GOA NATURAL GAS PVT. LTD.

A Joint Venture of Bharat Petroleum Corporation Limited (BPCL) & GAIL GAS Limited

CITY GAS DISTRIBUTION PROJECT

BID DOCUMENT

FOR

LAYING & CONSTRUCTION OF 8”, 6” & 4” NB U/G STEEL PIPELINE NETWORK & ASSOCIATED WORKS FOR CITY GAS DISTRIBUTION FOR NORTH GOA

OPEN DOMESTIC COMPETITIVE BIDDING

Bid Document No.: 05/51/23SA/GNGPL/001(ii)

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VOLUME – II OF III

PREPARED AND ISSUED BY
MECON LIMITED
(A Govt. of India Undertaking)
Delhi, India
## CONTENTS
### VOLUME-II OF II

### LIST OF SPECIFICATION / STANDARDS

#### A) Technical Specification for Pipe Laying, Piping and Mechanical Works

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Description</th>
<th>Drawing Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Specification for Preliminary Activities</td>
<td>MEC/S/05/62/101</td>
</tr>
<tr>
<td>2.</td>
<td>Specification for Excavation of Trench</td>
<td>MEC/S/05/62/102</td>
</tr>
<tr>
<td></td>
<td>Steel Pipes</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Specification for Preparation of Steel Pipes</td>
<td>MEC/S/05/62/104</td>
</tr>
<tr>
<td>5.</td>
<td>Specification for Lowering in</td>
<td>MEC/S/05/62/105</td>
</tr>
<tr>
<td>6.</td>
<td>Specification for Backfilling the Trench</td>
<td>MEC/S/05/62/106</td>
</tr>
<tr>
<td>7.</td>
<td>Specification for Obstacles Crossing and Special Passages</td>
<td>MEC/S/05/62/107</td>
</tr>
<tr>
<td>10.</td>
<td>Specification for Purging and Commissioning the Network</td>
<td>MEC/S/05/62/110</td>
</tr>
<tr>
<td>12.</td>
<td>Specification for Construction of Valve Assembly</td>
<td>MEC/S/05/62/112</td>
</tr>
<tr>
<td>13.</td>
<td>Specification for Mainline Construction (Onshore)</td>
<td>MEC/S/05/21/01</td>
</tr>
<tr>
<td>14.</td>
<td>Specification for Welding of Onshore Gas Pipelines + Welding Specification</td>
<td>MEC/S/05/21/02</td>
</tr>
<tr>
<td></td>
<td>Charts</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Specification for Hydrostatic Testing of Onshore Pipeline</td>
<td>MEC/S/05/21/03</td>
</tr>
<tr>
<td>16.</td>
<td>Specification for Major Water Crossings (Conventional)</td>
<td>MEC/S/05/21/04</td>
</tr>
<tr>
<td>17.</td>
<td>Specification for Pipeline Crossing Roads, Railroads, Minor Water and</td>
<td>MEC/S/05/21/05</td>
</tr>
<tr>
<td></td>
<td>Other Crossings</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Specification for Piping Fabrication and Erection</td>
<td>MEC/S/05/21/06</td>
</tr>
<tr>
<td>19.</td>
<td>Specification for Shop and Field Painting</td>
<td>MEC/S/05/21/07</td>
</tr>
<tr>
<td>20.</td>
<td>Specification for Repair of Pipeline Corrosion</td>
<td>MEC/S/05/21/08</td>
</tr>
</tbody>
</table>
21. Specification for Pipeline Markers               MEC/S/05/21/10
22. Specification for Flushing and Testing of Piping Systems     MEC/S/05/21/11
23. Specification for Casing Insulators and End Seals    MEC/S/05/62/12
24. Specification for Field Joint Coating (Onshore Pipelines) MEC/S/05/21/13
25. Specification for Vents, Drains and Wells           MEC/S/05/21/15
26. Specification for Blasting                          MEC/S/05/21/18
27. Specification for Gaskets, Bolts and Nuts           MEC/S/05/21/19
28. Specification for Piping Material Specification MEC/Q7AU/05/28/M/000/1092
29. Technical Specification for Pre-Commissioning and Commissioning MEC/Q7AU/05/28/M/000/1093
30. Specification for Health, Safety and Environment Management (HSE) MEC/S/05/21/65
31. Specification for Quality Assurance System Requirements MEC/S/05/62/66
32. Specification for Documentation for Pipeline Construction  MEC/S/05/21/69
33. Specification for Field Joint Coatings of Pipeline for HDD Crossing MEC/S/05/21/74
34. Specification for Pipeline Crossings Using HDD Method       MEC/S/05/21/75
35. Specification for Warning Mats                           MEC/TS/05/62/042, Rev-1
36. Specification for Seamless Fittings and Flanges [Size up to DN 400mm (16”) NB] MEC/S/05/21/025
37. Specification for Assorted Pipes                          MEC/TS/05/62/059A
38. Specification for Ball Valves                              MEC/TS/05/21/002
39. Specification for Plug Valves (NB≥2)                    MEC/TS/05/62/003, Rev-2
40. Specification For Insulation Joints                       MEC/TS/05/21/009
<table>
<thead>
<tr>
<th></th>
<th>B) Technical Specification for Civil &amp; Structural Works</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Specification for Civil Works MEC/S/05/11/01</td>
</tr>
<tr>
<td>2.</td>
<td>Technical Specification for Concrete Weight Coating MEC/S/05/11/03</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>C) Technical Specification for Cathodic Protection System</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Technical Specification for Temporary Cathodic Protection System MEC/TS/05/E9/016A</td>
</tr>
<tr>
<td>2.</td>
<td>Technical Specification for Corrosion Survey MEC/S/05/21/016C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>D) Technical Specification for MDPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Specification for Laying of MDPE Main Pipeline</td>
</tr>
<tr>
<td>2.</td>
<td>Specification for HDPE Pipes</td>
</tr>
<tr>
<td>3.</td>
<td>Specification for MDPE Fittings and Electro Fusion</td>
</tr>
<tr>
<td>4.</td>
<td>Specification for Polyethylene Pipes</td>
</tr>
<tr>
<td>5.</td>
<td>Specification for Isolation and Appliance Valve</td>
</tr>
</tbody>
</table>
WORKING SPECIFICATION
FOR
CONSTRUCTION OF
MAINS AND DISTRIBUTION NETWORK
FOR NATURAL GAS IN CITY CONDITION
## INDEX

<table>
<thead>
<tr>
<th>SPECIFICATION NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEC/S/05/62/101</td>
<td>Specification for Preliminary activities (5 sheets)</td>
</tr>
<tr>
<td>MEC/S/05/62/102</td>
<td>Specification for excavation of trench (6 sheets)</td>
</tr>
<tr>
<td>MEC/S/05/62/103</td>
<td>Specification for taking over, handling, hauling, stacking and stringing steel pipes (5 sheets)</td>
</tr>
<tr>
<td>MEC/S/05/62/104</td>
<td>Specification for preparation of steel pipes (5 sheets)</td>
</tr>
<tr>
<td>MEC/S/05/62/105</td>
<td>Specification for Lowering in (3 sheets)</td>
</tr>
<tr>
<td>MEC/S/05/62/106</td>
<td>Specification for Back filling the trench (4 sheets)</td>
</tr>
<tr>
<td>MEC/S/05/62/107</td>
<td>Specification for Obstacles crossing and special passages (8 sheets)</td>
</tr>
<tr>
<td>MEC/S/05/62/108</td>
<td>Specification for Marking out (2 sheets)</td>
</tr>
<tr>
<td>MEC/S/05/62/109</td>
<td>Specification for Testing (23 sheets)</td>
</tr>
<tr>
<td>MEC/S/05/62/110</td>
<td>Specification for Purging and commissioning the network (5 sheets)</td>
</tr>
<tr>
<td>MEC/S/05/62/111</td>
<td>Specification for Technical records (3 sheets)</td>
</tr>
<tr>
<td>MEC/S/05/62/112</td>
<td>Specification for construction of valve assembly (4 sheets)</td>
</tr>
</tbody>
</table>
PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

SPECIFICATION FOR
PRELIMINARY ACTIVITIES

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

1.0 OBJECT

2.0 EQUIPMENT

3.0 DRAWINGS

3.1 Surveys

3.2 Construction Drawings

4.0 PERMITS

4.1 Installation Permits

4.2 Circulation Permit

4.3 Digging Permit

4.4 Trial-Hole Permit

5.0 STAKING OUT
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 "Drawings" 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 charge 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.
SPECIFICATION FOR EXCAVATION OF THE TRENCH

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

1.0 OBJECT
2.0 MATERIALS AND EQUIPMENT
3.0 ROUTE
4.0 SIZE OF THE TRENCH
5.0 CLEARING
6.0 REMOVAL OF ROAD SURFACINGS
7.0 DIGGING OF THE TRENCH
8.0 SHEETING AND BRACING OR PROPPING
9.0 DEWATERNNNG
10.0 JOINT HOLES
11.0 EXCAVATED MATERIAL
12.0 SIGNALING, FENCING AND LIGHTING
13.0 ENCLOSURE
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 “Obstacle crossings and special passages.”

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 stop temporarily the traffic, the Contractor shall deal with the Municipality and Police authorities and inform the Engineer-in-charge of the arrangements agreed upon.

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-stones shall be removed with care for possible reuse. Materials unsuitable for reuse shall immediately be removed from the site as digging proceeds. Materials suitable for reuse shall tidily be piled-up as directed by the Engineer.

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 tunneled and underpinned 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 excavated material to be removed from the site and to be kept at a dump yard until the trench is to be back filled and to be brought back to the site for backfilling.

When the excavated material is judged by the Engineer to be unsuitable for re-use, the Contractor shall remove it from the site as the digging of the trench proceeds and shall supply in its place suitable material approved by the Engineer.
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)
SPECIFICATION
FOR
TAKING OVER, HANDLING, HAULING,
STOCKING AND STRINGING STEEL PIPES

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

1.0 OBJECT

2.0 EQUIPMENT

3.0 TALKING OVER PIPE AND PIPELINE ACCESSORIES

4.0 HANDLING AND STOCKING PIPES AND PIPELINE ACCESSORIES

4.1 Bare Pipes

4.2 Coated Pipes

4.3 Pipeline Accessories

5.0 STRINGING PIPES AND PIPELINE ACCESSORIES

6.0 USING CROP-ENDS

7.0 INVENTORY

8.0 RECOVERY AND STORAGE
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:

<table>
<thead>
<tr>
<th>Nominal pipe diameter</th>
<th>Number of layers</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm</td>
<td>10</td>
</tr>
<tr>
<td>32 mm</td>
<td>8</td>
</tr>
<tr>
<td>50 mm</td>
<td>6</td>
</tr>
<tr>
<td>80 mm and more</td>
<td>2</td>
</tr>
</tbody>
</table>

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 accordance 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”.
SPECIFICATION
FOR
PREPARATION OF THE STEEL PIPES

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

1.0 OBJECT

2.0 MATERIALS AND EQUIPMENT

3.0 CHECKING THE PIPES

4.0 INTERNAL CLEANING

5.0 CLEANING THE ENDS

6.0 CUTS AND BEVELS

6.1 Straight Pipes

6.2 Mitered Pipes

7.0 DIRECTION DIVERSION

7.1 Flexion

7.2 Field Cold Bending

7.3 Factory Elbows

7.4 Mitered Bends

8.0 TEES

9.0 CHECKING OF INSIDE SECTION

10.0 REJECTED PIPES
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 “REJECTED” in red paint.

These pipes shall be immediately removed from the work site by the Contractor hauled and stocked at a depot approved by the Engineer.
PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI 110 092

SPECIFICATION FOR LOWERING IN

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

1.0 OBJECT
2.0 EQUIPMENT
3.0 CAPPING PIPELINE SECTIONS
4.0 LOWERING-IN
5.0 FLOODED TRENCH
6.0 AIR PRESSURIZING PIPELINE SECTIONS
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/cm² and the constructed portions of network shall be maintained so pressurized until tightness tests.
SPECIFICATION FOR BACKFILLING THE TRENCH

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

1.0 OBJECT
2.0 MATERIALS AND EQUIPMENT
3.0 BACKFILLING
   3.1 Soft Layer
   3.2 Above The Soft Layer
   3.3 Temporary Reconditioning
4.0 PROTECTION OF BACKFILL
5.0 CLEANING
6.0 FINAL RESURFACING
7.0 OBSTACLES
8.0 SETTLEMENT OF DAMAGES
9.0 ENCLOSURE
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 BACKFILLING

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

- the good condition of the coating and any coating’s mechanical protection
- the 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 “Obstacle crossings and special passages”.

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 Contractor’s stockyard, offices and workshops.

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

This document does not release the Contractor from 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
2.0 MATERIALS AND EQUIPMENT
3.0 WORK SCHEDULE
4.0 NOTIFICATION OF THE RELEVANT AUTHORITIES OR OWNERS
5.0 CROSSING OF ABOVE GROUND OBSTACLES
6.0 CROSSING OF UNDERGROUND OBSTACLES
7.0 PARALLEL ROUTES
8.0 SPECIAL PASSAGES
9.0 ENCLOSURES
1.0 **OBJECT**

This specification refers to the crossing of obstacles encountered during the pipeline’s 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 required 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 increase the size of the trench according to the size of the encountered obstacle in order to allow sufficient working space and maintain the specified clearance between the pipe and the crossed underground obstacles and utilities.

The minimum clearance 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 Parallel 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 “Documents drawn up by the Contractor”

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

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
2.0 MATERIALS AND EQUIPMENT
3.0 LOCATION OF THE INDICATOR – PLATES
4.0 PAINTING
5.0 ENCLOSURE
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)**
CONTENTS

1.0 OBJECT
2.0 NATURE OF THE TESTS
3.0 MATERIALS AND EQUIPMENT
4.0 TEST SCHEDULE
5.0 PRESENCE OF THE ENGINEER
6.0 ORGANISATION OF THE TESTS AND CHECKS
7.0 RESISTANCE TEST
8.0 TIGHTNESS TEST
9.0 VALVE ASSEMBLIES
10.0 INSPECTION OF UNTESTED JOINTS
11.0 REPAIRS
12.0 REPORTS AND STATEMENTS
13.0 DRAINING
14.0 TEST REPORT
15.0 ANNEXURES

Procedure for Hydrostatic Tightness Test
Procedure for Pneumatic Tightness Test
Coating Resistance Test
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 (± 10%).

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 valves 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 apparatus 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 handed 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
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 $V \leq 20\text{m}^3$, duration 1 hour
If $V > 20\text{m}^3$, 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:-

- $\phi \leq 400\text{mm}$ : 1 days
- 40 mm $\phi \leq 750\text{mm}$ : 2 days
- $\phi \geq 800\text{mm}$ : 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 0.1°C.

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/cm².

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 his 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:

\[ q = \frac{1}{(P + 5)} \quad \text{for} \quad P \leq 100 \]

\[ q = 7 \quad \text{for} \quad P > 100 \]

q being expressed in litres/hour, and P in kg/cm²

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 \( \Delta P_1 \) measured on a dead weight tester.

3.1.2 Interpretation

The theoretical pressure drop \( \Delta P_0 \) corresponding to m is:

\[ \Delta P_0 = \frac{m}{D} \left( \frac{V}{\chi + \frac{e}{E}} \right) \]

with:

\( \chi \) : 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.

\( \Delta P_1 \)

The ratio \( \frac{\Delta P_1}{\Delta P_0} \) is formed.
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:

- \( (P_1 - P_2) < 0.5 \text{ kg/cm}^2 \) : test acceptable
- \( (P_1 - P_2) = 0.5 \text{ kg/cm}^2 \) : short extension
- \( (P_1 - P_2) > 0.5 \text{ kg/cm}^2 \) : test refused

3.2.2 Short Extension

A third reading \( P_3 \) shall be taken at time \( t_3 \) after an interval of time \( t \) equal to \( \frac{1}{2} \) hour after \( t_2 \).

Let \( \Delta P'0 \) be the pressure drop which would have been caused by the minimum leakage during \( (t_3 - t_2) \). \( \Delta P'0 \) 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 \( (t_3 - t_2) \).

Algebraically:

- \( (P_1 - P_2) < 0.5 \Delta P'0 \) : test acceptable
- \( (P_1 - P_2) > 0.5 \Delta P'0 \) : 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.
- $\partial f / f$: dispersion factor of $f$, given in the same graph.
- $\mu$: expansion factory of water
- $\gamma$: cubic expansion factor of steel
- $\chi$: 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

$$H = \frac{\partial f}{f} / \Delta P + 0.2 fK$$

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

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

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 \( 0.5 \Delta P'0 \). If the test is not satisfactory, it shall be redone.

3.4 Annexes

- Curves giving \( f \) and \( \partial f / f \) in terms of the pipeline diameter.
- Variations of the compressibility factor of water \( \chi \) in terms of its temperature.
- Variation of \( \mu - \gamma \) in terms of the temperature of the water.
HYDROSTATIC TEST

\[ \frac{\partial f}{\partial f} \]

Curves Giving \( f \) and \( \frac{\partial f}{\partial f} \) in terms of diameter \( \phi \)
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 0°C

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 (±10%).

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 : \(T_a\) in °C
- Relative pressure in the pipeline : $P$ in mm of mercury
- Temperature of the ground : $T$ in °C 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 0°C 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 0°C

$P =$ read relative pressure in the pipeline

$T =$ average temperature of the ground

2.2.3 **Absolute pressure for 0°C**

$$Pa = Po + br$$
2.3 **Interpretation**

The test shall be satisfactory if the difference in the absolute pressure $P_a$ in the pipeline, corrected for 0°C, 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.
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 $U_0$ 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 ($U_2$) and OFF ($U_1$) 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 it can be assumed that it is over the calculated value at the most underprivileged point, i.e. where $U_2 - U_1$ is minimum.

Therefore:

$\frac{S (U_2 - U_1) \text{ min.}}{I} \geq R$

Where:

$R = \text{Coating resistance of network in } \Omega \text{m}^2$
$S = \text{Total external surface of the pipeline}$
$U_1 = \text{potential with cathodic protection OFF, in V}$
$U_2 = \text{potential with cathodic protection ON, in V}$
$I = \text{current input in the work, in A}$

3.0 ACCEPTANCE

For a network without service lines:

$R > 4 000 \Omega \text{m}^2$

For a network with service lines (steel):

$R > 2 000 \Omega \text{m}^2$
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 μA/m² (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
2.0 Materials and Equipment
3.0 Work Schedule
4.0 Safety Precautions
5.0 Purging
  5.1 General
  5.2 Pipelines
  5.3 Accessories
6.0 Repairs
7.0 Performance Defects
8.0 Certificate of Completion
1.0 \textbf{OBJECT}

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

2.0 \textbf{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 \textbf{WORK SCHEDULE}

The contractor shall draw-up and submit a purging schedule to the Engineer’s approval, in the conditions specified in the specification “Documents drawn-up by the contractor”.

This schedule shall specify:

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

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

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

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) day’s 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 manufacturer's 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.
SPECIFICATION FOR TECHNICAL RECORDS

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

1.0 Object
2.0 Composition of Technical Records
3.0 Technical Documents
4.0 As-Built Document
5.0 Drawing up of Technical Records
6.0 Handing over of Technical Records.
1.0 **OBJECT**

These specifications 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, bearing 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 “Document drawn-up by the contractor”.

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.
SPECIFICATION FOR
CONSTRUCTION OF VALVE ASSEMBLY

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

1.0 General Dimensions

2.0 Civil Works

3.0 Protection against stray currents and Electrostatic loads.

4.0 Cathodic Protection
Valve assemblies location and construction will be as per contractor’s construct
drawing and technical instructions that must be submitted for Engineer’s 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 5°.
  - 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 “GAS”.

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 ingress of water and other objects likely to clog them.

3.0 PROTECTION AGAINST STRAY CURRENTS AND ELECTROSTATIC LOADS.

In order to avoid 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.
SPECIFICATION FOR
MAINLINE CONSTRUCTION (ONSHORE)

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

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
## CONTENTS

<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>SCOPE</td>
</tr>
<tr>
<td>2.0</td>
<td>REFERENCE CODES, STANDARDS AND SPECIFICATIONS</td>
</tr>
<tr>
<td>3.0</td>
<td>REQUIREMENTS OF R.O.U. AND ACCESS THERETO</td>
</tr>
<tr>
<td>4.0</td>
<td>RIGHT-OF-WAY</td>
</tr>
<tr>
<td>5.0</td>
<td>HANDLING, HAULING, STRINGING AND STORING OF MATERIALS</td>
</tr>
<tr>
<td>6.0</td>
<td>TRENCHING</td>
</tr>
<tr>
<td>7.0</td>
<td>BENDING</td>
</tr>
<tr>
<td>8.0</td>
<td>LINING UP</td>
</tr>
<tr>
<td>9.0</td>
<td>LAYING OF PIPE</td>
</tr>
<tr>
<td>10.0</td>
<td>BACK-FILLING</td>
</tr>
<tr>
<td>11.0</td>
<td>TIEING-IN</td>
</tr>
<tr>
<td>12.0</td>
<td>SPECIAL INSTALLATIONS ON THE PIPELINE</td>
</tr>
<tr>
<td>13.0</td>
<td>WORKING SPREAD LIMITATIONS</td>
</tr>
<tr>
<td>14.0</td>
<td>CLEAN-UP AND RESTORATION OF RIGHT-OF-WAY</td>
</tr>
<tr>
<td>15.0</td>
<td>MAINTENANCE DURING DEFECTS LIABILITY PERIOD</td>
</tr>
</tbody>
</table>

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1.0 SCOPE

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

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

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

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

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

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

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

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

2.0 REFERENCE CODES, STANDARDS AND SPECIFICATIONS

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

a) ANSI B 31.8 - Gas Transmission and Distribution Piping Systems
b) ANSI B 31.4 - Liquid Petroleum Transportation Piping Systems
c) API 1104 - Standard for Welding Pipelines and Related Facilities
d) API 1105 - Bulletin on Construction Practices for Oil and Products Pipelines
e) Part 1992 Title 49 - Transportation of Natural and Other Gas by Pipeline (US Department of Transportation - Pipeline Safety Standards)
f) Part 195 - Transportation of Liquids by Pipeline (US Department of Transportation - Pipeline Safety Standards).

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

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

- the words "Shall" and "Must" are mandatory.
the 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.
3.1.3 If it is 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.

3.1.4 During thunderstorms or when discharges are observed on insulators all personnel must leave the area of the high voltage line and pipeline.

3.1.5 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.

3.1.6 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 35mm².

Said connections must not be interrupted until after the permanent safety earth connections have been installed and connected to the entire uninterrupted pipeline.

3.1.7 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.

3.1.8 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:
The measures taken may be as follows:

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

2. In case the measures recommended in 1. above are not feasible, installation of clearly visible markers of sufficient height or laying out a "no passage beyond this point" line of drums painted bright red and white must prevent any work being done inside the danger area. Further, an inspector must be 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 until he has managed to leave "the dangerous area, or alternatively, when the Electricity Authorities have given notice that the cable(s) have been put out of circuit. In case a serious fire starts in the vehicle, he is permitted to jump from the vehicle, clearing it as far as possible, while the jump should possible be to a dry spot.

4.0 RIGHT-OF-WAY

The CONTRACTOR is required to perform his construction activities within the width of Right-of-way set aside for construction of pipeline, unless he has made other arrangements with the 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 grazing lands, villages etc.

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

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

4.4 **Row Clearing and Grading**

4.4.1 All stumps shall be grubbed for a continuous strip, with a width equal to trench top width plus two 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 jurisdiction and as soon as practical after the initial removal. In no case, it shall be left to interfere with the grading and laying operations. Whenever stumps are grubbed and a hole is left in the ground, CONTRACTOR shall back-fill the hole and compact it to prevent water from gathering in it and creating a big hole.

4.4.3 CONTRACTOR shall grade the pipeline Right-of-way as required for proper installation of the pipeline, for providing access to the pipeline during construction, and for ensuring that the pipeline is constructed in accordance with the good engineering and construction practices.

4.4.4 CONTRACTOR shall grade sharp points or low points, without prejudice to section 6.0 of this specification, to allow the pipe to be bent and laid within the limits set forth in these specifications and drawings as regards the minimum elastic curvature permitted, and shall drill, blast or excavate any rock or other material which cannot be graded off with ordinary grading equipment in order to make an adequate working space along the pipeline.
4.4.5 No temporary or permanent deposit of any kind of material resulting from clearing and grading shall be permitted in the approach to roads, railways, streams, ditches, drainage ditches and any other position which may hinder the passage and/or the natural water drainage.

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

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

4.4.8 In the case of Right-of-Way clearing and grading on hillside or in steep slope areas, proper barriers or other structures shall be provided to prevent the removed materials from rolling downhill. The Right-of-Way 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 restrictive features of the Right-of-Way and shall provide the necessary detours and execute the works without any extra cost to COMPANY. Public travel shall not be inconvenienced nor shall be wholly obstructed at any point.

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

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

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.

Handling, Hauling, Stringing and Storing of Materials.

General

The CONTRACTOR shall exercise utmost care in handling in pipe and other materials. CONTRACTOR shall be fully responsible for all materials and their identification until such time that the pipes and other materials are installed in permanent installation. CONTRACTOR shall be fully responsible for materials, however, method of storage shall be approved by COMPANY.

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

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

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

5.2 Handling and Hauling of Line Pipe

5.2.1 Bare Pipe

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

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

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

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

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

The lorries/rail wagons shall be equipped with adequate pipe supports having as many round hollow beds as the number of pipes to be placed on the bottom of the lorry bed. Supports shall be provided for at least 10% of the pipe length. These supports shall be lined with a rubber protection and shall be spaced in a manner as to support equal load from the pipes. The rubber protection shall be free from all nails and staples where pipes are in contact. The second layer and all subsequent layers shall be separated from other layers with adequate number of separating layers of protective material such as straw in plastic covers or otherwise to avoid direct touch between the coated pipes.

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

5.3 Striking of Pipe

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

The stringing of the pipe on the ROW shall be done in such a manner so as to cause the least interference with the normal use of the land crossed and to avoid damage to and interference with the pipes. The sequence of pipes must be interrupted at suitable intervals, spaced to coincide with passages, roads, 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, 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 characteristics did to unsuitable storage must be strictly complied with and, if required, an adequate heat conditioning shall be provided for these materials.

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

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

5.6 Identification

CONTRACTOR shall provide 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 permit general public, property owners or his tenants to cross or move stock or equipment from one side of the trench to the other.

Care shall be exercised to see that fresh soil recovered from trenching operation, intended to be used for backfilling over the laid pipe in the trench, is not mixed with loose debris or foreign material. The excavated material shall never be deposited over or against the strung pipe.

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

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

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

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

### 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 ground).

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.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Location</th>
<th>Minimum Cover in meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Industrial, Commercial &amp; Residential Areas</td>
<td>1.0</td>
</tr>
<tr>
<td>b)</td>
<td>Rocky Terrain</td>
<td>1.0</td>
</tr>
<tr>
<td>c)</td>
<td>Minor water crossings/ canals / drain / nala / stream</td>
<td>1.5</td>
</tr>
<tr>
<td>d)</td>
<td>River crossings for which scour depth is defined (below scour)</td>
<td>1.5</td>
</tr>
<tr>
<td>e)</td>
<td>River crossings (Bank width &lt; 50 m) below lowest bed level)</td>
<td>1.5</td>
</tr>
<tr>
<td>f)</td>
<td>Other crossings (Bank width &gt; 50 m) ( below lowest bed level)</td>
<td>2.5 (for normal soil) 1.5 (for rocky strata)</td>
</tr>
<tr>
<td>g)</td>
<td>Water crossing by HDD (below least bed level)</td>
<td>2.5</td>
</tr>
<tr>
<td>h)</td>
<td>Uncased/ Cased Road Crossings/ Station approach</td>
<td>1.2</td>
</tr>
<tr>
<td>i)</td>
<td>Railroad Crossings</td>
<td>1.7</td>
</tr>
<tr>
<td>j)</td>
<td>Drainage, ditches at roads / railway crossings</td>
<td>1.0</td>
</tr>
<tr>
<td>k)</td>
<td>Marshy land and creek area</td>
<td>1.5</td>
</tr>
</tbody>
</table>

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 approaches to crossings. Such trenching work shall be done by CONTRACTOR at no extra cost to the COMPANY.

COMPANY intends that there will be a minimum of hand grading of the trench bottom. However, to achieve this, CONTRACTOR will have to dig as square a bottom of the trench as possible with his equipment. This in part can be obtained by adjusting and
adoption the crumbling shoe and digging teeth of the trenching machines and by use of a drag behind the trenching machines or manually dressing-up the same. CONTRACTOR shall do such hand work in the trench as is necessary to free the bottom of the trench from loose rock and hard clods and to trim protruding roots from the bottom and side walls of the trench.

6.8 Padding

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

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

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

6.9 Protection of Trench

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

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

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

6.10 Protection of Underground Utilities and Special Methods

Details of some underground utilities, as far as acquired by COMPANY, shall be indicated in the Drawings. However, CONTRACTOR shall obtain plans and full details of all existing and planned underground services from the relevant Local Authorities and shall follow these plans closely at all times during the performance of work. CONTRACTOR shall be responsible for location and protection of all underground lines and structures. In special locations the use of trenching machine, backhoe may result
in damage to property and subsurface structures likely to be encountered during excavation. At such places, CONTRACTOR shall excavate the trench manually to same specification at no extra cost.

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

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

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

6.11 Encroachments and Working near other utilities

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

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

CONTRACTOR shall be liable for any damage occurring to, or resulting from damage to other pipelines, underground structure/utilities, as laid down in clause 6.10 of this specification.

6.12 Provisions for negative buoyancy to the pipe

CONTRACTOR shall check if up-floating danger is present in open trench and then shall take appropriate measures to prevent up-floating such as applying soil dams and dewatering of trench or temporary filling of water into the line (in exceptional cases).
In the case of water on the ditch bottom when the pipeline is being laid, the ditch shall be drained to the extent and for the time required to make a visual inspection of the ditch bottom. After this inspection, the presence of water will be allowed provided its level does not cause sliding of the ditch sides and pipe floating before backfilling when no concrete weighting is provided.

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

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

- weighting by applying a continuous concrete coating around the pipe;
- weighting by installing saddle weights;
- installing metal anchors screwed into the 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, etc., temporary caps approved by COMPANY shall be welded to the ends of the pipe.

9.0 LAYING OF PIPE

9.1 Lowering In Trench

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

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

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

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

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

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

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 backfilling is not possible, a covering of at least 200mm of earth, free of rock and hard lumps shall be placed over and around the pipe and coating.

On no account the top soil from the ROW be used for this purpose. In general, the trench shall be dry during backfilling. Deviations there of must have prior approval of the COMPANY. The backfill material shall contain no extraneous material and/or hard lumps of soil which could damage the pipe / coating or leave voids in the backfilled trench. After the initial backfill has been placed into the trench to a level slightly above the surrounding ground, CONTRACTOR shall compact the backfill material. The surplus material shall be neatly crowned directly over the trench and the adjacent excavated areas on both sides of the trench as per clause 6.2.1, to such a height which will, in COMPANY's opinion, provide adequately for future settlement of the trench backfill during the maintenance period and thereafter. The crown shall be high enough to prevent the formation of a depression in the soil when backfill has settled into its permanent position. Should depression occur after backfill, CONTRACTOR shall be responsible for remedial work at no extra cost to COMPANY. Surplus material, including rock, left from this operation shall be disposed of to the satisfaction of land owner or authority having jurisdiction at no extra cost to the COMPANY.

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

10.3 Rock, gravel, lumps of hard soil or like materials shall not be backfilled directly onto the pipe unless 'padding' and/or rock shell has been provided as per Section 6.0 of this specification. When "Padding" as described in Section 6.0 of this specification is to be used, the following shall be applicable.
Where rock, gravel, lumps of hard soil or like materials are encountered at the time of trench excavation, sufficient earth, sand or select backfill materials shall be placed around and over the pipe to form a protective cushion extending at least to a height of 150mm above the top of the pipe. Select backfill materials for padding that are acceptable to COMPANY shall be soil, sand, clay or other material containing no gravel, rock or lumps or hard soil. Whether such padding material would be taken from the adjacent spoil bank or imported from elsewhere shall be directed by COMPANY. All these works shall be carried out by CONTRACTOR at no extra cost to COMPANY. Loose rock may be returned to the trench after the required selected backfill material has been placed, provided the rock placed in the ditch will not interfere with the use of the land by landowner, or tenant.

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

10.5 Trenches excavated in dykes which are the property of railways or which are part of main roads shall be graded and backfilled in their original profile and condition. If necessary, new and/or special backfill materials shall be supplied and worked-up. The materials required may include gravel, special stabilization materials or stabilized mixtures. However, special processing and/or compacting methods shall require the approval of COMPANY and/or competent authorities.

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

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

10.8 CONTRACTOR shall furnish materials and install breakers in the trench in steep areas (slope generally 10% and more) for the purpose of preventing erosion of the backfill. The type of breakers installed shall be as per the approved drawings. Breakers shall be constructed of grout bags filled with a mixture of 4:1 Sand:Portland cement at COMPANY's direction. CONTRACTOR may propose other methods such as foam dams etc. which shall be subject to approval by COMPANY. Such works shall be at no extra cost to COMPANY. CONTRACTOR shall pay attention to the direction of backfilling in such steep areas.
10.9 When backfilling the trenches in sloping terrains or steep areas, where in the opinion of the COMPANY, the backfill may be washed out of the trench, sheet piling or other effective water breakers across the trench shall be provided by CONTRACTOR. This is to divert the flow of water away from the trench into normal drainage followed before laying the line. In no case, the water is to be drained via the trench or via channels other than those followed before the line was laid.

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

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

- Pipeline dia upto and including 24" : 200mm
- 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 stabilisation shall be at least 5.0 meters on either side of the pipeline, plus one meter for every 10 meters height of dune (where the line passes through the dune areas).

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

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

11.0 TIEING-IN

11.1 The unconnected sections of the pipe line at various locations have to be tied in after the sections are coated, lowered and backfilled. The sections to be connected shall have at the ends, sections of over lapping, uncovered pipe of sufficient length to absorb, without inducing excessive stresses in the steel, small displacements necessary for perfect alignment and connection of the ends.
11.2 Tie-in shall preferably be carried out at ambient temperatures corresponding to the average operating temperature in the case of a pipeline conveying fluids at normal temperatures and at the maximum ambient temperature in the case where the pipeline is carrying fluids at high temperature.

11.3 CONTRACTOR shall carry out tie-in-welding (including necessary cutting, bevelling, grinding of pipe weld seams and line-up etc.) cleaning, priming, coating and backfilling for the tie-in portion as per relevant specifications. CONTRACTOR shall also excavate the required bell-holes for the connection. Bell-holes made to facilitate welding shall provide adequate clearance to enable the welders to exercise normal welding ability and skill. All tie-in welds shall be radiographically examined.

11.4 The tie-in should be done in such a way as to leave a minimum of strain in the pipe. If necessary, with respect to the trench, realigning of the pipe shall be done to eliminate force or strain in the pipe by the CONTRACTOR at no extra cost to COMPANY.

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

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

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

12.0 SPECIAL INSTALLATIONS ON THE PIPELINE.

12.1 General

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

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

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

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

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

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

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 \( R = 10D \) 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 removed and discarded. It is mandatory that a torque wrench is used for bolt tightening.

12.1.4 **Threaded connections.**

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

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

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

12.1.5 **Welded connections**

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

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

12.1.6 **Civil Work**

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

12.1.7 **Painting**

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

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

All buried valves, insulating joints, flowtees, bends, other in-line fittings and appurtenances shall be coated with minimum three coats of approved quality of coal-tar epoxy or any other equivalent suitable COMPANY approved coating at no extra cost to the COMPANY. For buried pipes either heat shrink tapes conforming to COMPANY’s specification or coal tar epoxy shall be used. CONTRACTOR shall submit to COMPANY
a report used alongwith all the test certificates. Only after obtaining written approval from the COMPANY, CONTRACTOR shall commence the work of coating.

12.1.9 **Clean-up**

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

12.2 **Installation of Valves and Valve Stations**

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

12.2.2 The civil and structural work shall be carried 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 valves 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 Scrapper Launchers and Receivers

12.3.1 Scrapper 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 up to 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 geodetic markers which may have been removed during the execution of the works shall be restored in their exact position.

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

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

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

14.12 All openings in or damage to the fence or enclosures shall be repaired by installing new fencing of quality which shall be at least equal to the parts damaged or removed. Provisional gates shall be removed and replaced with new fencing. All repairs to fences and enclosures shall be carried out to the complete satisfaction of COMPANY, land owner and/or tenant.
14.13 If, in the opinion of COMPANY, the sod in pasture land has been damaged by vehicles and wheel tracks are visible, the ROW shall be tilled with a disc-harrow or rotary cultivator several times. The damaged sod shall be firmly cut up and thoroughly mixed through the top-soil. In general the ROW has also to be ripped. After this procedure no closed-in layers must be found and sufficiently loose top-soil 25 to 30cm thick must be present. The whole procedure has to be approved by COMPANY. Subsequently, the entire ROW which is part of pasture land, shall be prepared for seeding and fertilized according to the instructions of COMPANY.

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

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

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

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

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

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

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

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

### 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.
SPECIFICATION FOR WELDING OF ONSHORE GAS PIPELINES

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

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
## CONTENTS

<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.0</td>
<td>SCOPE</td>
</tr>
<tr>
<td>02.0</td>
<td>APPLICABLE CODES, STANDARDS &amp; SPECIFICATIONS</td>
</tr>
<tr>
<td>03.0</td>
<td>MATERIAL SPECIFICATIONS</td>
</tr>
<tr>
<td>04.0</td>
<td>WELDING CONSUMABLES</td>
</tr>
<tr>
<td>05.0</td>
<td>EQUIPMENT &amp; ACCESSORIES</td>
</tr>
<tr>
<td>06.0</td>
<td>WELDING PROCESSES</td>
</tr>
<tr>
<td>07.0</td>
<td>BEVEL CLEANING AND BEVEL INSPECTION</td>
</tr>
<tr>
<td>08.0</td>
<td>ALIGNMENT AND SPACING</td>
</tr>
<tr>
<td>09.0</td>
<td>WEATHER CONDITIONS</td>
</tr>
<tr>
<td>10.0</td>
<td>WELDING</td>
</tr>
<tr>
<td>11.0</td>
<td>HEAT TREATMENT</td>
</tr>
<tr>
<td>12.0</td>
<td>INSPECTION AND TESTING</td>
</tr>
<tr>
<td>13.0</td>
<td>REPAIR OF WELDS</td>
</tr>
<tr>
<td>14.0</td>
<td>DESTRUCTIVE TESTING OF WELDED JOINT - BUTT WELDS</td>
</tr>
<tr>
<td>15.0</td>
<td>ULTRASONIC INSPECTION</td>
</tr>
<tr>
<td>16.0</td>
<td>AUTOMATED ULTRASONIC TESTING (AUT)</td>
</tr>
<tr>
<td>17.0</td>
<td>RADIOGRAPHY</td>
</tr>
</tbody>
</table>

**ANNEXURE-I** - ELECTRODE QUALIFICATION TEST RECORD

**ANNEXURE-II** - STRESS RELIEF HEAT TREATMENT PROCEDURE SPECIFICATION

**ANNEXURE-III** - FORMAT FOR WELDING PROCEDURE SPECIFICATION (WPS)

**ANNEXURE-IV** - FORMAT FOR PROCEDURE QUALIFICATION RECORD (PQR)

**ANNEXURE-V** - FORMAT FOR MANUFACTURER’S RECORD FOR WELDER OR WELDING OPERATOR QUALIFICATION TESTS

**ANNEXURE-VI** - RADIOGRAPHIC PROCEDURE QUALIFICATION RECORD FOR PIPE WELDING

**ANNEXURE-VII** - WELDERS IDENTIFICATION CARD

**ANNEXURE-VIII** - TYPE OF SOURCE AND FILMS TO BE USED FOR RADIOGRAPHY
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 consumables necessary for the execution of the job such as electrodes, oxygen, acetylene etc. and the same shall be approved in advance by the Purchaser/ Consultant.

The welding electrodes/ filler wires supplied by the 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, for 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% O₂, 5% CO₂ the variation of such addition shall not exceed ± 10% of that stated. Moisture content shall correspond to a dew point of -30°C or lower.

### 05. EQUIPMENT & ACCESSORIES

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

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

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

### 06. WELDING PROCESSES

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

6.2 Main line (20” φ and above)

Semi-automatic Flux Cored Arc Welding for fill and cap passes, with root pass welding by Surface Tension Transfer Process (STTP) of Gas Tungsten Arc Welding (GTAW) / Shielded Metal Arc Welding (SMAW) process.

6.3 Tie-Ins and Crossings

Any of the processes specified above as per qualified procedures.

6.4 Double jointing of two pipe lengths using Submerged Arc Welding (SAW) process in a specially laid pipe welding yard is also permitted.

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

6.5 The welding procedure adopted and the consumables used shall be specifically approved.
6.6 The welding processes to be employed are given in the welding specification chart. Any deviation desired by the CONTRACTOR shall be obtained through the express consent of the COMPANY.

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

6.8 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 damaged ends shall be cut and re-bevelled to the satisfaction of the COMPANY, with an approved beveling 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 offset shall not exceed 1.6mm. The offset may be checked from outside using dial gauges. Any branch connection, sleeve, etc. shall be atleast 150mm from any other weld. The welds for fittings shall be so located that the toe of the cold dressing is permissible only in cases of slight misalignment and may only be carried out with a bronze headed hammer. Hot dressing shall not be permitted. When welding pipes of different wall thickness (as directed by COMPANY) a special transition piece shall be used. This shall have a minimum of 1:4 taper. The welds shall be subject to both ultrasonic and radiographic inspection.

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

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

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

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

09. WEATHER CONDITIONS

The parts being welded and the welding personnel shall be adequately protected from rain and strong winds. In the absence of such a protection no welding shall be carried out. The completed welds shall be suitably protected in case of bad weather conditions.

10.0 WELDING

10.1 Root Pass

a) Root pass shall be made with electrodes/ filler wires recommended in the welding specification chart attached along with other project data sheets. The size of the electrodes used shall be as per the approved welding procedure.
b) Position or roll welding (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 ordinary 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 irregularities, slag, etc., shall be removed by grinding and chiselling.

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

h) 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

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

The number of welders and the allowable welding sequences shall be as those laid down in the qualified welding procedure specification. Once the deposit of the first pass has been started, it must be completed as rapidly as possible, reducing
interruptions to the minimum. The welding and wire speed shall be approximately same as that established in the Qualified Welding Procedure Specification (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 at least 100°C shall be carried out. Subsequent passes up to weld completion shall be protected to avoid rapid cooling, if meteorological conditions so dictate. Cleaning between passes shall be done carefully so as to reduce the possibility of inclusions.

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

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

These requirements apply not only to completed welds but also to the bare strip at least so wide so as to allow full skid examination at both ends of the pipe to allow a good ultrasonic inspection when it is required.
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 gas burners, utilising acetylene or propane gas may also be carried out. Oxypropane gas may be used with the permission of the COMPANY under careful supervision.

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

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

11.2 Postweld Heat Treatment

a) Post weld heat treatment, wherever required for joints between pipes and fittings, pipe body and supports shall be carried out by the CONTRACTOR at his expense as per the relevant specifications, applicable standards and the instructions of the COMPANY.

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

c) The CONTRACTOR shall submit for the approval of the COMPANY, well before carrying out actual heat treatments the details of the post weld heat treatment procedure, as per Annexure-II attached, that he proposes to adopt for each of the materials/assembly/part involved.

d) Post weld heat treatment shall be done in a furnace or by using an electric resistance or induction heating equipment, as decided by the COMPANY.

e) While carrying out local post weld heat treatment, technique of application of heat must ensure uniform temperature attainment at all points of the portion being heat treated. Care shall be taken to ensure that width of heated band over which specified post weld heat treatment temperature is attained is at least 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 at least 2.5 rt where r is the bore radius and t is the pipe thickness at the weld.

f) Throughout the cycle of heat treatment, the portion outside the heat band shall be suitably wrapped with insulation so as to avoid any harmful temperature gradient on the exposed surface of pipe. For this purpose temperature at the exposed surface of the pipe shall not be allowed to exceed 400°C.

g) The temperature attained by the portion under heat treatment shall be recorded by means of thermocouple pyrometers. Adequate number of thermocouples shall be attached to the pipe directly at equally spaced locations along the periphery of the pipe joint. The minimum number of thermocouples attached per joint shall be 2 up to 10" dia and 3 for 12" dia and above. However, the COMPANY can increase the required minimum number of thermocouples to be attached, if found necessary.

h) Automatic temperature recorders which have been suitably calibrated shall be employed. The calibration chart of each recorder shall be submitted to the COMPANY prior to starting the heat treatment operation and its approval shall be obtained.

i) Immediately on completion of the heat treatment, the post weld heat treatment charts/records along with the hardness test results on the weld joints (whenever required as per the welding specification chart) shall be submitted to COMPANY for its approval.

j) Each joint shall bear an identification number which shall be maintained in the piping sketch to be prepared by the CONTRACTOR. The joint identification number shall appear on the corresponding post weld heat treatment 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 also provide the COMPANY's inspector all means and facilities necessary to carry out inspection.

