, edge preparation (inclusive of grinding the edges on fittings, flange, etc. to match with the matching

edges of different thickness wherever required, bending, pre-heating wherever required, NDT including radiography by X-ray / Gamma-ray and other non-destructive tests specified. NDT requirements for process and other piping shall be in accordance with relevant specifications enclosed with the tender document.

- Preparation of plot plan cum piping GAD based on schematic drawings provided in the tender document for tap-off station, various MRS at Industrial Consumer's Stations / DRS & SV stations. Preparation of isometric drawings and final Bill of Material based on piping detail GA drawings prepared by contractor & duly approved by Owner / Consultant.
- Cleaning and servicing of all free issue materials including equipment, valves to make it suitable for installation.
- Completion of all mechanical works as detailed in SOR.
- SV station, branch piping shall be hydrostatically tested to the test pressure in accordance with Specification for piping fabrication, erection. Test pressure shall be 1.5 times design pressure and minimum duration of test shall be four (4) hours. All ball and plug valves in the piping network being hydro tested shall be kept in the partially open position.

3.2.3.2 **Equipment and Vessels – As per SOR**

3.2.3.3 **Civil & Structural Works**

Civil & Structural Works shall be carried out as per the scope detailed in PJS, SOR and Technical Specification.

3.2.3.4 **Electrical – As per SOR**

3.2.3.5 **Deleted**

3.2.3.5.1 **Instrumentation – as per SOR**

3.2.3.5.2 **DELETED**

3.2.3.6 **Painting**

- Painting (including supply of all materials) of all equipment, piping, structural steel elements for pipe supports, and all structural miscellaneous items as required and as directed by Company. Paint shall be suitable as per specification providing total DFT of 345 μ minimum as per Specification No. MEC/S/05/21/07. Painting shall include primer and finish coats as per specifications. Prior to painting surface shall be sand blasted as per instruction of Engineer-in-charge.
- For equipment, valves and other free issue items only one finish coat of final paint will be provided.

3.2.3.7 **Other Works**

- Obtaining all necessary approvals and work permits, as applicable, for performing the work.
- Carrying out all additional surveys, test and collection of data not furnished by company but required for construction of facilities.
- Provision is to be kept in the terminal for installation of Permanent Cathodic System.
- Extension/ provision of the utilities at desired locations from the consumers battery limit, the utilities are fire water, instrument air, plant air, drinking water, service water and electrical power.
- Any other work not specifically listed herein but required for the construction of the terminals and making it ready for the operation.

4.0 SCOPE OF SUPPLY

4.1 Material to be supplied by Company as Free Issue

4.1.1 Line pipe (Bare/ Coated), Ball Valves of Size 4" & above

Three Layer PE Coated line pipes & Ball Valves of Size DN 100 & above as per details indicated in clause 1.2. Company shall supply bare and externally corrosion coated line pipe with 3-Layer polyethylene coating.

Contractor shall receive and take over the pipes & ball valves at designated store. At the time of taking-over contractor shall perform inspection of pipes, pipe coating & valves and record all defects noticed in the presence of Company's Representative. Contractor shall repair all defects recorded at the time of taking-over of pipes & valves and shall be compensated as per rates set forth in the Schedule of Rates.

Any repairs to 3-Layer Polyethylene coating shall be carried out by Contractor using suitable material compatible with parent coating system and meeting the requirements of coating system specified in specification for 3-layer polyethylene coating. The coating repair material and procedure for application shall be submitted to MECON for approval prior to start of construction.

4.1.2 Deleted.

4.1.3 Contractor to note that quantities of line pipe indicated in the bid document includes contingency/ extra length over and above the actual requirements. Surplus pipes shall be taken over by the Installation Contractor from Coating Contractor at storage yard after completion of installation works. It is the responsibility of Installation Contractor to return surplus pipes to the COMPANY storage yard as per instructions Engineer In- Charge after completion of installation works.

4.1.4 Receiving and taking over of bare and coated line pipes at Storage yard including its inspection. All trucks / trailers for transportation of line pipes from

storage yards to site/ ROU/ Contractor's storage Yard shall be supplied by contractor. The coating contractor shall load the coated/ bare line pipes onto the truck/ trailers supplied by Contractor.

4.1.5 Contractor shall note that Chainage indicated for SVs are approximate and may vary along the pipeline chainage, based on the availability of land and NH/ SH/ Rail approach. The exact location of Company's storage yard shall be intimated to the Contractor at the time of award. Contractor shall be responsible for performing all works as per scope of work at the finally selected storage yard location by the COMPANY at no extra time/ cost to the COMPANY.

4.1.6 Transportation of pipes and other free issue material from place of issue is in Contractor's scope. Contractor shall note that the prices indicated in the Schedule of Rates shall be inclusive of taking the delivery and transportation of line pipes and other material from the above storage yard/ stockyard to work place(s).

4.1.7 Bevel Protectors of the line pipes shall be the property of the pipeline installation Contractor. He has to collect and dispose off the bevel protectors. Contractor shall quote accordingly.

4.1.8 *Supply of Pipeline Safety System, Civil & Structural items as elaborated in respective particular job specification and SOR enclosed elsewhere with the tender document.*

4.2 Company's storage point for free issue material of this project shall be as mentioned in Annexure-2 to SCC.

Contractor shall arrange all trucks/ trailors, cranes etc. for transportation of above materials including loading at Company store, unloading at contractor's storage yard/ work site, arrangement of cranes, handling etc.

Contractor shall return all surplus material to company designated storage yard as decided by Engineer- In- charge.

4.3 **Conditions for issue of Company Supplied Material**

Contractor shall prepare and submit Material Issue Vouchers to enable stage wise issue of materials. All materials shall be issued for incorporation in permanent works only and shall not be used for any temporary or ancillary works without the written consent of Engineer-in-charge. These materials shall be issued to the contractor from the Owner's storage points. Contractor shall be responsible, at this own cost, for lifting of the materials from Owners issue points, measuring, weighing, loading, unloading, transportation and return of materials to designated storage points. Contractor shall also be responsible for constructing covered godowns with adequate supports and clearances for safe storage of materials.

Every month the contractor shall submit an account for all the materials issued

by the owner in the proforma prescribed by the Engineer-in-charge. On completion of the work, the contractor shall submit materials appropriation statement for all materials issued by Owner.

4.3.1 All materials issued by the COMPANY to the CONTRACTOR shall be preserved against deterioration and corrosion. Any damages/losses suffered on account of poor or improper storage while under CONTRACTOR'S custody and non-compliance with the requirements stipulated herein shall be considered as losses suffered due to willful negligence on the part of the CONTRACTOR and he shall be liable to compensate the COMPANY, for the losses suffered, at penal rates as elaborated elsewhere in the bid document.

Various equipments/ materials intended for the installation will be received by COMPANY in unpacked, skidded, crated, packed or loose condition and will be stored in the COMPANY warehouses & open yards. In general, material will be issued to the CONTRACTOR in "as-received" condition. It will be the CONTRACTOR'S responsibility to draw, load and transport all materials from COMPANY's designated place (s) of issue to the point of installation.

The CONTRACTOR at his own cost shall duly protect all materials supplied by the COMPANY with appropriate preservative like primer/lacquer coating, grease etc, if required.

The Contractor shall be required to take Insurance Cover in terms of general conditions of contract.

4.3.2 The CONTRACTOR shall check that valves, fittings and specials are not subject to corrosion from hydrostatic test liquid remaining saturated in the packing. Any such conditions when detected should be brought to the notice of the Engineer-in-charge and remedial measures taken as directed. Small and medium size pipe, fittings shall be stored in rack to be constructed from this purpose in a covered godown. When large size pipe fittings are to be stored, these may be kept in the open on surfaced storage yards on proper wooden supports.

4.3.3 All machined surfaces shall be properly greased and shall be maintained and protected from damages.

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

4.3.5 All valves, instruments, pressure gauges, thermometers etc. supplied independently, as well as alongwith equipment and machinery shall be stored separately, inside the covered godown on racks.

4.3.6 As far as possible materials shall be transported to the erection site, just prior to their actual erection and shall not be left laying around indefinitely. Instructions for the Engineer-in-charge shall be followed strictly in this regard.

4.3.7 **Repairs of Pipe Defects**

Immediately prior to aligning pipe for welding, the bevelled ends of each joint of pipe and the area immediately adjacent thereto (at least 25 mm from the edge on the inside and outside of the pipe) shall be thoroughly cleaned of paint, rust mill scale, dirt or other foreign matter by use of power driven wire buffing wheels, disc sanders, or by other method approved by COMPANY. This shall be done at no extra cost.
All damaged ends of pipe that are bent, cut or otherwise mutilated such that, in the opinion of the COMPANY, faulty alignment or unacceptable welding would result, shall be repaired or cut-off and re-beveled to the correct angle with a bevelling machine of a type approved by COMPANY. No compensation shall be allowed by reason of such re-cutting or beveling, except when required because of the original bevel being damaged before the pipe is "taken over" by CONTRACTOR.

CONTRACTOR shall remove dents in bevels with a depth of less than 1 mm during cleaning and grinding, ahead of the welding in the field. No compensation shall be paid to Contract or on this account.
CONTRACTOR shall re-bevel dented bevel ends with a depth of dent between 1 and 3 mm. Dents over 3 mm depth shall be repaired by cutting and re-beveling. The CONTRACTOR shall be entitled for extra compensation only for cutting and re-beveling of defects recorded at the time of taking delivery as per the rate set forth in the "Schedule of Rates".

4.4 **Material to be supplied by Contractor**

The procurement and supply, in sequence and at appropriate time and place, including inspection and expediting, of all materials and consumables required for completion of the work as defined in this bid document except the materials specifically listed under para 4.1 above as COMPANY free issue material, shall be entirely the CONTRACTOR's responsibility and the item rates quoted for the execution of the WORK shall be inclusive of supply of all these materials. All materials supplied by the CONTRACTOR shall be strictly in accordance with the requirements of relevant COMPANY material specifications enclosed with the Contract document. All equipments, materials, components etc. shall be new and specifically purchased for this job from Company approved vendors, duly inspected by third party inspection agency, only manufacturer certificate shall not be adequate.

Contractor shall appoint anyone of the following TPIA for inspection purpose, wherever required as per tender document. Contractor has to propose minimum 4 nos. of below listed agencies to be approved by GGPL / MECON :

a) Lloyd Register of Industrial Services

b) Technische Ulierwachungs Verein(TUV)

c) Det Norske Veritas (DNV)

d) AB-Vincotte

e) Bureau Veritas

f) SGS

g) American Bureau Services

h) Velosi Certification Services

i) Certification Engineers International Limited(CEIL)

Apart from inspection by TPIA, inspection may also be performed by MECON / GGPL personnel.

As a minimum, the materials to be supplied by CONTRACTOR shall include but not be limited to the following.

4.4.1 **Mainline**

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

4.4.1.2 Supply of 0.5 mm thickness & 600 mm wide warning tape. The material of warning tape shall be of high density polyethylene and non biodegradable type. It shall have non-toxic and anti-rodent properties.

4.4.1.3 All materials and consumables required for external corrosion coating and concrete coating (where required) of field weld joints.

4.4.1.4 All materials required for field joint coating, corrosion coating of LR bends, pup pieces of sectionalising valves and repair of damaged corrosion coating of line pipe. Contractor shall confirm that proposed field joint coating material is suitable for type of terrain encountered along pipeline route. Contractor shall take prior approval from COMPANY for field joint coating material to be used. The cut back length shall be 150 mm + 20 (-0) mm.

4.4.1.5 All material, equipment & consumables for HDD works including heat shrink sleeves.

4.4.1.6 All materials required for carrying out two component epoxy coating for internal surface of casing pipe, wherever required by statutory authorities.

4.4.1.7 All materials required for sand/ soft soil padding around pipeline and optical fibre cable, PVC warning mats, select backfill of approved quality, slope breakers, bank stabilization of water crossings etc.

4.4.1.8 Mobilizing and providing all necessary barricading material, safety signboards, warning lights etc to safeguard the pipeline against accidents during construction of line in city area.

4.4.1.9 All safety tools, tackles, devices, apparatus, equipment etc. including ladders and scaffolding complete as required.

4.4.1.10 All stud bolts, nuts, jack screws, all type of gaskets (metallic spiral wound gaskets) in required quantities to be used for permanent installation into the system for all sizes and ratings of flanges and flanged valves, equipment etc., including nuts, bolts, gaskets, washers, U bolts, clamps, clips etc. for pipe/ equipment supports. All materials for supports shall be in contractors account.

4.4.1.11 All types of coating and painting materials including primer and paints suitable for normal corrosive environment for painting above ground piping and 100% solid high build epoxy (minimum 500 micron thk) for underground piping/ valves, etc.

4.4.1.12 All pipes, fittings, flanges, blind flanges, gaskets, nuts, bolts, clamps, strainers, equipment/ consumable, metallic blinds, temporary gaskets as required for filling, pressurising, hydrostatic testing and dewatering, swabbing etc. including test headers for pigging and hydro testing.

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

4.4.1.14 All equipment and consumables required for hydrostatic testing like pumps, pressure and temperature gauges, test water and corrosion inhibitors for test water for hydrostatic testing.

4.4.1.15 Deleted

4.4.1.16 All materials, consumables and equipment required for welding and for all types of tests and NDT such as radiography, ultrasonic testing, magnetic particle, dye penetrate examination etc. including radiography film, X-ray/ gamma ray machines, developing equipment and consumables, Ultrasonic equipments etc.

4.4.1.17 All safety tools, tackles, devices, apparatus, equipment etc. including ladders and scaffolding complete as required.

4.4.1.18 All materials for corrosion protection of buried piping, pipe fittings, valves, casing pipes, etc.

4.4.1.19 Mobilizing Pipe/ cable locator for locating existing pipelines/ cables

4.4.1.20 Corrosion inhibitor, oxygen scavengers and bactericides for water used for hydrostatic testing including water for testing.

4.4.1.21 Required quantities of nitrogen for idle time preservation and pre-commissioning of Pipeline and associated facilities, if required.

4.4.1.22 Required quantities of nitrogen for commissioning of Pipeline and associated facilities.

4.4.1.23 All pigs for cleaning, gauging, filling, dewatering, swabbing, drying, pre-commissioning and commissioning of the pipeline.

4.4.1.24 All materials i.e. fittings, flanges, valves, blind flange etc. required for isolation and nitrogen purging for pipe section, manpower, equipment, pigs, consumables, nitrogen required for carrying out commissioning of pipeline along with necessary piping and instrumentation connection for monitoring flow rate, pressure, temperature etc. providing temporary facilities for venting/ flaring along with necessary piping, valves and instrumentation etc. shall be contractors scope.

4.4.1.25 All other materials not specified above but required for successful completion of the entire work whether temporary or permanent in nature.

4.4.1.26 Coating repair material compatible and suitable for 3 layer PE coated line pipe comprising of repair patches (i.e. PERP-80 or equivalent) complete with adhesive.

4.4.1.27 All materials for all types of pipeline markers / warning marker including HDPE Warning Sheet, cement, sand, reinforcements, structural steel etc.

4.4.1.28 All materials required for continuous concrete coating/ saddle weights for providing negative buoyancy to the pipeline wherever required.

4.4.1.29 Supply of nitrogen and other consumables, tools and tackles required for venting, pre-drying, purging and filling of mainline.

4.4.1.30 Supply of bare casing pipe including all other material like casing insulators, end seals, vent & drain assembly etc. for cased crossing if required as indicated in SOR.

4.4.1.31 Supply of Bends of radius (R=3D) in contractor's scope as detailed in SOR.

4.4.1.32 Supply of Barred Tees, Insulating Joints, Ball Valves of size below 4" & plug valves of all sizes in contractor's scope as detailed in SOR.

4.4.1.33 All other items/ materials as may be required for completion of contractual scope of work and not covered under material to be supplied by company as free issue material at 4.1.

4.4.2 **Terminals**

4.4.2.1 **Piping, Equipment & Vessels**

a) Piping material assorted pipe, valves (ball valves of size below 4" & plug valves of all sizes) flanges & fittings etc. in Contractor's scope as detailed in SOR.

b) Studs, nuts, washers, U bolts, clamps, clips, pipe supports, gaskets for piping works.

c) Shims, wedges and packing plates (machined wherever required).

d) Galvanized steel piping of all sizes for instrument air/ service air.

e) Portable Fire Extinguisher System.

f) Painting material

All other items/ materials as may be required for completion of contractual scope of work and in SOR but not covered under material to be supplied by company as free issue material at 4.1.

4.4.2.2 **Civil & Structural**

All materials as elaborated in respective SOR and PJS enclosed elsewhere with the tender.

4.4.2.3 Cathodic Protection Works – Scope of supply as per respective PJS, SOR & technical specification

4.4.2.4 Deleted

4.4.2.4.1 Instrumentation – As per SOR

4.4.2.4.2 Deleted

4.4.2.5 All painting materials. Paint shall be suitable for highly corrosive environment.

4.4.3 **General**

4.4.3.1 All consumables for welding such as oxygen, acetylene, inert gases and all types of electrodes suitable for pipes of grades as specified in the specification, low hydrogen electrodes, filler wire, solder wire, brazing rods, flux etc. for welding / cutting and soldering purpose.

4.4.3.2 Equipment like hydrostatic pump etc., water and corrosion inhibitor for water used for hydrostatic testing including all pipes, fittings and equipment, metallic blinds, temporary gaskets as required for filling, pressurising and dewatering in connection with hydrostatic testing completion.

4.4.3.3 All pipes, fittings and equipment metallic blinds temporary gaskets as required for filling, pressuring and dewatering in connection with hydrostatic testing completion.

4.4.3.4 All consumables for welding of structural steel.

4.4.3.5 Materials and equipment required for all types of test such as radiography, magnetic particle and dye penetrate examination.

4.4.3.6 All safety tools/tackles, devices / apparatus / equipment etc. including ladders and scaffoldings etc. complete as required.

4.4.3.7 Supply of nitrogen and other consumables, tools and tackles required for venting, pre-drying, purging and filling of station piping.

4.4.3.8 Any other material not specifically listed herein, but required for the execution of the work.

4.4.3.9 The item rates quoted for the execution of the work shall be inclusive of supply of all materials mentioned above unless specifically covered otherwise under schedule of rates. The quantities indicated in schedule of rates under Contractor's scope of supply are approximate. Contractor shall carryout MTO of all materials required based on IFC general arrangement drawings, P & IDs and firm up the actual requirement of materials. All escalation/ extra materials procured by Contractor for contingencies shall be Contractor's property and no payments shall be made for such materials. Payment shall be made for actual materials installed by the Contractor as a part of permanent installation.