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

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

   ii. To supervise the welding procedures qualification.

   iii. To supervise the welder's performance qualification.

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

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

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

12.2  **Welding Procedure Qualification**

a) Welding procedure qualification shall be carried out in accordance with the relevant requirements of API 1104 latest edition or other applicable codes and other 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 at least 2 weeks before the commencement of actual work. Standard tests as specified in the code shall be carried out in all cases. In addition to these, tests, other tests like radiography, macro/micro examination,
hardness tests, dye penetrant examination, 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 qualified in accordance with the API 1104 and other applicable specifications by the CONTRACTOR at his expense. The butt weld test pieces of the qualification test shall meet the radiographic test requirements specified in Clause 12.5 and 16.0 of this specification. The COMPANY's Inspector shall witness the test and certify the qualification of each welder separately. Only those welders who have been approved by the COMPANY's Inspector shall be employed for welding. CONTRACTOR shall submit the welder qualification test reports in the standard format as shown in Annexure-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 unqualified welder shall be cut and redone by a qualified welder at the expense of the CONTRACTOR.

12.4 **Visual Inspection**

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

12.5 **Non Destructive Examination**

The non destructive examination shall mainly consist of examination using x-ray radiography as detailed in Clause 17.0.

12.5.1 Radiographic 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 radiographic examination of 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 for pipes with wall thickness 9.5mm and above, ultrasonic inspection is required in the following cases as per clause 15.0 of this specification.

a) On the first 100 welded joints corresponding to each automatic GTAW / and Semi-automatic FCAW welding procedure used.

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

c) When welds are repaired.

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

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

f) 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 by approved by the COMPANY.

All other welds made of FCAW and SMAW processes and the 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 and semi-automatic FCAW 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 metallographic examination, hardness surveys and Charpy tests to determine the effects of repair welding on the associated structure.

Root sealing or single pass repair deposit shall not be allowed. Internal root defects shall be ground thoroughly and welded with a minimum of two passes. However, while
13. 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. 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 24 hours. 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**

<table>
<thead>
<tr>
<th>Type and Number of Test Specimens for Procedure Qualification Test &amp; Production Welds</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pipe Size, Outside Diameter-Inches</strong></td>
</tr>
<tr>
<td><strong>Wall Thickness - ½ inch (12.7mm) and Under</strong></td>
</tr>
<tr>
<td><strong>Tensile API</strong></td>
</tr>
<tr>
<td>Under 2-3/8</td>
</tr>
<tr>
<td>2-3/8 to 4-½ incl.</td>
</tr>
<tr>
<td>Over 4-½ less than 12.75</td>
</tr>
<tr>
<td>12-3/4 and over</td>
</tr>
<tr>
<td><strong>Wall Thickness - Over ½ inch (12.7mm)</strong></td>
</tr>
<tr>
<td>4-½ and smaller</td>
</tr>
<tr>
<td>Over 4-½ less than 12-3/4</td>
</tr>
<tr>
<td>12-3/4 and over</td>
</tr>
</tbody>
</table>

14.3 Nick-Break Test

14.3.1 Preparation

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

14.4 Macroscopic Inspection

14.4.1 Preparation

Specimens shall be taken from the positions indicated in Fig. 1 of this specification and shall be prepared in accordance with ASTM E2 and E3.
The width of the macrosection has to be at least three times the width of the weld. The section is to be prepared by grinding and polishing and etched to clearly reveal the weld metal and heat affected zone.

14.4.2 **Method**

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

14.4.3 **Requirements**

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

14.5 **Hardness Test**

14.5.1 **Preparation**

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

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

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

14.5.2 **Method**

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

14.5.3 **Requirements**

Hardness value shall not exceed the limit specified in welding Specification chart. In case of a single reading having a slightly (+10 HV) higher value than the specified limit, further indentations shall be made to check if the high value was an isolated case.
All the hardness values contained from the heat affected zone shall not exceed 100 HV with respect to the average hardness of the values obtained for the base metal. If these additional tests give a hardness within the specification limit the slightly higher value may be accepted.

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

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

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

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Nominal Wall Thickness in mm</th>
<th>Test Specimen width mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Over 12</td>
<td>10</td>
</tr>
<tr>
<td>2.</td>
<td>Over 9.5 and upto 12</td>
<td>7.5</td>
</tr>
<tr>
<td>3.</td>
<td>From 7 upto 9.5</td>
<td>5</td>
</tr>
<tr>
<td>4.</td>
<td>Less than 7</td>
<td>2.5</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Test Specimen in mm</th>
<th>&quot;Average of three Specimens (Note-2) Joules (Min.)</th>
<th>Minimum Single Value (Note-1) Joules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>10.0</td>
<td>27.0</td>
<td>22.0</td>
</tr>
<tr>
<td>2.</td>
<td>7.5</td>
<td>21.5</td>
<td>17.0</td>
</tr>
<tr>
<td>3.</td>
<td>5.0</td>
<td>18.5</td>
<td>15.0</td>
</tr>
<tr>
<td>4.</td>
<td>2.5</td>
<td>10.0</td>
<td>8.0</td>
</tr>
</tbody>
</table>
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 50mm wide on both sides of the weld with steel wire brushes and anyhow the cleaned strip must be at least wide enough to allow full skip examination.

If, during the test, echoes of doubtful origin appear, it shall be necessary to inspect a convenient area on the pipe surface, close to the weld, with a straight beam transducer in order to check whether any manufacturing defects are present which could have
interfered with the ultrasonic beam.
By way of an example, the equipment shall include but not be limited to the following:-

- ultrasonic equipment and coupling medium
- sample sections for calibration of instruments
- equipment for cleaning of surface to be examined
- rules calibrated in centimeters for exact location of the position of defects.

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

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

b) continuous operation

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

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

**15.5 Ultrasonic Instruments**

The Ultrasonic Instruments shall satisfy the following:

- be pulse-echo type, able to generate, receive and display, on the screen a cathode ray tube (CRT) pulse at frequencies between 1 and 6 MHz. The useful part of the CRT screen shall be at least 70mm wide and at least 50mm high.
- shall have variable amplification, with steps of 1 or 2 dB over a range of at least 60 dB.
- the regulation control shall be accurate to within ±1 dB and this accuracy shall be certified by the instrument manufacturer.
- may be powered by a battery or an electric generator. In the first case, the autonomy of operation (endurance) of the instrument shall be sufficient to carry on working without frequent interruptions, and the instruments shall be equipped with an automatic switch which switches it off when the battery runs down; in the second case, there must be a voltage stabilising device with a tolerance of ±2 Volts.
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 V1 and V2 sample block, IIW type or calibration block ASTM E-428.

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

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

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

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

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

15.8 **Calibration**

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

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

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

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

15.9 Regulation of Amplification During Production Testing

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


API Std. 1104 – “Welding of Pipeline and Related Facilities”.

#### APPROVED AGENCIES

Automated 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 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 $\geq 20$ 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 couplants 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 – i) after a weld repair, ii) 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 up to 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
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 than 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 Pipelines and Related Facilities.


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 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.

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

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

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

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 Oaqueur 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.
## ELECTRODE QUALIFICATION TEST RECORD

### A. Tested at (Site name)  

<table>
<thead>
<tr>
<th>Manufacturer's Name</th>
<th>:</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand Name</td>
<td>:</td>
<td></td>
</tr>
<tr>
<td>Batch Number &amp; Size Tested</td>
<td>:</td>
<td></td>
</tr>
<tr>
<td>Classification &amp; Code</td>
<td>:</td>
<td></td>
</tr>
<tr>
<td>Intended for Welding in Position</td>
<td>:</td>
<td></td>
</tr>
<tr>
<td>In combination with (if any)</td>
<td>:</td>
<td></td>
</tr>
<tr>
<td>Code of Reference (used for testing)</td>
<td>:</td>
<td></td>
</tr>
<tr>
<td>Special requirements (if any)</td>
<td>:</td>
<td></td>
</tr>
</tbody>
</table>

### B. All Weld Tensile Test  

| Base Material used | : |
| Pre-heat temp. | : |
| Postweld Heat Treatment Details | : |
| Visual Examination | : |
| Radiographic Examination Results | : |
| Tensile Test Results | : |

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Identification No.</th>
<th>U.T.S.</th>
<th>Yield Point</th>
<th>Elongation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
C. Impact Test Results

Test Temperature : Notch in :

Type of Specimens : Size of Specimens :
(Charpy)

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Specimen No.</th>
<th>Impact Valve</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2.</td>
<td></td>
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<td></td>
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<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D. Chemical Analysis Result

Electrode Size used :

Batch No. :

<table>
<thead>
<tr>
<th>% C</th>
<th>% S</th>
<th>% P</th>
<th>% SI</th>
<th>% Mn</th>
<th>% Cr</th>
<th>% Ni</th>
<th>% Mo</th>
<th>Other</th>
</tr>
</thead>
</table>

E. Fillet Weld Test Results

Welding Positions :

Base Materials :

Size of Electrode used :

Visual Inspection Results :
1)  
2)  
3)  

Macro Test results :
### F. Other Test Results

<table>
<thead>
<tr>
<th>Fracture Test Results</th>
<th>:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarks</td>
<td>:</td>
</tr>
</tbody>
</table>

#### 1. Transverse Tensile Test

- **In combination with**: 
- **Base Material used**: 
- **Position of Welding**: 
- **Preheat Temperature**: 
- **Post Weld Heat Treatment**: 
- **Radiography**: 

<table>
<thead>
<tr>
<th>Identification No.</th>
<th>U.T.S.</th>
<th>Fracture in</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 2. Guided Bend Test

<table>
<thead>
<tr>
<th>Position</th>
<th>ID No.</th>
<th>Root, Face or Side Bend</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Any other Tests** : 

**Conclusion** :
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.: 
<table>
<thead>
<tr>
<th>TITLE</th>
<th>DOCUMENT NO.</th>
<th>EDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>WELDING OF ONSHORE GAS PIPELINES</td>
<td>MEC/S/05/21/02</td>
<td>1</td>
</tr>
</tbody>
</table>

**ANNEXURE-II**

Sheet 2 of 2

Soaking Temp. °C : 

Soaking Time, Hrs. : 

Rate of Cooling, °C/ Hr. : 

Mode of Cooling : 

4. Other Details, if any.

**Notes**:
The following documents shall be furnished alongwith the specifications:

i. Material Test Certificates

ii. Assembly/ Part Drawing.
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 ______________________________________________________________________

_________________________________________________________________________________
### 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

- **Position (s) of Groove** ___________________________
- **Welding Progression: UP _____ Down ____**
- **Position (s) of Fillet** ___________________________

### Postweld Ed Heat Treatment

- **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** ___________________________
- **Current DC** ___________________________
- **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.)

- **Electrode Wire feed speed range** ___________________________
## TECHNIQUE

<table>
<thead>
<tr>
<th>String or Weave Bead</th>
<th>Orifice or Gas Cup Size</th>
<th>Initial and Interpass Cleaning (Brushing, Grinding, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

---

<table>
<thead>
<tr>
<th>Weld Layer(s)</th>
<th>Process</th>
<th>Filler Metal</th>
<th>Current</th>
<th>Volt Range</th>
<th>Travel Speed Range</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Class</td>
<td>Dia</td>
<td>Type Polarity</td>
<td>Amp. Range</td>
<td></td>
</tr>
</tbody>
</table>
## ANNEXURE-IV
Sheet 1 of 3

### FORMAT FOR PROCEDURE QUALIFICATION RECORD (PQR)

**RECORD ACTUAL CONDITIONS USED TO WELD TEST COUPON**

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Procedure Qualification Record No.</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

<table>
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<tbody>
<tr>
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</tr>
</tbody>
</table>

### JOINTS

#### Groove Design of Test Coupon

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

<table>
<thead>
<tr>
<th>BASE METALS</th>
<th>POSTWELD HEAT TREATMENT</th>
<th>GAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Spec.</td>
<td>Temperature</td>
<td>Type of Gas on Gases</td>
</tr>
<tr>
<td>Type of Grade</td>
<td>Time</td>
<td>Composition of Gas Mixture</td>
</tr>
<tr>
<td>P.No. _______ to P.No. _______</td>
<td>Other</td>
<td>Other</td>
</tr>
<tr>
<td>Thickness of Test Coupon</td>
<td>Other</td>
<td>Other</td>
</tr>
<tr>
<td>Diameter of Test Coupon</td>
<td>Other</td>
<td>Other</td>
</tr>
<tr>
<td>Other</td>
<td>Other</td>
<td>Other</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FILLER METALS</th>
<th></th>
<th>POSTWELD HEAT TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weld Metal Analysis A No.</td>
<td></td>
<td>Temperature</td>
</tr>
<tr>
<td>Size of Filler Metal</td>
<td></td>
<td>Time</td>
</tr>
<tr>
<td>Filler Metal E.No.</td>
<td></td>
<td>Other</td>
</tr>
<tr>
<td>SF A Specification</td>
<td></td>
<td>Other</td>
</tr>
<tr>
<td>A WS Classification</td>
<td></td>
<td>Other</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>Other</td>
</tr>
</tbody>
</table>

| POSITION | ELECTRICAL CHARACTERISTICS | |
|----------|-----------------------------||
| Position of Groove | Current | |
| Weld Progression (Uphill, Downhill) | Polarity | |
| Other | Amps. | |
| Other | Tungsten Electrode Size | |
| Other | Other | |

---

Page 92 of 514
### ANNEXURE-IV

Sheet 2 of 3

#### PREHEAT TECHNIQUE

<table>
<thead>
<tr>
<th>Phreheat Temp.</th>
<th>Interpass Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>___________________________</td>
<td>___________________________</td>
</tr>
</tbody>
</table>

#### TECHNIQUE

<table>
<thead>
<tr>
<th>Travel Speed</th>
<th>String or Weave Bead</th>
<th>Oscillation</th>
<th>Multipass or Single Pass (per side)</th>
<th>Single or Multiple Electrodes</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>___________________________</td>
<td>___________________________</td>
<td>___________________________</td>
<td>___________________________</td>
<td>___________________________</td>
<td>___________________________</td>
</tr>
</tbody>
</table>

#### GUIDED BEND TESTS

<table>
<thead>
<tr>
<th>Type of Figure No.</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### TOUGHNESS TESTS

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Notch Location</th>
<th>Notch Type</th>
<th>Test Temp.</th>
<th>Impact Value</th>
<th>Lateral Exp.</th>
<th>Drop Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

#### 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).
## 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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Record Actual Values Used in Qualification</th>
<th>Qualification Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backing (metal, Weld metal, flux, etc)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material Spec.</td>
<td>to</td>
<td>to</td>
</tr>
</tbody>
</table>

| Thickness                        |                                           |                     |
| Groove                          |                                           |                     |
| Filler                          |                                           |                     |

| Diameter                        |                                           |                     |
| Groove                          |                                           |                     |
| Filler                          |                                           |                     |

| Filler Metal                    |                                           |                     |
| Spec. No.                       |                                           |                     |
| Class                           |                                           |                     |
| F. No.                          |                                           |                     |

| Position                        |                                           |                     |
| Weld Progression                |                                           |                     |

| Gas Type                        |                                           |                     |

| Electrical Characteristics      |                                           |                     |
| Current                         |                                           |                     |
| Polarity                        |                                           |                     |
Guided Bend Test Results

<table>
<thead>
<tr>
<th>Type and Fig. No.</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<tr>
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<td></td>
</tr>
</tbody>
</table>

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 penetrant: (Source side)
17.* Type of penetrant: (Film side)

* 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.

---

Signature of Contractor / Agency with Seal

Approval of MECON's Inspector
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 : 

Approved by : 

Photograph

Employer's Signature with seal
## Type of Source and Films to be used for Radiography

<table>
<thead>
<tr>
<th>NOMINAL WALL THICKNESS (T) IN mm</th>
<th>SHOP WELDED JOINTS</th>
<th>IN-SITU WELDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SOURCE</td>
<td>FILM : CEN Class</td>
</tr>
<tr>
<td>T &gt; 19 All Materials</td>
<td>Gamma Ray</td>
<td>C5</td>
</tr>
<tr>
<td>8T &lt; 19 Carbon Steel</td>
<td>Gamma Ray</td>
<td>C4</td>
</tr>
<tr>
<td>All other materials</td>
<td>Gamma Ray</td>
<td>C3</td>
</tr>
<tr>
<td>&lt;8 Carbon Steel Other than Inspection Class IV *</td>
<td>Gamma Ray</td>
<td>C3</td>
</tr>
<tr>
<td>All other materials and Carbon Steel of Inspection Class IV *</td>
<td>X-Ray</td>
<td>C4</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>CEN Classification</th>
<th>KODAK</th>
<th>AGFA</th>
<th>FUJI</th>
</tr>
</thead>
<tbody>
<tr>
<td>---</td>
<td>CX</td>
<td>D8</td>
<td>---</td>
</tr>
<tr>
<td>C5</td>
<td>AA400</td>
<td>D7</td>
<td>IX 100</td>
</tr>
<tr>
<td>C4</td>
<td>T200</td>
<td>D5</td>
<td>IX80</td>
</tr>
<tr>
<td>C3</td>
<td>MX125</td>
<td>D4</td>
<td>IX50</td>
</tr>
<tr>
<td>C2</td>
<td>M100</td>
<td>D3</td>
<td>---</td>
</tr>
<tr>
<td>C1</td>
<td>DR50</td>
<td>D2</td>
<td>IX25</td>
</tr>
<tr>
<td>---</td>
<td>SR**</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

* * Special films, extremely fine grain & very high resolution
### WELDING SPECIFICATION CHARTS TO SPECIFICATION FOR WELDING OF ONSHORE GAS PIPELINES NO. : MEC/S/05/21/02

<table>
<thead>
<tr>
<th>8”, 6”, 4”</th>
<th>THK</th>
<th>6.4 mm</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>MATERIAL SPECIFICATIONS</th>
<th>PIPES</th>
<th>FITTINGS</th>
<th>FLANGES</th>
<th>OTHERS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>API 5L Gr X-52 PSL 2</td>
<td>LINE PIPE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| BASE METAL ‘P’ NO | 1 |

<table>
<thead>
<tr>
<th>WELDING PROCESS</th>
<th>GROOVE JOINTS</th>
<th>OTHER THAN BUTT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FILLET JOINTS / SOCKET JOINTS : N.A.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WELDING MATERIAL</th>
<th>GROOVE JOINTS</th>
<th>OTHER THAN BUTT</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUTT</td>
<td>ROOT PASS : E6010</td>
<td>FILLER PASS : E7010</td>
</tr>
<tr>
<td></td>
<td>FILLET JOINTS / SOCKET JOINTS : N.A.</td>
<td>CONSUMABLE INSERT : N.A.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>JOINT PREPARATION</th>
<th>API 1104 / ASME SEC. –IX</th>
</tr>
</thead>
<tbody>
<tr>
<td>GASES</td>
<td>PURGING : SHIELDING :</td>
</tr>
<tr>
<td>GAS COMPOSITION</td>
<td>PURGING : SHIELDING :</td>
</tr>
<tr>
<td>PREHEATING</td>
<td>PREHEAT TEMP: As Applicable</td>
</tr>
<tr>
<td>CONTINUITY OF WELDING AND PREHEAT</td>
<td>REFER TO SPECIFICATION</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POST WELD HEAT TREATMENT</th>
<th>HOLDING TEMP :</th>
<th>HOLDING TIME :</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RATE OF HEATING :</td>
<td>MIN. HOLDING TIME :</td>
</tr>
<tr>
<td></td>
<td>METHOD OF COOLING :</td>
<td>RATE OF COOLING :</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MECHANICAL PROPERTY REQUIREMENTS</th>
<th>CHARPY ‘V’ NOTCH VALUE :</th>
<th>MIN: 20 J</th>
<th>AVERAGE : 27J</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AT TEMPERATURE :</td>
<td>At 0°C</td>
<td>HARDNESS :</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CODE OF FABRICATION :</th>
<th>API 1104 / ASME SEC. –IX</th>
</tr>
</thead>
</table>

Technical Notes:
1. All passes will be carried out by SMAW process.
2. D7 Film shall be used for radiography by X-Ray
## Welding Specification Charts to Specification for Welding of Onshore Gas Pipelines

### Piping Class:
- A1A, A3A, B1A, D1A, E1A

### Material Specifications

<table>
<thead>
<tr>
<th>Details</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIPES</td>
<td>ASTM A106 GR.B, API 5L GR B PSL2, API 5L X52 PSL2, API 5L GR X-65 PSL2, API 5L GR X-70 PSL2, IS-1239 (Black) <strong>ASSORTED PIPES</strong></td>
</tr>
<tr>
<td>FITTINGS</td>
<td>ASTM A105, ASTM A234 GR.WPB, ASTM A234 RG.WPB-W, MSS SP-75 GR.WPHY-52, MSS SP-75 GR.WPHY-65</td>
</tr>
<tr>
<td>FLANGES</td>
<td>ASTM A105, ASTM A694 GR.F-52, ASTM A694 GR.F-65, ASTM A694 GR.F-70, ASTM A516 GR.70</td>
</tr>
<tr>
<td>OTHERS</td>
<td>-</td>
</tr>
</tbody>
</table>

### Base Metal ‘P’ No
- 1

### Welding Process

<table>
<thead>
<tr>
<th>Welding</th>
<th>Butt</th>
<th>Other Than Butt</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROOVE JOINTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUTT ROOT PASS</td>
<td>GTAW</td>
<td></td>
</tr>
<tr>
<td>FILLER &amp; CAP PASS</td>
<td>ER70S-2/ E7018-1</td>
<td></td>
</tr>
<tr>
<td>FILLER PASS</td>
<td>ER70S-2/ E7018-1</td>
<td></td>
</tr>
<tr>
<td>FILLER &amp; CAP PASS</td>
<td>ER70S-2</td>
<td></td>
</tr>
<tr>
<td>FILLER PASS</td>
<td>ER70S-2</td>
<td></td>
</tr>
</tbody>
</table>

- **GROOVE JOINTS**
- **BACKING RING**: N.A.
- **CONSUMABLE INSERT**: N.A.

### Welding Material

<table>
<thead>
<tr>
<th>Welding</th>
<th>Butt</th>
<th>Other Than Butt</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROOVE JOINTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUTT ROOT PASS</td>
<td>ER70S-2</td>
<td></td>
</tr>
<tr>
<td>FILLER &amp; CAP PASS</td>
<td>ER70S-2/ E7018-1</td>
<td></td>
</tr>
<tr>
<td>FILLER PASS</td>
<td>ER70S-2</td>
<td></td>
</tr>
<tr>
<td>FILLER &amp; CAP PASS</td>
<td>ER70S-2/ E7018-1</td>
<td></td>
</tr>
<tr>
<td>FILLER PASS</td>
<td>ER70S-2</td>
<td></td>
</tr>
</tbody>
</table>

### Joint Preparation
- **API 1104 / ASME SEC. -IX**

### Gases
- **Purging**: Argon
- **Shielding**: Argon

### Gas Composition
- **Purging**: 99.995%
- **Shielding**: 99.995%

### Preheating / Interpass
- **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: 20 J Average: 27 J
- **At Temperature**: At 0°C
- **Hardness**: |

### Code of Fabrication
- **API 1104 / ASME SEC. -IX**

### Technical Notes
- MECON Limited

---

**Welding Specification Chart Laying & Construction of 8", 6" & 4" NB U/G Steel Pipeline Network & Associated Works for City Gas Distribution for North Goa GA**

**Specification No.**: MEC.WSC_AG 01

**Rev.**: 0
## WELDING SPECIFICATION CHARTS TO SPECIFICATION FOR WELDING OF ONSHORE GAS PIPELINES NO. : MEC/S/05/21/02

<table>
<thead>
<tr>
<th>PIPING CLASS:</th>
<th>A4A, B4A, D4A, E4A</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATERIAL SPECIFICATIONS</td>
<td></td>
</tr>
<tr>
<td>PIPES</td>
<td>ASTM A 333 GR.6 ASSORTED PIPES</td>
</tr>
<tr>
<td>FITTINGS</td>
<td>ASTM A 350 GR.LF2, ASTM A 420 GR.WPL6, ASTM A 420 GR.WPL6-W</td>
</tr>
<tr>
<td>FLANGES</td>
<td>ASTM A 350 GR.LF2</td>
</tr>
<tr>
<td>OTHERS</td>
<td>-</td>
</tr>
</tbody>
</table>

### BASE METAL 'P' NO 1

<table>
<thead>
<tr>
<th>WELDING PROCESS</th>
<th>GROOVE JOINTS SINGLE SIDE BEVEL</th>
<th>OTHER THAN BUTT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROOT PASS :</td>
<td>GTAW</td>
<td>GTAW</td>
</tr>
<tr>
<td>FILLER PASS :</td>
<td>GTAW/SMAW</td>
<td>SMAW</td>
</tr>
<tr>
<td>FILLET JOINTS / SOCKET JOINTS :</td>
<td>SMAW</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WELDING MATERIAL</th>
<th>GROOVE JOINTS</th>
<th>OTHER THAN BUTT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROOT PASS :</td>
<td>ER70S-2</td>
<td>ER70S-2</td>
</tr>
<tr>
<td>FILLER &amp; CAP PASS :</td>
<td>E7018-1</td>
<td>E7018-1</td>
</tr>
<tr>
<td>BACKING RING :</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

### JOINT PREPARATION

<table>
<thead>
<tr>
<th>GASES</th>
<th>PURGING :</th>
<th>SHIELDING : Argon</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAS COMPOSITION</td>
<td>PURGING :</td>
<td>Shieling : 99.995%</td>
</tr>
<tr>
<td>PREHEATING</td>
<td>PREHEAT/ INTERPASS TEMP: 100°C max</td>
<td>POST HEATING :</td>
</tr>
</tbody>
</table>

### CONTINUITY OF WELDING AND PREHEAT : REFER TO SPECIFICATION

<table>
<thead>
<tr>
<th>POST WELD HEAT TREATMENT</th>
<th>HOLDING TEMP :</th>
<th>HOLDING TIME :</th>
</tr>
</thead>
<tbody>
<tr>
<td>RATE OF HEATING :</td>
<td>MIN. HOLDING TIME :</td>
<td></td>
</tr>
<tr>
<td>METHOD OF COOLING :</td>
<td>RATE OF COOLING :</td>
<td></td>
</tr>
</tbody>
</table>

### MECHANICAL PROPERTY REQUIREMENTS

| CHARPY 'V' NOTCH VALUE : | MIN: 20 J | AVERAGE : 27 J |
| AT TEMPERATURE : | At 0°C |
| HARDNESS : | |

### CODE OF FABRICATION : API 1104 / ASME SEC. -I X

### TECHNICAL NOTES :

**MECON Limited**

WELDING SPECIFICATION CHART LAYING & CONSTRUCTION OF 8", 6" & 4" NB U/G STEEL PIPELINE NETWORK & ASSOCIATED WORKS FOR CITY GAS DISTRIBUTION FOR NORTH GOA GA

Specification No. : Mec.WSC_AG02

Rev. 0
SPECIFICATION
FOR
HYDROSTATIC TESTING OF ONSHORE PIPELINE

SPECIFICATION NO.: MEC/ S/ 05/ 21/ 03

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
CONTENTS

SL.NO. |
---|
1.0  |
2.0  |
3.0  |
4.0  |
5.0  |
6.0  |
7.0  |
8.0  |
9.0  |
10.0 |
11.0 |
12.0 |
13.0 |
14.0 |

DESCRIPTION

1.0  SCOPE
2.0  REFERENCE CODES, STANDARDS AND SPECIFICATIONS
3.0  GENERAL
4.0  HYDROSTATIC TEST PROCEDURE MANUAL
5.0  TEST PRESSURE
6.0  EQUIPMENT AND INSTRUMENTATION
7.0  PROCEDURES
8.0  ACCEPTANCE
9.0  TERMINATION
10.0 TEST REPORT
11.0 MEASUREMENTS
12.0 CALCULATION
13.0 PRECAUTIONS DURING THE TEST
14.0 PRESERVATION OF PIPELINE

TABLES

TABLE A DIFFERENCE BETWEEN WATER THERMAL EXPANSION FACTOR AND STEEL THERMAL EXPANSION FACTOR.

FIGURES

FIG.1 WATER COMPRESSIBILITY FACTOR VS PRESSURE AND TEMPERATURE.

PREPARED BY: (Shalini Singh)  
CHECKED BY: (Sunil Kumar)  
APPROVED BY: (A.K. Johri)  
ISSUE DATE: Nov. 2008
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 caliper 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: 400m³/hr. min.; 1000m³/hr. max.
   If a single pump is used, a standby unit must be available.

c) Variable speed positive displacement pumps equipped with a stroke counter to pressurise the line with a known stroke and capable of exceeding the maximum test pressure by at least 20 bar.

d) Two positive displacement meters to measure the volume of water used for filling the line. These meters shall be provided with a calibration certificate not older than one month.

e) Portable tanks of sufficient size to provide a continuous supply of water to the pump during pressurizing.

f) Bourdon pressure gauges of suitable pressure range and accuracy.
g) Dead weight testers with an accuracy of 0.01 bar measuring in increments of 0.05 bar provided with a calibration certificate not older than one month.

h) Two 48 hours recording pressure gauges tested with charts and ink gauges tested with dead weight tester prior to use. These shall be installed at the test heads.

i) Pressure recording charts.

j) Two temperature recorders for fill water.

k) Thermocouples for measuring the pipe wall temperature.

l) Two laboratory thermometers 0°C to 60°C range, accuracy ± 0.1 degree to be used in thermowells.

m) Means to measure the volume of water necessary to drop the line pressure by 0.5 bar (container on scales or graduated cylinder).

n) Injection facilities to inject additives into the test medium in the required proportions.

o) Communication equipment suitable for a continuous connection between the beginning and the end of the test section and with the inspection team along the line, in accordance with the requirements of local Authorities.

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 predetermined 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 stabilization 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 from faulty COMPANY furnished materials, CONTRACTOR shall be reimbursed for furnishing all labour, equipment, materials, except those materials furnished by the COMPANY, and transportation necessary to repair and repressurize the section of the pipeline to the pressure at the time of recognition of leak or line failure. CONTRACTOR shall be entitled for compensation as per the provisions of the CONTRACT. All work of reinstalling line pipe, to replace pipe failures shall be done in accordance with the relevant specification included in the CONTRACT.

8.4 CONTRACTOR shall haul and stockpile all damaged and defective pipes to storage locations designated by the COMPANY. All cracks and splice resulting from failures shall be coated with an application of grease to preserve the characteristics of failures from corrosion. Joint of failed pipes shall be marked with paint, with a tag indicating failure details, date and location of failure and pressure at which failure occurred.

9.0 **TERMINATION**

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

9.1 CONTRACTOR shall dewater the tested line as per the following requirement after test acceptance.

The dewatering shall be carried out by using four cup pigs and foam pigs driven by compressed air. The detailed dewatering procedure shall be developed by the CONTRACTOR.
in such a way as to provide adequate control of pigs during dewatering. Pigs and equipment required for dewatering the line shall be furnished by CONTRACTOR and shall be approved in advance by the COMPANY. Four cup pigs shall first be passed through the line to displace the water. Foam pigs shall then be passed in order to complete the line dewatering. CONTRACTOR shall use a number of foam pigs, each in different colors/numbered for this purpose. The line shall be considered dewatered when a negligible amount of water is flushed out by the last foam pig and approval is given by the COMPANY.

9.2 During dewatering, care shall be taken to properly dispose the discharging water in order to avoid pollution, damages to fields under cultivation and/or existing structures and interference with the traffic. Before start of dewatering and disposal of hydrotest water, a procedure for treatment of inhibited water to prevent pollution shall be submitted by contractor to owner/consultant for review and approval.

9.3 Upon completion of the testing and dewatering operation, any provisional traps for pigs and all other temporary installation relating to the test shall be removed. Subsequently the individual sections of the line already tested shall be joined in accordance with the requirements of relevant specifications issued for the purpose.

10.0 **TEST REPORT**

A complete report signed by CONTRACTOR and the COMPANY shall be submitted upon completion of the hydrostatic test for each test section. This report shall contain as a minimum:

- the cleaning, flushing, filling and testing procedures used;
- schematic layout of cleaning, filling and testing facilities;
- instruments calibration certificates;
- a profile of the pipeline that shows the test sites, all instrument and injection connections;
- pipe filling logs and records;
- additive specification, required concentration and additive injection records;
- pig specifications;
- pig inspection records including photographs of the damages;
- records of gauging pig survey and photographs;
- pressurization and stabilization records;
- pressure and temperature recording charts with appropriate information inscribed thereon;
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°C to +40°C
- Recording: Continuous on tape or disk, diagram within 100mm
- Feed: 20mm/h for tape diagrams, 7.5°C/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°C to +60°C
- Recording: Continuous on tape or disk, diagram width 100mm
- Feed: 20mm/h for tape diagrams, 7.5°C/h for disk diagrams.

12.0 Calculations

12.1 The theoretical water amount that is necessary for filling the section to be tested shall be obtained from the geometrical volume of the section considering the pipe tolerances.
The theoretical water amount that is necessary for pressurizing the section shall be calculated by means of the following formula:

\[ V_p = (0.884 \, \frac{r_i}{t} + A) \times 10^6 \times V_t \times \Delta P \times K \]

Where:

- \( V_p \) = computed water amount required to raise by \( P \) the pressure in the section to be tested (m³).
- \( V_t \) = geometrical volume of the section (m³)
- \( \Delta P \) = Pressure rise (bar)
- \( r_i \) = nominal inner radius of the pipe (mm)
- \( t \) = nominal pipe thickness (mm)
- \( A \) = isothermal compressibility value for water at the pressurization temperature in the \( P \) range (bar⁻¹) \times 10^6.

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

- \( K \) = a dimensionless coefficient that is equal to a value of 1.02 for longitudinally welded pipe.

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

\[ \Delta P = \frac{B}{0.884 \, \frac{r_i}{t} + A} \Delta T \]

Where,

- \( \Delta P \) = pressure change resulting from a temperature change (bar)
- \( \Delta T \) = algebraical difference between water temperature at the beginning of the test and water temperature as measured at the end of the test (°C).
- \( B \) = value of the difference between the thermal expansion of water at the pressure and temperature as measured at the end of the test and that of steel (°C⁻¹) \times 10^6

(Refer table - A)

- \( A \) = Isothermal compressibility value of water as estimated at the pressure and temperature values obtained at the end of test (bar⁻¹) \times 10^6 (Refer Figure 1)
r_i = nominal inner radius of the pipe (mm).

\[ t = \text{nominal thickness of pipe (mm)}. \]

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.
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**DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL THERMAL EXPANSION FACTOR (°C⁻¹) (10⁻⁶)**
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Difference between the Water Thermal Expansion Factor and the Steel Thermal Expansion Factor (°C⁻¹) (10⁻⁶)
SPECIFICATION FOR MAJOR WATER CROSSINGS (CONVENTIONAL)

SPECIFICATION NO.: MEC/ S/ 05/ 21/ 04

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>DEFINITION</td>
</tr>
<tr>
<td>1.0</td>
<td>SCOPE</td>
</tr>
<tr>
<td>2.0</td>
<td>GENERAL</td>
</tr>
<tr>
<td>3.0</td>
<td>TRENCHING</td>
</tr>
<tr>
<td>4.0</td>
<td>CONTINUOUS CONCRETE COATING</td>
</tr>
<tr>
<td>5.0</td>
<td>HYDROSTATIC PRE-TESTING</td>
</tr>
<tr>
<td>6.0</td>
<td>INSTALLATION</td>
</tr>
<tr>
<td>7.0</td>
<td>BACKFILLING AND BANK PROTECTION</td>
</tr>
<tr>
<td>8.0</td>
<td>FINAL HYDROSTATIC TEST</td>
</tr>
<tr>
<td>9.0</td>
<td>POST-CONSTRUCTION SURVEY</td>
</tr>
<tr>
<td>10.0</td>
<td>FINAL CLEAN-UP</td>
</tr>
<tr>
<td>11.0</td>
<td>DOCUMENTATION</td>
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</tbody>
</table>

PREPARED BY: (Shalini Singh)  
CHECKED BY: (Sunil Kumar)  
APPROVED BY: (A.K. Johri)  
ISSUE DATE: Nov. 2008
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
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. Furthermore, 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/mm² and with a minimum elongation at failure of 12%. The minimum zinc coating of 275 gm² 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
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

<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>SCOPE</td>
</tr>
<tr>
<td>2.0</td>
<td>REFERENCE CODES, STANDARDS AND SPECIFICATIONS</td>
</tr>
<tr>
<td>3.0</td>
<td>GENERAL</td>
</tr>
<tr>
<td>4.0</td>
<td>ROAD AND RAIL-ROAD CROSSINGS</td>
</tr>
<tr>
<td>5.0</td>
<td>CROSSINGS OF BURIED SERVICES</td>
</tr>
<tr>
<td>6.0</td>
<td>MINOR WATER COURSE CROSSINGS</td>
</tr>
</tbody>
</table>

**Prepared By:** (Shalini Singh)  
**Checked By:** (Sunil Kumar)  
**Approved By:** (A.K. Johri)  
**Issue Date:** Nov. 2008
1.0 SCOPE

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

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

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

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

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

2.0 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 unnecessarily hamper the users of the roads, railroads, buried services and/ or water courses. The water flow shall not be obstructed in any way.

3.2 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 jurisdiction over the utility crossed.

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

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

Before the installation work of crossings is started, the CONTRACTOR shall provide suitable barricades, temporary bridge/bypass work (especially where roads are open-cut) with railing, if required by COMPANY for safety of traffic. Adequate traffic warning signals and/or traffic lights and suitable diversions shall be provided as directed by COMPANY/Authority having jurisdiction over these areas. Such diversions shall not cross the pipeline where it has already been installed, unless proper safeguarding in COMPANY's opinion is ensured.

Prior approval from the statutory authorities shall be obtained to lay the pipeline across highways/roads either by boring or by open-cut method. Installation of the crossing shall be by the method (i.e., boring/open-cut) approved by Authorities having jurisdiction. Railroad crossings shall always be bored/jacked.

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

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

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

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

- Soil investigation
- Lowering of groundwater table
- 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 up to at least 95% Proctor density to an elevation that will provide sufficient and continuous support to the pipeline so that the pipeline remains correctly aligned at the casing ends during and after backfilling.

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 jurisdiction thereof at no extra cost to COMPANY. Equipment used for installation of casing pipe shall be of the type approved by COMPANY.

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

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

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

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

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

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

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

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

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
### 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.

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

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

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 jurisdiction thereof and the COMPANY. Whenever boulders, rock, gravel and other hard objects are encountered, they shall not be placed directly on the pipe. Sufficient earth, sand or selected and approved backfill material shall be backfilled initially around and over the pipe to provide a protective padding or cushion extending to a minimum thickness of 30 centimeters around the pipe before backfilling remainder of the trench with excavated or other material as per approved drawings and standards.

After the trench has been backfilled and during the clean up works, the minor water crossing shall be cleaned at least across the whole of the ROW.
When directed by the COMPANY, CONTRACTOR shall stabilise and restore the bank of the water crossings with materials to be supplied by him as follows.

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

The GI wire shall be made from steel having tensile strength of 400 N/mm² 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.
SPECIFICATION
FOR
PIPING FABRICATION AND ERECTION

SPECIFICATION NO.: MEC/ S/ 05/ 21/ 06

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
PLT 466x752 to 515x803

STANDARD TECHNICAL SPECIFICATION
MECON LIMITED
REGD. OFF: RANCHI 834002
OIL & GAS SBU, DELHI

TITLE
PIPING FABRICATION AND ERECTION

DOCUMENT NO.
MEC/ S/ 05/ 21/ 06

REVISION : 0
EDITION : 1

CONTENTS

<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>GENERAL</td>
</tr>
<tr>
<td>2.0</td>
<td>SCOPE</td>
</tr>
<tr>
<td>3.0</td>
<td>BASIS FOR WORK</td>
</tr>
<tr>
<td>4.0</td>
<td>FABRICATION</td>
</tr>
<tr>
<td>5.0</td>
<td>ERECTION</td>
</tr>
<tr>
<td>6.0</td>
<td>WELDING</td>
</tr>
<tr>
<td>7.0</td>
<td>ERECTION</td>
</tr>
<tr>
<td>8.0</td>
<td>INSPECTION</td>
</tr>
<tr>
<td>9.0</td>
<td>PROTECTIVE COATING</td>
</tr>
<tr>
<td>10.0</td>
<td>FLUSHING</td>
</tr>
<tr>
<td>11.0</td>
<td>HYDROSTATIC TESTING</td>
</tr>
</tbody>
</table>

ANNEXURE-1 - WELDING SPECIFICATION
EXHIBIT-A - ELECTRODE QUALIFICATIONS TEST RECORD
EXHIBIT-B - STRESS RELIEF HEAT TREATMENT PROCEDURE SPECIFICATION
EXHIBIT-C - STANDARD PROCEDURE SPECIFICATION NO.
EXHIBIT-D - COUPON TEST RECORD
EXHIBIT-E - WELDER's IDENTIFICATION CARD
EXHIBIT-F - RADIOGRAPHIC PROCEDURE FOR PIPE WELDING
EXHIBIT-G - WELDING SPECIFICATION CHART

ANNEXURE-2 - DESTRUCTIVE TESTING OF WELDED JOINT - BUTT WELDS

ANNEXURE-3 - ULTRASONIC INSPECTION

ANNEXURE-4 - RADIOGRAPHY

PREPARED BY: (Shalini Singh)
CHECKED BY: (Sunil Kumar)
APPROVED BY: (A.K. Johri)
ISSUE DATE : Dec. 2008

Page 146 of 514
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:
   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


Title: Piping Fabrication and Erection

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 Equipments / 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 otherwise 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:-


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.- IIIC.

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
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 values specified for the base metal and shall correspond to the physical properties of the class of electrode adopted. The choice of electrode shall be made after conducting the required tests on the electrodes as per relevant standards, and shall be the sole prerogative of the Engineer-in-charge.

d) 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 offset should not exceed 1.6mm. Any branch connections sleeve shall be at least 150mm from any other weld. The welds for fitting shall be so located that top of the weld shall not come within 50mm of any other weld. The use of internal line up clamps is mandatory for diameters 10" and above. However, in case where it is impossible to use internal line up clamp, external line up clamp may be used.

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.
### 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.

### 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 at least three times the thickness of the joint, but not less than 50mm, on both sides of the weld.

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

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 his 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 at least 2 weeks before the commencement of actual work. Standard tests as specified in the code shall be carried out in all cases. In addition to these tests, other tests like radiography, macro/ micro examination, hardness testers, dye penetrant examination, Charpy V-notch etc. shall be carried out on specimens. It shall be the responsibility of the contractor to carry out all the tests required to the satisfaction of the COMPANY's Inspector. The destructive 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 penetrant/ MP inspection. The non destructive test system used for inspecting welds must be approved by the COMPANY.

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

Any weld which as a result of radiographic and/or ultrasonic examination in the opinion of COMPANY exhibits imperfections greater than the limits stated in API-1104 latest edition or as superseded in this article shall be considered defective and shall so be marked with an identification paint marker.
In addition to the API-1104 requirements, the welds containing cracks including crater cracks regardless of size of location are unacceptable.

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

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

iii. Unrepaired burn through areas are unacceptable.

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°C 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, for 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.
### ELECTRODE QUALIFICATIONS TEST RECORD

<table>
<thead>
<tr>
<th>A</th>
<th>Tested at (Site Name)</th>
<th>Date</th>
<th>Test Period</th>
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<tbody>
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</table>

- 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): 

<table>
<thead>
<tr>
<th>B</th>
<th>All - Weld Tensile Test</th>
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<tbody>
<tr>
<td></td>
<td>Base Material used:</td>
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<tr>
<td></td>
<td>Pre-heat temperature:</td>
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<tr>
<td></td>
<td>Postweld Heat Treatment Details:</td>
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<tr>
<td></td>
<td>Visual Examination:</td>
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<td></td>
<td>Radiographic Examination Results:</td>
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</table>
### Tensile Test Results

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Identification No.</th>
<th>U.T.S.</th>
<th>Yield Point</th>
<th>Elongation</th>
<th>Remarks</th>
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</table>

### Impact Test Results

- **Test Temperature**: Notch in:
- **Type of Specimens**: Impd, Charpy
- **Size of Specimens**

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Impact Value</th>
<th>Average</th>
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<tbody>
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<td>1.</td>
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<td>3.</td>
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<td>4.</td>
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<td>5.</td>
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### Chemical Analysis Result

- **Electrode size used**: 
- **Batch No.**

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<tr>
<th>%C</th>
<th>%S</th>
<th>%P</th>
<th>%Si</th>
<th>%Mn</th>
<th>%Cr</th>
<th>%Ni</th>
<th>%Mo</th>
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</tbody>
</table>
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: 

<table>
<thead>
<tr>
<th>Identification No.</th>
<th>U.T.S.</th>
<th>Fracture in</th>
<th>Remarks</th>
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-----------------------------------------------------------------------------------------------------------------
2. **Guide Bend Test**

<table>
<thead>
<tr>
<th>Position</th>
<th>ID No.</th>
<th>Root, Face or Remarks</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Side Bend</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td></td>
<td></td>
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<td>3</td>
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<td>4</td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td></td>
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</tbody>
</table>

3. **Any other tests**

**Conclusions**

Approved By:
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
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 ...........................

Sheet 2 of 2
### COUPON TEST RECORD

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>State</th>
<th>Roll Weld</th>
<th>Fixed position weld</th>
<th>Mark</th>
<th>M. Temperature</th>
<th>F. Weather Condition</th>
<th>Wing break used</th>
<th>Voltage</th>
<th>Amperage</th>
<th>Type of welding machine</th>
<th>Size</th>
<th>Filler Metal</th>
<th>Size of reinforcement</th>
<th>Dia O.D.</th>
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<table>
<thead>
<tr>
<th>Bead No.</th>
<th>Size of electrode</th>
<th>No. of electrode</th>
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<th>Coupon Stenciled</th>
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<th>Dimension of Plate</th>
<th>Original area of plate (inch^2)</th>
<th>Maximum Load</th>
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<tr>
<th>Tensile S/ in. plate area</th>
<th>Fracture Location</th>
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<table>
<thead>
<tr>
<th>Procedure Qualifying Test</th>
<th>Welder Line Test</th>
<th>Remarks on tensile strength</th>
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<table>
<thead>
<tr>
<th>Max. tensile strength</th>
<th>min. tensile strength</th>
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| Avg. 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
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

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.
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
   - A105
   - MSS-SP-44 Gr. F60: Thickness beyond 200°F
   - A234 Gr. WPB
   - 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:

<table>
<thead>
<tr>
<th>Specification</th>
<th>UTS (Min.) (As welded)</th>
<th>Impact (As welded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E7018-G</td>
<td>52.7 kg/mm²</td>
<td>20 ft. lb. at 0°C</td>
</tr>
<tr>
<td>E7018-I</td>
<td>52.7 kg/mm²</td>
<td>-</td>
</tr>
<tr>
<td>E6010</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>E6018</td>
<td>-</td>
<td>20 ft. lb. at 0°C</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Pipe Size, Out-side diameter Inches</th>
<th>Wall Thickness &gt; ½ inch (12.7mm) and under</th>
<th>Number of Specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tensile API</td>
<td>Tensile ISO</td>
</tr>
<tr>
<td>Under 2 3/8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2 3/8 to 4½ incl.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Over 4½ less than 12 3/4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>12 3/4 and over</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipe Size, Out-side diameter Inches</th>
<th>Wall Thickness &gt; ½ inch (12.7mm)</th>
<th>Number of Specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tensile API</td>
<td>Tensile ISO</td>
</tr>
<tr>
<td>4½ and smaller</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Over 4½ less than 12 3/4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>12 3/4 and over</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
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 V10 . In case of a single reading slightly (+10 HV) higher than the specified limit, further indentations should be made to check if the high value was an isolated case.

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

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

1.6 Charpy-V-notch Impact Test

1.6.1 Specimens shall be taken from the position indicated in Fig. 1 of this specification. The test specimens will be prepared in accordance with ISO R 148. Charpy 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:

<table>
<thead>
<tr>
<th>Nominal wall thickness in mm</th>
<th>Test Specimens width in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 12</td>
<td>12</td>
</tr>
<tr>
<td>&gt; 9.5 and ≤ 12</td>
<td>7.5</td>
</tr>
</tbody>
</table>
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 :-

<table>
<thead>
<tr>
<th>Test Specimens in mm</th>
<th>Average of Three specimens Joule (min) (Note-2)</th>
<th>Minimum Single Value Joules (Note 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>27</td>
<td>22</td>
</tr>
<tr>
<td>7.5</td>
<td>21.5</td>
<td>17.5</td>
</tr>
<tr>
<td>5</td>
<td>18.5</td>
<td>15.0</td>
</tr>
<tr>
<td>2.5</td>
<td>10.0</td>
<td>8.0</td>
</tr>
</tbody>
</table>

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:

\[ R_{A'} = 2t \]
\[ R_{B'} = 3t + 1.6\text{mm} \]
\[ C' = 50.8 \]

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)
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 at least 60 dB.

- The regulation control shall be accurate to within 1 dB and this accuracy shall be certified by the instrument manufacturer.

- May be powered by a battery or an electric generator. In the first case, the autonomy of operation (endurance) of the instrument shall be sufficient to carry on working without frequent interruptions, and the instrument shall be equipped with an automatic switch which switches it off when the battery runs down, in the second case, there must be a voltage stabilising device with a tolerance of 2 volts.

1.6 **Probes**

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

1.7 **Reference Sample Pieces**

The efficiency of the equipment used, the effective refraction angle of the probe, and the beam output points, shall be checked using a V₁ and V₂ 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 shall be repeated each time tests are re-started at intervals not longer than 30 minutes during normal operations; each time the conditions fixed in advance are altered. This calibration is applicable provided that the crystal of the probe is 8 x 9mm size. Should this size of the crystal be different, the value of the sensitivity obtained from the calibration by a crystal of a different size shall be brought to the value of sensitivity obtained from the calibration by a 8 x 9mm crystal. The sensitivities of the two different size probes shall be compared through the echoes obtained on the notch of the test piece with the probe position at half skip of the distance.

### 1.9 Regulation of Amplification during Production Testing

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


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 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.

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 pentrometer are clearly discernible.

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

3.6 When the radiation source and the film are both on the outside of the weld and located diametrically opposite each other, the maximum acceptable length of film for each exposure shall not exceed the values given in 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/05/62/02) 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.
Each day's production of processed radiographs shall be properly packaged separately, identified by at least the (1) date, (2) radiographic unit, (3) job locations, (4) starting and ending progress survey stations and (5) shall include original and three copies of the daily radiographic record. The package shall be submitted to the COMPANY daily when possible, but in no event later than noon of the following day.

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

The CONTRACTOR, if found necessary, may modify the procedure of radiographic examination suiting the local conditions prevailing. This shall, however, be subject to the approval of the COMPANY.

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

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

**RADIATION SOURCE**

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

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.

**LEVEL OF QUALITY**

The quality level of radiographic sensitivity required for radiographic inspection shall be at least equivalent to the values in Figure-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 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 accordance 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 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 subcontractors.

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.
# CONTENTS

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
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<td>CODES &amp; STANDARDS</td>
</tr>
<tr>
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</tr>
<tr>
<td>5.0</td>
<td>SURFACE PREPARATION</td>
</tr>
<tr>
<td>6.0</td>
<td>PAINT MATERIALS</td>
</tr>
<tr>
<td>7.0</td>
<td>PAINTING SYSTEMS</td>
</tr>
<tr>
<td>7.1</td>
<td>PRE-ERECTION/ PRE-FABRICATION AND SHOP PRIMING FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL &amp; LOW ALLOY STEEL, STEEL STRUCTURES, PIPING AND EQUIPMENT ETC.</td>
</tr>
<tr>
<td>7.2</td>
<td>REPAIR OF PRE-ERECTION/ FABRICATION AND SHOP PRIMING AFTER ERECTION/ WELDING FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL &amp; LOW ALLOY STEEL, ITEMS IN ALL ENVIRONMENTS.</td>
</tr>
<tr>
<td>8.0</td>
<td>FIELD PAINT SYSTEM FOR NORMAL CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL &amp; LOW ALLOY STEEL)</td>
</tr>
<tr>
<td>9.0</td>
<td>FIELD PAINT SYSTEM FOR CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL AND LOW ALLOY STEEL)</td>
</tr>
<tr>
<td>10.0</td>
<td>FIELD PAINT SYSTEM FOR HIGHLY CORROSIVE AREA (FOR CARBON STEEL, LOW ALLOY STEEL) EXTERNAL SURFACE OF UNINSULATED COLUMNS, VESSELS, HEAT EXCHANGERS, BLOERS, PIPING, PUMPS, TOWERS, COMPRESSORS, FLARE LINES, STRUCTURAL STEEL ETC.</td>
</tr>
<tr>
<td>11.0</td>
<td>FIELD PAINT SYSTEM FOR CARBON STEEL STORAGE TANKS (EXTERNAL) FOR ALL ENVIRONMENTS</td>
</tr>
<tr>
<td>12.0</td>
<td>FIELD PAINT SYSTEM FOR CARBON STEEL AND LOW ALLOY STEEL STORAGE TANK (INTERNAL)</td>
</tr>
<tr>
<td>13.0</td>
<td>COATING SYSTEM FOR EXTERNAL SIDE OF UNDERGROUND CARBON STEEL, PLANT PIPING AND TANKS.</td>
</tr>
<tr>
<td>14.0</td>
<td>PAINTING UNDER INSULATION FOR (HOT, COLD &amp; SAFETY) CARBON STEEL LOW TEMPERATURE CARBON STEEL &amp; STAINLESS STEEL PIPING AND EQUIPMENT IN ALL ENVIRONMENT</td>
</tr>
<tr>
<td>15.0</td>
<td>INTERNAL PROTECTION OF CARBON STEEL WATER BOXES AND TUBE SHEETS OF COOLERS/ CONDENSERS.</td>
</tr>
<tr>
<td>16.0</td>
<td>FIELD PAINTING SYSTEM FOR GI TOWERS/ NON-FERROUS TUBE SHEET</td>
</tr>
<tr>
<td>17.0</td>
<td>ST ORAGE</td>
</tr>
<tr>
<td>18.0</td>
<td>COLOURS CODE FOR PIPING</td>
</tr>
<tr>
<td>19.0</td>
<td>IDENTIFICATION OF VESSELS, PIPING ETC.</td>
</tr>
<tr>
<td>20.0</td>
<td>PAINTING FOR CIVIL DEFENCE REQUIREMENTS</td>
</tr>
<tr>
<td>21.0</td>
<td>INSPECTION AND TESTING</td>
</tr>
<tr>
<td>22.0</td>
<td>GUARANTEE</td>
</tr>
<tr>
<td>23.0</td>
<td>QUALIFICATION CRITERIA OF PAINTING CONTRACTOR.</td>
</tr>
<tr>
<td>24.0</td>
<td>PROCEDURE FOR APPROVAL OF NEW PAINT MANUFACTURERS.</td>
</tr>
</tbody>
</table>

ANNEXURE-I: LIST OF RECOMMENDED MANUFACTURES

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

<table>
<thead>
<tr>
<th>PREPARED BY:</th>
<th>CHECKED BY:</th>
<th>APPROVED BY:</th>
<th>ISSUE DATE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Shalini Singh)</td>
<td>(Sunil Kumar)</td>
<td>(A.K. Johri)</td>
<td>Dec. 2008</td>
</tr>
</tbody>
</table>
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, steel 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 surfaces and materials shall require shop, pre-erection and field painting.

a. All uninsulated C. S. & A. S. equipment like columns, vessels, drums, storage tanks, 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, stuctural steel support etc, walkways, handrails, ladders, platforms etc.
e. RCC/ MS chimneys with or without refractory lining & Flare lines.

f. Identification colour bands on all piping as required including insulated aluminium clad, galvanised, SS and non-ferrous piping.

g. Identification lettering/ numbering on all painted surface of equipment/ piping insulated aluminium clad, galvanised, SS and non-ferrous piping.

h. Marking/ identification signs on painted surfaces of equipment/ piping for hazardous service.

i. Supply of all primers, paints and all other materials required for painting other than owner’s supply.

j. Over insulation surface of equipments and pipes wherever required.

k. Painting under insulation for carbon steel and stainless steel as specified.

l. Repair work of damaged/ preerection/ fabrication shop primer and weld joints at field.

2.2.2 The following surface and materials shall not be painted unless otherwise specified:

a. Uninsulated austentic stainless steel.

b. Plastic and/ or plastic coated materials.

c. Non ferrous materials like aluminium, galvanised “piping”, “gratings” and “handrails” etc. except G. I. Towers.

2.3 Documents

2.3.1 The contractor shall perform the work in accordance with the following documents issued to him for executions of work.

a. Bill of quantities for piping, equipment, machinery and structure etc.

b. Piping line list.

c. Painting specifications including special civil defence requirement.
2.4 Unless otherwise instructed final painting on pre-erection/ shop primed pipes and equipments shall be paint ed in t he 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 paints and enamels.
- IS-2379:1990 Indian standard for piping systems: Colour code.
- ASTM Vol. 6.01 and 6.03 American standard test methods for Paints and coatings.

3.2 Surface Preparation Standards:

Following standards shall be followed for surface preparations:


This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-in-Charge.
3.2.2 Steel structure painting Council, U. S.A (surface preparations specifications (SSPC-SP).

3.2.3 British standard (surface finish or Blast-cleaned for painting) BS:4232

3.2.4 National Associations of Corrosion Engineers, U.S.A. (NACE)

3.2.5 Various international standards equivalent to Swedish standard for surface preparation are given in Table-I.

3.3 The contractor shall arrange, at his own cost, to keep a set of latest edition of any one of the above standards and codes at site.

3.4 The paint manufacturer's instructions shall be followed as far as practicable at all times. Particular attention shall be paid to the following:

a. Instructions for storage to avoid exposure as well as extremes of temperature.

b. Surface preparations prior to painting.

c. Mixing and thinning.

d. Application of paints and the recommended limit on time intervals between coats.

4.0 EQUIPMENT

4.1 All tools, brushes, rollers, spray guns, abrasive materials hand/ power tools for leaning and all equipments, scaffolding materials, shot / wet abrasive 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 2½ or equivalent as per Swedish Standard SIS-055900-1967/ISO-8501-1-1988. Where highly corrosive condition exits, then blast cleaning shall be Sa3 as per Swedish Standard.

Remove all other contaminants, oil, grease etc. by use of an aromatic solvent prior to surface cleaning.

5.1.3 Blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceeding 85%.

5.1.4 Irrespective of the method of surface preparation, the first coat of primer must be applied on dry surface. This should be done immediately and in any case within 4 hours of cleaning of surface. How ever, 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 thorough 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: AL2O3 particles chilled casts iron or malleable iron and steel at pressure of 7 kg. Cm² at appropriate distance and angle depending on nozzle size maintaining constant velocity and pressure. Chilled cast iron, malleable iron and steel shall be in the form of shot or grit of size not greater than 0.055” maximum in case of steel and malleable iron and 0.04” maximum in case of chilled iron. Compressed air shall be free from moisture and oil. The blasting nozzles should be venturi style with tungsten carbide or boron carbide as the material for liners. Nozzles orifice may vary from 3/16” to ¾”. On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey white metallic lustre. Primer or first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall not be done outdoors in bad weather without adequate protection or when there is dew on the metal which is to be cleaned, surface profile shall be uniform to provide good key to the paint adhesion (i.e. 35 to 50 µ). If possible vacuum collector shall be installed for collecting the abrasive and recycling.

5.2.1.2 Water Blast cleaning

Environmental, health and safety problems associated with abrasive blast cleaning limit the application of air blast cleaning in many installations. In such case water blast cleaning is resorted to.

Water blast cleaning can be applied with or without abrasive and high-pressure water blasting. The water used shall be inhibited with sodium chromate/phosphate. The blast cleaned surface shall be washed thoroughly with detergents and wiped solvent and dried with compressed air. For effective cleaning abrasives are used. The most commonly used pressure for high pressure water blast cleaning for maintenance surface preparation is 3000 to 6000 psi at 35-45 liters/minute water volume and pressure up to 10000 psi and water volume of 45 liters/minute provide maximum cleaning.

The water blast cleaned surface shall be comparable to SSPC-SP-12/ NACE No. 5. The operation shall be carried out as per SSPC guidelines for water blast cleaning. The indicative values for sand injection is

Air : 300 to 400 Cu.ft/ min.
Water : 5-10 liter/ min. with corrosion inhibitor
Sand : 200-400 lbs/ hr.
Nozzle : 0.5 to 1” dia

Special equipments for water blast cleaning with abrasives now available shall be used.

5.2.2 Mechanical of Power tool cleaning

Power tool cleaning shall be done mechanical striking tools, chipping hammers, grinding wheels or rotating steels wire-brushes. Excessive burnish of surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust mill scale etc. shall be removed by clean rags and/ or washed by water or stream and thoroughly dried with compressed air jet before application of paint.

5.2.3 Manual or hand tool cleaning

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

Hand tool cleaning normally consists of the following:

a. Hand descaling and/ or hammering
b. Hand scraping
c. Hand wire brushing

Rust, mill scale spatters, old coating and other foreign matter, shall be removed by hammering, scraping tools, emery paper cleaning, wire brushing or combination of the above methods. On completion of cleaning, loose materials shall be removed from the surface by clean rags and the surface shall be brushed, swept, deducted and blown off with compressed air/ steam to remove all loose matter. Finally the surface may be washed with water and dried for effective cleaning.

5.3 Non compatible shop coat primer

The compatibility of finishing coat should be confirmed from the paint manufacturer. In the event of use of primer such as zinc rich epoxy, inorganic zinc silicate etc. as shop coat the paint system shall depend on condition of shop coat, if shop coat is in satisfactory condition showing no major defects, the shop
coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer-in-Charge.

5.4 Shop coated (coated with primer & finishing coat) equipment should not be repainted unless paint is damaged.

5.5 Shop primed equipment and surface will only be ‘spot cleaned’ in damaged areas by means of power tool brush cleaning and then spot primed before applying one coat of field 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 paint system for particular environment.

5.6 For packaged units/equipment, shop primer should be as per the paint system given in this specification. However, manufacturer’s standard can be followed after review.

5.7 Coating Procedure and Application:

5.7.1 Surface shall not be coated in rain, wind or in environment where injurious airborne elements exists, when the steel surface temperature is less than 5°F above dew point when the relative humidity is greater than 85% or when the temperature is below 40°F.

5.7.2 Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hrs. the same day.

5.7.3 To the maximum extent practicable, each coat of material shall be applied as a continuous film uniform thickness free of probes. Any spots or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

5.7.4 Each coat shall be proper state of cure or dryness before the application of succeeding coat. Material shall be considered ed dry for recoating when an additional coat can be applied without the development of any detrimental film irregularities such as lifting or loose of adhesion of the under coat. Manufacturer instruction shall be followed for intercoat interval.

5.7.5 When the successive coat of the same colour have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life.
5.7.6 Air spray application shall be in accordance with the following:

a. The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied, and shall be equipped with suitable pressure regulators and gauges. The air caps, nozzles, and needles shall be those recommended by the manufacturer of the equipment for the material being sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.

b. Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. The air from the spray gun impinging against the surface shall show condensed water or oil.

c. Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous mechanical agitation.

d. The pressure on the material in the pot and of the air at the gun shall be adjusted for optimum spraying effectiveness. The pressure on the material in the pot shall be adjusted when necessary for change in elevation of the gun above the pot. The atomizing air pressure at the gun shall be high enough to properly atomize the paint but not so high as to cause excessive fogging of paint, excessive evaporation of solvent, or less by overspray.

e. Spray equipment shall be kept sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film.

Any solvents left in the equipment shall be completely removed before applying paint to the surface begin painted.

f. Paint shall be applied in a uniform layer, with overlapping at the edge of the spray pattern. The spray patterns shall be adjusted so that the paint is deposited uniformly. During application the gun shall be held perpendicular to the surface and at a distance which will ensure that a wet layer of paint is deposited on the surface. The trigger of the gun should be released at the end of each stroke.

g. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface repainted.
h. Areas inaccessible to the spray gun shall be painted by brush: if not accessible by brush, daubers or sheepking shall be used.

i. All nameplates, manufacturer's identification tags, machined surface instrument glass, finished flange faces, control valve items and similar items shall be masked to prohibit coating disposition. If these surface are coated, the component shall be cleaned and restored to its original condition.

j. Edges of structural shapes and irregular coated surface shall be coated first and an extra pass made later.

k. If spray gun shown choking, immediately dechoking procedure shall be followed.

5.7.7 Airless spray application shall be in accordance with the following procedure: as per steel structure paint manual vol. 1 & vol. 2. By SSPC, U.S.A., Air less spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor is used to operate a pump to produce pressures of 1,000 to 6,000 psi. Paint is delivered to the spray gun at this pressure through a single hose within the gun, a single paint stream is divided into separate streams, which are forced through a small orifice resulting in atomization of paint without the use of air. This result in more repeat coverage with less overspray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional airspray.

Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have in built agitator that keep the paint uniformly mixed during the spraying. The unit shall consists of in built strainer. Usually very small quantities of thinning is required before spray. Incase of High Build epoxy coating (two pack), 30:1 pump ratios and 0.020-0.023" tip size will provide a good spray pattern. Ideally fluid hoses should no be less than 3/8” I.D and not longer than 50 ft 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 O’clock position of pipe is not approachable)

A canvas strip (alternatively an inplate strip) about 450mm wide and 1.5m longs is held 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 obtained all round the bottom. This work shall be done very carefully and by experienced personnel. There shall not be any formation of “Whiskers” and holes in the coating. The coating film shall be inspected by mirror.

5.7.10 For each coat the painter should know the WFT corresponding to the specified DFT and standardise the paint application technique to achieve the desired WFT. This is to be ensured in the qualification trial.

5.8 Drying of Coated Surface

5.8.1 No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film or irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat; if it exceeds the paint material has possible deteriorated or mixing is faulty.

5.8.2 No paint shall be force dried under condition which will cause checking, wrinkling blistering formation of pores, or detrimentally after the condition of the paint.
No drier shall be added to a paint on the job unless specifically called for in the manufacturer’s specification for the paint.

Paint shall be protected from rain, condensation, contamination, snow and freezing until dry to the fullest extent practicable.

5.9 Repair of damaged paint surface.

5.9.1 Where paint has been damaged in handling and in transportation, the repair of damaged coating of pre-creation/fabrication shall be as given below.

5.9.2 Repair of damaged inorganic zinc silicate primer after erection/welding:

Quickly remove the primer from damaged area by mechanical scraping and emery paper to expose the white metal. Blast clean the surfaces possible. Feather the primer over the intact adjacent surface surrounding the damaged area by emery paper.

5.9.3 Repair of damaged pre-erection and shop priming in the design temperature of 90° C to 500° C.

- Surface preparation shall be done as per procedure 5.9.2
- One coat of F-9 shall be applied wherever damage 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 at sequentially as given below:
- Identify the environment from area classification details and choose 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 details of weather condition, particular of application no of coats and type of materials applied, anomalies, 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>
<thead>
<tr>
<th>S. NO.</th>
<th>DESCRIPTION</th>
<th>VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)</th>
<th>REMARK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SWEDISH STANDARD SIS-05-5900 1967</td>
<td>SSPC-SP USA</td>
</tr>
<tr>
<td>1.</td>
<td>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.</td>
<td>ST.2</td>
<td>SSPC-SP-2</td>
</tr>
<tr>
<td>2.</td>
<td>MECHANICAL OR POWER TOOL CLEANING REMOVAL OF LOOSE RUST, LOOSE MILL SCALE AND LOOSE PAINT TO DEGREE SPECIFIED BY POWER TOOL CHIPPING, DESCALING, SANDING, WIRE BRUSHING AND GRINDING, AFTER REMOVAL OF DUST, SURFACE SHOULD HAVE A PRONOUNCED METALLIC SHEEN.</td>
<td>ST.3</td>
<td>SSPC-SP-3</td>
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</table>
### TABLE-I (for clause 5.0)
**SURFACE PREPARATION STANDARDS**

<table>
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<tr>
<th>S. NO.</th>
<th>DESCRIPTION</th>
<th>VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)</th>
<th>REMARKS</th>
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<tbody>
<tr>
<td>3.</td>
<td>BLAST CLEANING (AIR &amp; WATER) THERE ARE FOUR COMMON GRADES OF BLAST CLEANING</td>
<td></td>
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<tr>
<td>3.1 W</td>
<td>WHITE METAL BLAST CLEANING TO WHITE METAL CLEANLINESS REMOVAL OF ALL VISIBLE RUST, MILL SCALE PAINT &amp; FOREIGN MATTER 100% CLEANLINESS WITH DESIRED SURFACE PROFILE</td>
<td>SWEDISH STANDARD SIS-05-5900 1967</td>
<td>WHERE EXTREMELY CLEAN SURFACE CAN BE EXPECTED FOR PROLONG LIFE OF PAINT SYSTEMS.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SSPC-SP-5 USA</td>
<td>NACE#1 FIRST QUALITY</td>
</tr>
<tr>
<td>3.2</td>
<td>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.</td>
<td>SA 2 ½</td>
<td>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.</td>
</tr>
<tr>
<td></td>
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<td>SSPC-SP-10 USA</td>
<td>NACE #2 SECOND QUALITY</td>
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<td>S. No.</td>
<td>DESCRIPTION</td>
<td>VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)</td>
<td>REMARKS</td>
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<td></td>
<td>SIS-05-5900 1967</td>
<td>USA</td>
</tr>
<tr>
<td>3.3</td>
<td>COMMERCIAL BLAST</td>
<td>SA-2 SSPC-6</td>
<td>No. 3</td>
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<td></td>
<td>BLAST CLEANING UNIT AT LEAST TWO—THIRD OF EACH ELEMENT OF SURFACE AREA IS FREE OF ALL VISIBLE RESIDUES WITH DESIRED SURFACE PROFILE.</td>
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<td>3.4</td>
<td>BRUSH- OFF BLAST</td>
<td>SA-1 SSPC-7</td>
<td>No. 4</td>
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<tr>
<td></td>
<td>BLAST CLEANING TO WHITE METAL CLEANLINESS, REMOVAL OF ALL VISIBLE RUST, MILL SCALE, PAINT &amp; FOREIGN MATTER, SURFACE PROFILE IS NOT SO IMPORTANT.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.0 PAINT MATERIALS

Paint manufacturers shall furnish all the characteristics of paint material on printed literature, along with the test certificate for all the specified characteristics given in this specification. 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**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>DESCRIPTION</th>
<th>P-2 P-</th>
<th>4 P-</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Technical Name</td>
<td>Chlorinated rubber Zinc Phosphaté primer</td>
<td>Etch primer/ wash primer</td>
<td>Epoxy zinc phosphate primer</td>
</tr>
<tr>
<td>2.</td>
<td>Type and composition</td>
<td>Single pack, air drying chlorinated rubber based medium plasticised with unsaponifiable plasticizer, pigmented with Zic phosphate.</td>
<td>Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pigmented with zic tetroxy chromate.</td>
<td>Tow component polyamide cured epoxy resin medium, pigmented with zinc phosphate.</td>
</tr>
<tr>
<td>3.</td>
<td>Volume solids (approx)</td>
<td>40%</td>
<td>7-8%</td>
<td>40%</td>
</tr>
<tr>
<td>4.</td>
<td>DFT (Dry dilm thickness) per coat (approx)</td>
<td>40-50µ 8-</td>
<td>10µ 40-</td>
<td>50µ</td>
</tr>
<tr>
<td>5.</td>
<td>Theoretical covering capacity in M2/ coat/ litre (approx)</td>
<td>8-10 8-</td>
<td>10 8-</td>
<td>10</td>
</tr>
<tr>
<td>6.</td>
<td>Weight per litre in kgs/ litre (approx)</td>
<td>1.3</td>
<td>1.2</td>
<td>1.4</td>
</tr>
<tr>
<td>7.</td>
<td>Touch dry at 30°C (approx)</td>
<td>30 minutes</td>
<td>2 hrs.</td>
<td>After 30 mins.</td>
</tr>
<tr>
<td>9.</td>
<td>Over Coating Interval (approx.)</td>
<td>Min : 8 hrs Max : No limitation</td>
<td>Min : 4.6 hrs Max : 24 hrs</td>
<td>Min : 8 hrs Max : 3-6 months</td>
</tr>
<tr>
<td>10.</td>
<td>Pot life (approx) at 30°C for two component paints (approx).</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>8 hrs.</td>
</tr>
<tr>
<td>11.</td>
<td>Temperature Resistance</td>
<td>60°C</td>
<td>Not applicable</td>
<td>80°C</td>
</tr>
</tbody>
</table>
### Paint Materials

**Table No.: 6.2 Finish Paint**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Description F-</th>
<th>F-2</th>
<th>F-3</th>
<th>F-6</th>
<th>F-7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Technical Name</td>
<td>Acrylic polyurethane finish paint</td>
<td>Chlorinated rubber based finish paint</td>
<td>Epoxy-High build finish paint</td>
<td>High build coal tar epoxy coating.</td>
</tr>
<tr>
<td>2.</td>
<td>Type and composition</td>
<td>Two-pack aliphatic isocynate cured acrylic finish paint</td>
<td>Single pack plasticised chlorinated rubber based medium with chemical and weather resistant pigments.</td>
<td>Tow-pack polyamide/ polyamine cured epoxy resin medium suitable pigmented.</td>
<td>Tow pack polyamide cured epoxy resin blended with coal/ tar medium, suitably pigmented.</td>
</tr>
<tr>
<td>3.</td>
<td>Volume solids (approx)</td>
<td>40%</td>
<td>40%</td>
<td>62%</td>
<td>65%</td>
</tr>
<tr>
<td>4.</td>
<td>DFT (Dry film thickness) per coat (approx)</td>
<td>30-40µ 40-</td>
<td>50µ 100-</td>
<td>125µ 100-</td>
<td>125µ</td>
</tr>
<tr>
<td>5.</td>
<td>Theoretical covering capacity in M2/ coat/ litre (approx)</td>
<td>10-13 8-</td>
<td>10</td>
<td>5-6</td>
<td>5-2-6.5</td>
</tr>
<tr>
<td>6.</td>
<td>Weight per litre in kgs/ litre (approx)</td>
<td>1.3 l.</td>
<td>2</td>
<td>1.4</td>
<td>1.5</td>
</tr>
<tr>
<td>7.</td>
<td>Touch dry at 30°C (approx)</td>
<td>1 hrs.</td>
<td>30 minutes</td>
<td>3 hrs.</td>
<td>4 hrs.</td>
</tr>
<tr>
<td>10.</td>
<td>Pot life at 30°C for two component paints (approx)</td>
<td>6-8 hrs.</td>
<td>Not applicable</td>
<td>4-6 hrs.</td>
<td>4-6 hrs.</td>
</tr>
<tr>
<td>11.</td>
<td>Temperature Resistance</td>
<td>80°C</td>
<td>60°C</td>
<td>80°C</td>
<td>125°C</td>
</tr>
</tbody>
</table>
## PAINT MATERIALS
### TABLE NO.: 6.3 FINISH PAINTS

<table>
<thead>
<tr>
<th>S. No</th>
<th>DESCRIPTION</th>
<th>F-8</th>
<th>F-9</th>
<th>F-11</th>
<th>F-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Technical Name</td>
<td>Self priming type surface tolerant high build epoxy coating (Complete rust control coating)</td>
<td>Inorganic Zinc Silicate coating</td>
<td>Heat resistant synthetic medium based two pack aluminum paint suitable up to 250°C dry temperature</td>
<td>Heat resistant silicone aluminum paint suitable up to 500°C temperature</td>
</tr>
<tr>
<td></td>
<td>Type and composition</td>
<td>Two-pack epoxy resin based suitable pigmented and capable of adhering to manually prepared surface and old coating</td>
<td>A two-pack air drying self-curing solvent based inorganic zinc silicate coating.</td>
<td>Heat resistant synthetic medium based two pack aluminum paint suitable up to 250°C</td>
<td>Single pack silicone resin based medium with aluminum flakes.</td>
</tr>
<tr>
<td>3.</td>
<td>Volume solids (approx)</td>
<td>72%</td>
<td>60%</td>
<td>25%</td>
<td>20%</td>
</tr>
<tr>
<td>4.</td>
<td>DFT (Dry film thickness) per coat (approx)</td>
<td>100-125µ</td>
<td>75µ</td>
<td>20-25µ</td>
<td>25µ</td>
</tr>
<tr>
<td>5.</td>
<td>Theoretical covering capacity in M2/ coat/litre</td>
<td>6.0-7.2</td>
<td>9</td>
<td>10-12</td>
<td>8-10</td>
</tr>
<tr>
<td>6.</td>
<td>Weight per litre in kgs/ litre (approx)</td>
<td>1.4</td>
<td>2.3 1.2 1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Touch dry at 30°C (approx)</td>
<td>3 hrs.</td>
<td>30 min.</td>
<td>3 hrs.</td>
<td>30 min.</td>
</tr>
<tr>
<td>9.</td>
<td>Overcoating interval (approx)</td>
<td>Min.: 10 hrs. Max.: 6 months</td>
<td>Min.: 8 hrs. at 20°C and 50% RH. Max.: Unlimited</td>
<td>Min.: 16 hrs. Max.: Unlimited</td>
<td>Min.: 16 hrs. Max.: Unlimited</td>
</tr>
<tr>
<td>S. No</td>
<td>DESCRIPTION F</td>
<td>-8</td>
<td>F-9</td>
<td>F-11</td>
<td>F-12</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>10</td>
<td>Pot life (approx) at 30°C for two component paints (approx).</td>
<td>90 min.</td>
<td>4-6 hrs.</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>11</td>
<td>Temperature resistance</td>
<td>80°C</td>
<td>400°C</td>
<td>250°C</td>
<td>500°C</td>
</tr>
</tbody>
</table>

F-14: Specially for mulated polyamine cured coal tal epoxy suitable for -45°C to 125°C for application under insulation
F-15: Two pack cold curved epoxy phenolic coating suitable for 45°C to 125°C for application under insulation
F-16: Eoxy siloxane anser coat 738
### PAINT MATERIALS

#### TABLE NO. 6.4 FINISH PAINTS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>F-14</th>
<th>F-15</th>
<th>F-16</th>
<th>F-17</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Technical name</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Polyamine cured coal tar epoxy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Two-component epoxy phenolic coating cured with poly amine adduct hardener system (primer + intermediate coat + finish paint)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ambient temperature curing Poly Siloxane coating / High build cold applied inorganic copolymer based aluminium coating suitable for under insulation coating of CS and SS piping for high temperature service.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Type &amp; composition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Specially formulated polyamine cured coal tar epoxy suitable for application under insulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Two pack ambient temperature curing epoxy phenolic coating system suitable for application under insulation of CS / SS piping.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Amercoat 738 from Ameron Products, USA / Berger 938 from Berger Paints Ltd., or Intertherm 751 CSA from Akzo Nobel coating. Note: 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Two component solvent free type high build epoxy / phenolic / novalac epoxy phenolic coating cured with Polyamine adduct hardener system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Volume Solids (minimum)</td>
<td>70% 65% 60% 98%</td>
<td>65% 60% 98%</td>
<td>65% 60% 98%</td>
<td>100%</td>
</tr>
<tr>
<td>4.</td>
<td>DFT (Dry Film thickness) per coat (minimum)</td>
<td>125 µm</td>
<td>75 - 100 µm</td>
<td>75 - 100 µm</td>
<td>125- 150 µm</td>
</tr>
<tr>
<td>5.</td>
<td>Theoretic covering capacity in M² / coat / litre (minimum)</td>
<td>5.5</td>
<td>6.5-8.5 6.0-</td>
<td>8.0 6.5-</td>
<td>8.0</td>
</tr>
<tr>
<td>6.</td>
<td>Weight per liter in kgs/litre (max paint) (minimum)</td>
<td>1.5 1.7 1.3 1.7</td>
<td>1.7</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>7.</td>
<td>Touch dry at 30°C (maximum)</td>
<td>4 hrs.</td>
<td>2 hrs.</td>
<td>1 hr.</td>
<td>2 hrs.</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>Description</td>
<td>F-14 F</td>
<td>-15</td>
<td>F-16 F</td>
<td>-17</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------</td>
<td>--------</td>
<td>-----</td>
<td>--------</td>
<td>-----</td>
</tr>
<tr>
<td></td>
<td></td>
<td>168 hrs.(7 days)</td>
<td>168 hrs.(7 days)</td>
<td>-</td>
<td>168 hrs.(7 days)</td>
</tr>
<tr>
<td>9. O</td>
<td>Over-coating interval</td>
<td>Min. 6 hrs.</td>
<td>Min. 36 hrs.</td>
<td>Min. 16 hrs.</td>
<td>Min. 16 hrs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max. 5 days</td>
<td>Max. 21 days</td>
<td>Max. Not applicable</td>
<td>Max. 21 days</td>
</tr>
<tr>
<td>10.</td>
<td>Pot life at 30°C for two component paints (minimum)</td>
<td>4 hrs.</td>
<td>1.5 hrs.</td>
<td>1 hr.</td>
<td>1 hr.</td>
</tr>
<tr>
<td>11. T</td>
<td>Temperature Resistance (min.)</td>
<td>-45°C to 125°C under insulation</td>
<td>-45°C to 125°C under insulation (Note : 5)</td>
<td>Up to 400°C for CS &amp; SS under insulation</td>
<td>-45°C to 150°C for immersion service</td>
</tr>
</tbody>
</table>

Notes:
1. Covering capacity and DFT depends on method of application. Covering capacity specified above are theoretical. Allowing the loose during the application, minimum specified DFT should be maintained.
2. All primers and finish coats should be cold cured and air drying unless otherwise specified.
3. All paints shall be applied in accordance with manufacturer’s instruction for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured.
4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.
5. 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

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-2</td>
<td>Chlorinated Rubber Zinc Phosphate Primer</td>
</tr>
<tr>
<td>P-4</td>
<td>Etch Primer/ Wash Primer</td>
</tr>
<tr>
<td>P-6</td>
<td>Epoxy Zinc Phosphate Primer</td>
</tr>
</tbody>
</table>

#### FINISH COATS/ PAINTS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-2</td>
<td>Acrylic- Polyurethane finish paint</td>
</tr>
<tr>
<td>F-3</td>
<td>Chlorinated Rubber Finish Paint</td>
</tr>
<tr>
<td>F-6</td>
<td>High Build Epoxy finish coating</td>
</tr>
<tr>
<td>F-7</td>
<td>High Build Coal Tar epoxy coating</td>
</tr>
<tr>
<td>F-8</td>
<td>Self-priming surface tolerant high build epoxy coating</td>
</tr>
<tr>
<td>F-9</td>
<td>Inorganic Zinc Silicate Coating.</td>
</tr>
<tr>
<td>F-11</td>
<td>Heat resistant Synthetic medium based Aluminum paint.</td>
</tr>
<tr>
<td>F-12</td>
<td>Heat resistant Silicone Aluminum paint.</td>
</tr>
<tr>
<td>F-14</td>
<td>Specially formulated polyamine-cured coal for epoxy coating</td>
</tr>
<tr>
<td>F-15</td>
<td>Epoxy phenolic coating</td>
</tr>
<tr>
<td>F-16</td>
<td>Epoxy Siloxane Coating : Amercoat 738</td>
</tr>
<tr>
<td>F-17</td>
<td>Two component solvent free high build epoxy phenolic / novalac epoxy phenolic coating cured with polyamine.</td>
</tr>
</tbody>
</table>
### 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.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1.1</td>
<td>-90 TO 400</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9</td>
<td>65-75</td>
<td>No overcoating is to be done</td>
</tr>
<tr>
<td>7.1.2</td>
<td>401 TO 500</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-12</td>
<td>40-50</td>
<td>Finish Coat at Site</td>
</tr>
<tr>
<td>7.1.3</td>
<td>-40 to 150 for Structures, hand rails and Grating only</td>
<td>SSPC-SP-3</td>
<td>1 COAT OF F-9 or 2 COATS OF P-7 @ 40µ DFT / COAT</td>
<td>65-75 OF F-9 or 80 (P-7)</td>
<td>For Damaged Area of more than 5 x 5 cm²</td>
</tr>
</tbody>
</table>

### 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.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2.1</td>
<td>-90 TO 400</td>
<td>SSPC-SP-3 (FOR REPAIR ONLY) SSPC-SP-10</td>
<td>1 COAT OF F-9</td>
<td>65-75</td>
<td>FOR DAMAGED AREA OF MORE THAN 5X5 CM.</td>
</tr>
<tr>
<td>7.2.2</td>
<td>401 TO 550</td>
<td>SSPC-SP-3</td>
<td>1 COAT OF F-12</td>
<td>20</td>
<td>FOR DAMAGED AREA OF MORE THAN 5X5 CM.</td>
</tr>
</tbody>
</table>
### TABLE 8.0: FIELD PAINT SYSTEM FOR NORMAL CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL)

All normal corrosive areas such as off sites external surface of uninsulated columns, vessels, heat exchangers, blowers, piping, pumps, towers, compressors, structural steel works, RCC chimney with or without refractory line inside chimney (all environments), excluding tank tops, flare lines, D.M. plants, interior of tanks etc. Flare lines for normal corrosive environment also to be painted as per Table 9.0

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>-90 TO -15</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT AT O F F -9 @ 65-75µ DFT/ COAT</td>
<td>65-75</td>
<td>No over coating to be done follow repair procedure only on damaged areas of pre-erection/ pre-fabrication primer/ coating F-9</td>
</tr>
<tr>
<td>8.2</td>
<td>-14 TO 60</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT AT O F F -9 @ 65-75µ DFT/ COAT + 2 COATS OF P-2 @ 40µ DFT/ COAT 2 X 40 = 80</td>
<td>225</td>
<td></td>
</tr>
<tr>
<td>8.3</td>
<td>61 TO 80</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT AT O F F -9 @ 65-75µ DFT/ COAT + 2 COATS OF P-6 @ 40µ DFT/ COAT 2 X 40 = 80</td>
<td>245</td>
<td></td>
</tr>
<tr>
<td>S. NO.</td>
<td>DESIGN TEMPERATURE IN °C</td>
<td>SURFACE PREPARATION</td>
<td>PAINT SYSTEM</td>
<td>TOTAL DFT IN MICRONS (MIN.)</td>
<td>REMARKS</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------------</td>
<td>-----------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>8.4</td>
<td>81 TO 250</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 µ DFT/COAT</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 COATS OF F-11 @ 20 µ DFT/COAT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 X 20 = 60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.5</td>
<td>251 TO 400</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 µ DFT/COAT</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 COATS OF F-12 @ 20 µ DFT/COAT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 X 20 = 40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.6</td>
<td>401 TO 500</td>
<td>SSPC-SP-10</td>
<td>REPAIR AS PER 7.2.2</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 COATS OF F-12 @ 20 µ DFT/COAT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 X 20 = 40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE 1 : FOR MS CHIMNEY OR WITHOUT REFRACTORY LINING 8.3, 8.4 AND 8.5 SHALL BE FOLLOWED.

NOTE 2 : FOR EXTERNAL SURFACE OF RCC CHIMNEY: 2 COATS OF F-6 @ 100 µ DFT/COAT TO OBTAIN 2 X 100=200 µ SHALL BE APPLIED AFTER MAKING SURFACE PREPARATION AS PER GUIDELINES IN 1.5

NOTE 3 : WHEREVER REQUIRED S.NO. 8.3 SHALL BE USED FOR 14°C TO 80°C AND S.NO. 8.2 WILL BE DELETED.
TABLE 9.0: FIELD PAINT SYSTEM FOR CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL)

FOR ALL CORROSIVE AREAS ABOVE GROUND WHERE \( \text{H}_2\text{S}, \text{SO}_2 \) FUMES OR SPILLAGE'S OF ACID/ALKALI/SALT ARE LIKELY TO COME IN CONTACT WITH SURFACE SUCH AS EXTERNAL SURFACE OF UNINSULATED COLUMNS, VESSELS, HEAT EXCHANGERS, BLOWERS, PIPING, PUMPS, TOWERS, COMPRESSORS, FLARE LINES, STRUCTURAL STEEL ETC.