In case, any item is covered in scope of work but is not present in Schedule of Rates (SOR), it will be assumed that bidder has included cost implication of those items in their total price.

4.4.3.10 List of materials to be supplied and quantities indicated in SOR is tentative. These quantities can vary during execution to any extent and the same unit rate shall be applicable for payment. Final quantities will be based on the drawing issued to the contractor for construction. Quantities covered in SOR are for as erected quantities. Bidder will procure additional materials as required to cover cutting, scraps, wastages and damages during erection, testing and commissioning. For these extra quantities no additional payment will be made.

5.0 DOCUMENTS, SPECIFICATION, STANDARDS AND DRAWINGS

5.1 Owner shall furnish tender purpose drawings as listed in content of Volume-III of III of the tender document and other typical standard drawings attached with respective technical specifications enclosed with Volume-II of III of the tender document. Contractor shall prepare detail engineering drawing, bill of materials and all construction drawings and submit to Consultant for approval prior to start of the job / any procurement.

5.2 Contractor shall prepare isometric drawings & bill of materials and submit the same for Owner/ Consultant's approval/ record.

Contractor shall prepare drawing for utilities line as required as per SOR and submit the same for Owner/ Consultant's approval/ record.

5.3 No construction small or big shall be carried out without proper construction drawings duly approved by Owner / Consultant.

For Mainline route alignment drawing shall be furnished alongwith bid by Owner. However, detail pipeline route alignment sheets, detail-crossing drawings with crossing methodology shall be submitted by Contractor for prior approval after survey carried out by contractor at site before execution of pipeline work. Any additional survey and data required to complete above shall be also done by Contractor without any extra time & cost implementation to Owner.

5.4 After Completion of construction & commissioning of pipeline system, Contractor shall incorporate all the correction in drawings, prepare and issue the drawings "as-built drawings" as listed below to Owner as final submission of drawings. For Mainline pipeline alignment sheet, all crossing details, all CP drawings, pipe book etc. and for tap-off points, various MRS at Industrial Consumer's Stations / DRS & SV Stations - layout drg., piping GAD, Isometric, all civil drawings. For final submission only 4 sets of documents plus the original transparencies shall be handed over by Contractor. Any construction done by Contractor without duly approved drawings shall be wholly at his risk and cost. Contractor shall also submit soft copy of pipe book in excel alongwith hard copy. Soft copy of all as-built drawings shall be also submitted in AutoCAD. Videography/ photograph of all major activities/ milestone achieved shall also be arranged and submitted by the Contractor. For details of documentation to be submitted for mainline and terminal refer enclosed specification for documentation for pipeline construction enclosed elsewhere with the tender.

5.5 **Specifications**

The work shall be carried out by CONTRACTOR strictly in accordance with the specifications enclosed in Volume II of III of this document.

5.6 **Drawings**

The drawings are included in Volume –III of III of the bid package for BIDDER's reference purpose only; Bidders are advised to go through these drawings and also visit the site before submitting their bids. The Contractor shall develop the all type of drawings required for construction works as detailed in respective SCC, PJS & SOR etc.

5.7 **Drawing and Documents**

5.7.1 *The drawings accompanying the Bid document are indicative of scope of work and issued for tendering / bidding purpose only. These drawings indicate the general scheme as well as the route layout to enable the contractor to make an offer in line with the requirements of the owner. Final construction shall be done as per construction drawing prepared by the successful bidder / contractor & duly approved by Owner.*

5.7.2 *Construction drawings prepared by successful bidder / contractor prior to execution work shall be submitted to Owner progressively based on construction progress achieved by contractor. Owner will take approval period*

as minimum 7 (seven) working days from the date of receipt of drawings / documents. No extra claims in terms of time & cost, whatsoever shall be entertained for any variation between tender drawings and approved for construction drawings.

6.0 RESOURCES FACILITIES

6.1 Recruitment of Personnel by Contractor

The Contractor shall not recruit personnel of any category from among those who are already employed by the other agencies working at the sites but shall make maximum use of local labour available.

6.2 Construction Water and Power Supply

No water and power will be provided by the owner. It should be the responsibilities of the contractor to arrange water and power at his own cost.

6.3 Land for Residential Accommodation

Owner shall not provide any land for residential accommodation of contractor's staff and labour.

7.0 PROJECT SCHEDULING & MONITORING

Refer clause no.63 of SCC

8.0 CONSTRUCTION

OWNER reserves the right to inspect all phases of Contractor's operations to ensure conformity to the SPECIFICATIONS. Owner will have Engineers, Inspectors or other duly authorised representatives, made known to the CONTRCTOR present during progress of the WORK and such representatives shall have free access to the WORK at all times. The presence or absence of a Owner's representative does not relieve the CONTRACTOR of the responsibility for quality control in all phases of the WORK. In the event that any of the WORK being done by the CONTRACTOR or any SUB-CONTRACTOR is found by OWNER's representatives to be unsatisfactory or not in accordance with the DRAWINGS, procedures and SPECIFICATIONS, the CONTRACTOR shall, upon verbal notice of such, revise the work in a manner to conform to the relevant DRAWINGS, procedures and SPECIFICATIONS.

8.1 Rules & Regulations

CONTRACTOR shall observe in addition to Codes specified in respective specification, all National and Local Laws, Ordinances, Rules and Regulations and requirements pertaining to the WORK and shall be responsible for extra costs arising from violations of the same.

8.2 Procedures

Various procedures and method statements to be adopted by CONTRACTOR during the construction as required in the respective specifications shall be submitted to OWNER in due time for APPROVAL. No such construction activity shall commence unless approved by OWNER in writing.

8.3 **Field Inspection**

CONTRACTOR shall have at all times during the performance of the WORK, a Competent Superintendent on the premises. Any instruction given to such superintendent shall be construed as having been given to the CONTRACTOR.

8.4 **Erection and Installation**

The CONTRACTOR shall carry out required supervision and inspection as per quality Assurance plan and furnish all assistance required by the OWNER in carrying out inspection work during this phase. The OWNER will have engineers, inspectors or other authorised representatives present who are to have free access to the WORK at all times. If an Owner's representative notifies the Contractor's authorised representative not lower than a Foreman of any deficiency, or recommends action regarding compliance with the SPECIFICATIONS, the CONTRACTOR shall make every effort to carry out such instructions to complete the WORK conforming to the SPECIFICATIONS and approved DRAWINGS in the fullest degree consistent with best industry practice.

8.5 **Construction Aids, Equipment, Tools & Tackles**

CONTRACTOR shall be solely responsible for making available for executing the work, all requisite Construction Equipments, Special Aids, Cranes, Tools, Tackles and testing equipments and appliances. Such construction equipments etc. shall be subject to examination by owner and approval for the same being in first class operating condition. Any discrepancies pointed out by OWNER shall be immediately got rectified, repaired or the equipment replaced altogether, by CONTRACTOR. OWNER shall not in any way be responsible for providing any such equipment, machinery, tools and tackles.

The OWNER reserves the right to rearrange such deployment depending upon the progress and priority of work in various sections.

Tie-end between main line and starting point of terminal is included in the scope of contract, as and when main line section is available for Tie-ins.

9.0 **DOCUMENTATION**

Refer cause no. 49.0 of SCC

10.0 **SURVEY AND LEVEL/SETTING OUT WORK**

10.1 Before the WORK or any part thereof are begun, the Contractor's agent and the Engineer-in-Charge's representative shall together survey and take levels of the SITE and decide all particulars on which the survey is to be made, and on which measurements of the WORK are to be based. The CONTRACTOR shall plot such particulars and after agreement the Engineer-in-Charge shall sign the

drawings.

10.2 The CONTRACTOR shall be entirely responsible for the horizontal and vertical alignment, the level and correctness of every part of the WORK and shall rectify any errors or imperfections therein. The CONTRACTOR at his own cost shall carry out such rectifications, when the Engineer-in-Charge or his representative issues instructions to this effect.

10.3 The Engineer-in-Charge shall furnish the relevant existing grid point with Bench Mark on the land. It shall be Contractor's responsibility to set out the necessary control points in and to set out the alignment of the various works. The CONTRACTOR shall have to employ efficient survey team for this purpose and the accuracy of such setting out work shall be Contractor's responsibility.

10.4 The CONTRACTOR shall give the Engineer-in-Charge not less than 24 (twenty four) hours notice in writing of his intention to set out or give levels for any part of the WORK so that arrangements may be made checking the same.

10.5 WORK shall be suspended for such times as necessary for checking lines and levels on any part of the WORK.

10.6 The CONTRACTOR shall at his own expense provide all assistance, which the Engineer-in-Charge may require for checking the setting out of WORKS.

10.7 Before commencement of any activity, contractor's quality control set up duly approved by company must be available at site.

11.0 **ORDER OF WORKS/PERMISSIONS/RIGHT OF ENTRY/CARE OF EXISTING SERVICES.**

11.1 The order in which the WORK shall be carried out shall be subject to the approval of the Engineer-in-charge and shall be so as to suit the detailed method of construction adopted by the CONTRACTOR, as well as the agreed joint programme. The WORK shall be carried out in a manner so as to enable the other contractors, if any, to work concurrently.
OWNER reserves right to fix up priorities, which will be conveyed, by Engineer-in-Charge and the CONTRACTOR shall plan and execute work accordingly.

11.2 **Existing Service**

11.2.1 Drains, pipes, cables, overhead wires and similar services encountered in course of the works shall be guarded from injury by the CONTRACTOR at his own cost, so that they may continue in full and uninterrupted use to the satisfaction of the Owners thereof, or otherwise occupy any part of the SITE in a manner likely to hinder the operation of such services.

11.2.2 Should any damage be done by the CONTRACTOR to any mains, pipes, cables or lines (whether above or below ground etc.), whether or not shown on the

drawings the CONTRACTOR must make good or bear the cost of making good the same without delay to the satisfaction of the Engineer-in-Charge.

12.0 **MAKE OF MATERIAL/BOUGHT OUT ITEMS**

An Appendix-I of approved vendors for various major items is enclosed with this tender specification. The bidder shall consider such names only as indicated in the aforesaid list and clearly indicate in the bid the name(s) as selected against these items. For any other item not covered in the list enclosed with this tender document, prior approval shall be obtained by the contractor for its make/ supplier's name.

13.0 **INSPECTION OF SUPPLY ITEMS**

All inspections and tests shall be made as required by the specifications forming part of this contract. Contractor shall advise Owner/ Consultant in writing at least 10 days in advance of the date of final inspection/tests. Manufactures inspection or testing certificates for equipment and materials supplied, may be considered for acceptance at the discretion of Owner/ Consultant. All costs towards testing etc. shall be borne by the contractor within their quoted rates. All inspection of various items shall be carried out based on Quality Assurance Plan, which will be submitted by the Contractor and duly approved by Owner/ Consultant.

14.0 **ESCALATION**

The Unit Rates quoted shall be kept firm till completion of work, and no price Escalation shall be paid.

15.0 DELETED

16.0 Following new clauses are also to be considered wherever required which are specific to city conditions laying.

i) **Preliminary Activities, Design and Detailed Engineering**

- Contractor shall carry out all preliminary activities, surveys of utilities to the extent required for main pipeline and distribution/ branch lines, laying underground pipelines and prepare alignment sheets, crossing drawings alongwith bill of material with all details necessary for construction of the main and branch lines. The minimum pipeline cover shall be kept as follows:

  Pipeline Burial Requirement

  The entire pipeline shall be buried and provided with a minimum cover as given in Table below :

Pipeline Burial Requirements	
Location	**Min. Cover (m)**
a) Stream / Canal / Nala and other minor water crossing (below firm bed level)	1.5
b) Cased/ Uncased Road/ cart track crossings	2.0
c) Cased railway crossings	2.0
d) Drainage, ditches at roads/ railway crossings	1.0
e) Industrial, Commercial, Residential and other locations including rocky areas	2.0
f) Major water crossings (below scour level)	2.5
g) River crossing with rocky bed (below scour level)	1.5

Note:

i) The depth of cover shall be measured from the top of the pipe coating to the top of the undisturbed surface of soil or the top of graded working strip, whichever is lower. The fill material in the working strip shall not be considered in the depth of cover.

ii) The cover shall be measured from the top of road or top of rail, as the case may be;

iii) For river / water courses that are prone to scour and erosion, adequate safe cover as mentioned above or as advised by concerned authorities (whichever is stringent) shall be provided below the predicted scour profile expected during the life time of the pipeline.

iv) When scour level is not known, an additional cover of at least 1 m or as advised by concerned authorities shall be provided from the existing firm bed of the river / water course except in case or rocky river bed;

v) Minimum cover mentioned above against sl. no. a), b), c), d) & e) category may be increased based on the statutory requirements from concerned authorities and authorities requirement shall be final and binding to the contractor.

vi) Soft soil / sand padding of minimum 100 mm at bottom and at top is 200 mm thickness or as mentioned in standard drawing (whichever is stringent) to be provided around the pipeline where gravel / hard soil or rocky area is encountered.

- Contractor shall carry out detailed engineering as required for preparation of General Arrangement Drawings (GADs) for DRS / MRS Stations, Piping at consumer ends, connection at existing tap-off location and for future connections alongwith bill of materials.

  Owner will provide typical sketches for above ground installation (i.e. at DRS/ MRS etc.) Contractor shall develop General Arrangement Drawings (GADs) good for construction for various sizes and locations based on typical sketches/ drawings alongwith bill of materials and submit to Owner for reviews/ approval. Construction work shall be carried out based on construction drawings duly approved by Owner/ Consultant.

- The detailed engineering for above ground installation shall include detail engineering pertaining to all disciplines alongwith bill of materials.
- All the documents/ drawings prepared by the Contractor shall be submitted to Owner/ Engineer-in-charge for review and approval. All works shall be executed based on the approved drawings/ documents only.

- Contractor shall obtain all clearance from Government authorities. However bank guarantee/ required fee or charges shall be submitted by Owner.

- Contractor shall carry out corrosion survey, design, detail engineering, installation, testing & Commissioning for temporary cathodic protection including supply of all items for design life of 2 years.

ii) **Main and Distribution Pipeline**

- "Receiving and Taking-over" as defined in the Specifications of Owner supplied Carbon Steel externally corrosion coated/ bare line pipe of specified sizes and thickness from Owner's designated stacking yard(s), place(s) of issue in/ around the concerned city, transportation including loading, unloading, handling, stacking, hauling and stringing of pipes from Owner's stacking yard(s)/ designated point(s) of issue to Contractor's own stock yard(s)/ work site(s)/ workshop(s)/ pipeline Right-of-Use, including arranging all necessary intermediate storage area(s) required thereof till the pipes are installed in permanent installation. The exact location of the Purchaser's stacking yard near each city shall be intimated to the Contractor after the award of contract.

- Carrying out inspection of pipes and pipe coating at the time of receiving and taking-over and recording all the defects etc., noticed in the presence of Owner's representative and carrying out all repairs including supply of all repair materials.

- Carrying out repairs of the pipes and pipe coating not attributable to Owner (including supply of all materials) including defects/ damage occurring during transportation and/ or handling after receiving and taking-over including supply of all materials.

- Receiving and taking-over of all owner supplied material other than corrosion coated CS line pipe, loading, unloading, handling, stacking, storing and transportation to workshop, work site of all materials that may be used for the construction of pipeline system either supplied by Owner at their designated stockyard(s)/ designated stores and/ or by Contractor as the case may be.

- All additional route/ topographic surveys and/ or soil investigation required for local detours of main line and survey soil data for branch lines as required, including preparation of plan and profile drawings

without any extra cost to Owner.

- Staking, clearing, grading, fencing of Right-of-Use (ROU) wherever required, trenching to all depths in all types of soil including soft and hard rock, including chiseling or otherwise cutting etc. to a width to also accommodate the optical fiber cable/ cable conduit as per the relevant standards, drawings, specifications etc. Aligning, bending, welding, NDT including 100% radiography, field weld joint coating, external corrosion coating of long radius bends and buried fittings/ valves including supply of coating material as per the field joint coating specification, laying and lowering, carrying out road, canal, utility and submerged water crossings including bank stabilisation of water crossings as required including arranging all temporary land/ area required for construction purposes; supply and installation of anti-buoyancy measures viz. Continuous concrete coating, select backfill, extra cover, etc. on pipeline. Blasting of rock is not allowed. The excavated soil is to be kept/ disposed at the place specified by the Engineer-in-charge.

- Barricading of trench as per instruction of EIC / tender drawings wherever required. Supply of barricade will be paid separately as per SOR
- Carrying out corrosion coating of 500 micron thick two component underground coal tar epoxy, applied with minimum three coats for underground valves & fittings.
- Welding of all tie-in joints for pipeline section laid across other utility crossings along with insulating joints up to and including valves and fittings.
- Placement of HDPE warning mat 600 mm wide and 0.5mm thick over pipeline along complete route or as per standard drawing, whichever is stringent.

- Backfilling, temporary restoration including supply of select back fill material wherever required, compaction, clean-up, flushing, pigging, hydrostatic testing with the quantity of corrosion inhibitor as required, de-watering, swabbing of the main pipeline and removal of water by compressed air in branch lines. The backfilling and sand padding shall be carried out as per the instructions of Engineer-in-charge/ any relevant drawing enclosed with tender.

- Clean-up and restoration of Right-of-Use as per specification and drawings and other conveniences like road, rail, canal, utility crossings etc. to original condition, to the entire satisfaction of Owner and/ or authorities having jurisdiction and returning excess construction materials to Owner's designated stock-yard(s).

- Obtaining all necessary permissions, approvals and work permits from local authorities as applicable for performing the work including shifting

of telephone/ electrical poles, hume pipes etc., if required.

- Pre-commissioning, providing commissioning assistance, nitrogen purging of the complete underground pipe network including supply of all materials such as required type and quantity of pigs, consumables and manpower that are required during pre-commissioning and commissioning activities including all coordination with and assistance to other agencies/ contractors during commissioning operations and all associated works.

- Installation of all on-line instruments, pressure gauge, valves, insulating joints, appurtenances, etc.

- Loading, unloading, handing over and transportation of all surplus Owner supplied free issue materials including short length pipes to Owner's designated store and stacking the same as per the directions of Engineer-in-charge.