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>FINISH PAINT</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1</td>
<td>-90 TO –15</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 µ DFT/COAT</td>
<td>NONE</td>
<td>65-75</td>
<td>Repair of pre-erection/ fabrication primer shall be done wherever damage is observed.</td>
</tr>
<tr>
<td>9.2</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 µ DFT/COAT + 1 COAT OF P-6 @40 µ DFT/COAT</td>
<td>1 COAT OF F-6 @ 100 µ DFT/COAT + 1 COAT OF F-2 @ 40 µ DFT/COAT</td>
<td>225</td>
<td>Surface preparation is required only for repairing of damaged pre-erection/fabrication primer</td>
</tr>
<tr>
<td>9.3</td>
<td>81 TO 400</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 µ DFT/COAT</td>
<td>2 COATS OF F-12 @ 20 µ DFT / COAT</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>9.4</td>
<td>401 TO 500</td>
<td>SSPC-SP-10</td>
<td>REPAIR 2S PER 7.2.2</td>
<td>2 COATS OF F-12 @ 20 µ DFT / COAT</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>
TABLE 10.0: FIELD PAINTING SYSTEM FOR HIGHLY CORROSIVE (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL) EXTERNAL SURFACES OF UNINSULATED COLUMNS, VESSELS, HEAT EXCHANGERS, BOILERS, PIPING PUMPS, TOWERS, COMPRESSORS, FLARE LINES, STRUCTURE STEEL ETC.

EXPOSED TO SPILLAGE OR FUMES OF HCL $\text{H}_2\text{SO}_4$, SALTY WATER IMPINGEMENT, CHLORIDE ETC.

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>FINISH PAINT</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1</td>
<td>-90 TO -15</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 µ DFT/COAT</td>
<td>NONE 65-75 µ DFT/COAT</td>
<td>75</td>
<td>Repair of pre-erection/fabrication primer shall be followed. No over coating is allowed.</td>
</tr>
<tr>
<td>10.2</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 µ DFT/COAT + 1 COAT OF P-6 @40 µ DFT/COAT</td>
<td>2 COATS OF F-6 @ 100 µ DFT/COAT = 2 X 100= 200 + 1 COAT OF F-2 @ 40 µ DFT/COAT</td>
<td>345</td>
<td>Surface preparation is required only for repairing of damaged pre-erection/fabrication primer.</td>
</tr>
<tr>
<td>10.3</td>
<td>81 TO 400</td>
<td>SSPC-SP-10</td>
<td>REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 µ DFT/COAT</td>
<td>2 COATS OF F-12 @ 20 µ DFT/COAT = 2 X 20 = 40</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>10.4</td>
<td>401 TO 500</td>
<td>SSPC-SP-10</td>
<td>REPAIR AS PER 7.2.2</td>
<td>3 COATS OF F-12 @ 20 µ DFT/COAT = 2 X 20 = 40</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 11.0: FIELD PAINT SYSTEM FOR CARBON STEEL STORAGE TANKS (EXTERNAL) FOR ALL ENVIRONMENTS.

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75μ DFT / COAT + 1 COAT OF P-6 @ 40μ DFT / COAT 65 X 40 = 105</td>
<td>285</td>
<td>F-6 should be suitable for occasional water immersion</td>
</tr>
<tr>
<td>11.1.1</td>
<td>81 TO 500</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75μ DFT / COAT + 2 COATS OF F-2 @ 40μ DFT / COAT 2 X 40 = 80</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>11.2</td>
<td>EXTERNAL SURFACE OF BOTTOM PLATE (SOIL SIDE) FOR ALL STORAGE TANKS.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.2</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75μ DFT / COAT + 3 COATS OF F-7 @ 100μ DFT / COAT 3 X 100 = 300</td>
<td>365</td>
<td>7 should be suitable for immersion service of the products given.</td>
</tr>
</tbody>
</table>

**NOTES:**
- SSPC-SP-10: Surface Preparation and Paint System Code.
- DFT: Dry Film Thickness.
### TABLE 12.0: FIELD PAINT SYSTEM FOR CARBON STEEL AND ALLOY STORAGE TANK: (INTERNAL)

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>FILED PRIMER</td>
<td>FINISH PAINT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.1</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75 µ DFT/ COAT</td>
<td>3 COATS OF F-7 @ 100 µ DFT/ COAT 3 x 100 = 300</td>
<td>365 F7 should be suitable for immersion service of the products given.</td>
</tr>
<tr>
<td>12.2</td>
<td></td>
<td>SSPC-SP-10</td>
<td>PHOSPHATING TREATMENT WITH PHOSPHATING CHEMICALS (2 COATS)</td>
<td>2 COATS OF @10 µ 2 x 10 = 20</td>
<td>20</td>
</tr>
<tr>
<td>12.3.1</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75 µ DFT/ COAT</td>
<td>3 COATS OF F-6 @ 100 µ DFT/ COAT 3 x 100 = 300</td>
<td>365 F-6 should be suitable for immersion service of petroleum products like ATF, Kerosene, petrol etc.</td>
</tr>
<tr>
<td>12.4.1</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75 µ DFT/ COAT</td>
<td>NONE</td>
<td>65-75 No over coating is allowed same as per pre-erecti on primer, if any</td>
</tr>
<tr>
<td>12.5</td>
<td></td>
<td>SSPC-SP-10</td>
<td>2 COAT OF F-6 @ 40 µ DFT/ COAT 2 X 40 = 80</td>
<td>2 COATS OF F-6 @ 100 µ DFT/ COAT 2 X 100 = 200</td>
<td>280 F-6 shall be suitable for immersion service.</td>
</tr>
<tr>
<td>12.6</td>
<td></td>
<td>SSPC-SP-10</td>
<td>E Bonite Rubber Lining as per SMMS specification 6-06-204</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.7.1</td>
<td>ALL</td>
<td>SSPC-SP-10</td>
<td>3 COATS OF VINYL CHLORIDE CO-POLYMER AMERCOAT 23 @ 75 µ COAT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. NO.</td>
<td>DESIGN TEMPERATURE IN °C</td>
<td>SURFACE PREPARATION</td>
<td>PAINT SYSTEM</td>
<td>TOTAL DFT IN MICRONS (MIN.)</td>
<td>REMARKS</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>----------------------</td>
<td>--------------</td>
<td>-----------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>12.8</td>
<td>INSIDE PONTOON AND INSIDE OF DOUBLE DECK OF ALL FLOATING ROOFS.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.8.1</td>
<td>-14 TO 80</td>
<td>SSPC-SP-3</td>
<td>1 COAT OF F-8 @ 100µ DFT/ COAT</td>
<td>1 COATS OF F-6 @ 100 µ DFT/ COAT 1 X 100 = 100</td>
<td>200</td>
</tr>
<tr>
<td>12.9</td>
<td>INTERNAL SURFACE OF AMINE &amp; SOUR WATER STORAGE TANKS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.9.1</td>
<td>-14 TO 80</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75µ DFT/ COAT 2 X 40 = 80</td>
<td>2 COATS OF F-15 @ 75 µ DFT/ COAT 2 X 75 = 150</td>
<td>215-225</td>
</tr>
</tbody>
</table>
### TABLE 13.0: COATING SYSTEM FOR EXTERNAL SIDE OF UNDERGROUND CARBON STEEL PLANT PIPING AND TANKS

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>PRIMER FINISH PAINT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.1</td>
<td>CARBON STEEL PLANT PIPING (UNDERGROUND)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.1.1</td>
<td>YARD COATING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.1.1.1</td>
<td>25 TO 60</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF SYNTHETIC FAST DRYING PRIMER TYPE-B AS PER AWWA-C-203 (1991)</td>
<td>4mm THICK CARALTAR COATING RAPPING AS PER AWWA-C-203 IN 2 LAYER OF EACH 2mm THICKNESS</td>
<td>4mm C</td>
</tr>
<tr>
<td>13.1.2</td>
<td>OVER THE DITCH COATING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.1.2.1</td>
<td>25 TO 60</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF SYNTHETIC FAST DRYING PRIMER TYPE-B AS PER AWWA-C-203 (1991)</td>
<td>2 LAYERS OF CARALTAR BASED TAPE COATING AS PER AWWA-C-203.</td>
<td>4 mm</td>
</tr>
<tr>
<td>13.2</td>
<td>CARBON STEEL PLANT PIPING (UNDERGROUND)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.2.1</td>
<td>61 TO 400</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75µ DFT/ COAT</td>
<td>NONE</td>
<td>65-75</td>
</tr>
<tr>
<td>13.3</td>
<td>EXTERNAL SIDE OF UNINSULATED UNDERGROUND STORAGE TANKS:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.3.1</td>
<td>40 TO 80</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75µ DFT/ COAT</td>
<td>3 COATS OF F-7 @ 100µ DFT/ COAT 3 X 100 = 300</td>
<td>365</td>
</tr>
<tr>
<td>13.3.2</td>
<td>-90 TO -41 81 TO 400° C</td>
<td>SSPC-SP-10</td>
<td>1 COAT OF F-9 @ 65-75µ DFT/ COAT 1 COAT OF AMERCOAT 738 @ 250µ DFT/ COAT</td>
<td>NONE</td>
<td>65-75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>250</td>
</tr>
</tbody>
</table>
### 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)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Design Temperature in °C</th>
<th>Surface Preparation</th>
<th>Paint System</th>
<th>Total DFT in Microns (Min.)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Primer Finish</td>
<td>Paints</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Paint System</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Primer Finish</td>
<td>Paints</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Paint System</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total DFT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Remarks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.1</td>
<td>Insulated Carbon Steel, Low Alloy Steel and LTCS Piping and Equipment &amp; Tanks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.1.1</td>
<td>-4 to 125</td>
<td>SSPC-SP-10</td>
<td>Repair of Prefabrication Primer F-9 @ 65-75µ DFT</td>
<td>2 coats of F-14 @ 125µ DFT/Coat 2 x 125 = 250 OR 3 coats of F-15 = 3 x 80 = 240</td>
<td>315</td>
</tr>
<tr>
<td></td>
<td>For other temperature ranges no painting is required under insulation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.1.2</td>
<td>Operating Temperature -45 to 125°C but Design Temperature 126-400°C</td>
<td>SSPC-SP-10</td>
<td>Repair of Prefabrication Primer F-9 @ 65-75µ DFT</td>
<td>3 coats of F-12 @ 20µ DFT/Coat 3 x 20 = 60</td>
<td>105-115</td>
</tr>
<tr>
<td>14.2</td>
<td>Insulated Stainless Steel Including Alloy-20- Piping</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.2.1</td>
<td>Below 0°C to All Minus Temperature</td>
<td>Aluminum Sheet Ing W ith Aluminum Inum Fo il and Chloride Free Containing Barium Chromate Shall be Applied</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.2.2</td>
<td>0 to 120</td>
<td>SSPC-SP-10 (15-25µ Surface Profile)</td>
<td>None</td>
<td>2 coats of F-1 @ 125µ DFT/Coat 2 x 125 = 250 OR 3 coats of F-15 = 3 x 80 = 240</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>If the piping &amp; equipments are already erected then surface shall be prepared by cleaning with ith emery paper and with ash/ flush with chloride free DM water followed by wiping with 2 emic solvent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. NO.</td>
<td>DESIGN TEMPERATURE IN °C</td>
<td>SURFACE PREPARATION</td>
<td>PAINT SYSTEM</td>
<td>TOTAL DFT IN MICRONS (MIN.)</td>
<td>REMARKS</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------</td>
<td>----------------------</td>
<td>--------------</td>
<td>-----------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>14.2.3</td>
<td>121 TO 500</td>
<td>SSPC-SP-10</td>
<td>NONE</td>
<td>3 COATS OFF -12 @ 20µ DFT/ COAT 3 X 20 = 60</td>
<td>60</td>
</tr>
<tr>
<td>14.2.4</td>
<td>501 TO 1000</td>
<td>SSPC-SP-10</td>
<td>NONE</td>
<td>1 COAT OF AMERCOAT 738 @ 150µ DFT/ COAT</td>
<td>150 O</td>
</tr>
<tr>
<td>14.2.5</td>
<td>CYCLIC SERVICE -196 TO 480 EXCEPTING –45 TO 120</td>
<td>SSPC-SP-10</td>
<td>NONE</td>
<td>1 COAT OF AMERCOAT 738 @ 150µ DFT/ COAT</td>
<td>150</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.1</td>
<td>Upto 65</td>
<td>SSPC-SP-10</td>
<td>1 COATS OF F-6 @ 40µ DFT/ COAT, 2 COATS OF F-7 @ 125µ DFT/ COAT = 250</td>
<td>290 For C. S.</td>
<td></td>
</tr>
<tr>
<td>15.2</td>
<td>Upto 65</td>
<td>SSPC-SP-10</td>
<td>1 COATS OF P-4 @ 8µ DFT/ COAT, 1 COATS OF P-6 @ 40µ DFT/ COAT = 250</td>
<td>300 NON FERROUS SURFACE</td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 16.0** FIELD PAINTING SYSTEM FOR GI TOWERS/ NON-FERROUS TUBE SHEET

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>DESIGN TEMPERATURE IN °C</th>
<th>SURFACE PREPARATION</th>
<th>PAINT SYSTEM</th>
<th>TOTAL DFT IN MICRONS (MIN.)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.1</td>
<td>Upto 65</td>
<td>SSPC-SP-10</td>
<td>1 COATS OF P-4 @ 8-10µ DFT/ COAT, 1 COAT OF P-6 @ 4µ DFT/ COAT = 40; 2 COATS OF F-2 @ 40µ DFT/ COAT = 80</td>
<td>130 SHADE AS PER DEFENCE REQUIREMENTS</td>
<td></td>
</tr>
<tr>
<td>16.2</td>
<td>Upto 65</td>
<td>SSPC-SP-10</td>
<td>1 COATS OF P-4 @ 8µ DFT/ COAT, 1 COATS OF P-6 @ 40µ DFT/ COAT = 250</td>
<td>300</td>
<td></td>
</tr>
</tbody>
</table>
17.0 STORAGE

17.1 All paints and painting materials shall be stored only in rooms to be arranged by contractor and approved by Engineer-in-Charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the words “PAINT STORAGE NO NAKED LIGHT-HIGHLY INFLAMMABLE” shall be clearly displayed outside.

18.0 COLOUR CODE FOR PIPING

For identification of pipeline, the colour code as per Table 18.1 shall be used. Paint material for color-coding shall be as specified in this standard in clause-6.0.

18.1 Colour coding scheme for pipe, equipment, machinery & structure:

<table>
<thead>
<tr>
<th>SR. NO.</th>
<th>DESCRIPTION</th>
<th>GROUND COLOUR</th>
<th>FIRST COLOUR BAND</th>
<th>SECOND COLOUR BAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.1.1</td>
<td>ALL KINDS OF WATER</td>
<td>Sea Green</td>
<td>French Blue</td>
<td>Signal Red</td>
</tr>
<tr>
<td></td>
<td>DRINKING WATER</td>
<td>-do-</td>
<td>Gulf Red</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DE-MINERALISED WATER</td>
<td>-do-</td>
<td>French Blue</td>
<td></td>
</tr>
<tr>
<td></td>
<td>COOLING WATER</td>
<td>-do-</td>
<td>Gulf Red</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BOILER FEED WATER</td>
<td>-do-</td>
<td>Light Brown</td>
<td>Signal Red</td>
</tr>
<tr>
<td></td>
<td>CONDENSATE</td>
<td>-do-</td>
<td>Dark Grey</td>
<td></td>
</tr>
<tr>
<td></td>
<td>QUENCH WATER</td>
<td>-do-</td>
<td>Canary Yellow</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WASH WATER</td>
<td>-do-</td>
<td>Oxide Red</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PROCESS WATER</td>
<td>-do-</td>
<td>Crimson Red</td>
<td></td>
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<tr>
<td></td>
<td>PROCESS WATER</td>
<td>-do-</td>
<td>White</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FIRE WATER</td>
<td>Fire red</td>
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<td></td>
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<tr>
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<td>SEA WATER</td>
<td>Sea Green</td>
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<td>18.1.2</td>
<td>ST EAM</td>
<td>aluminiumto IS2339</td>
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<tr>
<td></td>
<td>VERY HIGH PRESSURE STEAM (VHP)</td>
<td>-do-</td>
<td>French Blue</td>
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<tr>
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<td>HIGH PRESSURE STEAM (SH)</td>
<td>-do-</td>
<td>Gulf Red</td>
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<tr>
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<td>MEDIUM PRESSURE STEAM (SH)</td>
<td>-do-</td>
<td>Canary Yellow</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LOW PRESSURE STEAM (SL)</td>
<td>-do-</td>
<td>Grey</td>
<td>Canary Yellow</td>
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<td>SR. NO.</td>
<td>DESCRIPTION</td>
<td>GROUND COLOUR</td>
<td>FIRST COLOUR BAND</td>
<td>SECOND COLOUR BAND</td>
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<td>CO MPRESSED AIR</td>
<td>Sky Blue</td>
<td>Signal Red</td>
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<tr>
<td></td>
<td>PLANT AIR</td>
<td>-do-</td>
<td>Silver Grey</td>
<td>-</td>
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<tr>
<td></td>
<td>INSTRUMENT AIR</td>
<td>-do-</td>
<td>French Blue</td>
<td>-</td>
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<tr>
<td></td>
<td>NITROGEN</td>
<td>-do-</td>
<td>Black</td>
<td>-</td>
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<tr>
<td></td>
<td>OXYGEN</td>
<td>-do-</td>
<td>White</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>CO₂</td>
<td>-do-</td>
<td>Light Grey</td>
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<td>GÁSES</td>
<td>Canary Yellow</td>
<td>Grey</td>
<td>Dark Violet</td>
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<td>FUEL GAS AND SOUR GAS</td>
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<td>Signal Red</td>
<td>French Blue</td>
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<td></td>
<td>CHARGE GAS</td>
<td>-do-</td>
<td>Oxide Red</td>
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<td></td>
<td>RESIDUE GAS, LPG</td>
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<td>Service Brown</td>
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<td>ACETYLENE</td>
<td>-do-</td>
<td>Grey</td>
<td>-</td>
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<td></td>
<td>SWEET GAS</td>
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<td>-do-</td>
<td>-do-</td>
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<td>18.1.5</td>
<td>ACIDS AND CHEMICALS</td>
<td>DARK Violet</td>
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<td>SULFURIC ACID</td>
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<td>French Blue</td>
<td>-do-</td>
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<td>-do-</td>
<td>Signal Red</td>
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<td>-do-</td>
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<td>-do-</td>
<td>Light Orange</td>
<td>-do-</td>
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<td></td>
<td>CAUSTIC</td>
<td>smoke Grey</td>
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<td>-do-</td>
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<td></td>
<td>CHLORINE</td>
<td>Canary Yellow</td>
<td>Dark Violet</td>
<td>-do-</td>
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<td>18.1.6</td>
<td>HYDRO CARBONS</td>
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<td>Brilliant Green</td>
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<td>Smoke Grey</td>
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<td>PROPYLENE</td>
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<td>-do-</td>
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<td>PROPYLENE C.G. (LIQ)</td>
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<td>ETHYLENE GLYCOL</td>
<td>-do-</td>
<td>Gulf Red</td>
<td>-do-</td>
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<td>ETHYLENE DICHLORIDE</td>
<td>-do-</td>
<td>Canary Yellow</td>
<td>-do-</td>
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<tr>
<td></td>
<td>BENZENE</td>
<td>-do-</td>
<td>Black</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>BUTADIENE</td>
<td>-do-</td>
<td>Light Grey</td>
<td>French Blue</td>
</tr>
<tr>
<td></td>
<td>ETHANE(LIQ)</td>
<td>-do-</td>
<td>Signal Red</td>
<td>Black</td>
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<td>PROPYLENE(LIQ)</td>
<td>Dark Admiralty</td>
<td>Light Grey</td>
<td>Black</td>
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<td>ETHYLENE(LIQ)</td>
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<td>Signal Grey</td>
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</tr>
<tr>
<td></td>
<td>TAR</td>
<td>-do-</td>
<td>Signal Grey</td>
<td>-do-</td>
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<td>AROMATIC GASOLINE</td>
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<td>Brilliant Green</td>
<td>-do-</td>
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<td>METHANOL (LIQ)</td>
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</tr>
<tr>
<td></td>
<td>PYROLYSIS GASOLINE</td>
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<td>Signal Green</td>
<td>-do-</td>
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<td></td>
<td>MIXED C4(LIQ)</td>
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<td>Brilliant Green</td>
<td>-do-</td>
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<td>LPG(LIQ)</td>
<td>-do-</td>
<td>Signal Green</td>
<td>-do-</td>
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<tr>
<td></td>
<td>KEROSENE</td>
<td>-do-</td>
<td>Brilliant Green</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>DIESEL OIL (WHITE)</td>
<td>Light Brown</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>DIESEL OIL (BLACK)</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
</tr>
</tbody>
</table>
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:

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>Width : L(mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; NB and below</td>
<td>25mm</td>
</tr>
<tr>
<td>Above 3&quot; NB upto 6&quot; NB</td>
<td>50mm</td>
</tr>
<tr>
<td>Above 8&quot; NB upto 12&quot; OD</td>
<td>75mm</td>
</tr>
<tr>
<td>Above 12&quot; OD</td>
<td>100mm</td>
</tr>
</tbody>
</table>

Note: For insulated pipes, nominal pipe size means the outside diameter of insulation.
Nominal pipe size figures are to be inches.

18.5.2 Colour band(s) shall be arranged in the sequence shown in Table 18.1 and the sequence follows the direction of flow. The relative proportional width of the first colour band to the subsequent bands shall be 4:1, minimum width of any band shall be as per Clause 18.5.1.

18.5.3 Whenever it is required by the Engineer-in-charge to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal strips of black and golden yellow as per IS:2379 shall be painted on the ground colour.

18.6 Wherever it is required by the Engineer-in-charge to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal strips of black and golden yellow as per IS:2379 shall be painted on the ground colour.

19.0 IDENTIFICATION OF VESSELS, PIPING ETC.

19.1 Equipment number shall be stencilled in black or white on each vessel, column, equipment & machinery (insulated or uninsulated) after painting. Line number in black or white shall be stencilled on all the pipelines of more than one location as directed by Engineer-in-charge, size of letters printed shall be as below:

- Column & Vessels: 150mm (high)
- Pump, Compressor and other machinery: 50mm (high)
- Piping: 40-150mm
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 be maintained in the registers. Stages of inspection are as follows:

a. Surface preparation  
b. Primer application  
c. Each coat of paint

In addition to above, record should include type of shop primer already applied on equipment e.g. Redd oxide zinc chromate or zinc chromate or Red lead primer etc.

Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer-in-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work. Contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra cost to owner, the extra cost should have prior approval of Engineer-in-Charge.
21.4 **Primer Application**

After surface preparation the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-in-Charge.

21.5 The shades of successive coats should be slightly different in colour in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer-in-Charge before application of successive coats.

21.6 The contractor shall provide standard thickness measurement instrument with appropriate ranges(s) for measuring.

Dry film thickness of each coat, surface profile gauge for checking of surface profile in case of blast cleaning. Holiday detectors and pinhole detector and positector whenever required for checking in case of immersion conditions.

21.7 Prior to application of paints on surface of chimneys the thickness of the individual coat shall be checked by application of each coat of same paint on M.S test panel. The thickness of paint on test panel shall be determined by using gauge such as ‘Elkomere’. This thickness of each coat shall be checked as per provision of this specification. This shall be approved by Engineer-in-Charge before application of paints on surface of chimney.

21.8 At the discretion of Engineer-in-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations.

21.9 Final inspection shall include measurement of paint dry film thickness. Adhesion holiday detection on check of finish and workmanship. The thickness should be measured at as many points/locations as decided by Engineer-in-Charge and shall be within +10% of the dry thickness specified in the specifications.
21.10 The contractor shall arrange for spot checking of paint materials for Sp. Gr., flow time (ford cup) and spreading rate.

22.0 GUARANTEE

22.1 The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work.

22.2 The contractor shall produce test report from manufacturer regarding the quality of the particular batch of paint supplied. The Engineer-in-Charge shall have the right the test wet samples of paint at random, for quality of same as stipulated in clause 11 above. Batch test report of manufacturer’s for each batch paint supplied shall be made available by the contractor.

23.0 QUALIFICATION CRITERIA OF PAINTING CONTRACTOR

Painting contractor who is awarded any job for MECON, projects under this standard must have necessary equipment, machinery, tool and tackles for surface preparation, paint application and inspection. The contractor must have qualified trained and experienced surface preparator, paint applicator, inspector, and supervisors. The contractor supervisor, inspector, surface preparator 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 test ing of the inorganic zinc silicate coating materials as per the list of tests given in para 24.5 below from one of the reputed Government laboratories.
24.2 Samples of coating should be submitted to the Govt. laboratory in sealed containers with batch no. and test certificate on regular format of manufacturer’s testing laboratory. The sampling shall be certificate and sealed by a certifying agency.

24.3 All test panels should be prepared by Govt. testing agency. Coloured photographs of test panels should be taken before and after the test should be enclosed along with test report.

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

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

24.4 Manufacturers should intimate the company, details of sample submitted for testing name of Govt. testing agency, date, contact personnel of the Govt. testing agency. At the end of the test the manufacturer should submit the test report to the company for approval. The manufacturer(s) shall be qualified based on the result of these tests and other assessment and the Company’s decision in this regard shall be final and binding on the manufacturer.
24.5 Tests required for evaluation of acceptance of coating materials for offshore application.

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<thead>
<tr>
<th>Test</th>
<th>ASTM Method</th>
<th>Test Method</th>
</tr>
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<tbody>
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<tr>
<td>Dipping properties</td>
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**Film Characteristics**

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<tbody>
<tr>
<td>Drying time</td>
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<td>Flexibility</td>
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<td>Hardness</td>
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<tr>
<td>Adhesion</td>
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<td>Abrasion resistance</td>
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<td>968/D 1044</td>
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<td>DFT/ Coat</td>
<td>AS PER SSPC GUIDELINES</td>
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<td>Storage Stability</td>
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**Resistance to**

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<td>Humidity for 2000 hrs.</td>
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<td>Salt Spray for 2000 hrs.</td>
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<td>Accelerated Weathering</td>
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<td>% Zn in DFT</td>
<td>G</td>
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</table>

24.6 Coating system for panel test shall be decided after discussion with MECON.
LIST OF RECOMMENDED MANUFACTURERS

Indian Vendors

1.0 Asian Paints(I) Ltd.
2.0 Berger Paints Ltd.
3.0 Goodlass Nerolac Paints Ltd.
4.0 Jenson And Nicholson Paint Ltd & chokuGu Jenson & Nicholson Ltd.
5.0 Shalimar Paints Ltd.
6.0 Sigma Coating, Mumbai
7.0 CDC Carboline Ltd.
8.0 Premier Products Ltd.
9.0 Coromandel Paints & Chemicals Ltd.
10.0 Anupam Enterprises
11.0 Gr and 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 Amer on, USA
3.0 Kansai Paint, Japan
4.0 Hempe1 Paint, USA
5.0 Valspar Corporation, USA
6.0 Courtaulds Coating, UK.

Note: This list subjected to rev ision based fresh approval which will be intimated to PDD/ Vendor Cell.
# ANNEXURE-II

**LIST OF RECOMMENDED MANUFACTURER’S PRODUCTS**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>MANUFACTURER NAME</th>
<th>P2 CHLORINATED RUBBER Zn PRIMER</th>
<th>P4 ETCH PRIMER/ WASH PRIMER</th>
<th>P6 EPOXY ZINC PH. PRIMER</th>
<th>F9 INORGANIC ZINC SILICATE PRIMER/ COATING</th>
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<tbody>
<tr>
<td>1.</td>
<td>ASIAN PAINTS (I) LTD.</td>
<td>ASIOCHL OR HB. ZN.PH PRIMER RO PC 168</td>
<td>APCONYL WP 636 (PC 335)</td>
<td>APCODUR HB. RO.ZP-PC433</td>
<td>APCOCIL 605</td>
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<tr>
<td>2.</td>
<td>BARGER PAINT LTD.</td>
<td>LINSOL HIGH BUILD ZP PRIMER</td>
<td>BISON WASH PRIMER</td>
<td>EPILUX 610</td>
<td>ZINC ANODE 304</td>
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<tr>
<td>3.</td>
<td>AMERCOAT N/ GODDLASS NEROLAC PAINTS LTD.</td>
<td>-</td>
<td>AMERCOAT 187</td>
<td>AMERCOAT 71</td>
<td>DIMET COTE-9</td>
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<td>4.</td>
<td>JENSON &amp; NICHOSON PAINTS LTD. AND CHOKUGU JENSON NICHOLSON</td>
<td>JENSOLAC CHLORINATED RUBBER HB ZN.PH. PRIMER</td>
<td>J &amp; N ETCH PRIMER</td>
<td>EPILAC ZINC PHOSPHATE PRIMER</td>
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<td>5.</td>
<td>SHALIMAR PAINTS LTD.</td>
<td>CHIOROKOTE ZINC PHOSPHATE PRIMER GREY</td>
<td>TUFFKOTE ETC PRIMER</td>
<td>EPIGUARD 4 ZINC PHOSPHATE PRIMER GREY</td>
<td>TUFFKOTE ZILICATE TL</td>
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<td>6.</td>
<td>SIGMA COATING</td>
<td>SIGMA NUCOL UNICOAT 7321</td>
<td>SIGMA COVER PRIMER (7413)</td>
<td>COLTURE CM PRIMER 7412</td>
<td>SIGMASIL MC (7568)</td>
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<td>7.</td>
<td>CDC CARBOLINE LTD.</td>
<td>-</td>
<td>-</td>
<td>CARBOLINE 893</td>
<td>CARBOZINC 11</td>
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<td>U17/ 92 ETHYL SILICATE INORGANIC ZINC</td>
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<td>CORAMANDEL PAINTS CHEMICALS LTD.</td>
<td>COROCLORE CR HB. ZN. PH. PRIMER</td>
<td>CPC WASH PRIMER</td>
<td>COROPEX EPOXY ZH. PH. HIGH BILD PRIMER</td>
<td>-</td>
</tr>
<tr>
<td>S. No.</td>
<td>MANUFACTURER NAME</td>
<td>P2 CHLORINATED RUBBER Zp PRIMER</td>
<td>P4 ETCH PRIMER/ WASH PRIMER</td>
<td>P6 EPOXY ZINC PH. PRIMER</td>
<td>F9 INORGANIC ZINC SILICATE PRIMER/ COATING</td>
</tr>
<tr>
<td>-------</td>
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<td>---------------------------------------------</td>
</tr>
<tr>
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<td>ANUCHLOR ZP PRIMER</td>
<td>ANUPRIME 291</td>
<td>ANUPAM ANILICOR A-EZP-500</td>
<td>-</td>
</tr>
<tr>
<td>11.</td>
<td>GRAND POLYCOATS</td>
<td>GP CHLOROPRIME 601</td>
<td>GP PPRIME 401</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
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<td>MBAY PAINTS LTD. THEMPEL MAKINE PAINTS</td>
<td>HEMPA TEX HIGHTBUILD 4633</td>
<td>PENTOLITE WASH PRIMER 8520</td>
<td>HEMPEL'S SHOP PRIMER E-1530</td>
<td>GALVASOL 1570</td>
</tr>
<tr>
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<td>VANAPRABHA ESTERS &amp; GLYCERIDES,</td>
<td>VEGCHLOR HB PRIMER 1143</td>
<td>VEG WASH PRIMER 1181</td>
<td>VEGPOX 1241 Z/ P</td>
<td>-</td>
</tr>
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<td>SUNCHLOR HB ZINC PHOSPHATE PRIMER</td>
<td>SUN WASH</td>
<td>SUNPOXY ZINC PHOSPHATE PRIMER</td>
<td>-</td>
</tr>
<tr>
<td>15.</td>
<td>COURTALDS COATING LTD.</td>
<td>-</td>
<td></td>
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<td>INTERZINC</td>
</tr>
<tr>
<td>16.</td>
<td>ARK-CHEM INCOPORATED, (FOR PHOSPHATING CHEMICAL ONLY)</td>
<td>RUST PREVENTIVE LIQUID DRSAIO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>JOTACOTE – 2</td>
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</tr>
<tr>
<td>S. No.</td>
<td>MANUFACTURER NAME</td>
<td>F2 ACRYLIC-POLY YURETHANE FINISH PAINT</td>
<td>F3 CHLORINATED RUBBER FINISH PAINT</td>
<td>F6 HIGH BUILD FINISH PAINT</td>
<td>F7 HIGH BUILD COAL TAR EPOXY COATING</td>
</tr>
<tr>
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<tr>
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<td>ASIAN PAINTS (I) LTD.</td>
<td>APCOTHANE CF76 (PC 1109)</td>
<td>ASIOCHLOR CF 621 (PC 161)</td>
<td>APCODUR HB COATING 9466</td>
<td>APCODUR CF 300</td>
</tr>
<tr>
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<td>BARGER PAINT LTD.</td>
<td>BARGER THANE ENAMEL (81)</td>
<td>LINOSOL CHLORINATED RUBBER HB COATING</td>
<td>EPILUX 04 AND 78 HB EPOXY COATING</td>
<td>EPILUX 555</td>
</tr>
<tr>
<td>3. A</td>
<td>MERON/ GODDLASS NEROLAC PAINTS LTD.</td>
<td>AMERCOAT 450GL</td>
<td>AMERCOAT 515</td>
<td>AMER COAT 383 HS</td>
<td>AMERCOAT 78 HB</td>
</tr>
<tr>
<td>4. JE</td>
<td>JENSON &amp; NICHOSON PAINTS</td>
<td>J &amp; N 993 HB POLYURETHANE</td>
<td>JENSON HB CHLORINATED</td>
<td>EPILAC 981 ENAMEL</td>
<td>EPILAC SOLVENTLESS COAT</td>
</tr>
</tbody>
</table>

19. KCC PRODUCTS (KOREA)

SPECIAL ZINC PHOSPHATE PRIMER

EZ 180(N)
<table>
<thead>
<tr>
<th>S. No.</th>
<th>MANUFACTURER NAME</th>
<th>F2 ACRYLIC-POLYURETHANE FINISH PAINT</th>
<th>F3 CHLORINATED RUBBER FINISH PAINT</th>
<th>F6 HIGH BUILD FINISH PAINT</th>
<th>F7 HIGH BUILD COAL TAR EPOXY COATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>STANDARDS PVT LTD.</td>
<td>FINISH PAINT</td>
<td>RUBBER FINISH PAINT</td>
<td></td>
<td>TAR EPOXY COATING</td>
</tr>
<tr>
<td>2.</td>
<td>ACHELITE LTD.</td>
<td>FINISH PAINT</td>
<td>RUBBER FINISH PAINT</td>
<td></td>
<td>TAR EPOXY COATING</td>
</tr>
<tr>
<td>3.</td>
<td>BIPIGARD'S LTD.</td>
<td>FINISH PAINT</td>
<td>RUBBER FINISH PAINT</td>
<td></td>
<td>TAR EPOXY COATING</td>
</tr>
<tr>
<td>4.</td>
<td>SPHINX LTD.</td>
<td>FINISH PAINT</td>
<td>RUBBER FINISH PAINT</td>
<td></td>
<td>TAR EPOXY COATING</td>
</tr>
<tr>
<td>5.</td>
<td>SHALI MAR PAINTS LTD.</td>
<td>SHALITHANE FINISH</td>
<td>CHLORKOTE FINISH</td>
<td>EPIGARD KL FINISH</td>
<td>BIPIGARD'S BLACK HB COAL TAR EPOXY COATING</td>
</tr>
<tr>
<td>6.</td>
<td>SIGMA COATING</td>
<td>SIGMADOUR HS SEMIGLOSS 7530</td>
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<td>SIGMA COVER CM 7456</td>
<td>COLTURIET TCN 300</td>
</tr>
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<td>7.</td>
<td>CDC CARBOLINE LTD.</td>
<td>CARBOLINE 132</td>
<td>-</td>
<td>CARBOLINE 191</td>
<td>CARBOMASTIC-14</td>
</tr>
<tr>
<td>8.</td>
<td>PRI MER PRODUCTS LTD.</td>
<td>U3/ 92 POLYURETHANE CR-71 FINISH PAINT</td>
<td>42B/ 4A HIGH BUILD EPOXY</td>
<td>350B/ 3A, COAL TAR EPOXY COATING</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>RAMANDEL PAINTS CHEMICALS</td>
<td>- CO</td>
<td>ROCLORE CR FINISHING</td>
<td>COROPEX EPOXY HB COATING</td>
<td>COROPEX EPOXY COAL TAR COATING</td>
</tr>
<tr>
<td>10.</td>
<td>ANUPAM ENTERPRISES</td>
<td>ANUTHANE ENAMEL</td>
<td>ANUCHLOR HB ENAMEL</td>
<td>DURACOAT-6000 CO</td>
<td>ROGUARD</td>
</tr>
<tr>
<td>11.</td>
<td>GRAND POLYCOATS</td>
<td>GP COAT 131, 132</td>
<td>GP CHLOROGAURD 631</td>
<td>GP GUARD HP 234</td>
<td>POLYGUARD GE</td>
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<tr>
<td>S. NO.</td>
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<td>F2 F3</td>
<td>F6</td>
<td>F7</td>
<td></td>
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</tr>
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<td>PENTATHANE FP 4510</td>
<td>HEMPATEX HIBUILD 4633</td>
<td>HEMPADUR HIGH BUILD 5520</td>
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<td>VEGTHANE FP 3641</td>
<td>VEGCHLOR FP 3140</td>
<td>VEGPOX- 3265</td>
<td>VEGPOX 4265</td>
</tr>
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<td>SUNIL PAINTS AND VARNISHED PVT. LTD.</td>
<td>SUNTHANE (ALIPHATIC)</td>
<td>SUNCHLOR HB CR COATING</td>
<td>LPOXY HB ‘PS 901’</td>
<td>LPOXY BLACK P. S. 551</td>
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<td>INTEGARD EM SERIES</td>
<td>INTERTUF JXA 006/ 007/ 010</td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>MARK-CHEM INCOPORATED, (FOR PHOSPHATE PAINTS ONLY)</td>
<td>PIPCOTHANE ALIPHATIC POLYURETHANE FINISH PAINT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>VCM POLYURETHANE PAINTS (FOR POLYURETHANE PAINTS ONLY)</td>
<td>PIPCOTHANE ALIPHATIC POLYURETHANE FINISH PAINT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>JOTUN PAINTS</td>
<td>HARDTOP AS</td>
<td>PENGUARD</td>
<td>JOTAGUARD 85</td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>KCC PRODUCTS (KOREA)</td>
<td></td>
<td>KOPOX TOPCOAT HB ET 5740</td>
<td>EH 173</td>
<td></td>
</tr>
</tbody>
</table>
## LIST OF RECOMMENDED MANUFACTURER’S PRODUCTS

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>MANUFACTURER’S NAME</th>
<th>F-8 EPOXY MASTIC COATING SURFACE TOLERANT</th>
<th>F-11 HEAT RESISTANCE SYNTHETIC MEDIUM ALUMINUM PAINT</th>
<th>F-12 HEAT RESISTANCE SILICON AL. PAINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ASIAN PAINTS (I) LTD.</td>
<td>APCODOR CF 640</td>
<td>ASIAN HR ALUMINUM PAINT (PC 300)</td>
<td>HR SILICON ALUMINUM PAINT (PC 189)</td>
</tr>
<tr>
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<td></td>
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<tr>
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<td>AMERON/ GODDLASS NEROLAC PAINTS LTD.</td>
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<td>TECT SYNTHETIC RUBBER H/R ALUMINUM PAINT 4000</td>
<td>FERRLOTECT SILICON HEAT RESISTANCE 1000</td>
</tr>
<tr>
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<td>- FERRO</td>
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<td></td>
</tr>
<tr>
<td>5.</td>
<td>SHALIMAR PAINTS LTD.</td>
<td>EPIPLUS 56</td>
<td>HEAT RESISTING LUSTROL ALUMINUM</td>
<td>LUSTOTHERM HIGH TEMP ALUMINUM PAINT</td>
</tr>
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<td>6.</td>
<td>SIGMA COATING</td>
<td>SIGMA ETPC ALUMINUM</td>
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<td>AROSTA FINISH HR</td>
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<td>CARBOLINE 1248</td>
<td>CARBOLINE 4674</td>
</tr>
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</tr>
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<td>CPC SILICONE HR ALUMINUM PAINT</td>
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<td>ANUMASTIC-102</td>
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<td>ANUPAM HEAT GUARD</td>
</tr>
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<td>F12</td>
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<td>HEMPADUR HIGH BUILD 5520</td>
</tr>
<tr>
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<td>VEG HR AL PAINT TO IS211339</td>
<td>VEG HHR AL PAINT TO 600°C</td>
</tr>
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<td>LPOXY HIGHBUILD P.S.901</td>
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<td></td>
</tr>
<tr>
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<td>INTERPLUX -</td>
<td></td>
<td>INTERTHERM 50</td>
</tr>
<tr>
<td>16.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>JOTUN PAINTS</td>
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<td></td>
</tr>
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<td>EH 4158H</td>
<td>QT 606</td>
<td></td>
</tr>
</tbody>
</table>
SPECIFICATION FOR REPAIR OF PIPELINE CORROSION COATING

SPECIFICATION NO.: MEC/ S/ 05/ 21/ 08

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>SCOPE</td>
</tr>
<tr>
<td>2.</td>
<td>MATERIAL AND EQUIPMENT</td>
</tr>
<tr>
<td>3.</td>
<td>APPLICATION PROCEDURE</td>
</tr>
<tr>
<td>4.</td>
<td>INSPECTION/ TEST</td>
</tr>
<tr>
<td>5.</td>
<td>HOLIDAY INSPECTION</td>
</tr>
<tr>
<td>6.</td>
<td>DOCUMENTATION</td>
</tr>
</tbody>
</table>
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, rust 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 along with 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 feedback 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.
SPECIFICATION FOR PIPELINE MARKERS

SPECIFICATION NO.: MEC/ S/ 05/ 21/ 10

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
CONTENTS

SL.NO. DESCRIPTION
1.0 SCOPE
2.0 REFERENCE CODES AND DRAWINGS
3.0 GENERAL
4.0 AERIAL MARKERS
5.0 KILOMETRE MARKERS
6.0 PIPELINE WARNING SIGN
7.0 ROW BOUNDARY MARKERS
8.0 DIRECTION MARKERS
9.0 NAVIGABLE WATERWAY PIPELINE CROSSING WARNING SIGN

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

PREPARED BY: (Shalini Singh)
CHECKED BY: (Sunil Kumar)
APPROVED BY: (A.K. Johri)
ISSUE DATE: Jan. 2009
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.
SPECIFICATION
FOR
FLUSHING AND TESTING OF
PIPING SYSTEMS

SPECIFICATION NO.: MEC/S/05/21/11

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
CONTENTS

SL. NO. DESCRIPTION

1.0 SCOPE
2.0 REFERENCES
3.0 INSPECTION
4.0 FLUSHING
5.0 TESTING
5.1 EXTENT OF TESTING
5.2 GENERAL REQUIREMENT/TEST PREPARATION FOR TESTING
5.3 TESTING MEDIA, TEST PRESSURE AND TEST PRESSURE GAUGES.
5.4 TESTING PROCEDURE
5.5 COMPLETION OF TESTING
5.6 TEST RECORDS

PREPARED BY: (Shalini Singh)  CHECKED BY: (Sunil Kumar)  APPROVED BY: (A.K. Johri)  ISSUE DATE: Dec. 2008
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 stages 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 ‘fresh potable water’ or ‘dry compressed air, wherever water flushing is not desirable’ to clean the pipe of all dirt, debris or loose foreign materials.

Required pressure of water, flushing shall meet the fire hydrant pressure or utility water pressure. For air flushing the line, system will be pressurised by compressed air at the required pressure which shall be 50 psi maximum. The pressure shall then be released by quick opening of a valve, already in the line for this purpose. This procedure shall be repeated as many times as required till the inside of the pipe is fully cleaned.

In line instruments like control valves, orifice plates, rotameters, safety valves and other instruments like thermowells which may interfere with flushing shall not be included in the flushing circuit.
From all permanent strainers the screens/meshes shall be removed before flushing. Screens/meshes shall be re-installed after flushing but before testing.

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 compressed air, after flushing is completed.

During flushing discharged water/air shall be drained at the place directed the Engineer-in-Charge. If necessary, proper temporary drainage shall be provided by the contractor.

Care shall be taken during flushing so as not to damage/spoil work of other agencies. Precautions shall also be taken to prevent entry of water/foreign matter into equipment, electric motors, instruments, electrical installations etc. in the vicinity of lines being flushed.

The contractor shall carry out all the activities required before, during and after the flushing operation, arising because of flushing requirements, such as but not limited to the following.

Dropping of valves, specials, distance pieces, online instruments and any other piping part before flushing. The flanges to 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, ‘IBR Regulations’ shall 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 rotary equipments shall not be subjected to field test pressures.

Lines which are directly open to atmosphere such as vents, drains, safety valves, discharge need not be tested, but all joints shall be visually inspected wherever necessary such lines shall be tested by continuous flow of fluid to eliminate the possibility of blockage. However, such lines if provided with block valve shall be pressure tested up to the first block valve.