- Cutting/ up rooting of trees within ROU, counting the number and type of trees cut during pipeline laying works in presence of DFO/ concerned authorities and keeping record thereof, staking and banding over of all cut trees as per the direction of Engineer-in-charge.

- All requirements and stipulations of statutory authorities shall be adhered.

- Repair of leaks/ burst, not attributable to Contractor, occurring in Owner supplied material shall be carried out by the Contractor and the Contractor shall be compensated as per provisions of the contract. However repair of such defects attributable to Contractor shall be carried out by Contractor at no extra cost to Owner.

- Hook-up of piping facilities by welding, hot tapping or flanged connection (as shown in AFC drawings) with equipments and at the battery limit with the facilities installed by others including cutting, fit-up, welding, NDT, radiography, interface / co-ordination as required for inlet connection to DRS aboveground installation.

- Any other works not specifically listed herein above but are required to complete in installation work of pipeline and associated facilities in all respects.

- Preparation of as-built drawings, pipe-books, project records and photograph as per specifications and instruction of Engineer-in-charge.

iii) **Associated Works for Pipeline Construction**

- Installation of casing pipe (by open cut / jacking / boring / HDD) assembly, including supply of all materials viz. casing insulators and end seals etc. complete at cased crossings.

- Supply and installation of all types of pipeline markers including their painting, suitable for normal corrosive environment as per specification and all the associated civil works.

- Sand/ soft soil padding around pipe where required including supply of sand/ soft soil.

- Application of continuous concrete coating on line pipe and field joints as required.

- Excavation along existing pipe-route up to 2.0 m depth to locate existing underground tap-offs, backfilling, and restoration of excavated soil.

- Valve pits and joint pits shall be made as per drawing enclosed, at locations specified by the Engineer-in-charge.

- Fencing at SV Stations, DRS/ MRS installations shall be carried out by Contractor including supply of all civil & structure materials, complete foundation & civil works, fabrication & installation of chain link fencing, gates, painting etc. as per drawings & specifications.

- Corrosion survey, design, detailed engineering, supply & installation of temporary cathodic protection works as per enclosed specification and as directed by Engineer-in-charge.

- Providing barricading for safety during fabrication, installation and testing of pipeline as per tender specification.

iv) **Future Tap-off Connections**

- Complete works for installation of all piping works at all depths inside the pit, including all piping, valves, fittings at all depths inside the pit, all civil works including excavation of pits, pipe supports foundations etc. as shown in the relevant enclosed typical drawing. The side wall and bottom of the pit have to withstand an outside hydrostatic pressure of at least 1 kg/cm^2.

- Protective coating of 500 micron thick two component coal tar epoxy, applied with the help of minimum 3 coats, duly approved by Owner including supply of materials for all piping, valves, fittings, structural steel etc. for buried and installation inside pit.

- Corrosion coating of all field weld joint coating for buried piping of all sizes including supply of all materials.

- Filling and grading of areas around valve station for avoiding any local flooding of the area.

v) **Restoration of Existing Facilities**

All restoration works damaged during construction such as roads, pavements, utilities, cables, pipeline, sewers, streams, drains, ditches and any other facilities. All restoration work shall be carried out to original condition to entire satisfaction of Owner and concerned authorities.

- All roads, footpaths (including roads and footpaths inside colonies) shall be restored to original condition, and to the satisfaction of the Engineer-in-charge and the concerned authority. The specification for restoration work shall be inline with the technical specification of various elements such as footpath, filling work, curb stores, drains, pavement, service road, main road and highways as per the respective concerned Government Authorities such as PWD local civic authority etc. In case of any dispute, the decision of Engineer-in-charge shall be final and binding on the Contractor.

  In the event of Contractor's failure to adhere to these specifications and time schedule owner reserves the right to get these restoration work completed by approaching a third agency at Contractor's risk and cost.

  Contractor shall obtain clearance certificate regarding satisfactory restoration from concerned Authority.

  The concrete surfaces shall be restored and the concrete shall be placed with a minimum thickness of 50mm in footpaths and 100mm in roadways and driveways. To retard curing of the installed concrete, wet sack cloth is to be placed on the finished surface and kept damp for a period of 36 hours.

  Where slabs and blocks are to be restored, the level of the compacted sub-base is to be adjusted according to the slab/ block thickness. The slabs or blocks should be laid on moist bedding material, which should be graded sand, mortar or mortar mix. The slab or blocks should be tapped into position to ensure they do not rock after laying.

  The restored slabs or blocks should match the surrounding surface levels. Joint width should match the existing conditions, and be filled with a dry or wet mix of mortar.

  Turf shall be replaced in highly developed grassed area. In lesser-developed grassed areas topsoil should be replaced during the restoration process.

  When permanent surface restorations cannot be completed immediately, the Contractor shall provide and maintain a suitable temporary running surface for vehicular traffic and pedestrians. The Contractor will be responsible for the maintenance of all restoration carried out, for the duration of the contract guarantee period.

The Contractor is to ensure the restoration work is properly supervised, and that the material used is suitable for the purpose and properly compacted. Where the required standards are not achieved the Contractor will be required to replace the defective restoration work.

Note that payment for pipe laying will only be authorised on satisfactory restoration, and where the sites has been cleared of all surplus materials etc.

Markers are to be installed as part of the reinstatement process. The types of markers area as specified in the specification attached.

All trees to be uprooted at the time of pipe-laying activities should be properly replanted to a nearby area as directed by the Engineer-in-charge so that there is minimum loss of plantation.

In some areas restoration will be carried out by respective statutory authority. In this case Contractor has to backfill and compact the trench and remove all surplus material as per the instructions of Engineer-in-charge.

17.0 Following points shall be taken care by the contractor before/ during execution works.

i) Contractor shall be responsible for taking necessary precautions regarding traffic (installation of notice / warning boards).

ii) Contractor shall be totally responsible for the occurrence of any accident during excavation of road and shall be liable for damages / expenses due to the same.

iii) Concerned authority / Owner shall not be responsible for any loss / damage.

iv) One copy of the permission shall be made available with contractor's responsible workman at the place where excavation is undertaken.

v) While executing the subject work, excavation shall be done in consultation with the concerned authority engineer of that area.

vi) Necessary safety measures shall be taken for the gas pipeline, since high tension lines and other services carriers are running alongwith in gas pipeline route in the area.

18.0 Special note pertaining to Schedule of Rates (SOR).

i) All SOR item shall be quoted by the bidder in the price part of the bid,

other-wise bid will be rejected.

ii) The quantities given above against individual items are indicative and shall not be considered to be binding. The quantities may be increased, decreased or deleted at site at the time of actual execution and as per discretion of Owner / Engineer-in-charge. The unit rate shall be operated to work out the final payment due to Contractor.

iii) The payment will be made as per actual certified measurement at site.

iv) The scope as mentioned in the SOR is of indicative nature only and shall include all activities as detailed in the relevant clauses of the respective Particular Job Specifications, Technical Specifications, Data Sheets & drawings, etc.

v) The quantities mentioned in SOR for contractor supplied items shall be finalized and procured by contractor only after due approval of Engineer-in-charge. Contractor supplied any surplus item during reconciliation shall not be accepted / taken by the Owner.

LIST OF SUPPLIERS OF MAJOR BOUGHT-OUT ITEMS

(APPENDIX-I TO PARTICULAR JOB SPECIFICATION FOR MAINLINE, MECHANICAL & ASSOCIATED WORKS)

Appendix-I
To Particular Job Specification of Work

LIST OF SUPPLIERS OF MAJOR BOUGHT-OUT ITEMS
(Mechanical & Fire Fighting Equipment)

A) **Mainline & Mechanical**

i) PIPE CARBON STEEL TO INDIAN STANDARDS

1. A.S.T. PIPES PVT. LTD. (AST GROUP)
2. ADVANCE STEEL TUBE LTD.
3. APL APOLLO TUBES LTD. (ER. BIHAR TUBES LTD.
4. ASIAN MILLS PVT. LTD.
5. ASRANI TUBES LIMITED
6. DADU PIPES (P) LTD.
7. ESSAR STEEL LIMITED(ER HAZIRA PIPES MILL)
8. GAURANG PRODUCTS PVT LTD. (AST GROUP)
9. GOODLUCK STEEL TUBES LTD.
10. HI-TECH PIPES LIMITED
11. INDUS TUBE LIMITED
12. JINDAL INDUSTRIES LTD
13. JINDAL PIPES LTD.
14. JINDAL SAW LTD (KOSI WORKS)
15. JOTINDRA STEEL & TUBE LTD
16. LALIT PIPES AND PIPES LTD.
17. MAHARASHTRA SEAMLESS LTD.
18. MAN INDUSTRIES (INDIA) LTD. – PITHAMPUR
19. MAN INDUSTRIES (INDIA) LTD. ANJAR
20. MUKAT TANKS & VESSELS LTD.
21. NEZONE TUBES LIMITED
22. NORTH EASTERN TUBES LIMITED
23. PRATIBHA INDUSTRIES LIMITED
24. PRATIBHA PIPES & STRUCTURAL LTD.
25. PSL LTD (CHENNAI)
26. PSL LTD (V1, V2 & NC)
27. RAMA STEEL TUBES LTD.
28. RATNAMANI METALS AND TUBES LTD.
29. RAVINDRA TUBES LIMITED
30. SAMSHI PIPE INDUSTRIES LIMITED
31. SURYA ROSHNI LTD.
32. SWASTIK PIPES LTD.
33. UTKARSH TUBES & PIPES LTD. (FORMLY BMW)
34. WELSPUN CORP. LIMITED (DAHEJ)
35. ZENITH BIRLA (INDIA) LIMITED

ii) PIPE & TUBULARS TO A.P.I. STANDARDS

1. ARCELORMITTAL TUBULAR PRODUCTS ROMAN SA,ROMANIA
2. BHEL (TRICHY),INDIA
3. DALMINE SPA (ENQUIRY TO TENARIS),UAE
4. EEWKOREA CO. LTD (GERMANY), KOREA

5. EEW KOREA CO. LTD. (KOREA), KOREA
6. EISENBAU KRAMER GMBH, GERMANY
7. HYUNDAI RB CO. LTD. SOUTH KOREA
8. ILVA LAMIERE E TUBI SRL (ENQ TO ILVA SPA, ITALY
9. INOX TECH. SPA, ITALY
10. ISMT LTD. AHMEDNGR, INDIA
11. ISMT LTD. BARAMATI, INDIA
12. JINDAL PIPES LTD., INDIA
13. JINDAL SAW LTD. (KOSI WORKS), INDIA
14. JINDAL SAW LTD. (NASHIK WORKS), INDIA
15. LALIT PIPES AND PIPES LTD. INDIA
16. MAHARASHTRA SEAMLESS LTD., INDIA
17. MAN INDUSTRIES (I) LTD. (PITHAMPUR), INDIA
18. MUKAT TANKS & VESSELS LTD., INDIA
19. PRATIBHA INDUSTRIES LIMITED, INDIA
20. RATNAMANI METALS AND TUBES LTD., INDIA
21. SIDERCA S.A.I.C (ENQUIRY TOTENARIS), UAE
22. SUMITOMO METAL IND. LTD., INDIA
23. SURYA ROSHNI LTD., INDIA
24. SWASTIK PIPES LTD, INDIA
25. TATA STEEL UK LIMITED (FORMERLY C702)
26. TUBOS DE ACERO DE MEXICO SA (ENQ. TENARIS), UAE
27. TUBOS REUNIDOS SA SPAIN
28. UMRAN STEEL PIPE INC (TURKEY), TURKEY
29. VALCOVNY TRUB CHOMUTOV, CZECH REPUBLIC
30. VALLOUREC AND MANNESMANN TUBES, FRANCE
31. WELSPUN CORP LIMITED (DAHEJ), INDIA

iii) PIPE/TUBE CS (SEAMLESS) TO ASTM STDS

1. ARCELORMITTAL TUBULAR PRODUCTS ROMAN SA, ROMANIA
2. BHEL (TRICHY), INDIA
3. CHANGSHU SEAMLESS STEEL TUBE CO. LTD., CHINA
4. DALMINE SPA (ENQUIRY TO TENARIS, UAE
5. HEAVY METALS & TUBES LIMITED (MEHSANA), INDIA
6. ISMT LTD. AHMEDNGR, INDIA
7. ISMT LTD. BARAMATI INDIA
8. JFE STEEL CORPORATION, UAE
9. JINDAL SDAW LTD (NASHIK WORKS) INDIA
10. KLT AUTOMOTIVE AND TUBULAR PRODUCTS LTD., INDIA
11. MAHALAXMI SEAMLESS LIMITED, INDIA
12. MAHARASHTRA SEAMLESS LTD, INDIA
13. PRODUCTS TUBULARES S.A.U, SPAIN
14. RATNADEEP METAL TUBES LTD., INDIA
15. STAINEEST TUBES PVT LTD., INDIA
16. SUMITOMO METAL IND. LTD., INDIA
17. TUBOS REUNIDOS SA SPAIN
18. VALCOVNY TRUB CHOMUTOV, CZECH REPUBLIC
19. VALLOUREC ANDMANNESMANN TUBES FRANCE
20. YANGZHOU CHENGDE STEEL PIPE CO. LTD DUBAI (UAE)

iv) PIPE CARBON STEEL (WELDED) TO ASTM STDS

1. EEW KOREA CO. LTD. (GERMANY), KOREA
2. EEW KOREA CO. LTD. (KOREA), KOREA
3. EISENBAU KRAMER GMBH, GERMANY
4. HYUNDAI RB CO. LTD., SOUTH KOREA
5. INOX TECH. SPA, ITALY
6. JINDAL SAW LTD (KOSI WORKS), INDIA
7. LALIT PIPES AND PIPES LTD., INDIA
8. MAN INDUSTERIES (I) LTD.(PITHAMPUR), INDIA
9. MAN INDUSTRIES (INDIA) LTD. ANJAR, INDIA
10. MUKAT TANKS & VESSELS LTD., INDIA
11. RATNAMANI METALS AND TUBES LTD., INDIA
12. SUMITOMO METAL INDIA LTD., INDIA
13. TATA STEEL UK LIMITED

v) Valve

a) **Globe Valves**

1) M/s Weir BDK Valves (Aunit of Weir India Pvt. Ltd.)
2) M/s Datre Corpn (Calcutta)
3) M/s KSB Pumps Ltd., Coimbatore, India
4) M/s L&T Audco
5) M/s Neco Schuber & Salzer Ltd. (New Delhi)
6) M/s Niton Valve India Pvt. Ltd., India
7) M/s Ornate Valves (Mumbai)
8) M/s Panchavati Valves & Flages (P) Ltd., India
9) AV Valves Ltd., India
10) BHEL (Trichy), India
11) Econo Valves Pvt Ltd, India
12) Fouress Engg (I) Ltd (Aurangabad), India
13) Leader Valves Ltd, India
14) Oswal Industries Ltd, India
15) Petrochemical Engineering Enterprises, India (Fouress Group)
16) Sakhi Engineers Pvt Ltd., India
17) Shalimar Valves Pvt Ltd., India
18) Steel Strong Valves India Pvt Ltd, India
19) Petro Valves Pvt. Limited, Ahmedabad
20) Fluid Line Valves Co. (P) Ltd., India
21) MICON Engineers (Hubli) (P) Ltd., India

b) **Check Valves**

1. M/s Advance Valves Pvt. Ltd., Noida
2. M/s Aksons & Mechanical Enterprises, Mumbai
3. M/s Larsen & Toubro Limited (M/s Audco India Limited, Chennai)
4. M/s AV Valves Ltd., India
5. M/s Weir BDK Valves (A unit of Weir India Pvt. Ltd.)
6. M/s BHEL, Trichy

7. M/s Datre Coroportion Limited, Calcutta
8. M/s Leader Valves Ltd., Jalandhar
9. M/s Neco schubert &Salzer Ltd., New Delhi
10. M/s Niton Valves Industries (P) Ltd., Mumbai
11. M/s Precision Engg.Co., Mumbai
12. Econo Valves Pvt Ltd, India
13. Fouress Engg (I) Ltd (Aurangabad)
14. KSB Pumps Ltd (Coimbattore), India
15. NSSL Ltd. (Neco Schubert & SalzerLtd)
16. Oswal Industries Ltd, India
17. Panchvati Valves & Flanges Pvt Ltd, India
18. Petrochemical Engineering Enterprises, India (Fouress Group)
19. Sakhi Engineers Pvt Ltd
20. Shalimar Valves Pvt Ltd
21. Steel Strong Valves India Pvt Ltd, India
22) Fluid Line Valves Co. (P) Ltd., India
22. MICON Engineers (Hubli) (P) Ltd., India

c) **Plug Valves**

1. M/s Breda Energia Sesto Industria Spa, Italy
2. M/s Fisher Sanmar Ltd., Chennai
3. M/s Larsen & Toubro Ltd., (Audco) New Delhi
4. M/s Nordstrom Valves, USA
5. M/s Serck Audco Valves, UK
6. M/s Sumitomo Corporation India Pvt. Ltd., New Delhi
7. M/s Z Corporation, Korea
8. M/s Hawa Valves (India) Pvt. Ltd., Mumbai
9. M/s Steel Strong Valves India Pvt. Ltd., Navi Mumbai
10. M/s Econo Valves Pvt. Ltd., India (WSSL Ltd. Group Co.)
11. M/s Flow-Serve PTE (Mfr. SERCK), India
12. M/s Galli Cassina SPA, Italy

d) **Ball Valves**

1. M/s Hawa Valves (India) Pvt. Ltd, Navi Mumbai
2. M/s Larsen & Toubro (Audco), India
3. M/s Oswal Industries Ltd., India
4. M/s Virgo Engineers Ltd., Delhi
5. M/s Boteli Valve Group Co. Ltd., China
6. M/s Cameron Italy s.r.l., Italy
7. M/s Dafram S.P.A., Italy
8. M/s Fangyuan Valve Group Co. Ltd., China
9. M/s Franz Schuck GmbH, Germany
10. Kita Mura Valve Manufacturing Co.Ltd., India
11. Petrol Valve S.R. Italy
12. Piplviesse S.P.A. Italy
13. Tormene Gas Technology S.P.A. Valvetalia Group, Italy
14. Valbeot S.R.L. Italy

15. KMC Corporation, South Korea
16. MSA a.s. Czeek Republic
17. OMS Aleri, Italy
18. PCC Valves s.r.l. Italy
19. Perar s.p.a. (Engineering. To TRP srl), Italy
20. Italy s.r.l., Italy
21. MIR Valves, Malaysia

vi) Flow Tee

1) M/s Coprosider SPA, Italy
2) M/s GEA Energy System India Limited, Chennai
3) M/s Multitex Filteration
4) M/s Pipeline Engineering, UK
5) M/s Scomark Engg. Limited (U.K.)
6) M/s Skeltonhall Limited, Engaland(U.K.)
7) M/s Technospecial SPA, Italy
8) M/s Tectubi SPA, Italy
9) M/s RMA Germany

vii) Split Tee

1) M/s Ipsco, Canda
2) M/s TD Willamsons, USA

viii) Flanges

1. M/s Aditya Forge Ltd., Vadodara
2. M/s Amforge Industries Ltd., Mumbai
3. M/s CD Engineering Co., Ghaziabad
4. M/s Echjay Forgings Pvt. Ltd. (Bombay), Mumbai
5. M/s Echjay Industries Ltd., Rajkot
6. M/s Forge & Forge Pvt. Ltd., Rajkot
7. M/s Golden Iron & Steel Works, New Delhi
8. M/s JK Forgings, New Delhi
9. M/s Metal Forgings Pvt. Ltd., Mumbai
10. M/s Perfect Marketings Pvt. Ltd., New Delhi
11. M/s Sky Forge, Faridabad
12. M/s S&G, Faridabad
13. Chaudhry Hammer Works Ltd, India
14. JAV Forgings (P) Ltd, India
15. Kunj Forgings Pvt Ltd, India
16. MS Fittings Mgf. Co. Pvt. Ltd.
17. R.N. Gupta & Co. Ltd, India
18. R.P. Engineering Pvt Ltd, India
19. Sanghvi Forgings & Engineering Ltd
20. Shri Ganesh Forgings Ltd., India
21. Uma Shankar Khandelwal & Co., India
22. Sawan Engineers, Baroda
23. Stewarts & Lloyds of India Ltd., Kolkata
24. Engineering Services Enterprises

25. Abasi Engineersing Works, India
26. Anandmayee Forgings Pvt Ltd, India
27. CD Industries., India
28. Fivebros Forgings Vot Ltd., India
29. Good Luck Engineering Co., India
30. Korea Flange, South Korea
31. Lal Metal Forge Ltd, India
32. Melesi Officine
33. Amlrojie Melesi & C. srl. Italy
34. Nicola Galperti & Figlio S.P.AIndia
35. Paramount Forge, India
36. Pradeep Metal Limited, India
37. Punjab Steel Works (the), India
38. R.D.Forge, India
39. Shah Industrial & Comml. Corporation, India
40. Ulma Forja S. Coop.
41. Vivial Forge Pvt. Ltd., Vadodara

ix) Fittings

1. M/s Commercial Supplying Agency, Mumbai
2. M/s Dee Development Engineers Ltd.
3. M/s Eby Industries, Mumbai
4. M/s Flash Forge Pvt. Ltd., Vishakhapatnam
5. M/s Gujarat Infra Pipes Pvt. Ltd., Vadodara
6. M/s M.S. Fittings Mfg. Co. Pvt. Ltd., Kolkata
7. M/s Stewarts & Lloyds of India Ltd., Kolkata
8. M/s Teekay Tubes Pvt. Ltd., Mumbai
9. M/s Pipe Fit,Baroda
10. M/s Sky Forge, Faridabad
11. M/s S&G, Faridabad
12. M/s Sawan Engineers, Baroda
13. Eby Fasteners, India
14. R.N. Gupta & Co. Ltd, India
15. Exten Engg Pvt Ltd
16. Sivananda Pipe & Fittings Ltd
17. Chero Piping SPA, Italy
18. CSA Fittings, India
19. EBY Fasteners, India
20. Fittnox SRL, Italy
21. Keonsae High Pressure Co. Ltd., South Korea
22. Munro & Miller Fittings Ltd., U.K.
23. TK Corporation, South Korea
24. Tube Turn (India) Pvt Ltd., India
25. Topaz Piping Industries, India
26. Technoforge SPA, Italy
27. P.K. Tubes & Fittings Pvt. Ltd., India
28. Vivial Forge Pvt. Ltd., Vadodara

x) Gaskets

1. IGP Engineers (P) Ltd., Madras
2. Madras Industrial Products, Madras
3. Dikson & Company, Bombay
4. Banco Products (P) Ltd., Vadodara
5. Goodrich Gaskets Pvt Ltd
6. Starflex Sealing India Pvt Ltd, India
7. Teekay Meta Flex Pvt Ltd
8. UNIKLINGER Ltd
9. HEM Engg. Corp.
10. Unique Industrial Packing Pvt. Ltd.

xi) Fasteners

1. Nireka Engg. Co. (P) Ltd., Calcutta
2. Precision Taps & Dies, Bombay
3. AEP Company, Vithal Udyoug Nagar
4. Fix Fit Fasteners, Calcutta
5. Precision Engg. Industries, Baroda
6. Echjay Forgings Pvt. Ltd., Bombay
7. Capital Industries, Bombay
8. Boltmaster India Pvt Ltd, India
9. Deepak Fasteners Limited, India
10. Fasteners & Allied Products Pvt Ltd, India
11. Hardwin Fasteners Pvt Ltd, India
12. J.J. Industries, India
13. Multi Fasteners Pvt Ltd, India
14. Nexo Industries, India
15. Pacific Forging & Fasteners Pvt Ltd, India
16. Pioneer Nuts & Bolts Pvt Ltd, India
17. Precision Auto Engineers, India
18. President Engineering Works, India
19. Sandeep Engineering Works, India
20. Syndicate Engineering Industries, India
21. BEA SRL, Italy
22. Korea Parts & Fasteners (KPF), South Korea
23. Kundan Industries Ltd., India
24. Mega Engineering Pvt. Ltd., India
25. OME Metallurgica ERBESE S.R.L, Italy
26. Pankaj International, India
27. Udehra Fasters Ltd., India

xii) Welding Electrodes

1. For Mainline – Lincoln make
2. For Terminal –For root pass - Lincoln Make
   For other passes– Lincoln, D&H,ADOR,HONAVAR

xiii) Fire Fighting Equipments

a) Fire Extinguishers

1. Avon Services (Production & Agencies) Pvt. Ltd., Bombay
2. Kooverji Devshi & Co., Bombay
3. Zenith Fire Services, Bombay
4. Safex Fire Services, Bombay
5. Reliable (Fire Protection) India Ltd., Bombay
6. Brij Basi Hi
7. tech Udyog
8. Bharat Engg Works, India
9. Gunnebo India Ltd
10. Nitin Fire Protection Industries Ltd, India
11. Supremex Equipments, India
12. Vimal Fire Controls Pvt Ltd., India

b) Fire Hydrants, Monitors, Deluge Valve, Nozzles

1. Zenith
2. Minimax
3. Newage
4. HD Fire
5. Vijay Fire
6. Asco Strumech Pvt Ltd, India
7. Brij Basi Hi
8. tech Udyog
9. Gunnebo India Ltd
10. Nitin Fire Protection Pvt Ltd
11. Shah Bhogilal Jethamal & Brothers
12. Venus Pumps & Engineering Works

c) RRL Hose

1. Jayshree
2. Newage

d) Hoses

1. Ashit Sales Corporation, Bombay
2. Royal India Corporation, Bombay
3. Gayatri Industrial Corporation
4. Simplex Rubber Products Ltd., Ahmedabad
5. Zaverchand Marketing Pvt. Ltd., Baroda
6. Presidency Rubber Mill, Calcutta
7. The Cosmopolite, Calcutta
8. Simplex Rubber Products, Thane

e) Hose Delivery

1. Chhatarya Rubber & Chemical Industries,
2. Nitin Fire Protection Industries Ltd, India

f) Fire Hose Accessories

1. Asco Strumech Pvt Ltd
2. Brij Basi Hi-tech Udyog
3. Gunnebo India Ltd
4. Shah Bhogilal Jethamal & Brothers
5. Vimal Fire Controls Pvt Ltd., India

xiv) Heat Shrinkable Sleeves

1. Covalence Raychem (Berry Plastics Corporation)
2. Canussa – CPS
3. Seal for Life

xv) Cold Applied Tapes

1. Denso GmBH
2. Polyken (Berry Plastics Corporation)
3. Seal for Life

xvi) PUR Coating

1. Powercrete (Berry Plastics Corporation)

xvii) Casing End Closure

1. Raci, Italy
2. Raychem RPG Limited

xviii) Rockshield

1. Raychem RPG Limited

xix) Warning Tape

1. Sparco Multiplast Pvt. Ltd., Ahmedabad
2. M/s Raychem RPG Limited
3. M/s Bina Enterprise, Mumbai
4. M/s Singhal Industries, Ahemedabad

xx) High Build Epoxy Coating

1. Berry Plastics – Powercrete
2. Specialty Polymer Canada

3. Denso Protal, Canada

xxi) Casing Insulators

1. Raci, Italy
2. Raychem RPG Limited
3. Veekay Vikram

xxii) NDT AGENCY

1. NDT Services, Ahmedabad
2. GEECY Industrial Services Pvt. Ltd., Mumbai
3. Corrosion Control Services, Mumbai
4. Perfect Metal Testing & Inspection Agency, Calcutta
5. Inter Ocean Shipping Co., New Delhi
6. RTD, Mumbai
7. Sievert, Mumbai
8. X-Tech, Vizag
9. Riya NDT Engineers
10. TCR Engineering services Pvt.Ltd
11. Sitas Technical services

xxiii) LONG RADIUS BENDS

1. M/s BHEL, Trichy, Tamilnadu
2. M/s Jindal SAW Limited, (Koshi Works), U.P.
3. M/s PSL Limited, Gandhidham, Gujarat
4. M/s Welspun, Gujarat
5. M/s Fabricon, Belgium
6. M/s Commercial Supplying Agency, Mumbai
7. M/s Dee Development Engineers Ltd.
8. M/s Eby Industries, Mumbai
9. M/s Flash Forge Pvt. Ltd., Vishakhapatnam
10. M/s Gujarat Infra Pipes Pvt. Ltd., Vadodara
11. M/s M.S. Fittings Mfg. Co. Pvt. Ltd., Kolkata
12. M/s Stewarts & Lloyds of India Ltd., Kolkata
13. M/s Teekay Tubes Pvt. Ltd., Mumbai
14. M/s Pipe Fit,Baroda
15. M/s Sky Forge, Faridabad
16. M/s S&G, Faridabad
17. M/s Sawan Engineers, Baroda
18. Eby Fasteners, India
19. R.N. Gupta & Co. Ltd, India
20. Exten Engg. Pvt. Ltd.,
21. Sivananda Pipe & Fittings Ltd.
22. Chero Piping SPA, Italy
23. CSA Fittings, India
24. EBY Fasteners, India
25. Fittnox SRL, Italy
26. Keonsae High Pressure Co. Ltd., South Korea
27. Munro & Miller Fittings Ltd., U.K.

28. TK Corporation, South Korea
29. Tube Turn (India) Pvt. Ltd., India
30. Topaz Piping Industries, India
31. 26. Technoforge SPA, Italy
28. P.K. Tubes & Fittings Pvt. Ltd., India
32. Vivial Forge Pvt. Ltd., Vadodara

xxiv) PE FITTINGS

1) M/s Friatech AG, Germany (represented by M/s Sherman Sales in India)
2) M/s Jain Irrigation systems Ltd. Jalgaon (Fusion, UK)
3) M/s George Fisher
4) M/s Agru, Austria
5) M/s Kimplas piping Systems Ltd., Nashik
6) M/s Aliaxis Utilities & Industries Pvt.Ltd

xxv) PE VALVES

1. M/s Friatech AG, Germany
2. M/s George Fisher
3. M/s Agru, Austria
4. M/s Aliaxis Utilities & Industries Pvt.Ltd
5. M/s Plasson Ltd., Israel

xxvi) WARNING TAPE

1. M/s Sparco Multiplast Pvt. Ltd., Ahmedabad
2. M/s Singhal Industries , Ahemdabad
3. M/s Puja Packing, Mumbai
4. M/s Bina Enterprises, Mumbai

xxvii) HDPE PIPES & DUCT

1. M/s Mangalam Pipes Pvt. Ltd., Bengaluru
2. M/s Shand pipe Industry Pvt. Ltd., Bengaluru
3. M/s Varuna pipes Pvt. Ltd., Bengaluru
4. M/s Manikya Plastichem (P) Ltd., Mysore
5. M/s Jain Irrigation systems Ltd. Jalgaon

1) For procuring bought out items from vendors other than those listed above, except welding electrode the same may be acceptable subject to the following: -

a) The vendor/ supplier of bought out item(s) is a manufacturer/ supplier of said item(s) for intended services and the sizes being offered is in their regular manufacturing/ supply range.

b) The vendor / supplier should not be in the Holiday list of GGPL / MECON / other PSU.

c) Should have supplied at least one single random length (i.e. 5.5 meters to 6.5

meters) for item assorted pipes / tubes and for other items, which are to be supplied in quantity on number-basis (other than assorted pipes / tubes) minimum 01 (One) number of same or higher in terms of size and rating as required for intended services.

The bidder should enclose documentary evidences i.e. PO copies, Inspection Certificate etc. for the above, along with their bids.

2) For any other item(s) for which the vendor list is not provided, bidders can supply those item(s) from vendors/ suppliers who have earlier supplied same item(s) for the intended services in earlier projects and the item(s) offered is in their regular manufacturing/ supply range.

The bidder is not required to enclose documentary evidences (PO copies, Inspection Certificate etc.) along with their offer, however in case of successful bidder, these documents shall required to be submitted by them within 30 days from date of Placement of Order for approval to GGPL / MECON.

3) The details of vendors indicated in this list are based on the information available with MECON, Contractor shall verify capabilities of each vendor for producing the required quantity with. PMC does not guarantee any responsibility on the performance of the vendor. It is the contractor's responsibility to verify the correct status of vendor and quality control of each parties and also to expedite the material in time.

B) **Electrical**

Air Conditioner

1. O General
2. Daikin
3. Hitachi

Batteries (Lead Acid)

1. Amco Batteries Ltd.
2. Exide Industries Ltd.
3. HBLNIFE Power System Ltd.
4. Amara Raja Batteries Ltd.

Batteries (Nickel Cadmium)

1. Amco Batteries Ltd.
2. HBLNIFE Power Systems Ltd.

Batteries Charger/DC-DC Converter

1. Amara Raja Power System(P)Ltd.
2. BCH.

3. Chhabi Electricals Pvt. Ltd.
4. Caldyne Automatics Limited
5. Dubas
6. HBL Nife Power Systems Ltd.
7. Universal Industries Products
8. Universal Instrument Mfg Co Pvt Ltd

Cable – Fire Alarm & Communication Cables

1. Cords Cable Industries Ltd.
2. CMI
3. Delton cables Ltd.
4. ELKAY Telelinks
5. KEI Industries Ltd.
6. Reliance Engineers Ltd.

Cable – HT(XLPE)

1. Universal Cable Ltd.
2. KEI Industries Ltd.
3. *Industrial Cables*
4. *NICCO Corporation Ltd.*
5. Uniflex
6. Polycab.
7. Torrent cables Ltd.

Cable – LT Power and Control

1. Cords Cable Industries Ltd.
2. Universal Cable Ltd.
3. KEI Industries Ltd.
4. Havells.
5. Delton
6. Elkay Telelinks
7. Evershine Electricals
8. Ecko
9. Ravin
10. Rallison.
11. Suyog
12. Netco
13. Uniflex
14. Paramount
15. Gloster
16. Associated cables Pvt Ltd.
17. CMI
18. Gemscab
19. Industrial cables
20. NICCO
21. Polycab

22. Torrent

Cable – Gland

1. Baliga
2. Comet
3. Flexpro
4. Flameproof
5. FCG
6. Electro Werke
7. Dowels
8. CCI

Cable – Lugs

1. Dowels
2. Jainson
3. Ismal

Cable – Tray

1. Ercon Composites
2. Yamuna Power & Infrastructure Ltd.

Cable Termination and Jointing Kit

1. CCI
2. Raychem
3. M-Seal

Ceiling/Exhaust/Pedestal Fans & Circulators

1. Bajaj Electricals Ltd.
2. Crompton Greaves Ltd.
3. Khaitan Electricals Ltd.
4. Havell's

Contractors – AC Power

1 Andrew Yule
2 ABB
3 BHEL
4 C&S
5 Havell's
6 L&T
7 Schneider
8 Siemens Ltd.

9 Telemechanique

Control Transformer

1. AE
2. Indushree
3. Intra Vidyut
4. Kalpa Electrikals
5. Transpower Industries Ltd.
6. Siemens

Earthing Materials

1. Rukmani Electrical & Components Pvt Ltd.
2. Indiana Grating Pvt Ltd.

Flame proof LDB's/ JB,s/Control Station/ switches

1. FCG
2. Sudhir
3. Prompt Engineering Works
4. Flame Proof equipments pvt. Ltd.
5. Baliga Lighting Equipments Pvt. Ltd.
6. Flexpro Electricals Pvt. Ltd.

High Mast

1. Bajaj Electricals Limited
2. Crompton Greaves Limited.
3. Philips India Limited
4. Surya Roshani

High Voltage PCC/ MCC panels

1. BHEL
2. Control and Switchgear
3. Siemens
4. Tricolite Electrical Industries
5. Schneider
6. CGL
7. L&T

Indicating Lamps

1. Alstom Ltd.
2. BCH
3. L&T Ltd.

4. Siemens Ltd.
5. Vaishno Electricals

Indicating Meters

1. ABB
2. AMCO
3. AE
4. Alstom Ltd. (EE)
5. Conzerv/Schneider
6. Elecon Measurement Pvt. Ltd.
7. HPL Electric & Power Pvt. Ltd.
8. MECO Instruments Ltd.
9. Minilec
10. Rishabh Instruments Pvt. Ltd.
11. Trinity energy system
12. kaycee
13. Salzer

Lighting Fixtures

1. GE Lighting Pvt. Ltd.
2. Bajaj Electricals Ltd.
3. Crompton Greaves Ltd.
4. Philips India Ltd.

Lighting Fixtures – Flameproof

1. Bajaj Electricals Ltd.
2. Baliga Lighting Equipment Pvt. Ltd.
3. Crompton Greaves Ltd.
4. CEAG Flameproof Controlgear Pvt. Ltd.
5. Flexpro Electricals Pvt. Ltd.
6. Philips India Ltd.
7. Sudhir Switchgears Pvt. Ltd.
8. FCG.