Seats of all valves shall not be subjected to a pressure in excess of the maximum cold welding pressure of the valve. Test pressure applied to valves shall not be greater than the manufacturer's recommendation nor less than that required by the applicable code. Where desirable set pressure is less than test pressure, test shall be made through an open valve.

Instruments in the system to be tested, shall be excluded from the test by isolation or removal, unless approved otherwise by the Engineer-in-charge. Restrictions which interfere with filling, venting and drawing such as orifice plates etc. shall not be installed unless testing is complete.

Control valves shall not be included in the test system. Where by-passes are provided test shall be performed through the by-pass end/or necessary spool shall be used in place of the control valve.

Pressure gauges which are part of the finished system, but cannot withstand test pressure shall not be installed until the system has been tested. Where piping systems to be tested are directly connected at the battery limit 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 dirt loose scale, debris and other loose foreign materials.

All piping systems to be hydrostatically tested shall be vented at the high points and the systems purged of air before the test pressure is applied.

Wherever in the line any void is existing due to any reason, 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 blank cannot be used, such as pumps, compressors, turbines or wherever equipment or pipe spool have been received or disconnected prior to hydrostatic testing, shall be blinded—off by using standard blind flanges of same rating as the piping system being tested.

Pressure gauges used in testing shall be installed as close as possible to the lowest point in the piping system to be tested, to avoid overstressing of any of the lower portion of the system. For longer lines and vertical lines, two or more pressure gauges shall be installed at locations selected by the Engineer-in-charge. For lines containing check valves any of the following alternatives shall be adopted for pressure testing. Wherever possible 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-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/cm² (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 chlorine content in water for hydrostatic testing for MS piping shall be 15-20 ppm. Air shall be used for testing only if water would cause corrosion of the system or overloading of supports etc. in special cases as directed by Engineer-in-charge.

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 systems falls in 35% to 65% of gauge scale range. Pressure gauge 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 ±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. These gauges are to be checked by the standard test gauge before each pressure test.

Care shall be taken to avoid increase in the pressure due to atmospheric variation during the test.

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 complete 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 \textbf{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 INSULATIONS

1.0 SCOPE

2.0 FUNCTION

3.0 DESIGN

4.0 MATERIAL

5.0 INSPECTION AND TESTING

PART-B  CASING END-SEALS

1.0 SCOPE

2.0 FUNCTION

3.0 DESIGN

4.0 MATERIAL

5.0 INSPECTION AND TESTING

PART-C SUPPLEMENTARY REQUIREMENTS
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 up to 12” (generally). For larger diameters, the number of segments may be more than two, but their number shall be kept minimum.

The skid height shall be such that it is slightly less than the value obtained by following formula.
Casing internal dia-carrier outer dia  
2

Manufacturer shall obtain prior approval from COMPANY on casing insulators drawings/designs.

4.0 MATERIAL

Casing insulators shall be made of injection moulded high density polyethylene or other material equivalent or superior as approved by COMPANY and shall meet the following specifications:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>ASTM Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dielectric strength</td>
<td>450-500 Volts/Mil</td>
<td>D-149</td>
</tr>
<tr>
<td>Compressive strength</td>
<td>3200 psi</td>
<td>D-695i</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>3100-5000</td>
<td>D-638, D-651</td>
</tr>
<tr>
<td>Impact strength</td>
<td>4.Oft. 1b./inch of notch</td>
<td>D-256</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>0.01%</td>
<td>D-570</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Property</th>
<th>Minimum Value</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Backing (Sleeve and closure patch)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile strength</td>
<td>2200 psi</td>
<td>ASTM D-638</td>
</tr>
<tr>
<td>Ultimate Elongation</td>
<td>400%</td>
<td>ASTM D-638</td>
</tr>
<tr>
<td>Heat Shock flow</td>
<td>No visual cracks, or drips</td>
<td>ASTM D-2671 (at 225°C, 4 hours)</td>
</tr>
<tr>
<td>b) Adhesive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ring and Ball softening point</td>
<td>90°C</td>
<td>ASTM E-28</td>
</tr>
<tr>
<td>Lap Shear</td>
<td>60°C - 25 psi</td>
<td>ASTM D-1002</td>
</tr>
<tr>
<td></td>
<td>23°C - 250 psi inch/min)</td>
<td></td>
</tr>
<tr>
<td>c) System (as applied)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peel strength</td>
<td>5 pli</td>
<td>ASTM D-1000</td>
</tr>
<tr>
<td>(To casing and carrier pipe and closure patch)</td>
<td>10 inch/min.)</td>
<td></td>
</tr>
</tbody>
</table>

5.0 INSPECTION AND TESTING

Manufacturer shall furnish material test certificates of the components used in the assembly of casing end-seals as per the requirements of this specification.
PART-C SUPPLEMENTARY REQUIREMENTS

1.0 The Manufacturer shall replace, at no extra cost, any material not conforming to the material and performance requirements of this specification.

2.0 Manufacturer shall submit detailed specification of the materials used in the assemblies, along with instructions for handling, use and installation of the material for COMPANY approval prior to procurement.

3.0 Manufacturer shall submit all the documents, test reports, records and other information in six copies to the COMPANY for record after approval as per clause 2.0 above.
SPECIFICATION
FOR
FIELD JOINT COATING
(ONSHORE PIPELINES)

SPECIFICATION NO.: MEC/S/05/21/13

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
## CONTENTS

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>SCOPE</td>
</tr>
<tr>
<td>2.0</td>
<td>REFERENCE DOCUMENTS</td>
</tr>
<tr>
<td>3.0</td>
<td>MATERIAL AND EQUIPMENT</td>
</tr>
<tr>
<td>4.0</td>
<td>APPLICATION PROCEDURE</td>
</tr>
<tr>
<td>5.0 I</td>
<td>INSPECTION</td>
</tr>
<tr>
<td>6.0 T</td>
<td>TESTING</td>
</tr>
<tr>
<td>7.0 REPAIR</td>
<td>RS</td>
</tr>
<tr>
<td>8.0 DO</td>
<td>DOCUMENTATION</td>
</tr>
</tbody>
</table>

**PREPARED BY:** (Shalini Singh)  
**CHECKED BY:** (Sunil Kumar)  
**APPROVED BY:** (A.K. Johri)  
**ISSUE DATE:** May 2009
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 – “Cathodic Protection – External Organic Coatings for the Corrosion Protection of Buried or Immersed Steel Pipelines used in Conjunction with Cathodic Protection – Tapes and Shrinkable Materials” and the requirements of this specification. Unless modified/ replaced by this specification, all requirements of DIN EN 12068 shall remain fully applicable and complied with.

This specification shall be read in conjunction with the conditions of all specifications and documents included in the Contract between Company and Contractor. Unless specified otherwise, all sections of this specification shall apply to all specifications referred in this specification.

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.


c) ASTM D-570 : Standard Method of Test for Water Absorption of Plastics.

d) ISO 8502-3 : Preparation of Steel Substrates before Application of Paints and Related Products – Part 3 – Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure Sensitive Tape Method).


### 2.0 FIELD JOINT COATING

#### (ONSHORE PIPELINES)

**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 shrinkable wraparound sleeve or cold applied tape suitable for a maximum operating temperature of (+) 65°C ($T_{\text{max}}$) and shall conform to designation EN 12068 – C HT 60 UV. In addition the field joint anti-corrosion coating shall comply the requirements specified in para 3.3 of this specification.

**3.2.1 Heat Shrinkable Wraparound Sleeve**

Heat shrinkable wraparound sleeve shall consist of radiation cross-linked thermally stabilised, ultraviolet resistant semi-rigid polyolefin backing with a uniform thickness of high shear strength thermoplastic/copolymer hot melt adhesive. The joint coating system may consist of a solvent free epoxy primer applied to the pipe surface prior to sleeve application. The backing shall be coated with thermochrome paint which will change colour when the desired heat during shrinking is attained. The wraparound sleeve shall be supplied in pre-cut sizes to suit the diameter and the requirements of overlap.
The total thickness of heat shrinkable wraparound sleeve in the as applied condition shall be as follows:

<table>
<thead>
<tr>
<th>Pipe Size (Specified Outside Diameter)</th>
<th>Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On Pipe Body (Min.)</td>
</tr>
<tr>
<td>4” (114.3 mm) to 10” (273.0 mm)</td>
<td>2.0 mm</td>
</tr>
<tr>
<td>12” (323.9 mm) to 18” (457.2 mm)</td>
<td>2.2 mm</td>
</tr>
<tr>
<td>20” (508.0 mm) to 30” (762.0 mm)</td>
<td>2.5 mm</td>
</tr>
<tr>
<td>≥ 32” (812.8 mm)</td>
<td>3.0 mm</td>
</tr>
</tbody>
</table>

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:

Page 295 of 514
3.3.2 Functional Properties of Joint Coating System (As applied)

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

a) Cathodic Disbondment Resistance at $T_{\text{max}}$ i.e. 60°C shall be 20m when tested as per Annexure K of DIN EN 12068. Test shall be carried out at (+) 60°C.

b) Peel Strength shall be as follows:

<table>
<thead>
<tr>
<th>Peel Strength</th>
<th>Unit</th>
<th>Requirement for Mech Resistance Class C (Minimum)</th>
<th>Test Method as per DIN EN 12068</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner to Inner + Outer to Inner</td>
<td>@23°C N/mm</td>
<td>1.5</td>
<td>Annexure-B</td>
</tr>
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<td>@T_{\text{max}} N/mm</td>
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<tr>
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</tr>
<tr>
<td>To Pipe Surface</td>
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<td>3.5</td>
<td>Annexure-C</td>
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<td>@T_{\text{max}} N/mm</td>
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<tr>
<td>To Factory Coating</td>
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<td>3.5</td>
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<td>@T_{\text{max}} N/mm</td>
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</table>

Notes

($T_{\text{max}}$ shall be (+) 60°C)
Contractor shall obtain prior approval from Company regarding the manufacturer of the joint coating material. Complete technical details along with test certificates complying with the requirements of clause 3.2.1 and 3.2.2 shall be submitted to Company for this purpose. The Contractor shall furnish test certificates from an independent DIN recognized/approved laboratory for all the properties required for the specified EN designation of field joint coating and the requirements of this specification.

3.3 The materials shall not be older than their period of validity at the time of application by CONTRACTOR. Deteriorated/decomposed material shall be disposed of and replaced by CONTRACTOR at his own expense.

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

- Manufacturer’s name
- Material qualification
- Batch number
- Date of manufacturing and date of expiry.

3.4 CONTRACTOR shall ensure that the manufacturer has carried out all quality control tests on each batch and the manufacturer shall provide test certificates to certify that the supplied materials meet the manufacturer’s specifications as indicated in the purchase order and as approved by COMPANY. Certificates and data sheets certifying the qualities of the coating materials shall be submitted by CONTRACTOR to COMPANY prior to application. COMPANY reserves the right to have the materials tested by an independent laboratory.

3.5 Materials shall be stored in sheltered storage in the manufacturer’s original packing and away from direct sunlight and in accordance with manufacturer’s instructions.

3.6 CONTRACTOR shall provide and maintain mobile facilities which contain 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 manufacturer’s instruction and the minimum requirements specified below whichever are the most stringent and shall be demonstrated to and approved by the Company. Manufacturer’s expert shall supervise the application and shall be available at site upon request during qualification of application procedure and during construction at Contractor’s cost.

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 “Inspection” and “Testing” of 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 5°C and more than 3°C above ambient Dew Point, while the ambient Relative Humidity shall not be greater than 85%. Prior to surface cleaning the surface shall be completely dry. The surface shall be cleaned to a grade Sa 2½ in accordance with Swedish Standard SIS-055900 with a roughness profile of 50-70 microns. Surface roughness profile shall be measured using an approved profile comparator in accordance with ISO 8503-1 and shall be calibrated prior to the start of the work in accordance with ISO:8503-3 or ISO:8503-4. The blast cleanliness shall be checked on every joint and the roughness profile shall be checked 1 every 10 joints.

Dust 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:
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.
Before centering the wraparound sleeve, the bare steel surface shall be preheated with a torch moved back and forth over the surface or by induction heating. The minimum preheat temperature shall be as recommended by the manufacturer and shall be checked by means of contact type temperature recording thermometer (Digital Pyrometer with flat probe type contact) 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.

Upon pre-heating the pipe surface shall be applied with two pack epoxy primer of wet film thickness 150 microns or as per manufacturer’s recommendation whichever is higher, to cover the exposed bare metal of the welded field joint and 10mm min. onto the adjacent pipe coating if recommended by the manufacturer. The wet film thickness of the primer shall be checked on every joint with a wet film thickness gauge prior to installation of sleeve. Thickness gauge shall be calibrated once per shift.

Immediately after application of epoxy primer, the wraparound sleeve shall be entirely wrapped around the pipe within the stipulated time recommended by the manufacturer. Sleeve shall be positioned such that the closure patch is located to one side of the pipe in 10 or 2 O’clock position, with the edge of the undergoing layer facing upward and an overlap of min. 50mm. Gently heat by appropriate torch the backing and the adhesive of the closure and press it firmly into place.

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 underground installations.

For HDD Joint Coating fiber glass reinforced heat shrinkable sleeve certified to Stress class C60 type CANUSA- TBK or CO VALENCE / 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 above ground 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 manufacturer's recommendation whichever is higher to cover the exposed bare metal of the welded field joint and 10mm min. onto the adjacent pipe coating if recommended by the manufacturer. Any dirt on the primed surface shall be removed. If the primer is damaged, the damaged area shall be cleaned and re-primed.

4.3.3 Approximately 100mm of tape interleaving paper shall be peeled back and tape shall be applied with the adhesive side to the pipe. Whilst continuously removing the interleaving paper, the tape shall be spirally applied to provide a minimum of 55% overlap. Sufficient tension shall be applied to ensure good conformity, avoiding air pockets and also continuously smooth out as the wrapping proceeds. The wrapping shall start and finish to give a minimum of 50mm overlap on the adjoining yard applied coating. Outer wrap shall also be applied in similar method.
In the cases where carrier pipe is inst alled 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 t hese cases shall be such t hat 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 t hen 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 (+) 23°C & (+) 60°C on pipe sur face & factory applied coating and
at over laps (as applicable). If required to achieve the temperature of (+) 60°C,
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 coated 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 the 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.

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-destructive 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 25 mm 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 t o t h e com plete sat isfaction of t he Com pany, alr eady com pleted f ield 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 established, the Contractor shall be responsible for excavations at such points, repairing the coating, spark testing and back filling 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 feedback 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.

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

i. Test certificates/results as per Manufacturer's Quality Control Procedure for each batch of materials.

ii. Specific application instructions with pictorial illustrations.

iii. Specific storage and handling instructions.

8.3 All documents shall be in English Language only.
SPECIFICATION
FOR
VENTS, DRAINS AND WELLS

SPECIFICATION NO.: MEC/S/05/21/15

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
## CONTENTS

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>DESCRIPTION OF DRAWING</th>
<th>DRAWING NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Vent &amp; Drain for Line 2” &amp; above</td>
<td>MEC/SD/05/21/15/01</td>
</tr>
<tr>
<td>2.</td>
<td>Wells Installation 1½ Dia Taps</td>
<td>MEC/SD/05/21/15/02 (Sheet 1 of 2)</td>
</tr>
<tr>
<td>3.</td>
<td>Wells Installation 1½ Dia Taps</td>
<td>MEC/SD/05/21/15/02 (Sheet 2 of 2)</td>
</tr>
<tr>
<td>4.</td>
<td>Vent &amp; Drain for lines 1½” &amp; below</td>
<td>MEC/SD/05/21/15/03</td>
</tr>
<tr>
<td>5.</td>
<td>Pressure Tapping</td>
<td>MEC/SD/05/21/15/05</td>
</tr>
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</table>

**Prepared by:**
(Binita Brahma)

**Checked by:**
(Sunil Kumar)

**Approved by:**
(A.K. Johri)

**Issue Date:**
Feb. 2009
VENT & DRAIN
FOR LINES 2" & ABOVE
Page 308 of 514

NOTES:
1. DIMENSIONS ARE VALID FOR 75mm (MAX.) THICKNESS INSULATION FOR HIGHER INSULATION THICKNESSES INCREASE 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, BUSH 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.
WELLS INSTALLATION

1/2" DIA TAPS

Page 310 of 514

<table>
<thead>
<tr>
<th>LINE DIA</th>
<th>L</th>
<th>1.5&quot; FLANGED WELD</th>
</tr>
</thead>
<tbody>
<tr>
<td>4&quot;</td>
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<tr>
<td>VESSELS</td>
<td>AS REQUIRED</td>
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</table>
NOTES:—
1. DIMENSIONS ARE VALID FOR 50mm (MAX.) THICKNESS INSULATION.
   FOR HIGHER INSULATION THICKNESS INCREASE 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.
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 FLGID. VALVES BOLTING & GASKET ON BOTH SIDES OF VALVE SHALL BE IN PIPING SCOPE.
4. IN CASE OF TAPINGS PROVIDED OTHER THAN INDICATED IN THIS STD FOR LAYOUT REASONS DETAILED DIMENSIONS WILL BE CALLED OUT.
STANDARD SPECIFICATION
FOR
BLASTING

SPECIFICATION NO.: MEC/S/05/21/18

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
# CONTENTS

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>SCOPE</td>
</tr>
<tr>
<td>2.0</td>
<td>REFERENCE DOCUMENTS</td>
</tr>
<tr>
<td>3.0</td>
<td>GENERAL</td>
</tr>
<tr>
<td>4.0</td>
<td>MATERIALS</td>
</tr>
<tr>
<td>5.0</td>
<td>PERSONNEL</td>
</tr>
<tr>
<td>6.0</td>
<td>STORAGE OF EXPLOSIVES</td>
</tr>
<tr>
<td>7.0</td>
<td>PREPARATION OF EXPLOSIVES</td>
</tr>
<tr>
<td>8.0</td>
<td>PREPARATION OF PRIMERS</td>
</tr>
<tr>
<td>9.0</td>
<td>CHARGING OF HOLES</td>
</tr>
<tr>
<td>10.0</td>
<td>ELECTRICAL FIRING</td>
</tr>
<tr>
<td>11.0</td>
<td>VIBRATION RECORDING</td>
</tr>
<tr>
<td>12.0</td>
<td>MISFIRES</td>
</tr>
<tr>
<td>13.0</td>
<td>DISPOSAL OF DETERIORATED EXPLOSIVES</td>
</tr>
</tbody>
</table>

**PREPARED BY:** (Shalini Singh)  
**CHECKED BY:** (Sunil Kumar)  
**APPROVED BY:** (A.K. Johri)  
**ISSUE DATE:** Jan. 2009
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 enforced 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
   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 et c., 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 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-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 electrical 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 company 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 the 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 box(es) 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 prickler. 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 bugle with a distinctive note shall be used to give the warning signals. The bugle shall not be used for any other purpose. All the labor shall be made acquainted with the sound of the bugle and shall be strictly warned to leave their work immediately at the first warning signal and to take safe shelters, and not to leave the shelters until the all clear signals have been given.
All the roads and footpaths leading to the blasting area shall be watched. All the escape routes shall have been clearly marked.

10.0 ELECTRICAL FIRING

- Only the Supervisor-In-Charge shall keep the key of the firing apparatus and shall keep it always with himself.
- Special apparatus shall be used as source of current for the firing operations. Power lines shall not be tapped for the purpose.
- The firing cable shall have a proper insulating cover so as to avoid short circuiting due to contact with water, metallic parts or rock.
- The use of earth as a return line shall not be permitted.
- The firing cable shall be connected to the source of current only after ascertaining that nobody is in the area of blasting.
- Before firing, the circuit shall be checked by a suitable apparatus.
- After firing, whether with or without an actual blast, the contact between the firing cable and the source of current shall be cut off before any person is allowed to leave the shelter.
- During storms, charging with electrical detonators shall be suspended. The charges already placed into the holes shall be blasted as quickly as possible after taking all the safety precautions and giving necessary warning signals. If this is not possible, the site shall be abandoned till the storm has passed.

11.0 VIBRATION RECORDING

- Contractor shall use Company approved vibration recording system capable of measurement in three axes (tri-axial). The device shall have an accuracy of 0.0025 mm and a resonance of 2 Hz.
  - The device shall measure both frequency and amplitude of vibration.
- All the measurement devices shall be calibrated by an APPROVED certification body.
- Particle velocity shall not exceed the following:
  - Areas beyond 500 m of proposed pipeline 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 or jet of water or compressed air (using a pipe of soft material) and withdraw the fuse with the primer and detonator attached. A fresh primer and detonator with fuse shall then be placed in this hole and fired.

  II) The Supervisor shall get one foot of the tamping cleaned off and indicate the direction by placing a stick in the hole. Another hole may then be drilled at least 9" away and parallel to it, this hole should then be char ged 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 of 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 of shall be intimated to Company prior to its disposal. All the records of such disposal shall be maintained by Contractor.
SPECIFICATION FOR GASKETS, BOLTS & NUTS

SPECIFICATION NO.: MEC/S/05/21/19

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
## CONTENTS

<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>GASKETS</td>
</tr>
<tr>
<td>2.0</td>
<td>NUTS AND BOLTS</td>
</tr>
</tbody>
</table>

**Prepared By:** (Shalini Singh)

**Checked By:** (Sunil Kumar)

**Approved By:** (A.K. Johri)

**Issue Date:** Jan. 2009
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 / sealability & 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 :

<table>
<thead>
<tr>
<th>Ring Gasket Material</th>
<th>Maximum Hardness (BHN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft Iron</td>
<td>90</td>
</tr>
<tr>
<td>Carbon steel</td>
<td>120</td>
</tr>
<tr>
<td>5 Cr. ½ Mo</td>
<td>130</td>
</tr>
<tr>
<td>Type 304, 316, 321, 347</td>
<td>140</td>
</tr>
<tr>
<td>Type 304L, 316L</td>
<td>120</td>
</tr>
</tbody>
</table>
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 B18.2.2 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 PIPELINE NETWORK & ASSOCIATED WORKS FOR CITY GAS DISTRIBUTION FOR NORTH GOA GA)

DOC. NO. MEC/23SA/05/25/M/000/1092, R0

(PROCESS & PIPELINE DESIGN SECTION)
MECON LIMITED
DELHI - 110 092
# TABLE OF CONTENTS

1.0 SCOPE  
2.0 CODES AND STANDARDS  
3.0 MATERIAL SPECIFICATION  
4.0 CLASS DESIGNATION CODE  
5.0 PIPELINE  
6.0 PIPING  
7.0 FITTINGS  
8.0 BENDS  
9.0 FLANGES  
10.0 GASKETS  
11.0 BOLTING  
12.0 THREAD SEALANT  
13.0 QUICK OPENING END CLOSURE  
14.0 HYDROTESTING VENTS AND DRAINS  
15.0 PIPELINE SPECIALITY ITEMS  

| TABLE-1 | INDEX OF PIPING MATERIAL SPECIFICATIONS  
| TABLE-2 | PIPE WALL THICKNESS DETAIL FOR MAIN LINE  
| APPENDICES-I TO VI | PIPING MATERIAL SPECIFICATIONS AS PER TABLE - 1  

<table>
<thead>
<tr>
<th>PREPARED BY:</th>
<th>CHECKED BY:</th>
<th>APPROVED BY:</th>
<th>DATE ISSUED:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Rahul R) DE</td>
<td>(Shalini Singh) SDE</td>
<td>(Sunil Kumar) AGM</td>
<td>June, 2016</td>
</tr>
</tbody>
</table>
1.0 **SCOPE**

This specification covers the requirements of various piping materials used in piping/pipeline system handling Natural Gas / Regasified Liquid Natural Gas (RLNG) 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:

First letter indicates ANSI class rating e. g.
A-Class 150
B-Class 300
D-Class 600
The middle number indicates differences in the specification within the same rating and material.

The last letter indicates type of material e.g.

A-Carbon Steel

5.0 PIPELINE

The material for linepipe shall be as per the requirements of specification as indicated in Table-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.

7.5 Dimensions of butt welded carbon steel fittings shall be as per ASMEB 16.9 / MSS-SP-75, as applicable.
7.6 Butt welding ends shall conform to ANSI B 16.25/ API 5L. In case of difference in thickness of matching ends, requirements of ASME B 31.8 shall apply.

7.7 Integrally reinforced forged branch fittings such as sockolet, threadolet, weldolet, nipolet 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 up to 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 (\( R = 6D \)) may be permitted for reason of space constraints.

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.

9.7 Carbon steel flanges faces shall have smooth finish as indicated in the material specification. Flanges faces shall have smooth finish to 125-250 micro inches AARH as per MSS-SP-6.

9.8 Butt welding ends of WN flanges shall conform to ANSI B 16.25.
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 upto 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 1/8" to 3 ¾" : 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 1/8" to 3 ¾" : 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 scraper 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 socket, Plug & Ball valve for vent, Globe & Ball Valve for drain, flange & blind flange.

15.0 PIPELINE SPECIALITY ITEMS

Pipeline Specialty items viz., Scraper Traps, Flow Tee, Insulating Joints, LR bends, QOEC for Venting shall be as per respective data sheets, specifications and Project Specific drawing showing Mainline & Terminal materials.
### PIPE WALL THICKNESS DETAIL FOR MAIN LINE

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Pipe Material Description</th>
<th>Size (NB)</th>
<th>Thickness (mm)</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>API 5L Gr. X-52, PSL-2</td>
<td>8&quot;</td>
<td>6.4</td>
<td>As per SOR Quantity</td>
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<tr>
<td>2.</td>
<td>API 5L Gr. X-52, PSL-2</td>
<td>6&quot;</td>
<td>6.4</td>
<td>As per SOR Quantity</td>
</tr>
<tr>
<td>3.</td>
<td>API 5L Gr. X-52, PSL-2</td>
<td>4&quot;</td>
<td>6.4</td>
<td>As per SOR Quantity</td>
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</tbody>
</table>

### INDEX OF PIPING MATERIAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Class</th>
<th>Service</th>
<th>C.A. (mm)</th>
<th>Basic Material</th>
<th>Design Code</th>
<th>Enclosed as</th>
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<tbody>
<tr>
<td>A1A</td>
<td>Natural Gas</td>
<td>1.5</td>
<td>ASTM A 106 Gr. B / API 5L Gr. B</td>
<td>ANSI B31.8</td>
<td>Appendix-I</td>
</tr>
<tr>
<td>A4A</td>
<td>Natural Gas</td>
<td>1.5</td>
<td>ASTM A333 Gr. 6</td>
<td>ANSI B31.8</td>
<td>Appendix-II</td>
</tr>
<tr>
<td>B1A</td>
<td>Natural Gas/ RLNG</td>
<td>1.5</td>
<td>ASTM A 106 Gr. B / API 5L Gr. B</td>
<td>ANSI B31.8</td>
<td>Appendix-III</td>
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<tr>
<td>B4A</td>
<td>Natural Gas/ RLNG</td>
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<td>ASTM A 333 Gr. 6</td>
<td>ANSI B31.8</td>
<td>Appendix-IV</td>
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<td>D1A</td>
<td>Natural Gas</td>
<td>1.5</td>
<td>ASTM A 106 Gr. B / API 5L Gr. B</td>
<td>ANSI B31.8</td>
<td>Appendix-V</td>
</tr>
<tr>
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<td>Natural Gas</td>
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<td>ASTM A 333 Gr. 6</td>
<td>ANSI B31.8</td>
<td>Appendix-VI</td>
</tr>
</tbody>
</table>
ANSI CLASS: 150  
ALLOWANCE: 1.5 MM  
TEMP °C  
-29 38.0 50 100 150 200  
PRESS. KG/CM² 9.18 9.18 9.57 8.05 16.11 14.07  
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 19 KG/CM² & (-29° TO +65°C) RESPECTIVELY.
7. PRESSURE-TEMPERATURE RATING INDICATED ARE FOR FLANGES ONLY IN ACCORDANCE WITH ANSI B 16.5.
8. FOR VALVES, STEEL PIPE 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 SUBJECT TO MPI/DPT.
12. PRESSURE-TEMPERATURE RATING OF VALVE BODY SHALL BE AS PER API 6D.
14. FOR PIPELINE SPECIALITY ITEMS (SCRAPPER TRAP, BARRED TEE, U, LR BENDS ETC.) AND THEIR MATERIAL DESCRIPTIONS REFER DATA SHEET OF RESPECTIVE ITEMS.

STATION PIPING MATERIAL SPECIFICATION

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<thead>
<tr>
<th>ITEM</th>
<th>SIZE</th>
<th>DESCRIPTION</th>
</tr>
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<tbody>
<tr>
<td>MAINTENANCE JOINTS</td>
<td>ALL FLGD., BUT TO BE KEPT MINIMUM</td>
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<tr>
<td>PIPE JOINTS</td>
<td>1.5&quot; &amp; BELOW</td>
<td>SOCKET WELD</td>
</tr>
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<td></td>
<td>2&quot; &amp; ABOVE</td>
<td>BUTT WELDED</td>
</tr>
<tr>
<td>DRAINS</td>
<td>ON LINES &lt; 1.5&quot;</td>
<td>3/4&quot;, AS PER MEC/SD/05/21/15/03</td>
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<tr>
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BRANCH CONNECTIONS

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<tr>
<th>BRANCH PIPE NOMINAL DIA (INCHES)</th>
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<tbody>
<tr>
<td>E. TEES BW</td>
</tr>
<tr>
<td>H. H. COUPLING</td>
</tr>
<tr>
<td>P. PIPE TO PIPE</td>
</tr>
<tr>
<td>R. REINFORCED</td>
</tr>
<tr>
<td>S. SOCKETLETS</td>
</tr>
<tr>
<td>T. TEES SW</td>
</tr>
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<td>W. WELDLETS</td>
</tr>
<tr>
<td>D. TEE WITH RED.</td>
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RUN PIPE NOMINAL DIA (INCHES)
### Pipeline Piping Design Code

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<th>Wall Thickness (inches)</th>
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### Flange Material and Grade

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<tr>
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<td>RF 125A</td>
<td>SFN 125A</td>
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### Bolting Type and Material

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<td>Stud Bolts (Fully Threaded)</td>
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<td>Nuts (Heavy Hexagonal)</td>
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### Elbow-90 and Elbow-45

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### Coupling Type

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<tr>
<td>Coupling</td>
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### References

- GOA NATURAL GAS PRIVATE LTD
- CITY GAS DISTRIBUTION PROJECT
- PIPING MATERIAL SPECIFICATIONS 150# (A1A)

**Scale:** N.T.S. (SH. 2 OF 2)
### ANSI CLASS: 150#
ALLOWANCE: 1.5MM

<table>
<thead>
<tr>
<th>PRESS. KG/CM²</th>
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<td>18.55</td>
<td>17.74</td>
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### SERVICE: RLNG
BASE MATERIAL: CARBON STEEL (MATERIAL GROUP 1.3)

### 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. PRESSURE-TEMPERATURE RATING INDICATED ARE FOR FLANGES ONLY IN ACCORDANCE WITH ANSI B 16.5
7. FOR VALVES, STEEL PIPE 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.
8. AT STATIONS, BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE BELOW
9. ALL BUTT WELDS SHALL BE 100% RADIOGRAPHED.
10. 100% OF SOCKET WELD SHALL BE SUBMITTED TO MPI/DPT.
11. PRESSURE-TEMPERATURE RATING OF VALVE BODY SHALL BE AS PER API 6D.
13. FOR PIPELINE SPECIALTY ITEMS (SCRAPPER TRAP, FLOW TEE, IJ, LR BENDS ETC.) AND THEIR MATERIAL DESCRIPTIONS, REFER DATA SHEET OF RESPECTIVE ITEMS.
14. DESIGN PRESSURE & TEMP. FOR PIPELINE AND RELATED FACILITIES ARE 19 KG/cm² & (-45°C TO +65°C) RESPECTIVELY.

### STATION PIPING MATERIAL SPECIFICATION

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<tr>
<th>ITEM</th>
<th>SIZE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>MAINTENANCE JOINTS</td>
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<td>FLGD., BUT TO BE KEPT MINIMUM</td>
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<td>1.5&quot; &amp; BELOW</td>
<td>SOCKET WELD</td>
</tr>
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<td>2&quot; &amp; ABOVE</td>
<td>BUTT WELDED</td>
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<tr>
<td>DRAINS</td>
<td>ON LINES ≤ 1.5&quot;</td>
<td>3/4&quot;, AS PER MEC/SD/05/21/15/03</td>
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<td>ON LINES ≥ 2&quot;</td>
<td>3/4&quot; OR AS PER P&amp;D, MEC/SD/05/21/15/01</td>
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<td>FLANGE</td>
<td>TYPE, FLANGE FACING</td>
<td>SW RF 125AARH</td>
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<td>DIMENSION STD. B16.48</td>
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<td>BOLTING</td>
<td>TYPE</td>
<td>FIG.8 FLANGE</td>
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<td>STUD BOLTS (FULLY THREADED)</td>
<td>A 320 GR L7, B-18.2</td>
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<td>NUTS (HEAVY HEXAGONAL)</td>
<td>A 194 GR 4, B-18.2</td>
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<td>GASKET</td>
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<td>SPIRAL, SP-MONO SS316+GRAPHITE FILLED, B-16.20-ANSI B16.5</td>
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<td>ELBOW-90</td>
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<td>ELBOW-45</td>
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<td>MATERIAL</td>
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ANSI CLASS: 300 #  
CORROSION ALLOWANCE: 1.5 MM  
TEMP °C  
-29.0  38.0  50  100  150  200  
PRESS. KG/CM²  
52.1  52.1  51.10  47.52  45.98  44.60  
SERVICE: NATURAL GAS  
BASE MATERIAL: CARBON STEEL  
(MATERIAL GROUP 1.1)  

NOTES:

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5. PROCUREMENT OF MATERIALS SHALL BE AS PER DETAILED RELEVANT SPECIFICATIONS.
6. DESIGN PRESSURE & TEMP. FOR PIPELINE AND RELATED FACILITIES ARE 49 Kg/cm² 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, STEEL PIPE AND ASSOCIATED STEEL COMPONENTS OF 2" & LARGER NOTCH TOUGHNESS PROPERTIES SHALL BE AS SPECIFIED. IN RELEVANT SPECIFICATIONS/CODES, MECON'S STANDARD TECHNICAL SPECIFICATIONS AND DATA SHEETS ETC.
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BRANCH CONNECTIONS

- E TEES BW
- H H. COUPLING
- P PIPE TO PIPE
- R REINFORCED
- S SOCKETETS
- T TEES SW
- W WELDOUTS
- D TEE WITH RED.
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<td>10.0 12.0 14.0 16.0 18.0 20.0</td>
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<td>B36.10</td>
<td>API 5L</td>
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<td>SEAMLESS BE</td>
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<td>DIMENSION STD.</td>
<td>B16.48</td>
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<td>TYPE</td>
<td>FIG.8 FLANGE</td>
<td>SPACER &amp; BLIND</td>
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<tr>
<td><strong>BOLTING</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STUD BOLTS (FULLY THREADED)</td>
<td>A 193 GR B7, B-18.2</td>
<td></td>
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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 LIPPIE USED IN VARIOUS SECTIONS SHALL BE AS PER TABLE-1 OF PMS.
4. BALL VALVE TO BE USED IN MAINLINE SHALL HAVE BUTT WELD 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. PRESSURE-TEMPERATURE RATING INDICATED ARE FOR FLANGES ONLY IN ACCORDANCE WITH ANSI B 16.5.
7. FOR VALVES, STEEL PIPE AND ASSOCIATED STEEL COMPONENTS OF 2" & LARGER NOTCH TOUGHNESS PROPERTIES SHALL BE AS SPECIFIED. IN RELEVANT SPECIFICATIONS/CODES, MECON'S STANDARD TECHNICAL SPECIFICATIONS AND DATA SHEETS ETC.
8. AT STATIONS, BRANCH CONNECTIONS SHALL BE AS PER BRANCH CONNECTION TABLE BELOW.
9. ALL BUTT WELDS SHALL BE 100% RADIOGRAPHED.
10. 100% OF SOCKET WELD SHALL BE SUBJECTED TO MPI/DPT.
11. PRESSURE-TEMPERATURE RATING OF VALVE BODY SHALL BE AS PER API 6D.
13. FOR PIPELINE SPECIALITY ITEMS (SCRAPER TRAP, FLOW TEE, IJ, LR BENDS ETC.) AND THEIR MATERIAL DESCRIPTIONS REFER DATA SHEET OF RESPECTIVE ITEMS.
14. DESIGN PRESSURE & TEMP. FOR PIPELINE AND RELATED FACILITIES ARE 49 KG/cm² & (-45° TO +65°C)

STATION PIPING MATERIAL SPECIFICATION

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<td>3/4&quot;, AS PER MEC/SD/05/21/15/03</td>
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### ANSI
CLASS: 600
ALLOWANCE: 1.5 MM
TEMP C | -29.0 | 38.0 | 50 | 100 | 150 | 200 | 250
PRESS. KG/CM² | 104.14 | 104.14 | 102.2 | 95.04 | 91.97 | 89.35 | 85.07

### SERVICE
NATURAL GAS
BASE MATERIAL: CARBON STEEL (MATERIAL GROUP 1.1)

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2. FITTINGS SHALL BE OF SEAMLESS CONSTRUCTION UP TO 16" AND SHALL BE OF WELDED CONSTRUCTION 18" AND ABOVE.
3. WALL THICKNESS FOR LINE PIPE 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 92 Kg/CM² & (-29° TO +65°C) RESPECTIVELY.
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### BRANCH CONNECTIONS

- E TEES BW
- H H. COUPLING
- P PIPE TO PIPE
- R REINFORCED
- S SOCKETETS
- T TEES SW
- W WELDLOADS
- D TEE WITH RED.

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TECHNICAL SPECIFICATION
FOR
PRE-COMMISSIONING AND COMMISSIONING
OF
CITY GAS DISTRIBUTION FOR NORTH GOA GA

TS NO.: MEC/23SA/05/28/M/000/1093

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
TECHNICAL SPECIFICATION FOR
LAYING & CONSTRUCTION OF STEEL GAS PIPELINE
ALONG WITH ASSOCIATED WORKS FOR CITY GAS
DISTRIBUTION FOR NORTH GOA GA
TS NO.: MEC/23SA/05/28/M/000/1093

CONTENTS

SL. NO. DESCRIPTION
1.0 INTRODUCTION
2.0 RESPONSIBILITY OF CONTRACTOR
3.0 SCOPE OF WORK
4.0 DOCUMENTATION
5.0 SPARES AND CONSUMABLES
6.0 SAFETY

ANNEXURE – I : FORMAT FOR BIODATA OF KEY PERSONNEL FOR COMMISSIONING
ANNEXURE – II : QUESTIONNAIRE
ANNEXURE – III : FORMAT TO BE USED DURING PRE-COMMISSIONING AND COMMISSIONING (TOTAL 5 FORMATS)

FORMAT – I : INTIMATION REGARDING SYSTEM COMPLETION
FORMAT - II : CHECKLIST
FORMAT - III : READY FOR PRE-COMMISSIONING CERTIFICATE
FORMAT – IV : READY FOR COMMISSIONING CERTIFICATE
FORMAT - V : COMPLETION OF COMMISSIONING CERTIFICATE

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APPROVED BY: (Sunil Kumar, AGM)
1.0 INTRODUCTION

This specification covers the minimum technical requirements for:

i) Pre-commissioning activities consists of:

- Carrying out pre-commissioning checks of the underground pipeline system including above ground piping at dispatch station and at receipt stations, Sectionalizing Valve (SV) stations and tap-off / hook-up piping.
- Dewatering of the pipeline.
- Flushing and dry air blowing of underground & above ground piping at dispatch and receipt stations, SV stations and hook–up point.
- Swabbing of pipeline.
- Preparation of detailed commissioning procedures

ii) Commissioning activities consisting of Drying, Inertisation, Gas-in/Commissioning, stabilization and 72 hours run of all the pipe lines and facilities mentioned in (i).

Bidder, along with his bid documents, is required to submit the following:

- Execution plan and method statement for pre-commissioning and commissioning activities.
- Past experience of pre-commissioning and commissioning activities carried out for a similar pipeline system / network.
- Plan to engage an agency / subcontractor for these activities (if envisaged).
- Organization charts of bidder’s proposed pre-commissioning and commissioning team indicating the positions with the required qualifications and experience.
- Biodatas of Key personnel comprising the commissioning team along with their contact nos. In case the member of commissioning team as mentioned in the offer is not available at the actual time of commissioning then the contractor shall ensure a replacement with equivalent qualification & experience. The format of biodata is enclosed as Annexure-I.
- Clause wise list of deviations, if any, from this technical specification. In the absence of this, it shall be considered that the bidder has no deviation.
- Questionnaire as given in Annexure-II.
2.0 RESPONSIBILITY OF CONTRACTOR

The contractor shall be responsible for all the pre-commissioning and commissioning activities that need to be carried out for the pipeline system.

2.1 Pre-commissioning

In order to execute and perform pre-commissioning activities, the contractor shall be responsible for (but not limited to):

- Carrying out pre-commissioning checks of the underground pipeline system including above ground piping at dispatch station and at receipt stations, Sectionalizing Valve (SV) stations and tap-off / hook-up piping.
- Dewatering of the pipeline.
- Flushing and dry air blowing of under ground & above ground piping at dispatch and receipt stations, SV stations and hook-up point.
- Swabbing of pipeline.
- Low pressure leak check (with air) for the aboveground section of the pipelines.
- Supply and supervision of manpower for pre-commissioning.
- Supply and operation of machinery & equipment for pre-commissioning.
- Supply and use of materials and consumables as required for the pre-commissioning activities.
- Design and supply all temporary line connections, pig launcher/receiver, valves, instruments, manpower etc. as required during various operations.
- Preparation of detailed pre-commissioning procedures, activity schedules, bar charts, schemes etc. This shall include preparation of detailed procedures for dewatering, flushing, swabbing and low pressure leak check and shall address the sequence and methodology describing all operations, data on materials, equipment, instruments, consumables, communication systems, necessary calculations, detailed time schedule and organization chart.
- All necessary work to perform the job successfully including all modifications that would be required.

The contractor shall demonstrate to the COMPANY (for COMPANY’s approval) the successful completion of all of the above-mentioned activities.

In the event of any detail, which is not fully addressed, contractor should warrant that work shall be performed in accordance with the relevant codes, Company's specifications and the best recognized Engineering guidelines and practices being followed in the on-shore pipeline industry.
2.2 Drying, Inertisation, Gas-in / Commissioning, stabilization and 72 hours run

In order to execute and perform commissioning related activities, the contractor shall be responsible for (but not limited to):

- Drying of the underground pipeline and above ground piping system at dispatch and receipt stations, above ground piping system at SV stations and hook-up / tap-off points to a water dew point of –8 °C at atmospheric pressure, and maintain this dew point in the pipeline, till inertisation and gas-in activities commence.

- Commissioning checks including Safety review prior to start of commissioning activities to achieve ‘Ready for commissioning’ status for underground pipeline and above ground piping system at dispatch and receipt stations, above ground piping system at SV stations and hook-up / tap-off points.

- Inertisation of the pipeline system including above ground piping system at dispatch and receipt stations, above ground piping system at SV stations and hook-up / tap-off points.

- Gas-in activities including pressurization, carrying out high pressure leak checks and establishment of flows in the pipeline system including above ground piping at dispatch and receipt stations, SV stations, IP station and hook-up points.

- Stabilization and 72 hours run of the pipeline system.

- Supply and supervision of manpower for commissioning.

- Supply and operation of machinery & equipment for commissioning.

- Supply and use of materials and consumables as required for the commissioning activities.

- Design and supply all temporary line connections, pig launcher/receiver, valves, instruments, manpower etc. as required during various operations.

- Preparation of detailed commissioning procedures, activity schedules, bar charts, schemes etc. This shall include preparation of detailed procedures for drying, inertisation, gas-in / commissioning operations, high pressure leak check operations, pressurization, establishing flows and 72 hours run of the pipeline system, and shall address the sequence and methodology describing all operations, data on materials, equipment, instruments, consumables, communication systems, necessary calculations, detailed time schedule and organization chart.

- Ensuring all communication facilities are in place and in proper working condition prior to start of commissioning activities of the pipeline system.

- All necessary work to perform the job successfully including all modifications that
would be required.

The contractor shall demonstrate to the COMPANY (for COMPANY’s approval) the successful completion of all of the above-mentioned activities.

In the event of any detail, which is not fully addressed, contractor should warrant that work shall be performed in accordance with the relevant codes, Company's specifications and the best recognized Engineering guidelines and practices being followed in the on-shore pipeline industry.