Miniature Circuit Breakers (MCBs) and Lighting DB

1. ABB
2. Hagger
3. Havell's India Ltd.
4. Indo Asian Fusegear Ltd.
5. Legrand
6. MDS Switchgear Ltd.
7. Schneider
8. Siemens Ltd.
9. HPL

Moulded Case Circuit Breaker (MCCBs)

1. ABB
2. Andrew yule
3. Larsen & Toubro
4. Schneider
5. Siemens
6. Control and Switchgear

Protection Relays – Thermal

1. BCH
2. L&T Ltd.
3. Siemens Ltd.
4. Telemenchanique & Controls (India) Ltd.

Low Voltage Power Control Center (PCC)/ MCC/ PDB/ MLDB/ LDB

1. ABB
2. BCH
3. C & S
4. Elecmech Switchgear & Instrumentation
5. KMG ATOZ
6. L&T
7. Pyrotech Electronics Pvt. Ltd.
8. Risha control Engineers Pvt. Ltd.
9. Siemens
10. Tricolite Electrical Industries
11. Unilec Engineers ltd.
12. Vidyut Control India Pvt. Ltd.
13. Control and Schematic
14. Zenith Engineering

Push Buttons

1. BCH
2. Alstom Ltd.
3. L&T
4. Siemens Ltd.
5. Telemenchanique & Controls (India) Ltd.
6. Vaishno Electricals

Switches-Control

1. BCH
2. Easum Reyrolle Relays & Devices Ltd.
3. Alstom
4. Kaycee Industries Ltd.
5. L&T
6. Siemens Ltd.

Switches – 5/15A Piano/ Plate, Switch Socket

1. Anchor Electronics & Electricals Pvt. Ltd.
2. Kingal Electricals Pvt. Ltd.
3. North-West Switchgear Ltd.

Switch Socket Outlets (Industrial)

1. Alstom Ltd.
2. Best & Cromption Engineering Ltd.
3. BCH
4. Crompton Greaves Ltd.
5. Essen Engineering Company Pvt. Ltd.

Solar Modules

1. Tata BP Solar (I) Ltd.
2. REIL, Jaipur.
3. CEIL, Sahibabad.

Solar Street Lighting

1. Tata BP Solar (I) Ltd.
2. REIL, Jaipur.
3. CEIL, Sahibabad.

Terminals Blocks

1. Connectwell
2. Controls & Switchgear Co. Ltd.
3. Elmex Controls Pvt. Ltd.
4. Essen Engineering Co. Pvt. Ltd.

Transformers

1. ABB
2. Andrew Yule
3. Areva
4. BHEL
5. Bharat Bijlee
6. Crompton Greaves
7. EMCO Ltd.
8. Intra Vidyut
9. Indushree
10. Indcoil
11. Kirloskar
12. Skippers Electricals
13. Transformers & Rectifiers (I) Ltd.
14. Voltamp

UPS System and Inverter

1. DB POWER
2. APLAB
3. KELTRON
4. HI-REL
5. DUBAS
6. Toshiba Corporation
7. Fuzi Electric Co Ltd

Solar Street Lighting

1) Tata BP Solar (I) Ltd.
2) REIL, Jaipur
3) CEIL, Sahibabad

C) **Instrumentation**

I) PRESSURE REGULATOR AND SLAM SHUT VALVE

1) M/s Pietro Fiorentini S.P.A. (Italy)
2) M/s Emerson Process Management (Singapore)
3) M/s RMG-Regel Messtechnik (Germany)
4) M/s Nirmal Industrial Controls (India)-for maximum 300# and size ϕ 8"
5) M/s Gorter Controls (Netherlands)
6) M/s Dresser

II) FLOW CONTROL VALVE

1) M/s Forbes Marshall (Pune)
2) M/s ABB Ltd. (Nashik)
3) M/s Fisher Xomox (New Delhi)
4) M/s Fouress Engg. (New Delhi)
5) M/s Instrumentation Ltd. (Palghat)
6) M/s MIL Controls Ltd. (Noida)
7) M/s Samson Control (Thane)
8) M/s Dresser

IIIA) ULTRASONIC FLOW METER

1) M/s Emerson Process (represented by M/s Daniel Measurement & Control)
2) M/s Instromet International, Belgium (represented by M/s Siddha Gas Instromet (I) Ltd.)
3) M/s FMC Measurement Solution , UK (represented by M/s Trimax Engg., Mumbai)
4) RMG Messtechnik GMBH
5) M/s SICK MAHAIK , (Represented by Chemtrols Industries, Mumbai)

IIIB) TURBINE METER

1) M/s Instromet (Belgium)
2) M/s RMG (Germany)
3) M/s Elster (Germany)
4) M/s Fluid Components (USA)
5) M/s Barton Instruments (UK)
6) M/s Bopp & Reuther (Germany)
7) M/s Daniel Industries (USA)
8) M/s Hoffer Flow (USA)
9) M/s Rockwin Flow Meters

IVA) PANEL MOUNTED FLOW COMPUTERS

1) M/s Barton Instruments System Ltd. (UK)
2) M/s Daniel Measurement and Controls (M/s Emerson Group)
3) M/s Instromet International, Belgium (M/s Ester- Instromet,India)
4) M/s RMG Messtechnik GmbH (Germany)
5) M/s Omni Flow Computers Inc. (USA)/(Rockwin Flow Meter India)

IVB) FIELD MOUNTED FLOW COMPUTER

1) M/s Barton Instruments System LLC (UK)
2) M/s Daniel Measurement and Controls (M/s Emerson Group)
3) M/s Bristol Babcock (USA)

V) GAS CHROMATOGRAPH

1) ABB Ltd , India
2) Daniel Measurement & Control Asia Pacific, India
3) Instromet Internationa, NV
4) RMG Regal+Messtechnik GmbH

VI) L.E. L DETECTION SYSTEM

1) Crowcon Detection Instruments Ltd
2) Detection Instruments (I) Pvt Ltd
3) Detector Electronics Corporation
4) MSA – Mines safety appliances.
5) Oldham France S.A.
6) Chemtrols Engineering Ltd., India
7) Drager Safety AG & Co. KGAA
8) General Monitors Ireland Ltd
9) Riken Keiki Co Ltd
10) Simrad Optronics Icare

VII) CONTROL AND SIGNAL CABLES

1. M/s ASSOCIATED CABLES
2. M/s ASSOCIATED FLEXIBLES
3. M/s DELTON Cables Ltd, India
4. M/s BROOK
5. M/s KEI Industries Ltd INDIA
6. M/s Suyog Electricals Ltd, India
7. M/s Thermo Cables Ltd
8. M/s Udey Pyrocables Pvt Ltd, India
9. M/s UNIVERSAL Cables Ltd,India
10. M/s CMI Limited
11. M/s - Cords Cable Industries Ltd, India
12. M/s Elkay Telelinks (P) Ltd., India
13. M/s Fine Core Cables Pvt Ltd, India
14. M/s Goyolene Fibres (I) Pvt Ltd, India
15. M/s Netco Cable Industries Pvt Ltd, India
16. M/s NICCO Corporation Ltd, India
17. M/s Paramount Communications Ltd, India
18. M/s Polycab Wires Pvt Ltd, India
19. M/s Radiant Cables Pvt Ltd, India
20. M/s Reliance Engineers Ltd., India

VIII) ZENER BARRIERS/ISOLATORS

1) M/s MTL
2) M/s P & F

IX) RTDs

1) M/s General Instruments Ltd., Mumbai
2) M/s Nagman Sensors (Pvt.) Ltd.
3) M/s Pyro Electric, Goa

X) PRESSURE TRANSMITTERS, TEMP. TRANSMITTERS & DIFF. PRESSURE TRANSMITTER

1) M/s Fisher Rosemount (Emerson)
2) M/s Yokogawa
3) M/s Fuji
4) M/s Honeywell

XI) PRESSURE GAUGES, D. P. GAUGES & TEMPERATURES GAUGES

1) M/s AN Instruments Pvt. Ltd., New Delhi
2) M/s General Instruments Ltd., Mumbai

3) M/s WIKA

XII A) SS TUBE FITTINGS

1) M/s Swagelok
2) M/s Parker
3) M/s Excellsior
4) M/s Reliance
5) M/s Multimetal
6) M/s Aura Inc
7) M/s Arya Crafts & Engineering Pvt. Ltd.
8) M/s Excel Hydro Pneumatics Pvt. Ltd.
9) M/s Fluid Controls Pvt. Ltd.
10) M/s Swastic Engineering Works
11) M/s Panam Engineers

XII B) SS TUBE

1) M/s Sandvik, Sweden
2) M/s Ratnamani metals & tubes
3) M/s NFC
4) M/s Heavy Metals & Tube Limited (Mehasana)

XII C) SS VALVES & MANIFOLDS

1) M/s Swagelok
2) M/s Parker
3) M/s Excellsior
4) M/s Micro-Precision
5) M/s Technomatic India
6) M/s Aura Inc
7) M/s Arya Crafts & Engineering Pvt. Ltd.
8) M/s Excel Hydro Pneumatics Pvt. Ltd.
9) M/s Swastic Engineering Works
10) M/s Panam Engineers

XIII) JUNCTION BOXES AND CABLES GLANDS

1) M/s EX-PROTECTA
2) M/s FLAMEPROOF CONTROL GEARS
3) M/s BALIGA
4) M/s FLEXPRO ELECTRICALS
5) Sterling
6) Sudhir

XIV) PUSH BUTTONS/LAMPS:

1) L&T

2) SIEMENS

XV) MCB'S:

1) HAVELL'S
2) INDO ASIAN
3) MDS

XVI) RELAYS:

1) OEN
2) JYOTI

XVII) POWER SUPPLY UNIT:

1) ELNOVA
2) APLAB

XVIII) CONTROL ROOM EQUIPMENT CONTROL PANEL & ACCESSORIES

1) M/s Keltron Controls Ltd., Kerala
2) M/s RITTAL
3) M/s Pyrotech
4) M/s Positronics Pvt. Ltd.
5) M/s ABB Instruments Ltd., New Delhi
6) M/s Emerson Process Management (I) Pvt. Ltd.
7) M/s Rockwell Automation (I) Ltd., Ghaziabad
8) M/s Siemens Ltd.
9) M/s Tata Honeywell Ltd.

XIX) INDICATORS/CONTROLLERS/RECORDERS

1) M/s ABB
2) M/s YBL
3) M/s EUROTHERN
4) M/s TATA HONEYWELL
5) M/s MASIBUS

XX) HDPE DUCT

1. M/s Kirti Industries (India) Ltd.
2. M/s Kulja Industries
3. M/s Veekay Plast
5. M/s Jain Irrigation Systems Ltd.
6. M/s Shree Mohit Industries
7. M/s Duraline India Pvt. Ltd.

Note-1

For procuring bought out items from vendors other than those listed above, the same may be acceptable subject to the following: -

a) The vendor/ supplier of bought out item(s) is a regular and reputed manufacturer/ supplier of said item(s) for intended services and the sizes being offered is in their regular manufacturing/ supply range.
b) The vendor/ supplier should not be in the Holiday list of GGPL.
c) Should have supplied at least 50% of required quantity or minimum 1 number whichever is higher of maximum size and rating of item(s) as required for intended services.

The bidder should enclose documentary evidences i.e. PO copies, Inspection Certificate etc. for the above, along with their bids.

Note-2

For any other item(s) for which the vendor list is not provided, bidders can supply those item(s) from reputed vendors/ suppliers who have earlier supplied same item(s) for the intended services in earlier projects and the item(s) offered is in their regular manufacturing/ supply range.

The bidder is not required to enclose documentary evidences (PO copies, Inspection Certificate etc.) along with their offer, however in case of successful bidder these documents shall be required to be submitted by them within 30 days from date of Placement of Order.

3b) PARTICULAR JOB SPECIFICATION FOR CIVIL & STRUCTURAL WORKS

CIVIL & STRUCTURAL WORKS

I) General

The scope of work to be performed under this contract shall include complete civil works as per plans, equipment layout, drawings & technical specifications for MRS / SV Stations etc.:

II) Scope of Supply

Contractor shall procure & supply to site all the materials including cement, reinforcing steel, steel sections/plates, pipes, mesh and other accessories, other masonry materials, bitumen/asphalt, admixtures & bonding agents, sealants, kerb stones, pavior block, sand and boulder etc., and any other material/item required to complete the civil & structural works. All costs towards testing/inspection of materials/goods shall be borne by the Contractor. No materials/items shall be supplied by the Owner (except anchor bolts & base plates as free issue items).

III) Site Work

Complete construction work including supply of labour, construction materials, construction equipment, survey, tools & tackles, dismantling & modification/strengthening, supervision, testing etc. required to complete all the structures, foundations, roads, drains, pavements, finishes, fencing, painting, including site grading/earthwork in cutting & filling etc. as specified and required to complete the civil & road works in all respect.

(All enabling works e.g. construction water tank, casting/fabrication yard, electricity, site stores & office, safety and security measures, coordination with other contractors working at site etc. shall be Contractor's responsibility. Special permits to such as 'Hot Permit", "Fire Safety Permit" to work at dispatch terminal shall be contractor's responsibility.)

IV) Scope of Work

1. Tap Off / Receiving Terminal

a) Site grading of SV Stations plot including plot development by cutting / filling good/borrow earth wherever required with turfing of non paved/constructed areas.
b) PCC M-10C in leveling course / drains etc. over well compacted earth as shown in drawings.(wherever not included in the respective RCC item)
c) Sand filling as and where shown in drawings.
d) 150 mm thick RCC pavement in process area with pipe/equipment supports.
e) 150 mm thick RCC pavement for internal and external roads (if required).
f) Independent RCC supports for pipes, Equipment / Crossovers foundations, etc.
g) Grouting of all base plates/frames of equipment foundations and structural bases.
h) Provision of all inserts, conduits, pre-cast covers, fixing of free issue items into permanent works etc..

i) Clearing all construction debris and handing over completed work site.
j) Any other work not mentioned specifically but required to make the terminal functional.
k) Making as-built details/drawings on one set of construction drawings and return to owner.
l) Making approach roads if required.

V) Preamble To Schedule Of Quantities

The Preamble to Schedule of Items is an integral part of the schedule of quantities and rates and this is to be considered incorporated into the description of items themselves. The Contractor's rate for any item of work in the schedule of item shall, unless stated otherwise be held to include the cost of all materials including wastage, conveyance and delivery, unloading, storing, fabrication, hoisting, all labour for finishing to required shape and size, tools and plants, power fuel, consumables, all taxes, royalties, other revenue expenses, temporary facilities like roads etc

1.0 EARTHWORK IN SITE GRADING TO DEVELOP THE PLOT

Brief description of major items shall be as follows:

a) Taking pre-work and finished levels.
b) Stripping and grubbing the top soil of 150 mm and preparation of sub-grade.
c) Disposal of unserviceable and surplus earth to authorised dumping ground to any lead.
d) Borrowing of approved quality good earth from any lead.
e) Filling in layers of 150 mm thickness in controlled way.
f) Watering and compaction up to 92% of modified dry proctor density of soil with mechanical means.
g) Actual work shall be carried out as per certified construction drawings to be issued to successful tenderer.

Note : For all these items only consolidated final filling quantity in Cu.M *shall be measured for payment*

2.0 PCC WORK

Providing and laying PCC 1:3:6 in position (at locations where the same is not included in respective RCC item), construction and handing over of PCC in foundations, substructure, superstructure and under floor, etc complete in all respects as per scope of work, detailed construction drawings, technical specifications and direction of Engineer-in-charge.

Following works shall be inclusive in the rate of PCC item:

a) Earth Work in excavation including back filling (including using borrow earth and

disposal of surplus earth).

b) Providing shuttering and strutting of all types (If necessary).

Note : For all these items only net PCC concrete quantity in Cu.M *shall be measured for payment.*

3.0 REINFORCED CEMENT CONCRETE – SUBSTRUCTURE

Brief description of major items shall be as follows:

a) Earth Work in excavation including back filling (including using borrow earth and disposal of surplus earth), including bailing out water (where ever required) , shoring / etc.
b) 75 thk. PCC 1:3:6 in mud mat as required.
c) Providing shuttering and strutting of all types.
d) RCC M25 as per drg. & specification including reinforcement (supply of cement, coarse aggregate, fine aggregate, reinforcement bending, placement, binding/ welding all inclusive & testing of concrete and other materials).
e) RCC in foundation for pedestals for equipment like scrubber and filter.
f) RCC foundation including temporary partition , Complete civil works for trenches as per requirement.
g) Grouting of all base plates/frames of equipment foundations and structural bases as per requirement.
h) Provision of all inserts, conduits, precast covers/chequered plates, fixing of free issue items into permanent works etc.
i) Application of two coats of hot bitumen on surfaces in contact with soil.
j) Clearing all construction debris and handing over completed work site.
k) Any other work not mentioned specifically but required to make the terminal functional.
l) Marking as-built details on one set of construction drawings and return to owner.
m) Actual work shall be carried out as per certified construction drawings to be issued to successful tenderer.

Note : For all these items only net RCC concrete quantity in Cu.M *shall be measured for payment*

4.0 REINFORCED CEMENT CONCRETE – SUPERSTRUCTURE

Brief description of major items shall be as follows:

a) Providing shuttering and strutting of all types
b) RCC M25 as per drg. & specification including reinforcement (supply of cement, coarse aggregate, fine aggregate, reinforcement bending, placement, binding/ welding all inclusive & testing of concrete and other materials).
c) RCC for pedestals for equipment like scrubber, filter, cartridge, other equipments etc.
d) Complete civil works for pipe supports, sleepers etc.
e) Grouting of all base plates/frames of equipment foundations and structural bases as per requirement.
f) Provision of all inserts, conduits, precast covers/chequered plates, fixing of free issue items into permanent works etc.

g) Clearing all construction debris and handing over completed work site.
h) Any other work not mentioned specifically but required to make the terminal functional.
i) Marking as-built details on one set of construction drawings and return to owner.
j) Actual work shall be carried out as per certified construction drawings to be issued to successful tenderer.