2.3 Mechanical Completion

Mechanical Completion of system shall mean completion of underground / aboveground pipeline system and station work including pre-commissioning along with ECP of U/G pipeline and make the system ready to start commissioning activities.

3.0 SCOPE OF WORK

The work to be performed by the Contractor as part of the pre-commissioning activities for the facilities outlined in paragraphs (i) of Section-1.0 above and commissioning related activities for the facilities outlined in paragraphs (ii) of Section-1.0 above shall consist of the following:

3.1 Pre-commissioning activities

3.1.1 Pre-commissioning checks

Pre-commissioning checks shall be carried out for the pipeline system to ascertain that the pipeline system has been mechanically completed in all respects. These checks shall cover the pipelines including distribution network system, dispatch and receipt stations, I.P. stations, sectionalizing valve stations and the hook up points. The pre-commissioning checks shall include the following:

A) System Checks

The entire facilities shall be checked against the latest P&ID's, Engineering and Vendor drawings / documents and other design specifications. Any shortcomings observed shall be listed down in the form of punch lists and duly attended.

B) Checking of Field Instruments

All the field instruments like actuated valves, control valves, shutdown valves, transmitters, solenoid valves, shut down switches, alarms etc. shall be checked physically and also for their intended application by simulating the operating condition. It will also include checking of Different meters, gauges, action of
actuated valves, control valves, shutdown valves etc.

C) Survey of the Pipelines

This shall be performed to confirm that proper fittings/supports, cathodic protection system, route markets, warning signs, fencing around SV stations, crash barriers etc. have been installed along the pipeline.

D) Checking of Communication System

This is to check that there is proper communication with adequate back up power to ensure uninterrupted communication.

E) Checking of Electrical Distribution System

This is to ensure safety and also to ensure an uninterrupted power supply during startup and normal pipeline operation.

F) Checking of Instruments, Controls & Interlocks

This is to check that instrument controls and interlocks are functional as per the normal operating conditions.

G) Checking of Utilities

This is to check that utilities like power, nitrogen, UPS system, instrument air, etc. are available prior to start-up.

H) Any other checks as may be considered necessary.

3.1.2 Dewatering

3.1.2.1 General

Dewatering of a pipeline section shall be done subsequent to the hydro-test of the respective pipeline section. During the dewatering operation, the major quantity of hydro-test water shall be removed from the pipelines and distribution network. It is the responsibility of the contractor to develop suitable dewatering procedure and submit the same for Company's approval.

The disposal of the water shall be performed such that no harm is done to the environment and the Dewatering procedure should indicate this disposal methodology.

3.1.2.2 Operational requirements
The dewatering operation for the pipelines shall consist of a number of dewatering pig runs and dry air shall be used as propellant for pig trains.

Cup pigs shall be used and will be suitable for traversing the entire length of the pipelines / pipe segments being dewatered. Contractor shall ensure that all the pigs are designed to prevent damage to the pipeline’s internal coating (if any).

The contractor shall propose the minimum speed and the backpressure 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.

3.1.2.3 Flushing of aboveground piping

Flushing of above ground piping at dispatch and receipt stations, SV stations and hook-up / tap-off points shall be done with water to remove debris from within the piping and then with dry air to remove the residual amount of water from the aboveground piping.

3.1.2.4 Acceptance criteria

Before proceeding to the next stage of operations, Contractor shall ensure that bulk of the water has been removed from the pipeline system. Contractor shall specify when the dewatering phase (for the underground pipeline) and flushing and dry air blowing (for above ground piping) is finished and shall obtain approval of the company before proceeding to the next phase.

3.1.3 Swabbing

3.1.3.1 General

The swabbing operation, which shall be done subsequent to the dewatering operation, is meant to reduce the remaining water in the pipeline to acceptable condition and to ensure removal of free water left inside the pipeline prior to final drying, Inertisation and commissioning of the Pipeline system. This is done by driving number of foam pigs propelled by oil free compressed dry air, which can pick up free water in the pipeline. Hence for swabbing, air compressors of required capacity, after-coolers and dryers should be deployed by the contractor.

Contractor may suggest alternate methodology for Swabbing operation. The swabbing
activity is precursor for drying of the pipeline and is basically to reduce duration of drying.

The contractor shall submit the detailed procedure and the duration of the swabbing operation and obtain approval of the company before starting the operation.

3.1.3.2 Acceptance criteria

The Contractor shall ensure that swabbing operation is considered to be completed when it is considered that there is no free water left in the pipeline. This shall be subject to Company’s approval.

3.1.4 Safety review prior to start of commissioning activities

A pre-startup safety review of the pipeline system including the underground pipeline and the above ground piping at dispatch and receipt stations, SV stations and hook-up / tap-off points shall be carried out by the Contractor before permitting entry of natural gas into the new pipeline facility. Company / Company's representative shall also participate in the pre-startup safety review.

3.2 Commissioning related activities

3.2.1 Drying

Before charging the line with gas, the contractor may propose to dry the pipeline either by super drying or vacuum drying or any other suitable technique as approved by Engineer-in-charge (EIC). Following specifications shall govern the drying procedures and shall be submitted for approval of the EIC.

3.2.1.1 Vacuum Drying

a) General

The contractor shall dry the underground pipeline and the above ground piping at dispatch and receipt stations, SV stations and hook-up / tap-off points with vacuum drying technique prior to charging natural gas.

Water vapour shall be evacuated from the pipeline by vacuum units alone or in combination with dry air or dry nitrogen vacuum purging as specified in the scope of work. The final dew point temp. of the dry pipeline shall be -8 °C, which is equivalent to a pressure of 3 mbar (absolute), unless otherwise specified in the scope of work.

Vacuum drying should consist of the following stages:

- pre-drying checks;
- one or more leak tests;
- pump-down;
- evaporation/evacuation, including vacuum purging(if applicable);
- soak test/acceptance test;
The size of the vacuum units should be sufficient to reduce the pressure in the pipeline to the vaporisation pressure during pump-down within typically 12 h to 36 h of commencement of the pump-down operation, depending on the length and diameter of the pipeline. Vacuum units having excessive capacity would draw down the pressure too rapidly, which could cause localised ice formation.

The Contractor shall prepare a theoretical pressure/ time graph each of the drying phases and submit it along with detailed work procedure for approval of PMC/CLIENT.

b) Pre-drying checks

Before commencement of vacuum drying the Contractor shall verify that:

- The pipeline has been isolated from other pipelines and piping by closing valves at the battery limit. As a precaution against possible “air-in” leaks through the battery limit valves, all valves immediately adjacent to the battery limit valves shall also be closed wherever possible;
- All pressure safety valves, actuator tappings etc. shall be isolated by closing the respective valves;
- All vent drain, utility connections, tapping valves shall be closed and ends shall be blind flanged;
- The blow down piping (if any) shall also be isolated by closing the respective valves;
- The bypass piping across the mainline valves at SV stations shall be isolated by closing all the by-pass valves;
- valves are designed for vacuum drying and have been placed in to the half open position;
- valve body bleeder parts are vacuum tight;
- Temporary connections, pig trap valves and pig trap end closure seals are able to withstand the prevailing vacuum pressure. If this is not the case, Contractor shall provide adequate seals for the vacuum drying operation and replace these seals by the permanent seals once the vacuum drying operation has been completed.

c) Leak tests

I. Low pressure leak check of aboveground station piping
The above ground station piping including all instrument impulse tubing shall be pressurised with air to a minimum pressure of 6 kg/cm². All flanged threaded and tubing joints shall be checked for leaks by soap solution.

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

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

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

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

d) **Pump-down/ pull down**

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

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

e) **Evaporation/ evacuation**

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

Ice formation in the pipeline and associated fittings shall be avoided by control of the evacuation rate through the vacuum units. A vaporisation pressure plateau at a level markedly lower than expected or erratic pressure fluctuations during plateau are indications of ice formation.
Vaporisation and evacuation by pumping shall continue until the vapour pressure has reached the level that is equivalent to the dew point specified for the dry pipeline. This pressure shall be maintained for at least 3 hrs to confirm that a stable balanced vacuum pressure is established throughout the pipeline. Evacuation shall then be stopped and a soak test carried out.

Vacuum purging with dry air or nitrogen at pressures in the range of 4 mbar (abs) to 10 mbar (abs) may be applied in addition to evacuation by pumping to reduce the time needed for conventional evaporation and water vapour evacuation. The rates and pressures are dependent on the performance curves of the vacuum equipment, as the aim is to increase the pressure in the pipeline to an efficient volume transfer level. If applied, purging and evacuation shall continue until the dew point at the vacuum unit is constantly below the dew point for a dry pipeline as specified in the scope of work while replacing at least twice the contents of the pipeline. Purging shall then be stopped, and the pressure reduced to 3 mbar (abs) and maintained at this level for at least 3 hrs to achieve stable conditions in the pipeline. A soak test shall then be performed.

f) Soak test/acceptance test

Soak test is carried out to ensure that all free water has been evaporated. All the equipment other than that required for pressure monitoring shall be temporarily isolated from pipeline for a period of at least 12 hrs and pressure is monitored at an interval of 1 hr.

Pressure monitoring shall be carried out by means of pressure gauges and recorders with range 0 mbar to 10 mbar, a reading division of 0.1 mbar and an accuracy of ± 1% of the measured value.

Initially the pressure will rise as the higher pressure in the centre of the pipeline (or at the opposite end if a single vacuum plant is in operation) balances with that nearest to the vacuum plant. After this initial stabilisation, which should occur well below the evaporation plateau, the test shall be acceptable if the pressure remains more or less constant (+/-5% variation is acceptable) at 3 mbar. If this is not the case, the observed pressure increases must be due to further flashing-off of moisture vapour, indicating that additional drying is required.

3.2.2.2 Super drying

a) General

The pipeline shall be dried using super dry air or nitrogen. The contractor shall submit work procedure for super drying in line with the scope of work to Engineer-in-charge for approval prior to start of any activity.

The super drying operation shall follow within 48 hrs of swabbing. In case super
drying of the pipeline does not start within 48 hrs of completion of swabbing, then the swabbing shall be repeated again.

The drying medium to be used shall be as specified in the scope of work or as per the directions of Engineer-in-charge. Dry air or nitrogen drying shall be executed consecutively in the following phases:

- pigging;
- purging for drying; and
- Purging for acceptance testing.

The basis of this technique is to run a series of light weight foam pigs through the pipeline with super dry air or dry nitrogen. The pigs initially absorb large quantities of water and ensure that water in the pipeline is continually spread out in a thin film, thus facilitating evaporation into the dry air system. Where permanent pig- launcher and receivers are not available temporary traps must be connected to the line and the drying unit may then be connected to the pig launcher by flexible hoses of appropriate rating.

The sizing of the drying equipment and calculations of the time required for drying shall be based on a film thickness of the residual water of not less than 0.1 mm for internally uncoated pipes and not less than 0.05 mm for internally coated pipes. Air introduced into the pipeline during dry air drying shall have a dew point of at least 15 °C below the final dew point (-8°C) of the pipeline.

Nitrogen used during drying shall have a minimum dew point of -50 °C at atmospheric pressure.

b) Pigging

The pipeline shall be pigged with high sealing disc pigs driven by dry air or nitrogen in combination with water absorbing foam pigs having a large water absorption capacity (approximately 80 % of their body mass), high abrasion resistance and a density between 30 to 50 kg/m³ as follows:

- the travelling speed of the foam pigs should not exceed 1.2 m/s;
- a back-pressure of at least 0.5 bar shall be maintained at the receiving end; and
- pigs in a pig train should be separated by at least 300 meters

Pigging shall continue until the dew point of the drying medium at the receiving end remains below the dew point specified in the scope of work and does not fluctuate by more than 3°C whilst replacing the content of the line by a pig.

c) Purging For Drying

After pigging, the pipeline should be purged with the drying medium with a minimum velocity of 3 m/s in the pipeline at the discharge end. Purging shall continue until the dew point at the discharge end remains below the specified dew
point whilst replacing twice the content of the pipeline at purging pressure.

d) Purging For Acceptance Testing
The difficulty in defining the acceptance criterion is that the dew point sampling at each end of the pipeline does not necessarily represent the actual dew point condition prevailing within the whole pipeline. This is because the dry air (or nitrogen) entering the pipeline performs extensive drying at the start of the pipeline and then becomes saturated. As the pressure falls off towards the end of the pipeline, the air (or nitrogen) is again able to absorb moisture. Thus the situation can arise where the beginning and the end of a pipeline are dry but the middle may still be wet, or at a higher dew point than the ends. It can be checked that the acceptance criterion has been met by means of the following procedure.

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

Drying is complete when the dew point during acceptance purging remains below the final dew point (-8°C) specified for the pipeline whilst replacing the line content. Purging for drying shall recommence and the acceptance test shall be repeated until this requirement has been met.

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

e) Preservation after Drying
The Contractor shall increase the pressure in the pipeline with either dry air or dry nitrogen.

The requirements for preservation are as follows:
- the final pipeline pressure to be achieved at the end of the filling operation shall be 0.5 bar above the ambient pressure at any point along the pipeline, plus a margin allowing for the maximum possible ambient temperature fluctuation during the post pre-commissioning period;
- The dew point, pressure and temperature of the medium introduced into the pipeline shall be measured and recorded constantly at the inlet of the pipeline throughout the filling operation;
- Warning signs, in English and the local or working languages, such as "PIPELINE FILLED WITH NITROGEN" or "PIPELINE FILLED WITH DRY AIR" shall be provided and placed at block valve stations and pig trap systems.

3.2.2 Low Pressure leak check for aboveground piping
3.2.2.1 General

The aboveground piping sections of the pipeline system shall be checked for leaks at flange points of piping and equipment, instrument impulse tubing points etc. This shall be done by pressurizing the system piping / equipment with dry compressed air (for this purpose, oil free air compressors shall be used) and testing the system by means of soap solution for leaks.

The contractor shall submit the detailed procedure and the duration of the leak check operations and obtain approval of the company before starting the operation.

3.2.2.2 Acceptance criteria

The leak check operation shall be considered to be completed when the piping system / equipment is free of leaks when tested at a pressure of 6.0 Kg/cm$^2$. This shall be subject to Company’s approval.

3.2.3 Ready for Commissioning

After completion of drying activities and safety review prior to startup, Contractor shall notify the Company that the systems associated with the pipeline system including the underground pipeline and the above ground piping at dispatch and receipt stations, SV stations and hook-up / tap-off points are ready for gas-in/commissioning. 'Ready for commissioning status' shall be jointly reviewed by Company and Contractor and final clearance for start-up shall be given by the Company. After such joint assessment, if all the criteria are met, it will then be declared that the pipeline system has reached a stage of 'Ready for Commissioning'.

3.2.4 Inertisation

3.2.4.1 General

Contractor shall carry out inertisation of the entire pipeline system including the underground pipeline and the above ground piping at dispatch and receipt stations, SV stations and hook-up / tap-off points).

3.2.4.2 Operational requirements

During the Inertisation operation, the air left in the pipelines shall be replaced by nitrogen before admitting the natural gas into the pipeline for safe commissioning. The pipeline shall be inerted under vacuum condition after drying is achieved. For this, introduce nitrogen from one end of the pipeline maintaining vacuum from other end of the pipeline. After inertisation, gas charging shall be done into the pipeline. For above ground piping at dispatch and receipt stations, SV stations and hook-up / tap-off points, the piping shall be purged with nitrogen till the residual oxygen content in the
piping is below 1% (vol/vol).

Nitrogen required for Inertisation purpose of the pipeline and aboveground piping shall be supplied by the contractor and should be of purity level 99.9% or above. Nitrogen gas at ambient temperatures (AND NOT LIQUID NITROGEN) and in completely vaporized and gaseous state shall be used as the inertising medium. In case the source of gaseous nitrogen is from liquid nitrogen tankers, then all precautions (including verification of the lowest tolerable temperature of all components in the system under commissioning) should be ensured.

The contractor shall submit the detailed procedure (in line with the above suggested method or any other acceptable one) and the duration of the inertisation operation and obtain approval of the company before starting the operation. Inertisation shall be followed immediately by charging of pipeline by natural gas.

### 3.2.4.3 Acceptance Criteria

Inertisation of the pipelines may be accepted to be complete when the required quantity of nitrogen has been introduced into the pipeline. The contractor has to ensure this condition for safe commissioning of the pipeline. For above ground piping at dispatch and receipt stations, SV stations and hook-up / tap-of points, the inertisation may be accepted to be complete when the residual oxygen content in the piping is below 1% (vol/vol).

### 3.2.5 Gas-in/Commissioning and Stabilization

#### 3.2.5.1 General

Contractor shall carry out gas-in and commissioning activities of the entire pipeline system including the underground pipeline and the above ground piping at dispatch and receipt stations, SV stations and hook-up / tap-of points.

#### 3.2.5.2 Operational requirements

During introduction of natural gas into the pipeline, natural gas shall be the motive fluid for driving the last pig of the nitrogen slug train. The pig train speed shall be maintained at 3 to 4 Km/hr. Maintenance of proper backpressure shall control pig train speed. Venting shall be controlled at the pig-receiving end to achieve the desired dynamics. In this fashion, slowly the desired portion of the pipeline shall be commissioned. Alternatively contractor may propose procedure for introduction of gas in pipeline under vacuum condition after inertisation with Nitrogen.

Subsequently, the pipeline system shall be slowly pressurized upto its operating conditions and high pressure leak checks of the pipeline system at flange points,
instrument points etc. shall be carried out with soap solution at regular intervals during the course of pressurization of the pipeline system. Once the pipeline system is pressurized at its operating conditions, normal gas flows shall be established in the pipeline system.

The contractor shall submit the detailed procedure (in line with the above suggested method or any other acceptable one) and the duration of the commissioning operation and obtain approval of the company before starting the operation.

Commissioning shall also include establishing the process control parameters first at turn down & then at design value stipulated in the process package along with supplementary instructions, if any, from Company / Company’s Representative.

### 3.2.5.3 Acceptance Criteria

The system shall be considered to be commissioned successfully when the pipeline system including the underground pipeline and the above ground piping at dispatch and receipt stations, SV stations and hook-up / tap-of points is charged with natural gas, is free of leaks and run successfully at stable operating conditions with instrumentation / control systems process utilities and support systems taken on line for a minimum period of 72 hours.

The commissioning of pipeline system shall include commissioning of branch lines and associated facilities including auxiliary facilities and aboveground piping.

### 4.0 DOCUMENTATION

Contractor shall submit for approval of the Company, the complete description, detailed procedures and time schedule for all of the following activities:

- Pre-commissioning checks
- Dewatering
- Flushing
- Swabbing
- Drying
- Low pressure leak check of aboveground piping system with dry compressed air
- Inertisation
- Gas in and commissioning activities (including pressurization of pipeline system, high pressure leak check, establishment of flows and 72 hours run).

All these documents should be prepared covering all aspects of HSE, quality assurance and quality control plans.
Contractor shall ensure that his documents are related to “as-built” conditions of the pipeline and structure involved.

Documents shall also contain all safety plans, procedures, to be followed while carrying out the activities.

Upon successful completion of the work, contractor shall prepare a final report of the work which shall include necessary charts, diagrams, graphs, calculations, recordings, daily logs, measurements, details of the operation, etc. Report shall also include all certificates of calibration of instruments required, together with records of calibration performed at site prior to the start of any operation and the approved pre-commissioning and commissioning formats and check sheets.

5.0 SPARES AND CONSUMABLES

Contractor shall identify and arrange for supply of manpower, spares, tools, tackles and consumables as required for pre-commissioning and commissioning activities.

6.0 SAFETY

Contractor shall follow the safety practices during execution of pre-commissioning and Commissioning works as detailed in the scope of work. He shall also maintain and follow all safety practices equivalent or better than those being practiced by the industry during pre-commissioning and commissioning activities.
ANNEXURE - I

FORMAT FOR BIODATA OF KEY PERSONNEL FOR COMMISSIONING

1. PROPOSED POSITION IN ORGANISATION CHART:
2. NAME:
3. QUALIFICATION:
4. TOTAL YEARS OF EXPERIENCE IN PLANT OPERATION / COMMISSIONING:
5. DETAILS OF COMMISSIONING EXPERIENCE:

<table>
<thead>
<tr>
<th>SL NO.</th>
<th>PROJECT DESCRIPTION</th>
<th>PLANT CAPACITY</th>
<th>LICENSOR</th>
<th>OWNER</th>
<th>YEAR OF COMMISS.</th>
<th>DURATION OF STAY AT SITE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
## ANNEXURE - II

### QUESTIONNAIRE

<table>
<thead>
<tr>
<th>CLAUSE NO.</th>
<th>DESCRIPTION OF CLAUSE</th>
<th>AGREED</th>
<th>NOT AGREED</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>SCOPE</td>
<td>[  ]</td>
<td>[  ]</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>DEFINITIONS</td>
<td>[  ]</td>
<td>[  ]</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td>MANUFACTURER REPRESENTATIVE</td>
<td>[  ]</td>
<td>[  ]</td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>DOCUMENT FOR PRECOMMISSIONING AND COMMISSIONING</td>
<td>[  ]</td>
<td>[  ]</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>OTHER REQUIREMENTS</td>
<td>[  ]</td>
<td>[  ]</td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td>REVIEW/CHECKLISTING/INSPECTION/CO-ORDINATION</td>
<td>[  ]</td>
<td>[  ]</td>
<td></td>
</tr>
<tr>
<td>7.0</td>
<td>COMMISSIONING</td>
<td>[  ]</td>
<td>[  ]</td>
<td></td>
</tr>
<tr>
<td>8.0</td>
<td>CONSUMABLES</td>
<td>[  ]</td>
<td>[  ]</td>
<td></td>
</tr>
<tr>
<td>9.0</td>
<td>SPECIAL REQUIREMENTS</td>
<td>[  ]</td>
<td>[  ]</td>
<td></td>
</tr>
<tr>
<td>10.0</td>
<td>SAFETY</td>
<td>[  ]</td>
<td>[  ]</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
1) PLEASE TICK THE RELEVANT BOX.
2) MENTION THE REASON & THE SUB-CLAUSE NOT AGREED IN THE REMARKS COLUMN.
ANNEXURE-III

FORMAT TO BE USED DURING PRE-COMMISSIONING AND COMMISSIONING

(TOTAL 5 FORMATS)
FORMAT - I

INTIMATION REGARDING SYSTEM COMPLETION

PROJECT: __________________ CUSTOMER: __________ UNIT: ________________

Following system/sub-system has been mechanically completed in all respects with exceptions noted below. The system/sub-system can be taken up for checking and preparation of checklist.

SYSTEM NO.

SYSTEM DESCRIPTION:

EXCEPTIONS:

 grips ____________ SIGNATURE ____________ DATE ____________

CONTRACTOR’S CONSTRUCTION:

CO-ORDINATOR

The system is ready/ not ready for Check listing

OWNER/ PMC:
**FORMAT - II**

**CHECKLIST**

PROJECT: _______________ CUSTOMER: _______________ UINT: _______________

SYSTEM/SUB-SYSTEM: __________________________________________

<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>CHECKLIST ITEMS</th>
<th>PRELIMINARY/FINAL</th>
<th>REMARKS</th>
</tr>
</thead>
</table>

SIGNATURE: ________________________________ DATE: ______________________

PMC:

OWNER:
FORMAT - III

READY FOR PRE-COMMISSIONING CERTIFICATE

PROJECT:__________________ CUSTOMER:______________ UNIT:______________

SYSTEM/SUB-SYSTEM___________________________________________________________

This is to certify that the following Plant/system/sub-system as detailed below is completely installed and all the Checklist points are carried out except for minor details as given in the attached list.

DESCRIPTION ON PLANT/SECTION/SUB-SECTION_______________________________

SIGNATURE DATE

CONTRACTOR’S CONSTRUCTION CO-ORDINATOR:

CONTRACTOR’S COMMISSIONING CO-ORDINATOR

The system is ready/ not ready for pre-commissioning

PMC:

OWNER:
FORMAT - IV

READY FOR COMMISSIONING CERTIFICATE

PROJECT:________________ CUSTOMER:________________ UNIT:__________

SYSTEM/SUB-SYSTEM____________________________________________________

This is to certify that all the necessary pre-commissioning activities for the system/sub-system as detailed below have been completed and the system/sub-system is ready for commissioning except for the minor details as given below which will not effect the commissioning trial runs.

DESCRIPTION OF SYSTEM/SUB-SYSTEM_____________________________________

SIGNATURE DATE

CONTRACTOR'S COMMISSIONING:

CO-ORDINATOR SIGNATURE DATE

PMC: OWNER:
FORMAT - V

COMPLETION OF COMMISSIONING CERTIFICATE

PROJECT: ___________ CUSTOMER: ___________ UNIT: ___________

SYSTEM/SUB-SYSTEM __________________________________________

This is to certify that the system/sub-system as detailed below has been successfully commissioned and is under operational control of Client's Production department. The minor items, which will not effect the normal operation of the system/sub-system, are given in the attached list.

DESCRIPTION OF SYSTEM/SUB-SYSTEM __________________________________________

SIGNATURE DATE

CONTRACTOR’S COMMISSIONING:
CO-ORDINATOR SIGNATURE DATE

PMC: OWNER:
# CONTENTS

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>SCOPE</td>
</tr>
<tr>
<td>2.0</td>
<td>REFERENCES</td>
</tr>
<tr>
<td>3.0</td>
<td>REQUIREMENT OF HEALTH, SAFETY &amp; ENVIRONMENT (HSE) MANAGEMENT SYSTEM TO BE COMPLETED BY BIDDERS.</td>
</tr>
<tr>
<td>4.0</td>
<td>DETAILS OF HSE MANAGEMENT SYSTEM BY CONTRACTOR</td>
</tr>
<tr>
<td>5.0</td>
<td>RECORDS</td>
</tr>
</tbody>
</table>

**ANNEXURE-A**

**ANNEXURE-B**

**ANNEXURE-C**

**ANNEXURE-D**

**ANNEXURE-E**

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**PREPARED BY:** (Shalini Singh)  
**CHECKED BY:** (Sunil Kumar)  
**APPROVED BY:** (A.K. Johri)  
**ISSUE DATE:** Feb. 2009
1.0 SCOPE

This specification establishes the Health, 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 representative’s 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 he 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 all 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
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 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, up to a cumulative limit of 1.0% (one percent) of Contract value with a ceiling of Rs. 10 lakhs.

0.2% (Zero decimal two per cent) of the contract value for LSTK, EPC, EPCC or Package contracts with an overall ceiling of Rs. 1,00,00,000/- (Rupees one crore).

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Violation or HSE norms</th>
<th>Penalty Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>For not using personal protective equipment (Helmet, Shoes, Goggles, Gloves, Full body harness, Face shield, Boiler suit, etc.)</td>
<td>Rs. 250/- per day / item / person</td>
</tr>
<tr>
<td>2</td>
<td>Working without Work Permit</td>
<td>Rs. 5,000/- per occasion</td>
</tr>
<tr>
<td>S. No.</td>
<td>Violation or HSE norms</td>
<td>Penalty Amount</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>3.</td>
<td>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.)</td>
<td>Rs.3,000/- per item per day.</td>
</tr>
<tr>
<td>4.</td>
<td>Working at height without full body harness, using non-standard / rejected scaffolding and not arranging fall protection arrangement as required like Safety Nets.</td>
<td>Rs.1,000/- per case per day.</td>
</tr>
<tr>
<td>5.</td>
<td>Unsafe handling of compressed gas cylinders (No trolley, jubilee clips double gauge regulator, improper storage / handling).</td>
<td>Rs. 100/- per item per day</td>
</tr>
<tr>
<td>6.</td>
<td>Use of domestic LPG for cutting purpose.</td>
<td>Rs.1,000/- per occasion</td>
</tr>
<tr>
<td>7.</td>
<td>No fencing / bar ricading of excavated areas.</td>
<td>Rs.1,000/- per occasion</td>
</tr>
<tr>
<td>8.</td>
<td>Not providing shoring / strutting / proper slope and not keeping the excavated earth at least 1.5 M away from excavated area.</td>
<td>Rs.5,000/- per occasion</td>
</tr>
<tr>
<td>9.</td>
<td>Non display of caution boards, list of hospitals, emergency services available at work locations.</td>
<td>Rs.500/- per occasion</td>
</tr>
<tr>
<td>10.</td>
<td>Traffic rules violations like over speeding of vehicles, rash driving, wrong parking, not using seat belts, vehicles not fitted with reverse warning alarms.</td>
<td>Rs.1,000/- per occasion</td>
</tr>
<tr>
<td>11.</td>
<td>Absence of Contractor's top most executive at the site in the safety meetings whenever called by MECON / Owner</td>
<td>Rs.1,000/- per occasion</td>
</tr>
<tr>
<td>12.</td>
<td>Failure to maintain safety records by Contractor Safety personnel.</td>
<td>Rs.1,000/- per month.</td>
</tr>
<tr>
<td>13.</td>
<td>Failure to conduct daily safety site inspection, HSE meeting and HSE audit at predefined frequencies.</td>
<td>Rs.1,000/- per occasion</td>
</tr>
<tr>
<td>14.</td>
<td>Failure to submit the monthly HSE report by 5th of subsequent month to Engineer-in-Charge.</td>
<td>Rs. 1,000/- per occasion and Rs. 100/- per day for further delay.</td>
</tr>
<tr>
<td>15.</td>
<td>Poor House Keeping</td>
<td>Rs.1,000/- per occasion</td>
</tr>
<tr>
<td>16.</td>
<td>Failure to report &amp; follow up accident (including Near Miss) reporting system.</td>
<td>Rs. 10,000/- per occasion</td>
</tr>
<tr>
<td>S. No.</td>
<td>Violation or HSE norms</td>
<td>Penalty Amount</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>17</td>
<td>Degradation of environment (not confining toxic spills oil/lubricants onto ground)</td>
<td>Rs.1,000/- per occasion</td>
</tr>
<tr>
<td>18</td>
<td>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.</td>
<td>Rs.1,000/- per occasion</td>
</tr>
<tr>
<td>19</td>
<td>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.)</td>
<td>Rs.1,000/- per occasion</td>
</tr>
<tr>
<td>20</td>
<td>Any violation not covered above. To be decided by MECON / Owner</td>
<td></td>
</tr>
</tbody>
</table>

This penalty shall be in addition to all other penalties specified elsewhere 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 Contractor’s senior personnel for root cause and recommend corrective and preventive actions. Findings shall documented and suitable actions taken to avoid recurrences shall be communicated to OWNER / MECON. OWNER / MECON shall have the liberty to independently investigate such occurrences and Contractor shall extend all necessary help and cooperation 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 are 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 obstruct free movement of men & machineries.

e. Fabricated steel structures, pipes & piping materials shall be stacked properly for erection.

f. Water logging on rods shall not be allowed.

g. No parking of trucks/ trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movements.

h. Utmost care shall be taken to ensure overall cleanliness and proper upkeep 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 job 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 ¾” cotton chin strap (made of industrial HDPE), safety shoes with steel toe cap and antiskid sole, full body harness (CE marked and conforming to EN361), protective goggles, gloves, ear muffs, respiratory protective devices, etc. All these gadgets shall conform to applicable IS Specifications / CE 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 Arrestor 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
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 Flashback 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 equipment’s. All lifting equipments shall be tested certified for its capacity before use. Adequate and suitable lighting at every work place and approach there to shall be provided by the contractor before starting the actual work/operation at night.

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, scaffolding, 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 workplace 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 contractor exposure of hazardous materials could exceed limits or could otherwise have harmful affects, appropriate personal protective equipment’s such as gloves, goggles, aprons, chemical resistant clothing and respirator shall be used.

l) Contractor shall ensure the following facilities at work sites:

   I) A Crèche where 10 or more female workers are having children below the age of 6 years.

   II) Reasonable Canteen facilities are made available at appropriate location depending upon site conditions.

m) Suitable facilities for toilet, drinking water, proper lighting shall be provided at site and labor camps, commensurate with applicable Laws/Legislation.

n) Contractor shall ensure storage and utilization methodology of material that are not detrimental to the environment. Wherever required Contractor shall ensure that only the environment friendly material are selected.

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 & regulations relating to hazardous materials substance and wastes. Contractor shall not dump, release or otherwise discharge or dispose of 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 scaffoldings 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 scaffoldings 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. Scaffoldings 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
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 leak age 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 mm² 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 at least 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 earthing 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 airborne 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 / demolition / 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 back aches, Display Screen Equipment's 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 worksite 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 possess 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

<table>
<thead>
<tr>
<th>Date &amp; Time</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject</td>
<td></td>
</tr>
<tr>
<td>Presenter</td>
<td></td>
</tr>
<tr>
<td>Hazards involved</td>
<td></td>
</tr>
<tr>
<td>Precautions to be taken</td>
<td></td>
</tr>
<tr>
<td>Worker’s Name</td>
<td>Signature</td>
</tr>
<tr>
<td>Remarks, if any</td>
<td></td>
</tr>
</tbody>
</table>

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 carry out 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 / cordonning 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 equipment’s, Scaffolding, Electrical Installation, describing the risks involved, actions to be taken and methodology for monitoring each.

- Organizations structure along with responsibility and authority records/reports etc. on HSE activities.

4.2 During job execution

4.2.1 Implement approved Health, Safety and Environment management procedure including but not limited to as brought 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 second 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 subcontractor 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
2. Accident / Incident Report
3. Supplementary Accident / Incident Investigation report
4. Near Miss Incident Report
5. Monthly HSE Report
6. Permit for working at height
7. Permit for working in confined space
8. Permit for radiation work
9. Permit for demolishing / dismantling
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 electrical 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: 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: 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
<table>
<thead>
<tr>
<th>TITLE</th>
<th>DOCUMENT NO.</th>
<th>REVISION : 0</th>
<th>EDITION : 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IS: 8519</strong> Guide for selection of industrial safety equipment for body protection</td>
<td><strong>MEC/ S/ 05/ 21/ 65</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IS: 9167</strong> Ear protectors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IS: 11006</strong> Flash back arrester (Flame arrester)</td>
<td></td>
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<td></td>
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<tr>
<td><strong>IS: 11016</strong> General and safety requirements for machine tools and their operation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IS: 11057</strong> Specification for Industrial safety nets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IS: 11226</strong> Leather safety footwear having direct moulded rubber sole</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IS: 11972</strong> Code of practice for safety precaution to be taken when entering a sewerage system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IS: 13367</strong> Code of practice-safe use of cranes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IS: 13416</strong> Recommendations for preventive measures against hazards at working place</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**B. INTERNATIONAL STANDARDS ON HSE**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Glasses</td>
<td>ANSI Z 87.1, ANSI ZZ 87.1, AS 1337, BS 2092, BS 1542, BS 679, DIN 4646 / 58211</td>
</tr>
<tr>
<td>Safety Shoes</td>
<td>ANSI Z 41.1, AS 2210, EN 345</td>
</tr>
<tr>
<td>Hand Gloves</td>
<td>BS 1651</td>
</tr>
<tr>
<td>Ear Muffs</td>
<td>BS 6344, ANSI S 31.9</td>
</tr>
<tr>
<td>Hard Hat</td>
<td>ANSI Z 89.1 / 89.2, AS 1808, BS 5240, DIN 4840</td>
</tr>
<tr>
<td>Goggles</td>
<td>ANSI Z 89.1</td>
</tr>
<tr>
<td>Face Shield</td>
<td>ANSI Z 89.1</td>
</tr>
<tr>
<td>Breathing Apparatus</td>
<td>BS 4667, NIOSH</td>
</tr>
<tr>
<td>Welding &amp; Cutting</td>
<td>ANSI Z 49.1</td>
</tr>
<tr>
<td>Safe handling of compressed Gases in cylinders</td>
<td>P-1 (Compressed Gas Association 1235 Jefferson Davis Highway, Arlington VA 22202 – USA)</td>
</tr>
</tbody>
</table>
# DETAILS OF FIRST AID BOX

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>DESCRIPTION</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Small size Roller Bandages, 1 inch wide (Finger Dressing small)</td>
<td>6 Pcs.</td>
</tr>
<tr>
<td>2.</td>
<td>Medium size Roller Bandages, 2 inch wide (Hand and Foot Dressing)</td>
<td>6 Pcs.</td>
</tr>
<tr>
<td>3.</td>
<td>Large size Roller Bandages, 4 inch wide (Body Dressing Large)</td>
<td>6 Pcs.</td>
</tr>
<tr>
<td>4.</td>
<td>Large size Burn Dressing (Burn Dressing Large)</td>
<td>4 Pkts.</td>
</tr>
<tr>
<td>5.</td>
<td>Cotton wool (20 gms packing)</td>
<td>4 Pkts.</td>
</tr>
<tr>
<td>6.</td>
<td>Antiseptic Solution Dettol (100 ml.) or Savlon</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>7.</td>
<td>Mercurochrome Solution (100 ml.) 2% in water</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>8.</td>
<td>Ammonia Solution (20 ml.)</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>9.</td>
<td>A Pair of Scissors</td>
<td>1 Piece</td>
</tr>
<tr>
<td>10.</td>
<td>Adhesive Plaster (1.25 cm x 5 m)</td>
<td>1 Spool</td>
</tr>
<tr>
<td>12.</td>
<td>Tourniquet</td>
<td>1 No.</td>
</tr>
<tr>
<td>13.</td>
<td>Safety Pins</td>
<td>1 Dozen</td>
</tr>
<tr>
<td>14.</td>
<td>Tinc. Iodine / Betadin (100 ml.)</td>
<td>1 Bottles</td>
</tr>
<tr>
<td>15.</td>
<td>Ointment for burns (Burnol 20 gms.)</td>
<td>1 Bottles</td>
</tr>
<tr>
<td>16.</td>
<td>Polythene Wash cup for washing eyes</td>
<td>1 No.</td>
</tr>
<tr>
<td>17.</td>
<td>Potassium Permanganate (20 gms.)</td>
<td>1 Pkt.</td>
</tr>
<tr>
<td>18.</td>
<td>Tinc. Benzoine (100 ml.)</td>
<td>1 Bottles</td>
</tr>
<tr>
<td>20.</td>
<td>Band Aid Dressing</td>
<td>5 Pcs.</td>
</tr>
<tr>
<td>21.</td>
<td>Iodex / Moov (25 gms.)</td>
<td>1 Bottles</td>
</tr>
<tr>
<td>22.</td>
<td>Tongue Depressor</td>
<td>1 No.</td>
</tr>
<tr>
<td>23.</td>
<td>Boric Acid Powder (20 gms.)</td>
<td>2 Pkt.</td>
</tr>
<tr>
<td>24.</td>
<td>Sodium Bicarbonate (20 gms.)</td>
<td>1 Pkt.</td>
</tr>
<tr>
<td>25.</td>
<td>Dressing Powder (Nebasulf) (10 gms.)</td>
<td>1 Bottles</td>
</tr>
<tr>
<td>26.</td>
<td>Medicinal Glass</td>
<td>1 No.</td>
</tr>
<tr>
<td>27.</td>
<td>Duster</td>
<td>1 No.</td>
</tr>
<tr>
<td>28.</td>
<td>Booklet (English &amp; Local Language)</td>
<td>1 No. each</td>
</tr>
<tr>
<td>29.</td>
<td>Soap</td>
<td>1 No.</td>
</tr>
<tr>
<td>30.</td>
<td>Toothache Solution</td>
<td>1 No.</td>
</tr>
<tr>
<td>31.</td>
<td>Eye Ointment</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>32.</td>
<td>Vicks (22 gms.)</td>
<td>1 Bottle</td>
</tr>
<tr>
<td>33.</td>
<td>Forceps</td>
<td>1 No.</td>
</tr>
<tr>
<td>34.</td>
<td>Cotton Buds (5 nos.)</td>
<td>1 Pkt.</td>
</tr>
<tr>
<td>35.</td>
<td>Note Book</td>
<td>1 No.</td>
</tr>
<tr>
<td>36.</td>
<td>Splints</td>
<td>4 Nos.</td>
</tr>
<tr>
<td>37.</td>
<td>Lock</td>
<td>1 Piece</td>
</tr>
<tr>
<td>38.</td>
<td>Life Saving/Emergency/Over-the-Counter Drugs</td>
<td>As decided at site</td>
</tr>
</tbody>
</table>

Box size: 14” x 12” x 4”

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

<table>
<thead>
<tr>
<th>Fire Description</th>
<th>Water</th>
<th>Foam</th>
<th>Fire Extinguishers</th>
<th>CO₂</th>
<th>Can control minor surface fires</th>
<th>Dry Powder</th>
<th>Can control minor surface fires</th>
<th>Multi Purpose (ABC)</th>
<th>√</th>
</tr>
</thead>
<tbody>
<tr>
<td>Originated from paper, clothes, wood</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflammable liquids like alcohol, diesel, petrol, edible oils, bitumen</td>
<td>x</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Originated from gases like LPG, CNG, H₂</td>
<td>x x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Fires</td>
<td>x x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- ✓ Can be used
- x Not to be used

**Note:** Fire extinguishing equipment must be checked at least 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 given. 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

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>TYPE OF HAZARD</th>
<th>EFFECT OF HAZARD</th>
<th>PREVENTIVE MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) EXCAVATION</td>
<td>Falling into pit</td>
<td>Personal injury</td>
<td>Pr ovide guard rails/barricade with warning signal.</td>
</tr>
<tr>
<td>Pit Excavation up to 3.0m</td>
<td></td>
<td></td>
<td>Pr ovide at least two entries/exits.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pr ovide escape ladders.</td>
</tr>
<tr>
<td>Earth Collapse</td>
<td>Sufocation / Breathlessness</td>
<td>Buried</td>
<td>Provide suitable size of shoring and strutting, if required.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Keep soil heaps away from the edge equivalent to 1.5m or depth of pit whichever is more.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Don’t allow vehicles to operate too close to excavated areas. Maintain at least 2m distance from edge of cut.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Battering/benching the sides.</td>
</tr>
<tr>
<td></td>
<td>Contact with buried electric cables</td>
<td>Electrocution</td>
<td>Obtain permission from competent authorities, prior to excavation, if required.</td>
</tr>
<tr>
<td></td>
<td>Gas/Oil Pipelines</td>
<td>Explosion</td>
<td>Locate the position of buried utilities by referring to plant drawings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Start digging manually to locate the exact position of buried utilities and thereafter use</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
</tr>
<tr>
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</tr>
<tr>
<td>Pit Excavation beyond 3.0m</td>
<td>Same as above plus flooding due to excessive rain/ underground water</td>
<td>Can cause drowning situation</td>
<td>Prevent ingress of water, Provide ring buoys, Identify and provide suitable size dewatering pump or well point system</td>
</tr>
<tr>
<td></td>
<td>Digging in the vicinity of existing Building/ Structure</td>
<td>Building/ Structure may collapse, Loss of health &amp; wealth</td>
<td>Obtain prior approval of excavation method from local authorities, Use under-pining method, Construct retaining wall side by side</td>
</tr>
<tr>
<td></td>
<td>Movement of vehicles / equipments close to the edge of cut.</td>
<td>May cause cave-in or slides, Persons may get buried</td>
<td>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</td>
</tr>
<tr>
<td>Narrow deep excavations for pipelines, etc.</td>
<td>Same as above plus frequent cave-in or slides</td>
<td>May cause severe injuries or prove fatal</td>
<td>Battering/benching of sides, Provide escape ladders</td>
</tr>
<tr>
<td></td>
<td>Loading due to Hydrostatic testing</td>
<td>May arise drowning situation</td>
<td>Same as above plus, Bail out accumulated water, Maintain adequate ventilation</td>
</tr>
<tr>
<td>Rock excavation by blasting</td>
<td>Improper handling of explosives</td>
<td>May prove fatal</td>
<td>Ensure proper storage, handling &amp; carrying of explosives by trained personnel, Comply with the applicable explosive acts &amp; rules</td>
</tr>
<tr>
<td></td>
<td>Uncontrolled explosion</td>
<td>May cause severe injuries or prove fatal</td>
<td>Allow only authorized persons to perform blasting operations, Smoking and open</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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</tr>
<tr>
<td></td>
<td>➢ Scattering of stone pieces in atmosphere</td>
<td>➢ Can hurt people</td>
<td>➢ Use PPE like goggles, face mask, helmets etc.</td>
</tr>
<tr>
<td>Rock excavating by blasting (Contd)</td>
<td>➢ Entrapping of persons/animals.</td>
<td>➢ May cause severe injuries or prove fatal</td>
<td>➢ Barricade the area with red flags and blow siren before blasting.</td>
</tr>
<tr>
<td></td>
<td>➢ Misfire</td>
<td>➢ May explode suddenly</td>
<td>➢ Do not return to site for at least 20 minutes or unless announced safe by designated person.</td>
</tr>
<tr>
<td>Piling Work</td>
<td>➢ Failure of pile-driving equipment</td>
<td>➢ Can hurt people</td>
<td>➢ Inspect Piling rigs and pulley blocks before the beginning of each shift.</td>
</tr>
<tr>
<td></td>
<td>➢ Noise pollution</td>
<td>➢ Can cause deafness and psychological imbalance</td>
<td>➢ Use personal protective equipments like ear plugs, muffs, etc.</td>
</tr>
<tr>
<td></td>
<td>➢ Extruding rods/casing</td>
<td>➢ Can hurt people</td>
<td>➢ Barricade the area an install sign boards ovide first-aid</td>
</tr>
<tr>
<td></td>
<td>➢ Working in the vicinity of ‘Live-Electricity’</td>
<td>➢ Can cause electrocution/asphyxiation</td>
<td>➢ Keep sufficient distance from Live-Electricity as per IS code.</td>
</tr>
<tr>
<td></td>
<td>➢ Air pollution by cement</td>
<td>➢ May affect Respiratory System</td>
<td>➢ Shut off the supply, if possible</td>
</tr>
<tr>
<td>(B) CONCRETING</td>
<td>➢ Handling of ingredients</td>
<td>➢ Hands may get injured</td>
<td>➢ Pr ovide artificial/rescue breathing to he injured.</td>
</tr>
<tr>
<td></td>
<td>➢ Extruding reinforcement rods.</td>
<td>➢ Feet may get injured</td>
<td>➢ Use Safety shoes.</td>
</tr>
<tr>
<td></td>
<td>➢ Earthing of electrical mixers.</td>
<td>➢ Can cause electrocution/asphyxiation</td>
<td>➢ Ensure earthing of equipments and proper functioning of</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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<tr>
<td></td>
<td>vibrators, etc. not done</td>
<td></td>
<td>electrical circuit before commencement of work.</td>
</tr>
<tr>
<td></td>
<td>Falling of materials from height</td>
<td>Persons may get injured</td>
<td>Use hard hats, remove surplus material immediately from work place, ensure lighting arrangements during night hours.</td>
</tr>
<tr>
<td></td>
<td>Continuous pouring by same gang</td>
<td>Causes tiredness of workers and may lead to accident.</td>
<td>Insist on shift pattern, provide adequate rest to workers between subsequent pours.</td>
</tr>
<tr>
<td></td>
<td>Revolving or concrete mixer/vibrators</td>
<td>Parts of body or clothes may get entrapped.</td>
<td>Allow only mixers with hopper, provide safety cages around moving motors, ensure proper mechanical locking of vibrator.</td>
</tr>
<tr>
<td>Super-structure</td>
<td>Same as above plus Deflection in props or shuttering material</td>
<td>Shutting / props may collapse and prove fatal</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>Passage to work place</td>
<td>Improperly tied and designed props/planks may collapse</td>
<td>Ensure the stability and strength of passage before commencement of work, do not overload and under the passage.</td>
</tr>
<tr>
<td>(C) REINFORCEMENT</td>
<td>Curtailing and binding of rods</td>
<td>Persons may get injured</td>
<td>Use PPE like gloves, shoes, helmets, etc., avoid usage of shift tools.</td>
</tr>
<tr>
<td></td>
<td>Carrying of rods for short distance/at work</td>
<td>Workers may injure their hands and shoulders</td>
<td>Provide suitable pads on shoulders and use safety.</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
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<td>PREVENTIVE MEASURES</td>
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<td></td>
<td></td>
<td></td>
<td>heights</td>
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<td></td>
<td></td>
<td></td>
<td>gloves.</td>
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<td></td>
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<td></td>
<td>➢ Tie up rods in easily liftable bundles.</td>
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<td></td>
<td>➢ Ensure proper staging.</td>
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<td></td>
<td>➢ Use measuring devices tape, measuring rods, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>➢ Checking of clear distance/ cover with hands.</td>
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<td></td>
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<td></td>
<td>Rods may cut or injure the finger.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>➢ Use measuring devices tape, measuring rods, etc.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>➢ Hitting projected rods and standing on cantilever rods.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Persons may get injured and fall down.</td>
</tr>
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<td></td>
<td>➢ Use safety shoes and avoid standing unnecessarily on cantilever rods.</td>
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<tr>
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<td></td>
<td>➢ Avoid wearing loose clothes.</td>
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<td></td>
<td>➢ F alling of material from height.</td>
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<tr>
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<td></td>
<td></td>
<td>May prove fatal.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>➢ Use helmets.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>➢ Provide safety nets.</td>
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<tr>
<td></td>
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<td></td>
<td>➢ T ransportation of rods by trucks / trailers.</td>
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<td></td>
<td>Pr otruded rods may hit the persons.</td>
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<td></td>
<td>➢ Use red flags/lights at the ends.</td>
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<td></td>
<td>➢ Do not protrude the rods in front of or by the side of driver’s cabin.</td>
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<td></td>
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<td></td>
<td>➢ Do not extend the rods 1/3rd of deck length or 1.5 m which is less.</td>
</tr>
<tr>
<td>(D) WELDING AND GAS CUTTING</td>
<td>W elding radiates invisible ultraviolet and infrared says</td>
<td>Radiation can damage eyes and skin.</td>
<td>➢ Use specified shielding devices and other PPE of correct specifications.</td>
</tr>
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<td></td>
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<td></td>
<td>➢ Avoid throated tungsten electrodes for GTAW.</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>➢ Improper placement of oxygen and acetylene cylinders.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Explosion may occur.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>➢ Move out any leaking cylinder.</td>
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<td></td>
<td>➢ Keep cylinder in vertical position.</td>
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<td></td>
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<td></td>
<td>➢ Use trolley for transportation of cylinders and chain them.</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>➢ Use flash back arrestors.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>➢ Leakage / cuts in hoses.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>May cause fire.</td>
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<td></td>
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<td></td>
<td>➢ Purge regulators immediately and then turn off.</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>➢ Never use grease or...</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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</tr>
</tbody>
</table>
| O       pening-up of cylinder                  |                                                                                   |                                                                                              | ➢ 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.                                                                                                                |
|                                                                                                           |                                                                                   |                                                                                              | ➢ Always stand back from the regulator while opening the cylinder  
➢ Turn valve slowly to avoid bursting  
➢ Cover the lug terminals to prevent short circuiting.                                                                                                                                           |
| W     elding of tanks, container or pipes storing flammable liquids |                                                                                   |                                                                                              | ➢ 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) R A D I O G R A P H Y                      | Ioniz     ing Radiation                                                            |                                                                                              | ➢ E nsure 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  
➢ W ear 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                                                                                                                                       |
<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>TYPE OF HAZARD</th>
<th>EFFECT OF HAZARD</th>
<th>PREVENTIVE MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>storage room with lock and key arrangement. The pit should be approved by BARC/AERB&lt;sup&gt;(*)&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✓ Radiography source should never be carried either in passenger bus or in a passenger compartment of trains.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✓ BARC/AERB have to be informed before source movement.</td>
</tr>
<tr>
<td></td>
<td>Loss of Radio isotope</td>
<td>Same as above</td>
<td>✓ Try to locate with the help of Survey Meter.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✓ Inform BARC/AERB(*).</td>
</tr>
<tr>
<td></td>
<td>Shor t circuiting</td>
<td>Can cause Electrocution or Fire</td>
<td>✓ Use rubberized hand gloves and other PPE.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✓ Don’t lay wires under carpets, mats or door ways.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✓ Allow only licensed electricians to perform on electrical facilities.</td>
</tr>
<tr>
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<td></td>
<td>✓ Use one socket for one appliance.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✓ Ensure usage of only fully insulated wires or cables.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>✓ Don’t place bare wire ends in a socket.</td>
</tr>
</tbody>
</table>

<sup>(*)</sup> Atomic Energy Regulatory Board (AERB), Bhabha Atomic Research Centre (BARC), Anushaktinagar, Mumbai – 400 094.
<table>
<thead>
<tr>
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<th>PREVENTIVE MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overloading of Electrical System</td>
<td>System can overheat, which leads to fire</td>
<td>Display voltage and current ratings prominently with 'Danger' signs.</td>
</tr>
<tr>
<td></td>
<td>Im proper laying of overhead and underground transmission lines / cables</td>
<td>Can cause electrocution and prove fatal</td>
<td>Do not lay unarmored cable directly on ground, wall, roof of trees.</td>
</tr>
<tr>
<td></td>
<td>Im proper laying of overhead and underground transmission lines / cables</td>
<td>Can cause electrocution and prove fatal</td>
<td>Do not lay unarmored cable directly on ground, wall, roof of trees.</td>
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</tr>
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<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>(G) FIRE PREVENTION AND PROTECTION</strong></td>
<td>Sm all fires can become big ones and may spread to the surrounding areas</td>
<td>Caus e burn injuries and may prove fatal.</td>
<td>In case a fire breaks out, press fire alarm system and shout “Fire, Fire”&lt;br&gt;Keep buckets full of sand &amp; water/fire extinguishing equipment near hazardous locations&lt;br&gt;Confine smoking to ‘Smoking Zones’ only&lt;br&gt;Train people for using specific type of fire equipments under different classes of fire&lt;br&gt;Keep fire doors/shutters, passages and exit doors unobstructed&lt;br&gt;Maintain good house keeping and first-aid boxes (for detail refer Annex-2)&lt;br&gt;Don’t obstruct assess to Fire extinguishers&lt;br&gt;Do not use elevators for evacuation during fire&lt;br&gt;Maintain lightening arrestors for elevated structures&lt;br&gt;Stop all electrical motors with internal combustion.&lt;br&gt;Move the vehicles from dangerous areas.</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
</tr>
<tr>
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<td>-----------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>✓ Improper selection of Fire Extinguisher</td>
<td>It may not extinguish the fire</td>
<td>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/CO₂/sand or earth.</td>
<td></td>
</tr>
<tr>
<td>✓ Improper storage of highly inflammable substances</td>
<td>Same as above</td>
<td>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</td>
<td></td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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</tr>
<tr>
<td></td>
<td>Short circuiting of electrical system</td>
<td>Same as above</td>
<td>Don’t lay wires under carpets, mats or door ways</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can cause Electrocut</td>
<td>Use one socket for one appliance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Use only fully insulated wires or cables</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Do not allow open/bare connections</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Provide all connections through ELCB</td>
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<tr>
<td></td>
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<td></td>
<td>Ensure earthing of machineries and equipments</td>
</tr>
<tr>
<td>(H) VEHICULAR MOVEMENT</td>
<td>Crossing the Speed Limits (Rash driving)</td>
<td>Personal injury</td>
<td>Obey speed limits and traffic rules strictly</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Always expect the unexpected and be a defensive drive</td>
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<td></td>
<td>Use sat belts/helmets</td>
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<td></td>
<td>Blow horn at intersections and during overtaking operations.</td>
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<td></td>
<td>Maintain the vehicle in good condition</td>
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<td></td>
<td>Do not overtake on curves, bridges and slopes</td>
</tr>
<tr>
<td></td>
<td>Adverse weather condition</td>
<td>Same as above</td>
<td>Read the road ahead and ride to the left</td>
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<tr>
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<td></td>
<td>Keep the wind screen and lights clean</td>
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<td>Do not turn at speed</td>
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<td></td>
<td>Recognize the hazard, understand the defense and act correctly in time.</td>
</tr>
<tr>
<td></td>
<td>Consuming alcohol before and during he</td>
<td>Same as above</td>
<td>Alcohol and driving do not mix well. Either choose</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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<tr>
<td>driving operation</td>
<td>Falling objects / Mechanical failure</td>
<td>May prove fatal</td>
<td>E nsure effective braking system, adequate visibility for the drives, reverse warning alarm.</td>
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<td></td>
<td>Pr oper maintenance of the vehicle as per manufacturer instructions</td>
</tr>
<tr>
<td>(I) PROOF TESTING (HYDROSTATIC/ PNEUMATIC TESTING)</td>
<td>Bursting of piping</td>
<td>May cause injury and prove fatal</td>
<td>Pr epare test procedure &amp; obtain CONSULTANT/ Owner’s approval</td>
</tr>
<tr>
<td></td>
<td>Collapse of tanks</td>
<td></td>
<td>Pr ovide separate gauge for pressurizing pump and piping/equipment</td>
</tr>
<tr>
<td></td>
<td>Tanks flying off</td>
<td></td>
<td>Check the calibration status of all pressure gauges, dead weight testers and temperature recorders</td>
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<td></td>
<td>Take dial readings at suitable defined intervals and ensure most of them fall between 40-60% of the gauge scale range</td>
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<td>Provide safety relief valve (set at</td>
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<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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<td></td>
<td>pressure slightly higher than test pressure) while testing with air/nitrogen</td>
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<td></td>
<td>✓ Ensure necessary precautions, stepwise increase in pressure, tightening of bolts/ nuts, grouting, etc. before and during testing</td>
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<td></td>
<td>✓ Keep the vents open before opening any valve while draining out of water used for hydro testing of tanks</td>
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<td></td>
<td>✓ 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</td>
</tr>
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<td>✓ 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 the test pressure. The gas used as test fluid, if not air, shall be nonflammable and nontoxic.</td>
</tr>
<tr>
<td>(J) WORKING AT HEIGHTS</td>
<td>Person can fall down</td>
<td>May sustain severe injuries or</td>
<td>Provide guard rails/barricade at the...</td>
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<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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<td></td>
<td></td>
<td>prove fatal</td>
<td>Use PPE like safety belts, full body harness, life line, helmets, safety shoes, etc.</td>
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<tr>
<td></td>
<td></td>
<td>work place</td>
<td>Obtain a permit before starting the work at height above 3 meters</td>
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<td>Fall arrest systems like safety nets, etc. must be installed</td>
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<td></td>
<td>Provide adequate working space (min. 0.6 m)</td>
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<td>Tie/weld working platform with fixed support</td>
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<td>Use roof top walk ladder while working on a slopping roofs</td>
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<td>Avoid movement on beams</td>
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<td></td>
<td>May hit the scrap / material stacked at the ground or in between</td>
<td>Keep the work place neat and clean</td>
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<td></td>
<td>Remove the scrap immediately</td>
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<td></td>
<td></td>
<td>Material can fall down</td>
<td>May hit the workers working at lower levels and prove fatal.</td>
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<td></td>
<td>Same as above plus</td>
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<td></td>
<td>Do not throw or drop material or equipment from height</td>
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<td>All tools to be carried in a toolkit bags or on working uniform</td>
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<td>Remove scrap from the planks</td>
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<td>Ensure wearing of helmet by the workers at low level</td>
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<td></td>
<td></td>
<td>Sufocation / drowning</td>
<td>Uncconsciousness, death</td>
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<td>Use respiratory devices, if required</td>
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<td>Avoid over crowding inside a confined space</td>
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<td>Provide Exhaust Fans for ventilation</td>
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<td></td>
<td>Do not wear loose clothes, neck ties,</td>
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<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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<tr>
<td>Presence of foul smell and toxic substances</td>
<td>Inhalation can pose threat to life.</td>
<td>Same as above plus check for hydrocarbon and Aromatic compounds before entering a confined space</td>
<td>Depute one person outside the confined space for continuous monitoring and for extending help in case of an emergency</td>
</tr>
<tr>
<td>Ignition / flame can cause fire</td>
<td>Person may sustain burn injuries or explosion may occur</td>
<td>Keep fire extinguishers at a hand distance</td>
<td>Remove surplus material and scrap immediately</td>
</tr>
</tbody>
</table>

- Fulfill conditions of the permit.
- Check for presence of hydrocarbons, O₂ 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.
<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>TYPE OF HAZARD</th>
<th>EFFECT OF HAZARD</th>
<th>PREVENTIVE MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>(L) HANDLING AND LIFTING EQUIPMENTS</td>
<td>Failure of load lifting and moving equipments</td>
<td>Can cause accident and prove fatal</td>
<td>Avoid standing under the lifted load and within the operating radius of cranes</td>
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<tr>
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<td>Check periodically oil, brakes, gears, horns and tyre pressure of all moving machinery</td>
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<td>Check quality, size and condition of all chain pulley blocks, slings, U-clamps, D-shackles, wire ropes, etc.</td>
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<td></td>
<td>Allow crane to move only on hard, firm and leveled ground</td>
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<td>Allow lifting slings as short as possible and check gunny packings at the friction points</td>
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<td>Do not allow crane to tilt its boom while moving</td>
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<td>Install Safe Load Indicator</td>
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<td>Ensure certification by applicable authority.</td>
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<tr>
<td></td>
<td>Overloading of lifting equipments</td>
<td>Can cause electrocution and fire</td>
<td>Safe lifting capacity of derricks and winches written on them shall be got verified.</td>
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<td></td>
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<td>The max safe working load shall be marked on all lifting equipments</td>
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<td>Check the weight of columns and other heavy items painted on them and accordingly decide about the crane</td>
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<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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</tbody>
</table>
|          | Overhead electrical wires | Can cause electrocution and fire | - Allow only trained operators and riggers during crane operation  
- 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 | Per son can fall down | Per son 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 ¼ 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 |
<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>TYPE OF HAZARD</th>
<th>EFFECT OF HAZARD</th>
<th>PREVENTIVE MEASURES</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>for max. load carrying capacity</td>
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<td>Sc scaffolding planks shall not be less than</td>
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<td>50x250 mm full thickness lumber or equivalent.</td>
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<td>These shall be cleared or secured and must extend over the end supports by at least 150mm and not more that 300 mm</td>
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<td>Don’t overload the scaffolds</td>
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<td></td>
<td>Do not splice short ladders to make a longer one. Vertical ladders shall not exceed 6m.</td>
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<td></td>
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<td></td>
<td>Material can fall down</td>
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<td></td>
<td>Per sons working at lower level gets injured.</td>
<td>Remove excess material and scrap immediately</td>
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<td>Carry the tools in a tool-kit bag only</td>
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<td>Provide safety nets</td>
</tr>
<tr>
<td>(N) STRUCTURAL WORKS</td>
<td>Per sonal negligence and danger of fall</td>
<td>Can cause injury or casualty</td>
<td>Do not take rest inside rooms built for welding machines or electrical distribution system</td>
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<td></td>
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<td></td>
<td>Avoid walking on beams at height</td>
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<td></td>
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<td></td>
<td>Wear helmet with chin strap and safety belts when working at height</td>
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<td></td>
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<td></td>
<td>Use hand gloves and goggles during grinding operations</td>
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<td></td>
<td>Cover or mark the sharp and projected edges</td>
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<td></td>
<td>Do not stand within the operating radius of cranes</td>
</tr>
<tr>
<td></td>
<td>Lifting / slipping of</td>
<td>Same as above</td>
<td>Do not stand under the lifted load</td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>TYPE OF HAZARD</td>
<td>EFFECT OF HAZARD</td>
<td>PREVENTIVE MEASURES</td>
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<td>------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>material</td>
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<td>➢ Stack properly all the materials. Avoid slippage during handling</td>
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<td>➢ Control longer pieces lifted up by cranes from both ends</td>
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<td></td>
<td>➢ Remove loose materials from height</td>
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<td></td>
<td></td>
<td></td>
<td>➢ Ensure tightening of all nuts and bolts</td>
</tr>
<tr>
<td>(O) PIPELINE</td>
<td>Er ection / lowering</td>
<td>Can cause injury</td>
<td>➢ Do not stand under the lifted Load</td>
</tr>
<tr>
<td>WORKS</td>
<td>failure</td>
<td></td>
<td>➢ Do not allow any person to come within the radii of the side boom handling pipes</td>
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<td></td>
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<td>➢ Check the load carrying capacity of the lifting tools and tackles</td>
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<td>➢ Use safe Load Indicators</td>
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<td></td>
<td></td>
<td>➢ Use appropriate PPEs</td>
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<tr>
<td></td>
<td>Other</td>
<td>Same as above</td>
<td>➢ Wear gum boots in marshy areas</td>
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<td></td>
<td>➢ Allow only one person to perform signaling operations while lowering of pipes</td>
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<td></td>
<td>➢ Provide night caps on pipes</td>
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<td></td>
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<td></td>
<td>➢ Provide end covers on pipes for stoppage of pigs while testing/cleaning operations.</td>
</tr>
</tbody>
</table>
## HSE Checklist Cum Compliance Report (1/6)

**Project:** ______________________  
**Contractor:** ______________________  
**Date:** ______________________  
**Owner:** ______________________  
**Inspection By:** ______________________  
**Report No.:** ______________________  
**Frequency:** Fortnightly  
**Job No.:** ______________________  

Note: write ‘NA’ wherever the item is not applicable

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>ITEM</th>
<th>YES</th>
<th>NO</th>
<th>REMARKS</th>
<th>ACTION</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>HOUSEKEEPING</strong></td>
<td></td>
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<tr>
<td>a)</td>
<td>Waste containers provided and used</td>
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<tr>
<td>b)</td>
<td>Sanitary facilities adequate and clean</td>
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<tr>
<td>c)</td>
<td>Passageways and Walkways clear</td>
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<tr>
<td>d)</td>
<td>General neatness of working areas</td>
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<tr>
<td>e)</td>
<td>Others</td>
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<tr>
<td>2</td>
<td><strong>PERSONNEL PROTECTIVE EQUIPMENT</strong></td>
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<tr>
<td>a)</td>
<td>Goggles; Shields</td>
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<tr>
<td>b)</td>
<td>Face protection</td>
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<tr>
<td>c)</td>
<td>Hearing protection</td>
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<td>d)</td>
<td>Safety shoes</td>
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<td>e)</td>
<td>Hand protection</td>
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<tr>
<td>f)</td>
<td>Respiratory Masks etc.</td>
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<td>g)</td>
<td>Safety Belts</td>
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<tr>
<td>h)</td>
<td>Safety Helmet/Hard Hat</td>
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<td>i)</td>
<td>Others</td>
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<td>3</td>
<td><strong>EXCAVATIONS/OPENINGS</strong></td>
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<tr>
<td>a)</td>
<td>Openings properly covered or barricaded</td>
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<tr>
<td>b)</td>
<td>Excavations shored</td>
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<tr>
<td>c)</td>
<td>Excavations barricaded</td>
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<td>d)</td>
<td>Overnight lighting provided</td>
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<td>e)</td>
<td>Others</td>
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<tr>
<td>4</td>
<td><strong>WELDING &amp; GAS CUTTING</strong></td>
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<tr>
<td>a)</td>
<td>Gas cylinders chained upright</td>
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<tr>
<td>b)</td>
<td>Cables and hoses not obstructing</td>
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<tr>
<td>c)</td>
<td>Screens or shields used</td>
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<tr>
<td>d)</td>
<td>Flammable materials protected</td>
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<tr>
<td>e)</td>
<td>Fire extinguisher(s) accessible</td>
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<tr>
<td>f)</td>
<td>Others</td>
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<tr>
<td>5</td>
<td><strong>SCAFFOLDING</strong></td>
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<tr>
<td>a)</td>
<td>Fully decked platforms</td>
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</tr>
<tr>
<td>b)</td>
<td>Guard and intermediate rails in place</td>
<td></td>
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<tr>
<td>SL. NO.</td>
<td>ITEM</td>
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<td>NO</td>
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<td>ACTION</td>
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<td>c)</td>
<td>Toe boards in place</td>
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<td>d)</td>
<td>Adequate shoring</td>
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<tr>
<td>e)</td>
<td>Adequate access</td>
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<tr>
<td>f) O</td>
<td>others</td>
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<td>6</td>
<td>LADDERS</td>
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<tr>
<td>a)</td>
<td>Extension side rails 1m above</td>
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<td>b)</td>
<td>Top of landing</td>
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<tr>
<td>c)</td>
<td>Properly secured</td>
<td></td>
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<tr>
<td>d)</td>
<td>Angle + 70 from horizontal</td>
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<tr>
<td>e) O</td>
<td>others</td>
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<td>HOISTS, CRANES AND DERRICKS</td>
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</tr>
<tr>
<td>a)</td>
<td>Condition of cables and sheaves OK</td>
<td></td>
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<tr>
<td>b)</td>
<td>Condition of slings, chains, hooks and eyes OK</td>
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<tr>
<td>c)</td>
<td>Inspection and maintenance logs maintained</td>
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<tr>
<td>d)</td>
<td>Outriggers used</td>
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<td>e)</td>
<td>Signs/barricades provided</td>
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<td>f)</td>
<td>Signals observed and understood</td>
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<td>g)</td>
<td>Qualified operators</td>
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<tr>
<td>h) O</td>
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<td>MACHINERY, TOOLS AND EQUIPMENT</td>
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<tr>
<td>a)</td>
<td>Proper instruction</td>
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<td>b)</td>
<td>Safety devices</td>
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<td>c)</td>
<td>Proper cords</td>
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<td>d)</td>
<td>Inspection and maintenance</td>
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<tr>
<td>e) O</td>
<td>others</td>
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<td>VEHICLE AND TRAFFIC</td>
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<tr>
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<td>Rules and regulations observed</td>
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<td>c)</td>
<td>Licensed drivers</td>
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<td>d) O</td>
<td>others</td>
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<td>10</td>
<td>TEMPORARY FACILITIES</td>
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<td>Emergency instructions posted</td>
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<td>b)</td>
<td>Fire extinguishers provided</td>
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<tr>
<td>c)</td>
<td>Fire-aid equipment available</td>
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<td>d)</td>
<td>Secured against storm damage</td>
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<td>e)</td>
<td>General neatness</td>
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<td>f) O</td>
<td>others</td>
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<td>11</td>
<td>FIRE PREVENTION</td>
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<tr>
<td>a)</td>
<td>Personnel instructed</td>
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<td>b)</td>
<td>Fire extinguishers checked</td>
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<td>c)</td>
<td>No smoking in Prohibited Areas</td>
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<td>d)</td>
<td>Hydrants Clear</td>
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<td>REMARKS</td>
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<td>Others</td>
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<td>Handling and Storage of Materials</td>
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<td>Flammable Gases and Liquids</td>
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<td>15</td>
<td>Working at Height</td>
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<td>16</td>
<td>Confined Space</td>
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<td>17</td>
<td>Radiography</td>
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<td>SL. NO.</td>
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<td>REMARKS</td>
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<tr>
<td>d)</td>
<td>Use of appropriate PPE’s ensured</td>
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<tr>
<td>e)</td>
<td>Proper training to workers/supervisors imparted</td>
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<td>f)</td>
<td>Minimum occupancy of workplace ensured</td>
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<td>18</td>
<td>HEALTH CHECKS</td>
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<tr>
<td>a)</td>
<td>Workers medically examined and found to fit for working:</td>
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<tr>
<td></td>
<td>i) At heights</td>
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<td></td>
<td>ii) In confined space.</td>
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<tr>
<td>b)</td>
<td>Availability of First-aid facilities</td>
<td></td>
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<tr>
<td>c)</td>
<td>Proper sanitation at site, office and labour camps</td>
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<tr>
<td>d)</td>
<td>Arrangement of medical facilities</td>
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<tr>
<td>e)</td>
<td>Measures for dealing with illness</td>
<td></td>
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<tr>
<td>f)</td>
<td>Availability of Portable drinking water for workmen &amp; staff</td>
<td></td>
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<td>g)</td>
<td>Provision of crèches for children</td>
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<tr>
<td>h)</td>
<td>Stand by vehicle available for evacuation of injured.</td>
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<td>19</td>
<td>ENVIRONMENT</td>
<td></td>
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<tr>
<td>a)</td>
<td>Chemical and other effluents properly disposed</td>
<td></td>
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<tr>
<td>b)</td>
<td>Cleaning liquid of pipes disposed off properly</td>
<td></td>
<td></td>
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<tr>
<td>c)</td>
<td>Seawater used for hydro-testing disposed off as per agreed procedure</td>
<td></td>
<td></td>
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<tr>
<td>d)</td>
<td>Lubricant Waste/Engine oils properly disposed</td>
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<tr>
<td>e)</td>
<td>Waste from Canteen, offices, sanitation etc. disposed properly</td>
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<tr>
<td>f)</td>
<td>Disposal of surplus earth, stripping materials, oily rags and combustible materials done properly</td>
<td></td>
<td></td>
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<tr>
<td>g)</td>
<td>Green belt protection</td>
<td></td>
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</tbody>
</table>

Signature of Resident Engineer with Seal
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 INJURED........................................................................................................................................
AGE ......................................................................................................................................................
FATHER’S NAME ........................................................................................................................................
SUB-CONTRACTOR M/S ............................................................................................................................
DATE & TIME OF ACCIDENT ....................................................................................................................
LOCATION ............................................................................................................................................

BRIEF DESCRIPTION OF ACCIDENT

CAUSE OF ACCIDENT

NATURE OF INJURY/DAMAGE

MEDICAL AID PROVIDED/ACTIONS TAKEN

INTIMATION TO LOCAL AUTHORITIES (IF APPLICABLE)

DATE:       SIGNATURE OF CONTRACTOR
W           WITH SEAL

To : OWNER…………………………..  1 COPY
: RCM/SITE-IN-CHARGE, MECON  3  COPIES

Divisional Head (Constrn.) through RCM
Project Manager MECON, through RCM
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 ………………………………………………………………………………
AGE : …………………………………………………………………………………...
SUB-CONTRACTOR M/S……………………………………………………………………………
DATE & TIME OF ACCIDENT / INCIDENT …………………………………………………………
LOCATION……………………………………………………………………………………………

BRIEF DESCRIPTION & CAUSE OF AN 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: OWNER…………………………….. 1 COPY
   RCM/SITE-IN-CHARGE, MECON 3 COPIES

Divisional Head (Constn.) through RCM
Project Manager MECON, through RCM
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

YES ☐ NO ☐

DATE: __________  SIGNATURE OF CONTRACTOR
With SEAL

To : OWNER…………………………..  1 COPY
RM/SITE-IN-CHARGE, MECON  3 COPIES

Divisional Head (Constrn.) through RCM
Project Manager MECON, through RCM
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:______________

<table>
<thead>
<tr>
<th>ITEM U</th>
<th>PTO PREVIOUS MONTH</th>
<th>THIS MONTH</th>
<th>CUMULATIVE</th>
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</thead>
<tbody>
<tr>
<td>a)</td>
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<td>b)</td>
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<td>c)</td>
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<tr>
<td>d)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>e)</td>
<td>Number of Lost Time Accidents (LTA)</td>
<td>Fatal</td>
<td>Other LTA</td>
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<tr>
<td>f)</td>
<td>Number of Loss time Injuries (LTI)</td>
<td>Fatalities</td>
<td>Other LTI</td>
</tr>
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<td>g)</td>
<td>Number of Loss Time Accidents</td>
<td></td>
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<tr>
<td>h)</td>
<td>Number of First Aid Cases</td>
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<tr>
<td>i)</td>
<td>Number of Near Miss Incidents</td>
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<td>j)</td>
<td>Man-days lost due to accidents</td>
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<td>k)</td>
<td>LTA Free Manhours i.e. Number of LTA free manhours from the Lst LTA</td>
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<td>l)</td>
<td>Compensation cases raised with Insurance</td>
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<tr>
<td>m)</td>
<td>Compensation case resolved and paid to workmen</td>
<td></td>
<td></td>
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<tr>
<td>n)</td>
<td>Whether workmen compensation policy taken</td>
<td>Y/N</td>
<td></td>
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<tr>
<td>o)</td>
<td>Whether workmen compensation policy valid</td>
<td>Y/N</td>
<td></td>
</tr>
<tr>
<td>p)</td>
<td>Whether workmen registered under ESI Act</td>
<td>Y/N</td>
<td></td>
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</tbody>
</table>

Remark

DATE: ______________ Safety Officer / Resident Engineer
( Signature and Name)

To: ______________ OWNER
: RCM, MECON (2 COPIES)
PERMIT FOR WORKING AT HEIGHT (ABOVE 2 METER)

Project Site: .................................................. Sr. No.: .........................
Name of the work: ........................................... Date: .............................
Name of Contractor: ......................................... Nature of Work: ..............
Total No.of Workers: ................................. Exact location of work: ......

Duration of work: from ............... to ...........

The following items have been checked and compliance shall be ensured during the currency of the permit:

<table>
<thead>
<tr>
<th>Sl.</th>
<th>ITEM</th>
<th>DONE</th>
<th>NOT REQD.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Equipment/Work Area inspected</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>2.</td>
<td>Considered hazard from other routine/non-routine operations and concerned person alerted</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>3.</td>
<td>ELCB provided</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>4.</td>
<td>Proper lighting provided</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>5.</td>
<td>Area cordoned off.</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>6.</td>
<td>Precautions against public traffic taken</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>7.</td>
<td>Sound Scaffolding provided</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>8.</td>
<td>Adequate protected Platform provided</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>9.</td>
<td>Access and Exit to the area</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td></td>
<td>(Ladder properly fixed)</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>10.</td>
<td>Floor Openings covered</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>11.</td>
<td>Safety Net provided</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>12.</td>
<td>Health check of personnel</td>
<td>☐</td>
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</tr>
</tbody>
</table>

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 …………………………………………………………………

Permission is granted to work (See overleaf) = Yes/No

Name of Contractor's Supervisor (Initiator) Name of Contractor's Safety Officer (Issuing Authority)

---

### GRANT OF PERMIT AND EXTENSIONS

<table>
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<tr>
<th>Sl. No.</th>
<th>Validity Period From ……… To ………</th>
<th>Work time From …….Hrs. To ………Hrs.</th>
<th>Initiator (Supervisor of Contractor)</th>
<th>Issuing Authority (Safety Officer) of Contractor</th>
<th>Verification by CONSULTANT with date</th>
</tr>
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<tbody>
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</table>

Additional safety instructions, if any.
### Project Site: ………………………………………   Sr. No.: ………………………
### Name of the work: ……………………………….   Date: ……………………………
### Name of Contractor : ……………………………..   Nature of Work : ……………
### Exact location of work : ………………………………

**Safety Requirements**: POSITIVE ISOLATION OF THE VESSEL IS MANDATORY

#### (A) Has the equipment been?

<table>
<thead>
<tr>
<th>Y NR</th>
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<tbody>
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- ☐ isolated from power / steam / air
- ☐ isolated from liquid or gases
- ☐ depressurized &/or drained
- ☐ blanked / blinded / disconnected

<table>
<thead>
<tr>
<th>Y NR</th>
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</tbody>
</table>

- ☐ water flushed &/or steamed
- ☐ Manways open & ventilated
- ☐ cont. inset gas flow arranged
- ☐ adequately cooled

- ☐ radiation sources removed
- ☐ proper lighting provided

#### (B) Expected Residual Hazards

<table>
<thead>
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<tbody>
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</tr>
</tbody>
</table>

- ☐ lack of O₂
- ☐ combustible gas / liquid
- ☐ pyrophoric iron / scales
- ☐ high humidity
- ☐ H₂S / toxic gases
- ☐ electricity / static
- ☐ ionizing radiation

#### (C) Protective Measures

<table>
<thead>
<tr>
<th>Y NR</th>
<th></th>
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</tr>
</tbody>
</table>

- ☐ gloves
- ☐ protective clothing
- ☐ G rounded aireducateur / blower / AC
- ☐ F fire fighting arrangements
- ☐ ear plug / muff
- ☐ dust / gas / air line mask
- ☐ at tendant with SCBA / air mask
- ☐ safety harness & lifeline
- ☐ goggles / face shield
- ☐ personal gas alarm
- ☐ rescue equipment / team
- ☐ communication equipment
Authorization / Renewal (It is safe to enter the confirmed space)

<table>
<thead>
<tr>
<th>Date No. of Persons Allowed</th>
<th>Name of Person allowed</th>
<th>Signature Time</th>
<th>Signature Image</th>
<th>Signature Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

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:
### RADIATION WORK PERMIT

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Item Description</th>
<th>Done</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Safety regulations as per BARC/AERB ensured while source in use/in transit &amp; during storage.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Area cordoned off.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Lighting arrangements for working during nights ensured.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Warning signs/flash lights installed.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Cold work permit taken (if applicable)</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>PPEs like film badges, dosimeters used.</td>
<td></td>
</tr>
</tbody>
</table>

Additional precautions, if any ______________________________________________________

(Radiography Agency's BARC/AREB authorized Supervisor)  (Contractor's Safety Officer)

**Permission is granted.**

Permit is valid from __________ AM/PM __________ Date to __________ AM/PM __________ Date

(Signature of permit issuing authority)
Permit renewal:

<table>
<thead>
<tr>
<th>Permit extended upto</th>
<th>Additional precautions required, if any.</th>
<th>Sign of issuing authority with date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Work completed / stopped / area cleared at ____________ Hrs. of Date ________________

(Sign of permit issuing authority)
Name:  


## RADIATION WORK PERMIT

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Item Description</th>
<th>Done</th>
<th>Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Services like power, gas supply, water, etc. disconnected.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Dismantling / Demolishing method reviewed &amp; approved.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Usage of appropriate PPEs ensured.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Precautions taken for neighboring structures</td>
<td></td>
<td></td>
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<tr>
<td>5.</td>
<td>First-Aid arrangements made</td>
<td></td>
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</tr>
<tr>
<td>6.</td>
<td>Fire fighting arrangements ensured</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Precautions taken for blasting</td>
<td></td>
<td></td>
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</tbody>
</table>

(Contractor's Supervisor)          (Contractor's Safety Officer)

Permission is granted.

(Permit issuing authority)
Name: 
Date: 

Page 435 of 514
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/05/21/66

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
## CONTENTS

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>INTRODUCTION</td>
</tr>
<tr>
<td>2.0</td>
<td>DEFINITIONS</td>
</tr>
<tr>
<td>3.0</td>
<td>CONTRACTORS SCOPE OF WORK</td>
</tr>
<tr>
<td>4.0</td>
<td>QUALITY ASSURANCE REQUIREMENTS</td>
</tr>
</tbody>
</table>

- FORMAT FOR QUALITY PLAN: FORMAT 00001
- FORMAT FOR OBSERVATION ON: FORMAT 00002

**PREPARED BY:** (Shalini Singh)  
**CHECKED BY:** (Sunil Kumar)  
**APPROVED BY:** (A.K. Johri)  
**ISSUE DATE:** Nov. 2009
1.0 INTRODUCTION

This specification establishes the Quality Assurance Requirements to be met by the subcontractors (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 along with 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, along with 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 documents 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 plans shall be made on enclosed format complete in all respects. 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 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 are reliable enough. It is expected that during development of design, the bidder shall take recourse to detailed checking, interdepartmental 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 & testing 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 not noticed by M ECON/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 M ECON/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/input 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 performance 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.
<table>
<thead>
<tr>
<th>Activity Description</th>
<th>Procedure Number</th>
<th>Code of Conformance</th>
<th>Performer</th>
<th>Checker</th>
<th>Reviewer/Approver</th>
<th>Sampling Plan</th>
<th>Testing and Inspection Code</th>
<th>Type of (Approval) Surveillance</th>
<th>Audit Scope</th>
<th>Owner’s/MECON Review/Audit Requirement</th>
</tr>
</thead>
</table>

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.
## OBSERVATION OF QUALITY ASPECTS

**FORMAT – 00002**

<table>
<thead>
<tr>
<th>Job No. and Description</th>
<th>No.</th>
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</thead>
<tbody>
<tr>
<td>Issued to: M/s</td>
<td>Date</td>
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</table>

<table>
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<tr>
<th>Location of Work:</th>
<th>Item of Work:</th>
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</table>

<table>
<thead>
<tr>
<th>Details of Observation(Deficiency)</th>
<th>Recommended Course of Action</th>
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<tbody>
<tr>
<td></td>
<td>Time Allowed for Correction:</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Issued by:</th>
<th>Name of Signature of RCM, MECON Site</th>
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</table>

<table>
<thead>
<tr>
<th>Corrective Action taken report by Contractor/ Vendor:</th>
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</table>

<table>
<thead>
<tr>
<th>Date:</th>
<th>Name and Signature</th>
</tr>
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</table>

<table>
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<tr>
<th>Distribution (before resolution):</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager</td>
<td>Chief Business Executive</td>
</tr>
<tr>
<td>Owner</td>
<td>Executive</td>
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</tbody>
</table>

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<thead>
<tr>
<th>Verification of Resolution by MECON:</th>
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<tr>
<th>Date:</th>
<th>Name of Signature</th>
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<tr>
<th>Distribution (before resolution):</th>
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<tbody>
<tr>
<td>Project Manager</td>
<td>Chief Business Executive</td>
</tr>
<tr>
<td>Owner</td>
<td>Executive</td>
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</table>
SPECIFICATION
FOR
DOCUMENTATION FOR PIPELINE CONSTRUCTION

SPECIFICATION NO.: MEC/ S/ 05/ 21/ 69

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
# CONTENTS

<table>
<thead>
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</thead>
<tbody>
<tr>
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<td>OPE</td>
</tr>
<tr>
<td>2.0 RE</td>
<td>CORDS</td>
</tr>
<tr>
<td>3.0</td>
<td>AS-BUILT DRAWINGS AND PIPE BOOK</td>
</tr>
</tbody>
</table>

**PREPARED BY:**  
(Shalini Singh)  

**CHECKED BY:**  
(Sunil Kumar)  

**APPROVED BY:**  
(A.K. Johri)  

**ISSUE DATE:**  
Jan. 2008  

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Page 447 of 514
### 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 documents required to be prepared and submitted by Contractor as per this specification shall be in addition to the various reports, records, methodology statement, calculations, drawings, etc. to be submitted by the Contractor for Company's record, review or approval as per the requirements of all other specifications included in the Contract between the Company and Contractor.

**1.3** This specification shall be read in conjunction with the conditions of all specifications and document included in the Contract between Company and Contractor.

### 2.0 RECORDS

Contractor shall submit daily, weekly, monthly and after completion to the Company, various records and reports for Company's documentation purpose during and immediately after the construction. This shall as minimum include, but not limited to the following:

#### 2.1 Daily

- Separate progress reports of all crews
- Daily welding results and repairs
- Actual weather conditions
- Application for deviations, if any
- Accident(s)
- Damages
- Activities required from Company
- Materials Receipts
- Urgently required materials

#### 2.2 Weekly

- Up-to-date list of confirmed site instruction issued by Company
- Materials 'taken over'
- Material defects and repairs
- Outstanding activities of Company
<table>
<thead>
<tr>
<th>TITLE</th>
<th>DOCUMENTATION FOR PIPELINE CONSTRUCTION</th>
<th>DOCUMENT NO.</th>
<th>Page 2 of 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MEC/ S/ 05/ 21/ 69</td>
<td></td>
<td>REVISION : 0</td>
</tr>
<tr>
<td></td>
<td>EDITION : 1</td>
<td></td>
<td>EDITION : 1</td>
</tr>
</tbody>
</table>

- 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.
- Vendor's 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.
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)
### Title: Pipeline Construction

**Document No.:** MEC/S/05/21/69  
**Revision:** 0  
**Edition:** 1

- Isometric drawings of installations
- Special installation

Further Contractor shall prepare a pipe Weld Book.

If required by the Company, Contractor shall update the diskettes for drawings issued for construction of the job.

#### 3.2 “As-Built” Drawings

Contractor shall prepare a complete set of “as-built” drawings. From the start of construction, Contractor shall on daily basis process any changes in two sets of drawings. Deleted parts shall be indicated in red, new parts in blue, remarks in green and unchanged parts in yellow. Said drawings shall be kept at site and be available to the Company at all times. Contractor shall prepare “as-built” drawings based on these data. On completion of the work, one revised film transparency of all drawings made “as-built” by Contractor containing the “as-built” information shall be handed over to Company as well as one complete set of CD ROM/ floppy diskettes as specified by Company.

Contractor shall prepare and submit a specimen of the layout of the drawings for the Company’s approval.

The required measurement for “as-built” drawing shall be executed by Contractor by experienced, qualified surveyors.

The surveyors shall daily take care of all measurement required such as but not limited to:

- Horizontal location of pipeline with regard to deviations and Permanent Grid Pillars.
- Vertical Level with regard to Mean Sea Level of pipeline and grade.
- Location and type of bends, fittings etc. and grades, points of intersection.
- Change of wall thickness, materials.
- Location and details of valves, insulating flanges, fencing.
- Location and details of crossing pipes, vents.
- Location and type of coating.
- Location and type of weighting, anchoring.
- Location and type of markers.
- Location of further appurtenance (Pig-Signallers).
- Location of ROU and of pipeline with respect to ROU.
- Type of soil.
- Type of rock
- Type of blasting and ripping.
- Sand padding.
- Type of road pavement.
- Details of bank protection, number of insulators, seals.

Contractor shall also prepare isometric drawings of all installation (facilities) 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 at least the location thereon of two welds on every page of the pipe Book.