Note : For all these items only net RCC concrete quantity in Cu.M *shall be measured for payment except building. The RCC quantity of building superstructure is included in the Plinth area item.*

5.0 CONCRETE PAVEMENT

Brief description of major items shall be as follows:

a) Earth Work in excavation including back filling (including using borrow earth and disposal of surplus earth).
b) 50 Thk. PCC 1:3:6 mud mat.
c) Providing shuttering and strutting of all types.
d) RCC M25 as per drg & specification including reinforcement (supply of cement, coarse aggregate, fine aggregate, reinforcement bending, placement, binding/ welding all inclusive & testing of concrete and other materials).
e) Providing and laying 150 mm thick reinforced cement concrete of (M-25 grade) with 20mm and down grade crushed stone aggregate in pavement, including preparation of base (i.e. compacted subgrade, 200 thk sand and 50 thk PCC (1:3:6).
f) Providing pockets if necessary, making recess, trenches with covers projections, fixing inserts conduit pipes (GI, PVC, HDPE, etc.) laying in alternate panels, filling the gaps between the panels with bitumen etc.
g) Making slopes, finishing edges, leaving bars for pedestals & sleepers including providing sand fill isolation.
h) Providing and fixing reinforcing steel, curing, chipping and modification works etc. as specified in any shape, thickness, position and finishing the top surface smooth as per requirement etc. all complete as per drawings, specifications and directions of the Engineer-in-charge.
i) Application of two coats of hot bitumen on surfaces in contact with soil.
j) Actual work shall be carried out as per certified construction drawings to be issued to successful tenderer.

Note: Pavement – Completed civil works for pavement including, earth work in excavation, preparation of base i.e., compacted sub grade, 200 mm thk. sand filling and compaction, 50mm thk. PCC of grade M-7.5, shuttering, providing reinforcement, providing and fixing of inserts plates, conduits etc.

6.0 BRICK WORK

Complete works in brick masonry foundation is included in the scope.

Brief description of major civil items shall be as follows:
a) Earth Work in Excavation including back filling.

b) Brick work with 1:4 cement mortar.
c) 15 mm thk Plastering in CM (1:4) on exposed brick surfaces.
d) Applying Bitument Paint on surfaces coming in contact with earth.
e) Lime wash /Cement Punning on plastered surface.

Note : Only net brick masonry quantity shall be measured for payment purpose.

The construction of brick foundation work shall be done as per detailed construction drawings to be issued to the successful tenderer. Offer to be prepared by the tenderer based on work described above and payment will be made on rate (per CuM) of brickwork done

7.0 CONSTRUCTION OF RCC SUPPORTS FOR CHAIN LINK FENCING

Brief description of major items shall be as follows:

a) Earth Work in excavation including back filling (including using borrow earth and disposal of surplus earth).
b) 50 thk. PCC 1:3:6 mud mat.
c) Providing shuttering and strutting of all types.
d) RCC M25 as per drg & specification including reinforcement (supply of cement, coarse aggregate, fine aggregate, reinforcement bending, placement, binding/ welding all inclusive & testing of concrete and other materials).
e) Grouting of all structural bases as per requirement.
f) Application of two coats of hot bitumen on surfaces in contact with soil.
g) Actual work shall be carried out as per certified construction drawings to be issued to successful tenderer.

Note : For all these items only net RCC concrete quantity in Cu.M *shall be measured for payment in RCC in Sub-structure*

8.0 SUPPLY, FABRICATION AND ERECTION OF CHAIN LINK FENCING 3.0 M HIGH WITH MESH UP TO 2.4 M HEIGHT

Brief description of major items shall be as follows:

a) Providing, cutting, fabrication and installation of structure made in structural steel, fixed on RCC pedestals/footing with base plates, permanent bolts with plane and spring washers.
b) Fixing of 3.15mm 50mm^2 mesh as per IS 2721-1979.
c) Fixing of four rows of barbed wire on top.
d) Painting all structural steel elements.
e) Fencing shall be erected as per detailed construction drawings to be issued to the successful tenderer.

Note : For all these items only net length of chain link fencing in RM *shall be measured for payment.*

9.0 SUPPLY, FABRICATION AND ERECTION OF MILD STEEL GATE 2.5M HIGH

Brief description of major items shall be as follows:

a) Supply, fabrication and erection of mild steel gate 2.5 m high and 3 m wide.
b) Fixing of 3.15mm 50mm 2 mesh as per IS 2721-1979.
c) Fixing of four rows of barbed wire on top.
d) Painting on MS gate for corrosive environment as per specification and drawings.
e) Gate shall be erected as per detailed construction drawings to be issued to the successful tenderer.

10.0 SUPPLY, FABRICATION AND ERECTION OF MISCELLANEOUS STEEL STRUCTURAL WORKS

Brief description of major items shall be follows :

a) Supply, fabrication and erection of crossovers, platforms, gate, inserts etc. as per requirement.
b) Painting on steel structure for corrosive environment as per specification and drawings.

3c) PARTICULAR JOB SPECIFICATION FOR INSTRUMENTATION

SCOPE OF WORK FOR INSTRUMENTATION & PIPELINE SAFETY SYSTEM

1. SCOPE OF WORK:-

a) INSTRUMENTATION WORK:-

The scope of work shall include but not limited to the following:

Supply, Handling, Transportation, Installation, Calibration, Commissioning of field Instruments such as Pressure Gauges & Temperature Gauges

Start-up, testing & commissioning of complete metering skid terminal instruments, including all labour, test equipments and other auxiliaries, etc. including Nitrogen cylinders as required, complete in all respects as per specifications / drawings / directions of EIC **(If required)**

Erection of control panel and its instruments, laying of cablesbetween control panel and metering skids and GC including excavation for cable trench, cable protection (sand filling 1 brick protection I Hume pipes, etc.), Cable termination and loop-checking including all labour, test equipments & other auxiliaries, etc., complete in all respects as per specifications/ drawings/ directions of BC (Including all type of cable supply) **(If required)**

Supply of erection materials such as :

i) SS tubes & fittings, angle supports, etc.
ii) All instrumentation valves as per installation standards
iii) Double compression glands and lugs for terminations

3d) PARTICULAR JOB SPECIFICATION FOR TCP WORKS

Scope of works for Temporary Cathodic Protection works

CONTENTS

Appendix-I (List of Vendors for Bought out items)
Annexure-A (Format for Daily Progress Report for TCP System)
Annexure-B (Format for TCP system commissioning & Monthly Monitoring of TCP system)
Annexure-C Organogram for the CP work

1.0 GENERAL

1.1 Introduction

Special Condition of Contract shall be read in Conjunction with the General Conditions of Contract, specification of work, Drawing and any other documents forming part of this contract wherever the context so requires.

Notwithstanding the sub-division of the documents into these separate sections and volumes every part of each shall be deemed to be supplementary to and complementary of every other part and shall be read with and into the contract so far as it may be practicable to do so.

Where any portion of the General Condition of Contract is repugnant, to or at variance with any provisions of the Special Conditions of Contract, unless a different intention appears, the provisions of the Special Conditions of Contract shall be deemed to over-ride the provisions of the General Condition of Contract and shall to the extent of such repugnancy, or variations, prevail.

The materials, design and workmanship shall satisfy the relevant INDIAN STANDARDS, the TECHNICAL SPECIFICATIONS contained herein and CODES referred to. Where the technical specification stipulate requirements in addition to those contained in the standard codes and specifications, these additional requirements shall also be satisfied.

Wherever it is mentioned in the specifications that the CONTRACTOR shall perform certain work or provide certain facilities, it is understood that the CONTRACTOR shall do so at his cost and the VALUE OF CONTRACT shall be deemed to have included cost of such performance and provisions, so mentioned.

It will be Contractor's responsibility to bring to the notice of Engineer-in-charge any irreconcilable conflict in the contract documents before starting the work(s) or making the supply with reference which the conflict exists.

In the absence of any specifications covering any material, design of work(s) the same shall be performed/ supplied/ executed in accordance with Standard Engineering Practice as per the instructions/ directions of the Engineer-in-charge, which will be binding on the Contractor.

2.0 PROJECT DESCRIPTION

M/s GGPL intends to lay underground steel pipeline network of various sizes (8'', 6"& 4"dia) alongwith associated facilities, emanating from existing SVs of M/s GGPL to make natural gas available for CNG & PNG facilities in the Geographical Area (GA) of East & West Godavari Districts (A.P.)

PROJECT DETAIL

The work being tendered is covered as indicated below:

Details of Proposed Pipeline

I) Total pipe length 149 km (Part – A,B,C& D)

–	Material of Construction	: Carbon Steel
–	Line Size	: 8'', 6" & 4" NB
	Thickness	: 6.4 mm
–	Design pressure	: 49 kg/cm^2
–	Corrosion Allowance	: 0.5 mm
–	External Coating	: 3-LPE
–	Internal Coating	: Liquid epoxy
–	Design Code	: ANSI/ ASME B31.8 (Latest Edition)
–	Major Water Crossings	: As per Alignment Sheet
–	Major Road Crossings	: As per Alignment Sheet
–	Rail Crossings	: As per Alignment Sheet
–	HT line crossing	: As per Alignment Sheet
–	Gas Temperature (Design)	
	-Buried	: 45°C
	-Aboveground	: 65°C

3.0 STANDARDS

3.1 The work shall be performed in conformity with this specification, standard specifications and installation standards enclosed elsewhere in this tender and code of practices of the Bureau of Indian Standards. In case of any conflict, the stipulations under this specification shall govern.

In addition, the work shall also conform to the requirements of the following:

3.2 The Indian Electricity Act, and the rules framed there under.
The regulations laid down by the Chief Electrical Inspector of the state government/ Central Electricity Authority (CEA).
The regulations laid down by the Factory Inspector.
The regulations laid down by the Chief Controller of Explosives.
Any other regulations laid down by the Central, State or Local Authorities from time to time during the execution of this contract.
OISD Standards
GGPL's Safety Standard

3.3 The design, selection and installation of equipment and materials shall also conform to the requirements of the relevant latest standards of:
BS Specification and codes of practice
OISD Standard 138

IS: 8437 (Part-II)/ 8062 (Part-I)
NACE Standards
DNV Publications
IEEE Publications

4.0 GUARANTEE

4.1 The contractor shall guarantee the installation against any defects of workmanship and materials (supplied by the contractor) for a period 24 months after supply of CP material at site or 12 months after successful commissioning at site, whichever is earlier. Any damage or defects connected with the erection of materials, equipments of fittings supplied by the contractor that may be undiscovered at the time of issue of the completion certificate, or may arise or come to light thereafter, shall be rectified or replaced by the contractor at his own expense as deemed necessary and as per the instruction of the Engineer-in-charge within the time limit specified by Engineer-in-charge.

4.2 The above guarantee shall be applicable for the quality of work executed as well as for the equipment/ cable/ fittings/ other materials etc supplied by the contractor.

Equipments installed or commissioned by others within the battery limit. This is for the purpose of obtaining a comprehensive approval from competent authority.

5.0 SITE CONDITIONS

The equipment offered and the installation shall be suitable for continuous operation under the following site conditions:

Ambient temperature	:	45°C/ 2˚C
Max relative humidity	:	95%
Altitude	:	less than 1000 m
Atmosphere	:	To withstand site condition (Humid & low temp during winter)
Hazardous area Classification	:	Zone-II, Gas group IIA & IIB, Temp. Class T3

6.0 Abbreviations

3LPE	-	Three layer Ploy Ethylene
AJB	-	Anode Junction Box
CJB	-	Cathode Junction Box
CPPSM	-	Cathodic protection power supply module
CTSU	-	Computerised Test Station Unit
CAT	-	Current Attenuation Test
DCVG	-	Direct Current Voltage Gradient
D/T	-	Despatch Terminal
ER Probe	-	Electrical Resistance Probe
ICCP	-	Impressed Current Cathodic Protection
IP	-	Intermediate Pigging

PCP	-	Permanent Cathodic Protection
PSP	-	Pipe to Soil Potential
R/T	-	Receiving Terminal
SV	-	Sectionalizing Valve
TCP	-	Temporary Cathodic Protection
TR Unit	-	Transformer Rectifier Unit
TLP	-	Test Location Point (Test Station)
QA/QC	-	Quality Assurance & Quality Control
XLPE	-	Cross Link Poly-Ethylene

7.0 CO-ORDINATION WITH OTHER CONTRACTORS

i) CP contractor shall entirely responsible for Co-ordination with other contractors & it should be ensured that the CP work should be executed simultaneously with laying of pipeline. Contractor shall mobilize necessary teams in each respective section as per the site organisation chart (Annexure-C) enclosed with this tender with the key responsibility, education qualification, designation, experience as defined and shall be responsible for the timely execution of CP work.

If the contractor fails to timely execution of the CP work, mobilization of teams as defined in tender and it founds delay in the pipeline laying due to of CP work & poor co-ordination with laying contractor necessary penalty clause shall be applied as per the direction of the Engineer-in-Charge.

8.0 SCOPE OF WORK (SUPPLY, INSTALLATION, TESTING & COMMISSIONING)

The brief scope of work covered in this document broadly consist of Temporary Cathodic Protection of underground steel pipeline network of various sizes (8'', 6" & 4"dia) alongwith associated facilities of M/s GGPL in the Geographical Area (GA) of East & West Godavari Districts (A.P.)covering areas mentioned in Part-A, Part-B & Part-C. The TCP installation work should start within 2 months from the FOI, any delay in this regard will attract a penalty @ Rs. 5 Lakhs/month from RA bills.

General

Contractor shall execute both TCP work simultaneously in coordination with laying contractor when lowering of the -pipeline is going on. Activities like- Cable to pipe connection, installation of ER probe, Polarisation cell, Polarisation coupon etc should be completed before the backfilling of the trench.

8.1 Temporary Cathodic Protection System

Corrosion survey, design, detail engineering, fabrication, supply, installation, testing and commissioning of the temporary cathodic protection system using Mg/ Zn galvanic anodes to protect the external surface of 3LPE coated pipeline against corrosion for design life of minimum 2 years or till the commissioning of PCP system, whichever is later. The detailed length of pipeline is as under-

Sl. No.	Sections/ Part	Location Description	Pipeline Dia.	Length (KM) (Approx.)
1	-	CNG & CITY GAS NETWORK AT EAST&WEST GODAVARI DIST.	8", 6" & 4" NB	149 Km (PART-A,B,C&D)

Maintaining and keeping of PSP value as specified and monitoring at monthly basis of PSP voltage & AC voltage of the temporary cathodic protection system (As per format Enclosed in Annexure-B) till commissioning of the permanent cathodic protection system. All work shall be carried out conforming to the Scope of work, Design Basis, Data Sheets, national & international standard & as per standard specification No.- MEC/TS/05/E9/016A for temporary cathodic protection system. Scope shall also include but not limited to the following for completion of jobs:-

a) Measurement of soil resistivity along the right of way of the main pipeline (At 500mtr Interval) & collection of soil sample at every 10.00 kM for its chemical & microbial analysis along the pipeline route as per specification for corrosion survey **MEC/TS/05/21/016C**.

b) Collection of additional data related to cathodic protection along the right of way of pipeline as per standard specifications during the survey.

c) Preparation of TCP design document based on the corrosion survey results & chemical and microbial analysis of the soil & tender specifications.

d) Supply, Installation, Testing & commissioning of Test stations (Big Size & Normal Size) weather proof (IP-55) as per specification & enclosed drawings.

e) Supply, installation, testing & commissioning of Mg/ Zn Galvanic anodes as per the standard specification- **MEC/TS/05/E9/016A**. The weight of the Mg Anode & the total nos. of anodes shall be calculated as per the corrosion survey, soil chemical analysis, total weight and current requirement of the pipeline section. **However, Min one anode is to be installed at every one KM with test station.**

f) Supply, Laying of HDPE sheets (Min 6 mm) between the GGPL pipeline and the other CP protected/un-protected foreign pipelines at the crossing/running parallel locations for providing electrical isolation.

g) Earthing of above ground catholically unprotected pipeline at IP, SV, R/T & D/T etc, and the earth electrode shall be 65 mm dia, 4.5 mm thickness & 3000mm long.

h) Supply, installation, testing & commissioning of one set of Explosion proof type spark gap arrestor (100 kA) across each insulating joint provided at dispatch terminal, receiving terminal, tap-off, SV & various consumer terminals as per P&ID / specification.

i) Supply, installation, testing & commissioning one set of polarization cell (Solid state) with zinc anode at all high tension electrical power transmission line/equipments /railway tractions (all 66 KV & above) crossing or running parallel to the pipeline for grounding purpose as per specification.

The rating of the cell shall depend upon anticipated fault current & ground bed resistance at the location of installation and the calculation of the same shall be furnished to MECON for review & selection of rating of the Polarisation Cell. However, the rating of polarisation cell shall not be less than 3.7 KA @ 30 Cycle & number of 20 kg net weight zinc anode shall not be less than two. If required Zn Ribbon anode (Dia 15mm with back fill trench) may also be used for the grounding purpose to get lower grounding resistance.

j) Supply, installation, testing & commissioning of Electrical resistance Probe (01 No. for with 1 no. ER probe reading instrument) probes utilizing the electrical resistance technique shall be provided along the pipeline at marshy / vulnerable locations to monitor the external corrosion activity on the pipeline. Location of external ER probe shall be decided during detail engineering.

k) Supply, installation, testing & commissioning of Polarisation coupons (02 Nos.) have one side exposed area of 100 mm x 100 mm with permanent reference cell shall be provided along the pipeline at marshy areas and at vulnerable locations to monitor the external corrosion activity on the pipeline as per enclosed standard specification. Location of external Polarisation coupons & Number of magnetic devices for operation of magnetic switch shall be decided during detail engineering in consultation with GGPL/MECON.
The works related to collection of approximately 2-5 m of pipeline material (In pieces of 300 to 1000mm length) for fabrication of Polarisation coupons is in the scope of the Contractor.

l) Supply & installation of Zinc Ribbon Anodes for protection of the carrier pipe inside the coated casing pipe for design life of 35 years. Protection of the Coated Cased Crossing for design life of PCP by 5 kg Pre Packed Mg anodes on both side of casing.

m) Bonding of pipeline with foreign pipeline crossing or parallel run.

n) Supply, laying, termination, Glanding and ferruling of all the cables of TCP system.

o) PSP Monitoring on monthly basis of the TCP system till commissioning of the permanent cathodic protection system.

p) All civil/ structural & other miscellaneous works related to TCP system including supply of bricks, cement & steel etc. required for completion of the system.

Note-

i) Additional protection of carrier pipe (By Zn ribbon anodes) inside the bare casing is not required, accordingly no Mg anodes shall be provided for

protection of casing pipe also, however carrier in bare casing pipe, the annular space between two would be filled by bentonite in slurry form.

ii) Connection scheme of CP system in TLP boxes shall be permanently fixed inside the test station box (TLP Box).

iii) At saline soil Ag/Agcl Permanent Reference electrode shall be used.

iv) Vendor list of Make of CP Materials is enclosed with the tender as appendix-I all CP material shall be as per the make mentioned in the vendor list.

v) For chainages refer Pipeline Schematic Route Diagram

8.2 **Tentative Bill of Material**

Tentative bill of material of CP system (TCP) shall be prepared separately by the successful contractor for each section as per the approved design and the same shall be submitted with the detail engineering package for review.

8.3 **Other Miscellaneous Works**

i) The job includes all civil works including supply of bricks, cements steel etc. connected with grouting of equipment to be installed. The job includes repairing of all civil works damaged during installation of electrical and other facilities.

ii) Preparation of buried cable trenches including excavation, back filling, compacting, providing of brick protection by second-class bricks, spreading of fine river sand, including all supplies.

iii) CP contractor shall provide Colour code identification for the various CP System cables used in the system with design document for approval.

iv) The scope of work under this contract shall be inclusive of breaking of walls and floors, and chipping of concrete foundations necessary for the installation of equipment, materials, and making good of the same. Minor modifications wherever required to be done in the owner free supplied equipments or devices to enable cable entry, termination, etc.

v) Checking of all connections, i.e. power, control, earthing and testing and commissioning of all equipment erected and/or connected under this contract as per testing procedures and instructions of Engineer-in-Charge.

vi) All electrical equipments are to be doubly earthed by connecting two earth wires from the frame of the equipment to be earth grid. The cable armours will be earthed thro'cable glands.

The following shall be earthed:

- All non-current carrying metallic parts of electrical equipments such as lighting

and power panels, push button stations, cable trays etc.

vii) Supply and installation of all other accessories not specifically mentioned herein but nevertheless necessary for completion of job.

viii) Engineering and preparation of specifications, data sheets, procedures and drawings etc required for procurement & installation of CP System wherever applicable/required by GGPL/ MECON and submit to GGPL/ MECON for approval/comments.

ix) Correction and submission of all owners' drawings for as-built status.

x) Test certificates, catalogues, vendor drawings, installation, operation and maintenance manuals for all equipment/materials in contractor's scope of supply.

xi) All civil work related to the CP work is in scope of the CP contractor.

xii) Co-ordination with other Contractors/Pipeline contractor.

8.4 WORK CONTRACT

The entire work as per Scope of Work covered under this contract shall be treated as "Works Contract".

All works included in the scope of CP work will be done simultaneously with main pipeline construction by main pipeline Contractor. Bidder will supply all the materials required for completing the system and organise manpower & equipments accordingly to meet the requirement of Cathodic Protection work in time as per completion schedule given in Volume I of II.

8.5 SCOPE OF SUPPLY

8.5.1 Owner's Supply – NIL

Supply, testing, Packing, Forwarding, Delivery, Installation and commissioning of all the equipment covered in this package are included in the scope of the contractor. No equipment will be free issued by the owner to the contractor.

8.5.2 Contractor's scope of supply shall be as mentioned in Cl. No. 8.1, 8.2 & 8.3.

9.0 STATUTORY APPROVAL OF WORKS

The submission of application on behalf of the Owner to Govt. Authority/ Central Electricity Authority/State authority/Private bodies, if required along with copies of required certificates complete in all respects, shall be done by the contractor well ahead of time so that the actual commissioning of are not delayed for want of approval from respective authority. The actual inspection of work by the above mentioned authority inspector shall be arranged by the Contractor and necessary coordination and liaison work in this respect shall be the responsibility of the contractor. However any fee paid to

these Authorities in this regard shall be reimbursed by the Owner on submission of bills with documentary evidence.

The Inspection and acceptance of the work as above shall not absolve the Contractor from any of responsibilities under this contract.

The necessary permissions required for the bonding etc for the interference mitigation (From SEB's, Water works Departments/ Boards, Railways & Other pipeline owners) shall be obtain before taking mitigation measures in the scope of contractor & the same will be hand over to GGPL after commissioning of CP system.

10.0 QUALITY ASSURANCE, INSPECTION AND TESTING

All the equipment supplied by the contractor shall be inspected by the Owner/MECON and/or their approved inspection agency (TPI) at the manufacturer's works prior to despatch. The equipment will be inspected as per the tests pre-identified in the approved QAP to ensure conformity of the same with relevant approved drawings, data sheets, specifications, National/International standards. The TPI shall be arranged by the CP contractor for the testing of the material/equipments at the vendor works.

10.1 Performance tests of any equipments which cannot be conducted/demonstrated either partially of wholly at the manufacturer's work, shall be conducted after erection at site in the presence of Owner & their inspection agency. In all the cases, prior approval of the approval shall be obtained.

10.2 In case of waiver category of items, the same shall be pre identified. For such items, the contractor shall furnish necessary certificates, test reports etc for Review/Approval to Owner/Inspection agency. The issue of Inspection Certificate/Waiver Certificate for any equipment or component there of does absolve the contractor from his contractual obligations towards subsequent satisfactory performance of the equipment at site. Should any equipment be found defective, In whole or part thereof after receipt at site or during erection/commissioning and testing shall be Rectified/Changed by contractor free of cost.

10.3 Contractor shall submit test plan for the equipments with four week advance notice.

10.4 The following equipment/items shall be tested and inspected by MECON/ owner at manufacturer's works before dispatch. Test certificates duly signed by MECON/ Owner shall be issued by the contractor as part of the final document.

- Hazardous area equipment
- CP TR/ CPPSM units

11.0 TESTING & COMMISSIONING

11.1 The successful bidder shall submit detailed installation, site testing & commission procedure with time schedules for Review/Approval to GGPL/MECON.

11.2 The successful tenderer shall provide adequate supervisory/ skilled personnel and all tools and tackles, testing equipment and instruments required for complete checking of installations and testing and commissioning of all equipment and accessories.

11.3 All the tests shall be conducted in the presence of GGPL/ MECON/Engineer-in/charge or his authorized representative unless he waives this requirement in writing.

11.4 The testing and commissioning of all equipment under the scope of the bidder & shall be carried out in accordance with the latest edition of relevant Indian Standards, International Standard NACE standards and IE Rules.

11.5 Test reports shall be submitted in required number of copies duly signed by the ***Bidder*** to ***MECON*** and ***GGPL***.

11.6 On successful completion of erection of each item /equipment, a final inspection will be carried out at site by **GGPL / MECON**, for correctness and completeness of erection.

11.7 After the completion of all tests and rectification of all defects pointed out during final inspection, start-up trials would be commenced. During the start-up trials contractor shall provide skilled / unskilled personnel and supervision round the clock at his cost. The number and category of workmen and duration up to which required, will be decided by the Engineer-in-charge. Any defects noticed during the start-up trial relating to the equipment supplied and work carried out by the Contractor, will be rectified by the contractor at his own cost.

11.8 Any work not conforming to the execution drawings, specifications or codes shall be rejected forthwith and the contractor shall carry out the rectification at his own cost.

11.9 After the operating conditions are fully achieved for CP system and the other requirements as stated in the General Conditions of Contract are fulfilled, the contractor would be eligible for applying for a completion certificate.

12.0 DRAWINGS, STANDARD SPECIFICATION AND INSTALLATION STANDARDS

12.1 The drawings accompanying the tender document are indicative of the nature of work and issued for tendering purposes only. Construction shall be as per drawings/specifications issued/ approved by the GGPL/ MECON during the course of execution of work.

After the job completion, contractor shall prepare 'AS-BUILT' drawings, final certified as built drawings vendor drawings for bought out equipments shall be submitted by the contractor to owner in bound volume with one set of reproducible original sepia plus five sets of prints & one set to MECON.

The equipments/ materials to be supplied by the contractor shall conform to the requirements of the applicable standard specifications. Also the installation of various material/ equipment shall also conform to the standard specification.

The purpose of the pipeline alignment drawings, P&IDs & Plot Plan drawings enclosed with the tender is to enable the tenderer to make an offer in line with the requirements of the Owner. These are indicative of the nature of work and issued for tendering purposes only. The bidders, however, shall visit the site before bidding for proper information of site conditions. Construction shall be as per drawings/ specifications issued/ approved by the Owner/ Consultant during the course of execution of work.

A) SPECIFICATION

1.	Specification for TCP system	MEC/TS/05/E9/016A
2.	Specification for Corrosion Survey	MEC/TS/05/21/016C

B) QAP

1.	Quality Assurance Plan	MEC/05/E9/23ME/QAP/082

C) STANDARD DRAWINGS

1.0	Prepacked Zinc Anode	MEC/SD/05/E9/E/CP/1601
2.0	Prepacked Mg Anode	MEC/SD/05/E9/E/CP/1602
3.0	Mg Ribbon anode for Grounding	MEC/SD/05/E9/E/CP/1603
4.0	Details of Test Station for TCP	MEC/SD/05/E9/E/CP/1604
5.0	Test Station Connection Schemes	MEC/SD/05/E9/E/CP/1605
6.0	Galvanic Anode Installation	MEC/SD/05/E9/E/CP/1606
7.0	Zinc Ribbon Anode for Cased Crossings with Coated Casings	MEC/SD/05/E9/E/CP/1607
8.0	Pipeline Grounding Through Polarisation Cell and Galvanic Anodes	MEC/SD/05/E9/E/CP/1608
9.0	Details of Zinc Grounding Cell	MEC/SD/05/E9/E/CP/1609
10.0	Permanent Copper – Copper Sulphate Reference Cell & Installation Details	MEC/SD/05/E9/E/CP/1610
11.0	Anode Lead Junction Box	MEC/SD/05/E9/E/CP/1612
12.0	Casing Pipe Detail	MEC/SD/05/E9/E/CP/1613
13.0	Test station for polarization cell	MEC/SD/05/E9/E/CP/1614
14.0	Deep well anode bed	MEC/SD/05/E9/E/CP/1615
15.0	Connection scheme for hoocking through CJB/TLP	MEC/SD/05/E9/E/CP/1616

16.0	Details of thermit weld for cable to pipe joint	MEC/SD/05/E9/E/CP/1618
17.0	Earth Electrode in Test Pit	MEC/SD/05/E9/02/1601

12.2 **Drawings for Tender purpose enclosed with construction tender**

Schematic Route Diagram
P&ID
Plot Plan
Alignment Sheets
Crossings Sheets

12.3 **Survey Drawings/ Details**

a) Overall Schematic Route Diagram
b) Soil resistivity report

13.0 RESOURCES FACILITIES

13.1 **Recruitment of Personnel by Contractor**

The Contractor shall not recruit personnel of any category from among those who are already employed by the other agencies working at the sites but shall make maximum use of local labour available.

13.2 **Construction Water and Power Supply**

No water and power will be provided by the owner. It should be the responsibilities of the contractor to arrange water and power at his own cost.

13.3 **Land for Residential Accommodation**

Owner shall not provide any land for residential accommodation of contractor's staff and labour.

14.0 PROJECT SCHEDULING & MONITORING

Refer clause no. 63.0 of SCC

15.0 CONSTRUCTION

OWNER reserves the right to inspect all phases of CONTRACTOR's operations to ensure conformity to the SPECIFICATIONS. Owner will have Engineers, Inspectors or other duly authorised representatives, made known to the CONTRCTOR present during progress of the WORK and such representatives shall have free access to the WORK at all times. The presence or absence of a OWNER's representative does not relieve the CONTRACTOR of the responsibility for quality control in all phases of the WORK. In the event that any of the WORK being done by the CONTRACTOR or any

SUB-CONTRACTOR is found by OWNER's representatives to be unsatisfactory or not in accordance with the DRAWINGS, procedures and SPECIFICATIONS, the CONTRACTOR shall, upon verbal notice of such, revise the work in a manner to conform to the relevant DRAWINGS, procedures and SPECIFICATIONS.

15.1 **Rules & Regulations**

CONTRACTOR shall observe in addition to Codes specified in respective specification, all National and Local Laws, Ordinances, Rules and Regulations and requirements pertaining to the WORK and shall be responsible for extra costs arising from violations of the same.

15.2 **Procedures**

Various procedures and method statements to be adopted by CONTRACTOR during the construction as required in the respective specifications shall be submitted to OWNER in due time for APPROVAL. No such construction activity shall commence unless approved by OWNER in writing.

15.3 **Field Inspection**

CONTRACTOR shall have at all times during the performance of the WORK, a Competent Superintendent on the premises. Any instruction given to such superintendent shall be construed as having been given to the CONTRACTOR.

15.4 **Erection and Installation**

The CONTRACTOR shall carry out required supervision and inspection as per quality Assurance plan and furnish all assistance required by the OWNER in carrying out inspection work during this phase. The OWNER will have engineers, inspectors or other authorised representatives present who are to have free access to the WORK at all times. If an Owner's representative notifies the Contractor's authorised representative not lower than a Foreman of any deficiency, or recommends action regarding compliance with the SPECIFICATIONS, the CONTRACTOR shall make every effort to carry out such instructions to complete the WORK conforming to the SPECIFICATIONS and approved DRAWINGS in the fullest degree consistent with best industry practice.

15.5 **Construction Aids, Equipment, Tools & Tackles**

CONTRACTOR shall be solely responsible for making available for executing the work, all requisite Construction Equipments, Special Aids, Cranes, Tools, Tackles and testing equipments and appliances. Such construction equipments etc. shall be subject to examination by owner and approval for the same being in first class operating condition. Any discrepancies pointed out by OWNER shall be immediately got rectified, repaired or the equipment replaced altogether, by CONTRACTOR. OWNER shall not in any way be responsible for providing any such equipment, machinery, tools and tackles.

The OWNER reserves the right to rearrange such deployment depending upon the

progress and priority of work in various sections.

Tie-end between main line and starting point of terminal is included in the scope of contract, as and when main line section is available for Tie-ins.

15.6 **ORDER OF WORKS/PERMISSIONS/RIGHT OF ENTRY/CARE OF EXISTING SERVICES**

The order in which the WORK shall be carried out shall be subject to the approval of the Engineer-in-charge and shall be so as to suit the detailed method of construction adopted by the CONTRACTOR, as well as the agreed joint programme. The WORK shall be carried out in a manner so as to enable the other contractors, if any, to work concurrently.

OWNER reserves right to fix up priorities which will be conveyed by Engineer-in-Charge and the CONTRACTOR shall plan and execute work accordingly.

Existing Service

Drains, pipes, cables, overhead wires and similar services encountered in course of the works shall be guarded from injury by the CONTRACTOR at his own cost, so that they may continue in full and uninterrupted use to the satisfaction of the Owners thereof, or otherwise occupy any part of the SITE in a manner likely to hinder the operation of such services.

Should any damage be done by the CONTRACTOR to any mains, pipes, cables or lines (whether above or below ground etc.), whether or not shown on the drawings the CONTRACTOR must make good or bear the cost of making good the same without delay to the satisfaction of the Engineer-in-Charge.

16.0 DOCUMENTATION

16.1 Drawings and design documents

16.1.1 The following documents shall be submitted along with the offer:

a) Filled up data sheets & Check lists
b) HSE Policy
c) QAP
d) Bar Charts & Project completion schedule
e) Un-priced List of two years operation and maintenance spare

16.1.2 The following drawings (in three sets) & documents shall be submitted for approval within 3 weeks of award of contract.

a) Various Procedures of CP system Installation Like- Soil survey (TCP), Thermit weld, Pin Brazing, Sacrificial anode (Zn/Mg/Ribbon) installations, Test stations & Junction Boxes installation, Cable laying, Installation of polarization cell, External ER probe, Surge diverter &

grounding cell, connection & sealing of sacrificial anode, Earthing of above ground pipeline, anode ground bed, CP units etc.

b) Soil survey report with marked location vulnerable area.
c) QA & QC Procedures.
d) Basis of system design and design calculations, equipment selection criteria and sizing calculations, formulae used
e) Detailed design calculations of TCP system (Complete Design Package).
f) Equipment layout, Cable layout & schedule.
g) Colour code identification for the various CP System cables used in the system
h) Procedure for field testing, pre-commissioning & commissioning of TCP.
i) Procedure for Monitoring & maintenance of CP system.
j) Equipment layout, Cable layout & schedule.
k) TLP's & junction boxes installation & erection details drawings.
l) Incorporation of Polarisation cell, surge arrester, TLP, Junction boxes & other relevant feature in CP system design in Alignment sheet, pipeline route diagram & Plot plan.
m) Tentative Bill of Material

16.1.3 After the job completion, contractor shall prepare AS-BUILT drawings/data sheets and documents, submit catalogues/manuals (O&M) of major brought out items. Final certified as built drawings, documents and manuals etc shall be submitted by the contractor to owner in bound volume with one set in soft copy (CD) plus three sets of prints to owner

Other drawings and documents shall be submitted by contractor along with AS-BUILT Drawings/Datasheets-

a) Test documents & drawings for bought out items.
b) Detailed commissioning report of pipeline CP system (TCP).

17.0 MAKE OF MATERIAL/BOUGHT OUT ITEMS

An Appendix-I of approved vendors for various major items is enclosed with this tender specification. The bidder shall consider such names only as indicated in the aforesaid list and clearly indicate in the bid the name(s) as selected against these items. For any other item not covered in the list enclosed with this tender document, prior approval shall be obtained by the contractor for its make/ supplier's name.

18.0 INSPECTION OF SUPPLY ITEMS

All inspections and tests shall be made as required by the specifications forming part of this contract. Contractor shall advise Owner/ Consultant in writing at least 10 days in advance of the date of final inspection/tests. Manufactures inspection or testing certificates for equipment and materials supplied, may be considered for acceptance at the discretion of Owner/ Consultant. All costs towards testing etc. shall be borne by the contractor within their quoted rates. All inspection of various items shall be carried out based on Quality Assurance Plan, which will be submitted by the Contractor and duly

approved by Owner/ Consultant.

19.0 ESCALATION

The Rates quoted shall be kept firm till completion of work and no price Escalation shall be paid.

APPENDIX-I
Sheet 1 of 2

1.0 APPENDIX-I (LIST OF SUPPLIER/S OF MAJOR BOUGHT OUT ITEMS)

1) CABLES

i) Brooks Cables
ii) Nicco Corporation Ltd
iii) CMI Ltd
iv) Delton Cables Ltd
v) KEI Industries
vi) Torrent Cables
vii) Universal cables
viii) Victor Cables
ix) Associated Flexible & Wires Pvt Ltd
x) Asain Cables (RPG Cables)
xi) Fort Gloster (Gloster Cables Ltd)
xii) Finolex Cable
xiii) Rediant Cables
xiv) NETCO Cables Pvt Ltd

2) JUNCTION BOX (FLP Type)

i) Exprotecta, Beroda
ii) Baliga
iii) Flexpro
iv) FFLP Control Gears
v) Sterling
vi) Sudhir

3) SACRIICIAL ANODES

i) M/s Scientific Metals Engineers Pvt. Ltd., Karaikudi
ii) M/s PSL Holding Pvt. Ltd., Mumbai
iii) M/s BHEL, Bhopal
iv) M/s Nippon Corrosion, Japan
v) M/s AFIC, KSA

vi) M/s Platt Bros. and Company, USA
vii) M/s YUXI, CHINA
viii) M/s Wilson Walton International
ix) M/s XIANG METAL, CHINA
x) M/s SHUNRUI, CHINA
xi) M/s Impalloy International
xii) M/s Corrpro International
xiii) M/s HOCKWAY, UK
xiv) M/s NAKABOHTEC, Japan

APPENDIX-I
Sheet 2 of 2

4)	Portable Reference Cell	:	M/s MC Miller (USA) or Equivalent
5)	Permanent Reference Cell	:	M/s Borin Manufacturer USA, M/s MC Miller USA, M/s Corrtech
6)	AC operated Automatic Transformer Rectifier Unit/DC operated Automatic CPPSM Unit	:	M/s Canara Electric (M/s Raychem RPG Ltd), M/s Kriston systems
7)	Thermit Weld Pin Brazing	: :	M/s Erico, USA, M/s Cad Weld M/s Safe Track, M/s BAC UK
8)	Surge diverter (Ex-d)	:	M/s Dhen, M/s OBO, M/s Corrpro system, M/s Sohne
9)	Digital Multimeter	:	MOTWANE, Rishabh, Fluke or Equivalent
10)	CTSU	:	M/s Kriston systems or equivalent
11)	Solid state polaristation cell	:	M/s Dairyland, M/s Corrpro systems
12)	Anode (MMO Type)	:	1) Titanor Component Ltd., Goa, India 2) Denora Permelic S.P.A (Italy) Oronzio De Nora S.A. Ingano, Switzerland 3) CER Anode Technologies International USA 4) ACTEL, UK 5) ELTECH System Corporation, Texas 6) MAGNETO-CHEMIE, Netherlands 7) M/S MATCOR (USA)
13)	Backup Agency for doing:		PLE Germany, Vendor Velde, Nippon Japan, CIPL / interference survey,Balslev Denmark, SSS Germany

14)	Anode Backfill Material	:	1) M/S Goa Carbon (Goa) 2) M/S India Carbon (Calcutta), 3) M/S Petrocarbon & Chemical Company (Haldia)
15)	Heat Shrink Cap For Anode To Cable Joint	:	M/s RAYCHEM, M/s MATCOR (USA)
16)	MCCB/MCB for Power Distribution Board	:	Siemens, Indo Asian, L&T, Hager, Merlin Gerin Schneider Electric, AEG, HAVELL'S, ABB, MDS
17)	ER- PROBE (External Corrosion Monitoring)	:	M/s Rose Corrosion Services UK, M/s Metal Samples, USA M/s Roharbak Cosasco, USA M/s Caproco, UK
17)	ER- PROBE & Corrosion Coupon Samples, USA Assembly	:	M/s Rose Corrosion Services UK, M/s Metal M/s Roharbak Cosasco, USA, M/s Caproco, UK
18)	CP Contractor	:	Corrtech International Pvt Ltd Ahmedabad Underground Pipeline & Ndts (P) Ltd Noida Sark epc projects pvt.ltd. Ahmedabad Raychem

Note-For any other brought out item(s) for which the vendor list is not provided in the tender , bidders can supply those item(s) from vendors/ suppliers who have earlier supplied similar item(s) for the intended services in earlier Oil and Gas projects and the item(s) offered is in their regular manufacturing/ supply range.

1) The vendor / supplier should not be in the Holiday list of GGPL/ MECON / other PSU

2) The bidder is not required to enclose documentary evidences (PO copies, Inspection Certificate etc.) along with their offer, however in case of successful bidder, these documents shall required to be submitted by them within 30 days from date of Placement of Order for approval to GGPL/ MECON.

Annexure-A

Format for Daily Progress report

DAILY PROGRESS REPORT – TCP SYSTEM							
CLIENT:				DPR NO.			
CONSULTANT:	MECON Limited			PROGRESS DATE:			
CONTRACTOR:				REPORT DATE:			
PROJECT:				PLACE:			
S.No.	ACTIVITY	UOM	SCOPE	PROGRESS PROGRESS (Spreads I, II……)			Remarks
				PREVIOUS	TODAY	CUMULATIVE	
1	Soil Resistivity & Chemical Analysis						
2	Additional Data Collection						
3	TCP design Document						
4	P/L LENGTH	KM					
5	P/L LOWERED	KM					
6	TCP PROVIDED	KM					
7	PSP LEVEL	(-V)					
S.No.	Material Work Description						

1	Test station	Nos.					
2	Mg anode	Nos.					
3	Zn anode	Nos.					
4	Zn Ribbon Anode	Mtr.					
5	No. of Thermit	Nos.					
5(a)	No. of Pin Brazing	Nos.					
5	Surge Diverter	Nos.					
6	ER Probe	Nos.					
7	Polarisation Coupon	Nos.					
8	Polarisation Cell	Nos.					
9	Cased crossings	Loc					
10	TCP Cables						
10(a)	1Cx6 mm² Armoured	Mtr.					
10(b)	1Cx6 mm² Un-Armoured	Mtr.					
10(c)	1Cx10 mm²	Mtr.					
10(d)	1CX25 mm²	Mtr.					

Annexure -B

Format for TCP system Commissioning

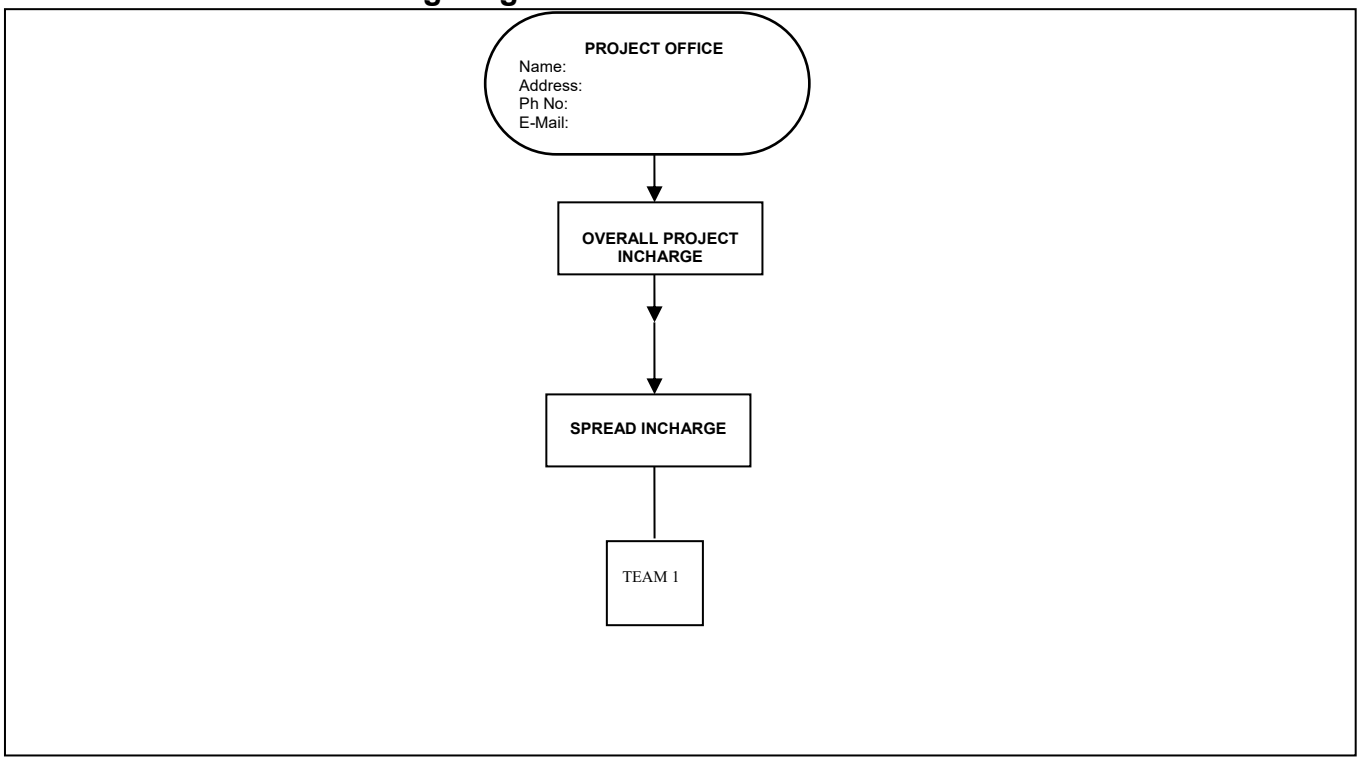
Sr. No	TS No	Chainage	TS Type	Natural PSP	Instant PSP	Polarised PSP (24 Hrs.)	Anode Voltage (V)	Anode Current (mA)	AC Voltage (V)	Other Readings (If Any)	Remarks

Format for Monthly Monitoring Report of TCP system

Sr. No	TS No	Chainage	TS Type	PSP (-) Voltage			Anode Voltage (V)	Anode rrent (mA)	AC Voltage (mV)	Other Readings (If Any)	Remarks
				Carrier		Casing					
				Without Bonding	Bonding						

Annexure-C

Organogram for the CP work



Note-

1. Overall Project In charge should have B.E. in (Electrical, Electronics and Metallurgical Engineering) & at least 10 year Experience in the Cathodic Protection Field.

2. Spread Incharge should have B.E. or Diploma in (Electrical, Electronics and Metallurgical Engineering) & at least 3 year Experience in the Cathodic Protection Field and shall be available at site office for entire time schedule of the project.

3. CVs including Experience & Qualification shall be submitted along with the bid.

Design basis for Temporary cathodic protection system

1.0 INTRODUCTION-

M/s Godavari Gas Private Limited (GGPL) a Joint Venture of APGDC & HPCL have been authorized by PNGRB for implementation of CGD Project in East and West Godavari Districts excluding Kakinada Geographical Area (GA). M/s GGPL is implementing CNG & City Gas Distribution Network (CGDN) to supply Natural Gas to domestic, commercial, industrial and automobile Consumers in the Geographical Area (GA) of East & West Godavari Districts.

M/s GGPL intends to lay underground steel pipeline network of various sizes (8'', 6"& 4"dia) alongwith associated facilities, emanating from existing SVs to make natural gas available for CNG & PNG facilities in the Geographical Area (GA) of East & West Godavari Districts (A.P)

2.0 SCOPE-

Survey, Design, detailed engineering, supply, packing, transportation to site, installation, testing and commissioning of the temporary cathodic protection system using Mg/ Zn galvanic anodes for design life of minimum 2 years or till the commissioning of PCP system whichever is later, to protect the external surface of 8'' , 6'' & 4'' NB of total 149 km long , 3LPE coated pipeline against corrosion as per standard Specification No. MEC/S/05/E9/016A for Temporary cathodic protection system, scope of work, data Sheets & Other relevant standards.

3.0 CODES & STANDARDS-

The system design, performance and materials to be supplied shall, unless otherwise specified, conform to the requirements of the following latest relevant applicable specifications:

i)	NACE Standard RP-0169 Control of	:	Standard Recommended Practice External Corrosion on Underground or Submerged Metallic Piping Systems.
ii)	NACE Publication 10A190 criteria for	:	Measurement technique related to CP of Underground or Submerged Steel Piping System (as defined in NACE Standard RPO169-83).
ii)	NACE Standard RP-0177 Mitigation of	:	Standard Recommended Practice Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control System.
iv)	NACE Standard RP-0286	:	Standard Recommended Practice the electrical isolation of Cathodically

			Protected Pipelines.
v)	NACE Publication No. 54276 Buried	:	Cathodic Protection Monitoring for Pipelines.
vi)	NACE Standard RP-0572 Design,	:	Standard Recommended Practice Installation & Operation of Impressed Current Deep Ground beds.
vii)	IS 8062 Underground	:	Recommended Practice ICCP for Piping.
viii)	BS 7361 Part I for land	:	Code of Practice for Cathodic Protection and marine application.
ix)	VDE 0150 Stray	:	Protection against Corrosion due to Current from DC Installations.
x)	IS: 7098 Part I	:	XLPE Insulated Cables.
xi)	IS: 1554 Part I	:	PVC Insulated (heavy duty) cables.

3.2 In case of imported equipments standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

3.3 The equipment shall also confirm to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

3.4 In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations the following order of priority shall govern.

- Statutory regulations.
- Data sheets.
- Scope of Work/ Job specification.
- Design Basis.
- Standard Specification.
- Codes and standards.

4.0 SITE CONDITIONS-

The equipment offered and the installation shall be suitable for continuous operation under the following site conditions:

Ambient temperature	:	45°C/ 2˚C (max.)
Max relative humidity	:	95%
Altitude	:	less than 1000 m
Atmosphere	:	To withstand site condition (Humid & low temp during winter)

Hazardous area Classification	:	Zone-II , Gas group IIA & IIB, Temp. Class T3

5.0 ARES CLASSIFICATION-

Classification of hazardous area will be in accordance with BIS and IS: 5572.

Following selection will be considered for proper selection of electrical equipment for use in hazardous area:

a) Area Classification	:	Zone-II
b) Gas Group	:	IIA and IIB
c) Temperature Classification	:	T3

All electrical equipment installed in hazardous area will be selected as per IS: 5571.

5.1 All the electrical equipment for hazardous areas shall be of Ex-d type suitable for temp classification T3.

8.0 CABLES-

TCP Cables -

TCP Cables shall be annealed high conductivity, tinned, stranded copper conductor, XLPE insulated 650/1100 V grade, armoured/un-armoured, PVC sheathed. The size of the copper conductor shall be 6 sq mm for anode cable from anode to buried junction box, 10 sq mm from junction box to test station, 10mm² from test station to pipeline. The size of the conductor shall be 6 sq mm for potential measurement, 10 sq.mm for current measurement and 25mm² for bonding, polarization cell / grounding cell/Earthing 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.

Note- Underground buried junction box shall be provided only at locations where more than two (02) nos. of anodes required for the pipeline protection.

CABLING SYSTEM

Cable laying philosophy

A. Paved area:	Cable tray/RCC trench
B. Unpaved area:	Directly buried
C. Type of cable trays:	Galvanized prefabricated

9.0 CATHODIC PROTECTION SYSTEM-

TCP system-

A.	Type	Sacrificial
B.	Design life	2 Year or till commissioning of PCP whichever is later
C.	Pipeline coating	Three Layer Polyethylene
D.	Protective current Density	As per specification
E.	Anode material (for sacrificial CP System)	Sacrificial Mg/ Zn (High/Low Potential as per specification) as decided during detail engineering.
F.	Electrical resistance probes	Shall be provided as per specification
	a) Quantity of E/R probes	As per scope of work
	b) No. of E/R probe reading instrument	As per scope of work
G.	Polarisation cell	Solid state type (shall be provided as per specification/scope of work)
H.	Polarisation coupons	Shall be provided as per specification/scope of work
	a) Size of exposed area of coupon	100mm x 100mm
	b) No. of coupons	As per scope of work. Location To be decided by CP contractor in consultation with GGPL/MECON
I.	Proposed location of E/R probes / Polarisation Coupons	To be decided by CP contractor during detail engineering based on specifications and in consultation with the GGPL/MECON

10.0 STATUTORY APPROVAL-

The submission of application on behalf of the Owner to Govt. Authority/ Central Electricity Authority, if required along with copies of required certificates complete in all respects, shall be done by the contractor well ahead of time so that the actual commissioning of are not delayed for want of approval from authority. The actual inspection of work by the Govt. inspector shall be arranged by the Contractor and necessary coordination and liaison work in this respect shall be the responsibility of the contractor. However any fee paid to the Govt. Authority in this regard shall be reimbursed by the Owner on submission of bills with documentary evidence.

The Inspection and acceptance of the work as above shall not absolve the Contractor from any of responsibilities under this contract.

11.0 DRWINGS AND DESIGN DOCUMENTS-

11.1 The following documents shall be submitted along with the offer:

f) Filled up data sheet/Checklist.
g) HSE Policy
h) Bar Charts & Project completion schedule
i) QAP
j) Design calculations of TCP system
k) List of two years operation and maintenance spare.
l) Approx. dimensions of the system
m) Catalogues for polarization cells, spark gap arrestors, ER Probe, reference cells etc.

11.2 The following drawings (in three sets) & documents shall be submitted for approval within 3 weeks of award of contract.

n) Various Procedures of CP system Installation Like- Soil survey (TCP), Thermit weld, Pin Brazing, Sacrificial anode (Zn/Mg/Ribbon) installations, Test stations & Junction Boxes installation, Cable laying, Installation of polarization cell, External ER probe, Surge diverter & grounding cell, connection & sealing of sacrificial anode, Earthing of above ground pipeline, anode ground bed, CP units etc.
o) Soil survey report with marked location vulnerable area.
p) QA & QC Procedures.
q) Basis of system design and design calculations, equipment selection criteria and sizing calculations, formulae used
r) Detailed design calculations of TCP system (Complete Design Package).
s) Equipment layout, Cable layout & schedule.
t) Color code identification for the various CP System cables used in the system
u) Procedure for field testing, pre-commissioning & commissioning of TCP.
v) Procedure for Monitoring & maintenance of CP system.
w) Equipment layout, Cable layout & schedule.
x) TLP's & junction boxes installation & erection details drawings.
y) Incorporation of Polarisation cell, surge arrester, TLP, Junction boxes & other relevant feature in CP system design in Alignment sheet, pipeline route diagram & Plot plan.
z) Tentative Bill of Material

11.3 After the job completion, contractor shall prepare AS-BUILT drawings/data sheets and documents, submit catalogues/manuals (O&M) of major brought out items. Final certified as built drawings, documents and manuals etc shall be submitted by the contractor to owner in bound volume with one set in soft copy (CD) plus five sets of prints to owner & one set to MECON..
Other drawings and documents shall be submitted by contractor along with AS-BUILT Drawings/Datasheets-

c) Test documents & drawings for bought out items.
d) Detailed commissioning report of pipeline CP system (TCP).