Further,

- Diameter of pipeline
- Length of each pipe
- Wall thickness
- Pipe number
- Heat number, certificate number
- Cut and re-numbered pipe ends
- Coating type
- Date of stringing
- Date of welding
- Weld number
- Welder number
- Direction of working
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:

<table>
<thead>
<tr>
<th>Type of document</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Reports/ Documents</td>
<td>MS Office</td>
</tr>
<tr>
<td>b) Drawings</td>
<td>AutoCAD</td>
</tr>
</tbody>
</table>

For the purpose of preparation of as-built drawings, Contractor shall update the “Issued for construction” drawings issued by the Company. It shall be the Contractor’s responsibility to covert the drawings furnished by the Company in hard copy into CAD drawings including scanning, digitising and converting the drawings into a suitable format compatible with the AutoCAD and above. As-built drawings shall be prepared only on AutoCAD drawings.
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

2.0 REFERENCE DOCUMENTS

3.0 SPECIFICATION FOR FIELD JOINT COATING MATERIAL

4.0 APPLICATION PROCEDURE

5.0 INSPECTION

6.0 TESTING

7.0 REPAIR OF FIELD JOINT COATING

8.0 REPAIR OF PIPE COATING DEFECTS

9.0 DOCUMENT

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**PREPARED BY:** (Binita Brahma)  
**CHECKED BY:** (Sunil Kumar)  
**APPROVED BY:** (A.K. Johri)  
**ISSUE DATE:** May 2009
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 ± 20 mm to be left at both the ends of coated pipes. The job includes supply of all materials equipment, consumables, labour, supervision, quality control, inspection repairs.

1.2 Manpower, Material & Equipment

1.2.1 The Contractor shall supply wrap around heat shrinkable sleeves which is composed of two parts such as adhesive coated wrap around and a curable modified epoxy primer alongwith applicator pads.

1.2.2 The supply of wrap around heat shrinkable sleeve shall be under Contractor’s scope.

1.2.3 The Contractor shall provide all skilled/ unskilled personnel required for execution of this work.

1.2.4 The joint coating operation starting from cleaning and surface preparation till application of joint coating and wrapping of the pipe joints shall be performed under the supervision of skilled personnel who are well versed in the work.

1.2.5 Contractor shall at his own cost provide a fully equipped laboratory and test facilities with adequate inventory to carry out tests required for procedure qualification and during regular production, for testing of joint coating system.

2.0 REFERENCE DOCUMENTS

2.1 Provision of the following documents/ codes shall generally be followed for standard of specification and workmanship.

a) DIN – 30672 : Corrosion protection tapes and Heat Shrinkable Sleeves.

b) SIS – 055900 : Pictorial surface preparation standard for painting steel surfaces.

c) SSPC – SP1 : Steel structure painting council – Solvent Cleaning.
2.2 In case of conflict between the requirements of this specification and that of above referred documents/ codes, the requirements of this specifications shall govern.

3.0 SPECIFICATION FOR FIELD JOINT COATING MATERIAL

3.1 General

This scope covers the minimum requirement of materials, equipment required for installation of field joint coating by wraparound fibre-reinforcement heat-shrinkable sleeve used for corrosion protection and sealing of field joints in pipelines that are forced through the soil by Horizontal Directional Drilling technique. The sleeves shall be suitable for 3LPE/FBE coated pipes operating up to 60°C continuously.

3.1.1 Each Joint Coating System shall consist of:

a) 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

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Condition</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Crack</td>
<td>ISO 4675</td>
<td>Below 40°C</td>
<td></td>
</tr>
<tr>
<td>Chemical resistance</td>
<td>ISO 175</td>
<td>168 hrs. immersion on either 0.1 N NaCl @ 23°C, 0.1N H₂SO₄ @</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>23°C, 0.1 N NaOH @ 23°C, Fuel oil @ 23°C, Petroleum jelly @ 70°C</td>
<td></td>
</tr>
<tr>
<td>Followed by test for bursting strength</td>
<td>ISO 3303</td>
<td>23°C</td>
<td>1100 N Min.</td>
</tr>
<tr>
<td>Thermal ageing</td>
<td>ISO 188</td>
<td>150°C</td>
<td>1700 N Min.</td>
</tr>
<tr>
<td>Followed by test for bursting strength</td>
<td>ISO 3303</td>
<td>23°C</td>
<td></td>
</tr>
</tbody>
</table>

3.2.2 Adhesive material

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Condition</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Softening point</td>
<td>ASTM E28</td>
<td></td>
<td>85°C minimum</td>
</tr>
<tr>
<td>Peel Strength</td>
<td>DIN 30672</td>
<td>23°C. CHS* 100 mm/ min. 60°C</td>
<td>200 N/cm minimum</td>
</tr>
<tr>
<td>Peel Strength After immersion for 4 weeks at 23°C~NaOH pH12 H₂SO₄ pH2 ground water solution: - 1.2% H₃PO₄ 1.6% KOH</td>
<td>DIN 30672</td>
<td>23°C. CHS* 100 mm/ min. 60°C</td>
<td>200 N/cm minimum</td>
</tr>
</tbody>
</table>
## Property Test Method Condition Requirement

<table>
<thead>
<tr>
<th>1.2NaCl 1.0% Fe₂O₃</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Peel Strength after conditioning for 30 cycles from -30°C to 60°C</td>
<td>DIN 30672</td>
<td>23°C. CHS* 100 mm/ min.</td>
<td>60 N/cm minimum</td>
</tr>
<tr>
<td>Shear strength</td>
<td>ISO 4587</td>
<td>23°C. CHS* 50 mm/ min.</td>
<td>200 N/cm² minimum</td>
</tr>
<tr>
<td>Corrosive effect</td>
<td>ASTM D 2671</td>
<td>120°C. 16 hrs.</td>
<td>No corrosion</td>
</tr>
</tbody>
</table>

### 3.2.3 Primer Material

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Condition</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>ASTM D1084</td>
<td>23 +/- 0.5° C Part A: 2 rpm, spindle #6 Part B: 20 rpm, spindle #3</td>
<td>Part A: 60 +/- 30 Pas Part B: 1.55 +/- 0.55 Pas</td>
</tr>
<tr>
<td>Mixing ratio</td>
<td>By weight</td>
<td>23°C</td>
<td>100:40</td>
</tr>
<tr>
<td></td>
<td>By volume</td>
<td></td>
<td>100:60</td>
</tr>
<tr>
<td>Shear strength</td>
<td>ISO 4587</td>
<td>23°C. CHS* 50 mm/ min.</td>
<td>1000 N/cm² minimum</td>
</tr>
</tbody>
</table>

* CHS = Cross Head Speed

### 3.2.4 Functional Properties

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Property</th>
<th>Test Method</th>
<th>Condition</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Impact resistance</td>
<td>DIN 30672</td>
<td>23°C. Class C</td>
<td>No holidays when tested at 20 KV</td>
</tr>
<tr>
<td>b)</td>
<td>Penetration resistance</td>
<td>DIN 30672</td>
<td>60°C. Class C</td>
<td>Minimum 70% of original resistance thickness left; no holidays when tested at 20 KV</td>
</tr>
<tr>
<td>c)</td>
<td>Specific coating resistance</td>
<td>DIN 30672</td>
<td>23°C.</td>
<td>10⁸ Ohm sq. m minimum; no oxidation on pipe surface</td>
</tr>
</tbody>
</table>
### Field Joint Coatings of Pipeline for HDD Crossing

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Property</th>
<th>Test Method</th>
<th>Condition</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>d)</td>
<td>Cathodic disbondment resistance</td>
<td>ASTM G42</td>
<td>60°C, 30 days</td>
<td>15 mm increase in radius of disbondment max.</td>
</tr>
<tr>
<td>e)</td>
<td>Resistance to split propagation</td>
<td>TEST METHOD-1*</td>
<td></td>
<td>No cut propagation</td>
</tr>
<tr>
<td>f)</td>
<td>Resistance to circumferential edge loading</td>
<td>TEST METHOD-2*</td>
<td></td>
<td>50 KN minimum</td>
</tr>
<tr>
<td>g)</td>
<td>Resistance to local edge loading (chisel test)</td>
<td>TEST METHOD-3*</td>
<td></td>
<td>6 KN minimum</td>
</tr>
</tbody>
</table>

#### 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°C.

After 15 minutes, the sample shall be removed from the oven, allowed to cool down to room temperature and examined for cut propagation.

This test simulates the unlikely event when the sleeve gets cut during the installation phase. Sleeves based upon extruded polyelfin show a distinct tendency to propagate the cut along the total width of the sleeve. Sleeves suitable for HDD works shall not exhibit this behaviour.

**3.3.2 Resistance to circumferential edge loading (Test method -2)**

The sleeve shall be installed on a DN 200 three-layer PE coated steel pipe piece. A thick wall steel ring that fits a DN 200 three-layer PE coated steel pipe with a tolerance of 0.2+-0.2 mm shall be positioned against the front edge of the wear cone sleeve and then pushed towards the sleeve system at a constant speed of 5 mm/min over a distance of 50 mm. The forces necessary shall continuously be registered. The minimum required force shall be less than 50 KN.
During the pushing or pulling operation, any obstacle protruding from the smooth pipe surface is loaded by the surrounding soil that passes by. This test simulates the shear forces that are exerted on to the sleeve by rigid soil type.

### 3.3.3 Resistance to local edge loading (Chisel test: Test Method -3)

The sleeve shall be installed on a DN 200 three-layer-PE coated steel pipe piece.

A chisel as depicted in Figure -1 shall be positioned against the front edge of the wear cone sleeve and, pushed parallel to the pipe surface towards the sleeve system at a constant speed of 5mm/ min over a distance of 50 mm. The forces necessary shall continuously be registered. The minimum required force should not be less than 6 KN.

During the pushing or pulling operation, the pipe may traverse soil area containing solid particles, such as stones, pebbles or crushed rock. These particles tend to rip away the pipe coating locally. Any obstacle protruding from the smooth pipe surface is lifted, leading to soil undercutting. This test determines the resistance of sleeve against this type of abuse.

![Chisel Diagram](image)

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 Owner’s approval prior to commencement of joint coating work.

b) Prior to cleaning operation, Contractor shall visually examine the joint surface area and shall ensure that all defects, flats and other damages have been repaired or removed.

c) Where oil, grease or other materials detrimental to the finished coating is present, it shall be removed with a continuous removal solvents cleaning system to remove completely all such materials in accordance with SSPC-SP1.

d) The standard of finish for cleaned pipe surface shall conform to SA 2½ of Swedish Standard SIS-055900 latest edition. The degree of preparation required to obtain an end product that fulfil the requirements of this specification may not be sufficiently covered and is not limited by SIS-055900. Surface of pipe after shot blasting shall be have an anchor pattern of 50 to 70 microns. This shall be measured by a suitable instrument such as Elecometer.

e) Piper temperature immediately prior to blasting shall be minimum 20°C. At no time shall be blast cleaning be performed when the relative humidity exceeds 85%. Surface temperature must be at least 3°C above the dew point temperature.

f) The abrasive blast material shall be free of impurities and inclusions, water and oil. All abrasives shall be removed after blast by brush or vacuum type
cleaner prior to applying joint coating. The abrasive shall be stored in a dry condition and maintained dry during use.

g) The compressed air for blasting shall be free of water and oil. Contractor to verify air cleanliness at the start of the work and every four hours thereafter. Separators and the traps shall be provided at the compressor and blasting station. Separators and traps shall be checked daily for effective moisture and oil removal during coating operations.

h) The ends of existing line pipe protective coating shall be inspected and chamfered. Unbonded portions of the coating shall be removed and then suitably trimmed. Portions where parent coating is removed shall be thoroughly cleaned as specified.

i) Pipe shall be visually inspected by Contractor immediately after blast cleaning for surface defects such as slivers, laminations, leafing, scores, indentation slugs or any other defects considered injurious to the coating integrity. Such defects shall be reported to Owner and on permission from Owner, such defects shall be removed by filling or grinding in such a way as not to "blue" the steel.

4.3 Procedure

a) The application procedure shall be in accordance with manufacturers instruction and the minimum requirements specified below whichever are the most stringent and shall be demonstrated to and approved by the owner.

b) Applicators for coating application shall be given necessary instructions and training before start of work by the CONTRACTOR. To verify and qualify the application procedures, all coating applied during the qualification test, shall be removed for destructive testing until the requirements stated in sections ‘Inspection’ and ‘testing’ of this specification are met.

c) Prior to surface cleaning, the surface shall be completely dry. An effective heating equipment which shall not give rise to deposits shall be used. Care shall be taken to avoid damage to existing coating.

d) All pipe joint surfaces shall be thoroughly examined before the application of the coating in order to ensure that the surfaces are free of oil, grease, rust, mud, earth or any other foreign matter.

e) Liquid epoxy primer shall be applied on the joints immediately after the completion of heating operation.

f) The heat shrink sleeve is then wraparound the joint while the primer is still wet and shall overlap the existing pipe coating by minimum 100 mm on each side.
g) The wraparound sleeve is shrunk on pipe joint with a propane torch moved back and forth over the surface when heated above 125°C, the sleeve shall shrink tightly around the substrate onto the wet-primer. At the time of application of the primer, the pipe surface temperature shall be at least 60°C at every point. To check this, approved temperature indicators shall be used. Temperature indicating crayons shall not be used.

h) The wraparound sleeve shall be entirely wrapped around the pipe positioning the closure patch off to one side of the pipe in 10m or 2 o’clock position, with edge of the undergoing layer facing upward and an overlap of min. 100 mm.

i) Heat shrinking shall be procedure shall be applied to shrink the sleeve in such a manner that all entrapped air is removed using gloved hands and hand rollers. The complete shrinking of entire sleeves shall be obtained without undue heating of existing pipe coating and providing due bonding between pipe, sleeve and pipe coating. A thermochrome paint shall be applied an closure patch to indicate that sufficient heat/temperature has been obtained. The joint coating shall have wear cone applied over the leading edge of the sleeve and the clamping belt tightened over it.

j) Application of Wear Cone - The leading edge will be given an extra wear cone. Start by heating the leading edge area of the main sleeve to 70°C. Wrap the leading edge sleeve over the transition Mill coating. Ensure that the closure is placed away from the main sleeve closure Shrink the leading edge sleeve.

k) Application of Metal Belt - The metal belt shall be applied over the wear cone sleeve. The metal belt will be tightened using the strapper tool supplied by the manufacturer.

l) Sufficient manpower working on opposite sides of each pipe joint are required for installation of the sleeve.

m) The installed sleeve shall not be disturbed until the adhesive has solidified.

5.0 INSPECTION

5.1 For wraparound coating, a visual inspection shall be carried out for the following:

- Mastic extrusion on either ends of the sleeves shall be examined
- There shall be no sign of punctures or pinholes or bond failure. The external appearance of the sleeves shall be smooth, free of dimples, air entrapment or void formation.
- Weld bead profile shall be visible over the sleeves.
- The entire closure patch shall have changed colour uniformly.
5.2 Holiday Inspection

5.2.1 The Holiday Detector used shall be checked and calibrated daily with an accurate D.C. voltmeter. The detector electrode shall be in direct contact with the surface of coating to be inspected.

5.2.2 The entire surface of the joint section shall be inspected by means of a full circle Holiday Detector approved by OWNER set to DC Voltage of at least 25 kV for wraparound sleeves. Inspection of the heat shrink sleeve coating shall be conducted only after the joint has cooled below +50°C.

5.2.3 All the coated joints shall be subjected to Holiday Detection test.

5.2.4 An installed sleeve with more than two holiday shall be stripped and a new one be installed.

6.0 TESTING

a) OWNER reserves the right to test one out of every 30 joint coating subject to a minimum of 2 joints. CONTRACTOR shall provide all assistance in removing and testing of field joint coatings. From each test sleeve, one or more strips of size 25 mm x 200 mm shall be cut one perpendicular to the pipe axis and slowly peeled off. This test shall be conducted between either sleeve and metal or sleeve and mill coating as per direction of Owner/Engineer-in-charge.

b) The required peel strength shall be 60 N/cm (min.) at 23°C. The system shall fail only in the adhesive layer. No failure either in adhesion to steel or adhesion to backing shall be permitted. The adhesive layer that remains on the pipe surface shall be free of voids resulting from air or gas inclusion.

c) If the sleeve taken away for test does not meet the requirement of clause 6.0 (b), the adjacent two sleeves do not meet the requirements of clause 6.0 (b) the field joint coating shall be stopped until OWNER is satisfied with application methods.

d) For the test tensile strength, two parallel incisions spaced 1 CM. Apart are made right down to the surface of the steel. A further incision shall then be at right angles to the first angles to the first two incisions. With the aid of a 1 cm. Wide knife the coating is lifted over a length of about 2 cm. And clamped into the tensile tester, where upon a uniform pull is exerted at an angle of 90 degree. The tensile strength shall be more than 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.
### FIELD JOINT COATINGS OF PIPELINE FOR HDD CROSSING

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.
SPECIFICATION
FOR
PIPELINE CROSSINGS USING HORIZONTAL DIRECTIONAL DRILLING METHOD

SPECIFICATION NO. MEC/S/05/21/ 5

OIL & GAS SBU
MECON LIMITED
DELHI 110 092
<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>SCOPE</td>
</tr>
<tr>
<td>2.0</td>
<td>REFERENCE DOCUMENTS</td>
</tr>
<tr>
<td>3.0</td>
<td>DESIGN AND ENGINEERING</td>
</tr>
<tr>
<td>4.0</td>
<td>CONSTRUCTION</td>
</tr>
<tr>
<td>5.0</td>
<td>DOCUMENTATION</td>
</tr>
</tbody>
</table>

**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.

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, canals, streams, etc. The following minimum requirements of cover to the pipe shall be satisfied unless specified otherwise in the scope of work in SCC.

For Road Crossing : 1.4 m from top of road to top of pipe.
For railroad crossing : 1.7 m from base of Rail to top of pipe.
For canal crossing : 1.5 m from lowest bed level to top of pipe.

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

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 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 alongside with 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 calculate 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 from 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 addition to the documents specified elsewhere in this specification. Contractor shall submit to the Owner the following documents/records.

- Copies of the permits obtained from authorities having jurisdiction.
Records of pre and post installation hydrostatic testing.

Record of non-destructive testing of welds.

Detailed drilling log and downhole data, including, but not limited to, the following:

i) Torque and pulling/pushing force
ii) Data on drilling fluid.
   - Density
   - Type of mud and additive employed.
   - Mixing, pumping and cleaning.

Wash and drill pipe data, viz.,

i) Dimension and material properties.
ii) Data on API classification.
iii) Age of and type of inspection previously carried out on these pipes.

Permits obtained from authorities having jurisdiction for the various works.

Plan & profile of the drilled hole along with the water level variations.

Records of hydrostatic pre-testing and final testing.

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 landowners 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 along with 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 ANTI RODENT WARNING MATS
FOR PIPELINE

Purpose : For using as a warning sign for Underground Pipeline

Width : D + 300 mm, D – Dia of Line Pipe

Thickness : 1.0 mm thick

Material of the mat : The material shall be of high density Polyethylene of virgin quality and non Biodegradable type. It shall have Non Hazardous, Non Toxic and Anti – Rodent properties.

Colour of the mat : Golden Yellow with letters printed in RED of 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/cm²

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-biodegradable 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.
HIGH PRESSURE GAS PIPELINE BELOW

CLIENT NAME

COMPANY NAME

IN EMERGENCY PLEASE CONTACT

PHONE NOS. ........................................
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
# CONTENTS

<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>SCOPE</td>
</tr>
<tr>
<td>2.0</td>
<td>REFERENCE DOCUMENTS</td>
</tr>
<tr>
<td>3.0</td>
<td>MANUFACTURER’S QUALIFICATION</td>
</tr>
<tr>
<td>4.0</td>
<td>MATERIALS</td>
</tr>
<tr>
<td>5.0</td>
<td>DESIGN AND MANUFACTURE</td>
</tr>
<tr>
<td>6.0</td>
<td>INSPECTION AND TESTS</td>
</tr>
<tr>
<td>7.0</td>
<td>TEST CERTIFICATES</td>
</tr>
<tr>
<td>8.0</td>
<td>PAINTING, MARKING AND SHIPMENT</td>
</tr>
<tr>
<td>9.0</td>
<td>DOCUMENTATION</td>
</tr>
</tbody>
</table>

**PREPARED BY:** (Shalini Singh)  
**CHECKED BY:** (Sunil Kumar)  
**APPROVED BY:** (A.K. Johri)  
**ISSUE DATE:** 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
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 0°C 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 HV10.

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, nipolets, 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 90° 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
### 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

TECHNICAL SPECIFICATION
FOR
ASSORTED PIPES

SPECIFICATION NO. : MEC/TS/05/62/59A, R-0
## CONTENTS

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>GENERAL</td>
<td>2</td>
</tr>
<tr>
<td>2.0</td>
<td>IBR PIPES</td>
<td>4</td>
</tr>
<tr>
<td>3.0</td>
<td>HYDROSTATIC TEST</td>
<td>5</td>
</tr>
<tr>
<td>4.0</td>
<td>MARKING &amp; DESPATCH</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>ANNEXURE-I : HYDROSTATIC TEST</td>
<td>7</td>
</tr>
</tbody>
</table>
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.F.S.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.F.S.W. pipes < 36” shall not have more than one longitudinal seam joint and E.F.S.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:

<table>
<thead>
<tr>
<th>Material</th>
<th>Wall Thickness</th>
<th>Weld Contour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Steel (Except Low Temp. Carbon Steel)</td>
<td>Upto 22mm</td>
<td>Figure 2 Type A</td>
</tr>
<tr>
<td></td>
<td>&gt; 22mm</td>
<td>Figure 3 Type A</td>
</tr>
<tr>
<td>Alloy Steel Stainless Steel &amp; Low Temp. Carbon Steel</td>
<td>Upto 10 mm</td>
<td>Figure 4</td>
</tr>
<tr>
<td></td>
<td>&gt;10 mm &amp; Upto 25 mm</td>
<td>Figure 5 Type A</td>
</tr>
<tr>
<td></td>
<td>&gt; 25 mm</td>
<td>Figure 6 Type A</td>
</tr>
</tbody>
</table>

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

$$\frac{E_t}{1.5} \geq \frac{S_r}{1.5} \geq S_a$$

where,
- $S_A$ : Allowable stress at the working metal temperature.
- $E_t$ : Yield point (0.2% proof stress at the working metal temperature).


**2.2**

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

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

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

**3.0**

**HYDROSTATIC TEST**

Refer Annexure – I.

**4.0**

**MARKING AND DESPATCH**

**4.1**

All pipes shall be marked in accordance with the applicable codes, standards and specifications. In addition, the purchase order number, the item code & special conditions like “IBR”, “CRYO”, “NACE”, etc., shall also be marked.

**4.2**

Pipes under “IBR”, “CRYO”, & “NACE” shall be painted in red stripes, light purple brown stripes & canary yellow stripes, respectively, longitudinally throughout the length for easy identification.

**4.3**

Paint or ink for marking shall not contain any harmful metal or metallic salts such as zinc, lead or copper which cause corrosive attack on heating.
4.4 Pipes shall be dry, clean and free from moisture, dirt and loose foreign materials of any kind.

4.5 Pipes shall be protected from rust, corrosion and mechanical damage during transportation, shipment and storage.

4.6 Rust preventive used on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.

4.7 Both ends of the pipe shall be protected with the following material:

<table>
<thead>
<tr>
<th>Plain end</th>
<th>Plastic cap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bevel end</td>
<td>Wood, Metal or Plastic cover</td>
</tr>
<tr>
<td>Threaded end</td>
<td>Metal or Plastic threaded cap</td>
</tr>
</tbody>
</table>

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.
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

<table>
<thead>
<tr>
<th>Material Standard</th>
<th>Test Press re Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM A 106 Gr. B</td>
<td>ASTM A 530</td>
</tr>
<tr>
<td>API 5L Gr. B, Seamless</td>
<td>API 5L</td>
</tr>
<tr>
<td>API 5L, E.R.W.</td>
<td></td>
</tr>
<tr>
<td>API 5L, Spiral</td>
<td></td>
</tr>
<tr>
<td>ASTM A333 Gr. 3 &amp; 6, Seamless</td>
<td>ASTM A 530</td>
</tr>
<tr>
<td>ASTM A33 Gr. 3 &amp; 6, E.R.W.</td>
<td>ASTM A 530</td>
</tr>
</tbody>
</table>

b) Seamless Alloy Steel

<table>
<thead>
<tr>
<th>Material Standard</th>
<th>Test Press re Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM A335 GR.P1, P12, P11, P22, P5, P9</td>
<td>ASTM A 530</td>
</tr>
<tr>
<td>ASTM A268 TP 405, TP410</td>
<td>ASTM A530</td>
</tr>
</tbody>
</table>

c) Seamless Stainless Steel

<table>
<thead>
<tr>
<th>Material Standard</th>
<th>Test Press re Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM A312 Gr.TP304, 304L, 304H, 316, 316L, 316H, 321, 347</td>
<td>ASTM A 530</td>
</tr>
</tbody>
</table>

d) Seamless Nickel Alloy

<table>
<thead>
<tr>
<th>Material Standard</th>
<th>Test Press re Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM B161 UNS No.2200</td>
<td>ASTM B161</td>
</tr>
<tr>
<td>ASTM B165 UNS No.4400</td>
<td>ASTM B165</td>
</tr>
<tr>
<td>ASTM B167 UNS No.6600</td>
<td>ASTM B167</td>
</tr>
<tr>
<td>ASTM B407 UNS No.8800</td>
<td>ASTM B407</td>
</tr>
</tbody>
</table>
3.2.2 Electric Fusion Welded

a) Carbon Steel & Alloy Steel E.FS.W. 1 & a o e

<table>
<thead>
<tr>
<th>Material Standard</th>
<th>Test Pressure Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>API 5L Gr.B</td>
<td>P=2ST/D</td>
</tr>
<tr>
<td>ASTM A 671 Gr.CC65, 70 (Cl.32)</td>
<td>S=90% of SMYS (except for API 5L Gr.B)</td>
</tr>
<tr>
<td>ASTM A 672 Gr.C60, 65, 70 (Cl.12,22)</td>
<td>S=85% of SMYS for API 5L Gr.B</td>
</tr>
<tr>
<td>ASTM A 671 Gr.CF60, 65, 66, 70 (Cl.32)</td>
<td>T=Nominal Wall Thickness</td>
</tr>
<tr>
<td>ASTM A 691 Gr. ½ Cr, 1Cr, 1 ¼Cr, 2 ½Cr, 5Cr, 9Cr (Cl.42)</td>
<td>D=O.D. of Pipe</td>
</tr>
</tbody>
</table>

Stainless Steel E.FS.W. 2 to

The hydrostatic test pressure in kg/cm² 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

<table>
<thead>
<tr>
<th>Size</th>
<th>Pipe Schedule</th>
<th>Material Gr.1</th>
<th>Material Gr.2</th>
<th>Pipe Schedule</th>
<th>Material Gr.1</th>
<th>Material Gr.2</th>
<th>Pipe Schedule</th>
<th>Material Gr.1</th>
<th>Material Gr.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2”</td>
<td>100</td>
<td>80</td>
<td>155</td>
<td>130</td>
<td>230</td>
<td>190</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3”</td>
<td>80</td>
<td>60</td>
<td>155</td>
<td>130</td>
<td>230</td>
<td>190</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4”</td>
<td>80</td>
<td>50</td>
<td>155</td>
<td>130</td>
<td>230</td>
<td>190</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6”</td>
<td>65</td>
<td>35</td>
<td>90</td>
<td>75</td>
<td>155</td>
<td>130</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
c) Stainless Steel E.F.S.W. and a.o.e.

<table>
<thead>
<tr>
<th>Material Standard</th>
<th>Test Pressure Standard</th>
</tr>
</thead>
</table>
| 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 |
S = 72% of SMYS  
T = Nominal Wall Thickness  
D = O.D. of Pipe |

3.2.3 Carbon Steel Pipes to IS Standards

<table>
<thead>
<tr>
<th>Material Standard</th>
<th>Test Pressure Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS :1239</td>
<td>IS :1239</td>
</tr>
<tr>
<td>IS :3589</td>
<td>IS :3589</td>
</tr>
</tbody>
</table>
STANDARD TECHNICAL SPECIFICATION

FOR

BALL VALVES

SPECIFICATION NO.: MEC/TS/05/21/002

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
# AMENDMENT STATUS

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<thead>
<tr>
<th>Sl. No.</th>
<th>Clause / Paragraph / Annexure / Exhibit / Drawing Amended</th>
<th>Page No.</th>
<th>Rev.</th>
<th>Date</th>
<th>By</th>
<th>Verified</th>
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<tr>
<td>1.</td>
<td>Cl. No. 4.6</td>
<td>4</td>
<td>1</td>
<td>April 09</td>
<td>Gurdeep Singh</td>
<td>K.K. De</td>
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<tr>
<td>2.</td>
<td>Overall Revision</td>
<td>All</td>
<td>1</td>
<td>July 20</td>
<td>K.P. Singh</td>
<td>A.K. Tyagi</td>
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</table>

*Name* | *Sig.* | *Name* | *Sig.*
### Abbreviations:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>API</td>
<td>American Petroleum Institute</td>
</tr>
<tr>
<td>BHN</td>
<td>Brinell hardness number</td>
</tr>
<tr>
<td>DN</td>
<td>Nominal Size</td>
</tr>
<tr>
<td>HAZ</td>
<td>Heat Affected Zone</td>
</tr>
<tr>
<td>LC</td>
<td>Lock Close (valve locked in full close position)</td>
</tr>
<tr>
<td>LO</td>
<td>Lock Open (valve locked in full open position)</td>
</tr>
<tr>
<td>MSS-SP</td>
<td>Manufacturers Standardization Society – Standard Practice</td>
</tr>
<tr>
<td>NDT</td>
<td>Non Destructive Testing</td>
</tr>
<tr>
<td>NPS</td>
<td>Nominal Pipe Size</td>
</tr>
<tr>
<td>RTJ</td>
<td>Ring Type Joint</td>
</tr>
<tr>
<td>SSPC</td>
<td>Steel Structures Painting Council</td>
</tr>
</tbody>
</table>
# CONTENTS

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>SCOPE</td>
</tr>
<tr>
<td>2.0</td>
<td>REFERENCE DOCUMENTS</td>
</tr>
<tr>
<td>3.0</td>
<td>MATERIALS</td>
</tr>
<tr>
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<td>DESIGN AND CONSTRUCTION</td>
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<tr>
<td>5.0</td>
<td>INSPECTION AND TESTS</td>
</tr>
<tr>
<td>6.0</td>
<td>EXTENT OF INSPECTION &amp; TESTING</td>
</tr>
<tr>
<td>7.0</td>
<td>TEST CERTIFICATES</td>
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<td>8.0</td>
<td>PAINTING, MARKING AND SHIPMENT</td>
</tr>
<tr>
<td>9.0</td>
<td>SPARES AND ACCESSORIES</td>
</tr>
<tr>
<td>10.0</td>
<td>DOCUMENTATION</td>
</tr>
<tr>
<td>11.0</td>
<td>GUARANTEE</td>
</tr>
</tbody>
</table>

FIGURE-1 VENT, DRAIN & SEALANT INJECTION DETAILS
1.0 SCOPE

This specification covers the minimum requirements for design, manufacture, testing and supply of carbon steel ball valves of size DN 50 mm (2") and above and ANSI pressure rating class 150 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 – 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
### 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 °C. Test procedure shall conform to ASTM A370. The average absorbed energy value of three full sized specimens shall be 27 J.
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 HV10.

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.

4.3 Ball shall be of single piece, solid type construction.

For buried valves, valve body design shall be fully welded type only. Valve body joints with bolts or threads are not permitted.
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 Manufacturer’s standard.

<table>
<thead>
<tr>
<th>Nominal Valve Size</th>
<th>Nominal Valve Size for Reduced Opening</th>
<th>Nominal Valve Size</th>
<th>Nominal Valve Size for Reduced Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td>DN mm (NPS inches)</td>
<td>DN mm (NPS inches)</td>
<td>DN mm (NPS inches)</td>
<td>DN mm (NPS inches)</td>
</tr>
<tr>
<td>50 (2)</td>
<td>50 (2)</td>
<td>600 (24)</td>
<td>500 (20)</td>
</tr>
<tr>
<td>80 (3)</td>
<td>80 (3)</td>
<td>700 (28)</td>
<td>600 (24)</td>
</tr>
<tr>
<td>100 (4)</td>
<td>100 (4)</td>
<td>750 (30)</td>
<td>600 (24)</td>
</tr>
<tr>
<td>150 (6)</td>
<td>150 (6)</td>
<td>800 (32)</td>
<td>650 (26)</td>
</tr>
<tr>
<td>200 (8)</td>
<td>200 (8)</td>
<td>850 (34)</td>
<td>700 (28)</td>
</tr>
<tr>
<td>250 (10)</td>
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<td>900 (36)</td>
<td>750 (30)</td>
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<tr>
<td>300 (12)</td>
<td>300 (12)</td>
<td>950 (38)</td>
<td>800 (32)</td>
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<td>350 (14)</td>
<td>350 (14)</td>
<td>1000 (40)</td>
<td>850 (34)</td>
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<tr>
<td>400 (16)</td>
<td>400 (16)</td>
<td>1050 (42)</td>
<td>900 (36)</td>
</tr>
<tr>
<td>450 (18)</td>
<td>450 (18)</td>
<td>1200 (48)</td>
<td>1050 (42)</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>ANSI Pressure Rating</th>
<th>Nominal Valve Size (NPS inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Floating Ball</td>
</tr>
<tr>
<td>1.</td>
<td>150#</td>
<td>&lt; 8&quot;</td>
</tr>
<tr>
<td>2.</td>
<td>300#</td>
<td>≤ 4&quot;</td>
</tr>
<tr>
<td>3.</td>
<td>600#</td>
<td>&gt; 4&quot;</td>
</tr>
</tbody>
</table>

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.
### Ball Valve

<table>
<thead>
<tr>
<th>Title</th>
<th>Document No.</th>
<th>Page 10 of 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball Valve</td>
<td>MEC/TS/05/21/002</td>
<td></td>
</tr>
</tbody>
</table>

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.
### 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 ≤ DN 100 mm (4 inches) shall be wrench operated and valve sizes ≥ 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") | Nil
      | ≥ DN 450mm (18") | 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.
<table>
<thead>
<tr>
<th>TITLE</th>
<th>DOCUMENT NO.</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BALL VALVE</td>
<td>MEC/TS/05/21/002</td>
<td>19</td>
</tr>
</tbody>
</table>

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.
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

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>SCOPE</td>
<td>2</td>
</tr>
<tr>
<td>2.0</td>
<td>REFERENCE DOCUMENTS</td>
<td>2</td>
</tr>
<tr>
<td>3.0</td>
<td>MATERIALS &amp; TEST PROCEDURES</td>
<td>3</td>
</tr>
<tr>
<td>4.0</td>
<td>DESIGN &amp; CONSTRUCTION</td>
<td>4</td>
</tr>
<tr>
<td>5.0</td>
<td>INSPECTION &amp; TESTS</td>
<td>7</td>
</tr>
<tr>
<td>6.0</td>
<td>EXTENT OF INSPECTION &amp; TESTING</td>
<td>9</td>
</tr>
<tr>
<td>7.0</td>
<td>TEST CERTIFICATES</td>
<td>9</td>
</tr>
<tr>
<td>8.0</td>
<td>PAINTING, MARKING &amp; SHIPMENT</td>
<td>10</td>
</tr>
<tr>
<td>9.0</td>
<td>SPARES &amp; ACCESSORIES</td>
<td>10</td>
</tr>
<tr>
<td>10.0</td>
<td>DOCUMENTATION</td>
<td>11</td>
</tr>
<tr>
<td>11.0</td>
<td>GUARANTEE</td>
<td>12</td>
</tr>
</tbody>
</table>

**PREPARED BY:** Gurdeep Singh  
**CHECKED BY:** A.K. Sarkar  
**APPROVED BY:** A.K. Johri
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:

<table>
<thead>
<tr>
<th>Class</th>
<th>Size Range, NB mm (inch)</th>
<th>Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>50-100 (2-4)</td>
<td>Short</td>
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<tr>
<td></td>
<td>150-300 (6-12)</td>
<td>Regular</td>
</tr>
<tr>
<td></td>
<td>350 (14) &amp; above</td>
<td>Venturi</td>
</tr>
<tr>
<td>300</td>
<td>50-100 (2-4)</td>
<td>Short</td>
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<tr>
<td></td>
<td>150-250 (6-10)</td>
<td>Regular</td>
</tr>
<tr>
<td></td>
<td>300 (12) &amp; above</td>
<td>Venturi</td>
</tr>
<tr>
<td>600</td>
<td>50-250 (2-10)</td>
<td>Regular</td>
</tr>
<tr>
<td></td>
<td>300 (12) &amp; above</td>
<td>Venturi</td>
</tr>
<tr>
<td>900</td>
<td>50-250 (2-10)</td>
<td>Regular</td>
</tr>
</tbody>
</table>

300 (12) & above

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 ≤ DN 100mm (4") shall be wrench operated and valves of sizes ≥ 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 at least 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:

<table>
<thead>
<tr>
<th>ANSI Class</th>
<th>DN Range</th>
<th>Acceptance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>150-</td>
<td>All Sizes</td>
<td>Nil</td>
</tr>
<tr>
<td>300-</td>
<td>≤ DN 400mm (16&quot;)</td>
<td>Nil</td>
</tr>
<tr>
<td></td>
<td>≥ DN 450mm (18&quot;)</td>
<td>100%</td>
</tr>
<tr>
<td>600-</td>
<td>All Sizes</td>
<td>100%</td>
</tr>
</tbody>
</table>

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 does 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 along with 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 along with 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.
SPECIFICATION
FOR
INSULATING JOINTS

SPECIFICATION NO.: MEC/TS/05/21/009

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
# CONTENTS

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>SCOPE</td>
</tr>
<tr>
<td>2.0</td>
<td>REFERENCE DOCUMENTS</td>
</tr>
<tr>
<td>3.0</td>
<td>MATERIALS</td>
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<tr>
<td>4.0</td>
<td>DESIGN &amp; CONSTRUCTION REQUIREMENTS</td>
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<tr>
<td>5.0</td>
<td>INSPECTION AND TESTS</td>
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<td>6.0</td>
<td>TEST CERTIFICATES</td>
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<td>7.0</td>
<td>PAINTING, MARKING AND SHIPMENT</td>
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<tr>
<td>8.0</td>
<td>GUARANTEE</td>
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<td>9.0</td>
<td>DOCUMENTATION</td>
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</table>

**Prepared by:** (SACHIN SINGHAL)  
**Checked by:** (A.K. Gupta)  
**Approved by:** (A.K. Johri)  
**Issue Date:** Oct. 2008
<table>
<thead>
<tr>
<th>SL No.</th>
<th>Clause / Paragraph / Annexure / Exhibit / Drawing Amended</th>
<th>Page No.</th>
<th>Revision</th>
<th>Date</th>
<th>By (Name)</th>
<th>Verified (Name)</th>
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</table>
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 vii & ix
g) API 1104 Standard for welding pipelines and Related facilities.
h) SSPC-VIS-1 Steel Structures painting Council Visual Standard.
i) MSS-SP-S3 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.
### MATERIALS

3.0

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:

\[
CE = C + \frac{Mn}{6} + \frac{(Cr + Mo + V)}{5} + \frac{(Ni + Cu)}{15}
\]

3.3 When specified in the ID 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 Data sheet, 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 A 370 for each heat of steel used. The maximum hardness of base metal, weld metal and heat affected zone of all pressure parts shall be 240 HV10, unless specified otherwise.

3.6 Insulation material shall be minimum 20 mm thick and shall comply section 5, NACE RP 0286.

### DESIGN & CONSTRUCTION REQUIREMENTS

4.0

4.1 Mechanical

4.1.1 Insulating joints shall be of integral type fabricated by welding and with pups on either
<table>
<thead>
<tr>
<th>TITLE</th>
<th>DOCUMENT NO.</th>
<th>Page 3 of 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSULATING JOINTS</td>
<td>MEC/TS/05/21/009</td>
<td>REVISION: 0</td>
</tr>
</tbody>
</table>

**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 B31.4/8 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 scrapers/ 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 position 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 CI, 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 pipe on either side of the
insulating joint for connecting 10 mm² and 30 mm² 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 cleaned & 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 50mm 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 3 kg/cm² 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 AC, 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.
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OIL & GAS SBU, DELHI  
| DOCUMENT NO.  
MEC/TS/05/21/009  
|
| TITLE  
INSULATING JOINTS  
| Page 6 of 7  
REVISION : 0  
EDITION : 1  
|

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 burned 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:-

- Manufacturer's name
- Suitable for ____ inch nominal diameter pipeline
- End thickness in mm
- Material
- Design Pressure/ Hydrostatic Test Pressure
- ANSI Class Rating
- Tag No.
- 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.
<table>
<thead>
<tr>
<th>8.0 GUARANTEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1 The manufacturer shall guarantee that the materials used comply with the requirements of this specification.</td>
</tr>
<tr>
<td>8.2 Manufacturer shall replace or repair insulating joints found defective due to inadequate engineering or quality of material.</td>
</tr>
<tr>
<td>8.3 Manufacturer shall replace the insulating joint without delay if the defect or malfunctioning can not be eliminated.</td>
</tr>
<tr>
<td>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.</td>
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</tbody>
</table>

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<tr>
<th>9.0 DOCUMENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1 All documents shall be in English Language.</td>
</tr>
<tr>
<td>9.2 At the time of bidding, Bidder shall submit the following documents:-</td>
</tr>
<tr>
<td>a) General arrangement drawing along with cross sectional view, overall dimensions and details of insulating materials recommended.</td>
</tr>
<tr>
<td>b) Reference lists of previous supplies of insulating joint of similar specification.</td>
</tr>
<tr>
<td>c) Clause wise list of deviation from this specification, if any.</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>a) Fabrication drawings and relevant calculations for pressure containing parts.</td>
</tr>
<tr>
<td>b) Welding procedure and method of manufacture for all phases of manufacture.</td>
</tr>
<tr>
<td>c) Quality Control Manual &amp; Quality Control Plan.</td>
</tr>
<tr>
<td>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 insulating joint are manufactured.</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>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.</td>
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</tbody>
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TECHNICAL / STANDARD SPECIFICATION
FOR
CIVIL & STRUCTURAL WORKS
SPECIFICATION

FOR

CIVIL ENGINEERING WORKS

MECON LIMITED
SPECIFICATION FOR CIVIL ENGINEERING WORKS

INDEX

PART - I MATERIALS I-I to I-IX & I-1 to I- 66
PART - II WORKMANSHP II-I to II-IX & II-1 to II-180
PART - III NORMS OF CEMENT CONSUMPTION III-I & III-1 to III-14
PART - IV DIMENSIONAL TOLERANCE IV-1 to IV-10
PART - V METHOD OF MEASUREMENT V-I & V-1 to V-16
PART - VI SAFETY REQUIREMENTS FOR CONSTRUCTION WORK VI-1 to VI-19
ANNEXURE LIST OF IS & CODES REFERRED A-1 to A-25
SPECIFICATION FOR CIVIL WORKS

PART – I MATERIALS
C O N T E N T S

1.0 GENERAL
   1.1 Scope
   1.2 Standard
   1.3 Approval and Tests
   1.4 Codes
   1.5 Rejection of Materials

2.0 MATERIALS FOR CONCRETE
   2.1 Aggregates
   2.2 Coarse Aggregates
   2.3 Fine Aggregates
   2.4 Lime
   2.5 Surkhi
   2.6 Cement
   2.7 Water
   2.8 Admixtures for Concrete
   2.9 Interval of Routine Test

3.0 STEEL
   3.1 For Reinforcement
   3.2 For Binding Works
   3.3 For Light Structural Work and Insert
3.4 Steel Tubes
3.5 Foundation Bolts
3.6 Steel tubes for Non-structural use
3.7 Threaded Fasteners
3.8 Testing
3.9 Cast Steel
3.10 Conduits

4.0 **ASBESTOS CEMENT PRODUCTS**

4.1 General
4.2 Building Boards
4.3 Flat Sheets
4.4 Pipes and Fittings
4.5 Corrugated and Semi-corrugated sheets
4.6 Asbestos Cement Roof fittings

5.0 **BRICK AND STONES**

5.1 Bricks
5.2 Handling
5.3 Inspection
5.4 Brick Bats
5.5 Laterite Stone Blocks
5.6 Stones (Granite, trap, sandstone and quartzite etc.)
5.7 Hollow and Solid Concrete Blocks

5.8 Cement, Lime and Water

5.9 Sand for Masonry Mortar

6.0 SAND FOR PLASTERING

7.0 MATERIALS FOR FLOORING & PAVING

7.1 Cement & Binders

7.2 Aggregates

7.3 Tiles

7.4 Pigments

7.5 Red oxide of Iron

7.6 Hardening Agents

7.7 Dividing Strips

7.8 Marble chips

7.9 Marble powder

8.0 TIMBER

8.1 General

8.2 Teak Wood / Sal / Beja Sal / Deodar / Kail and other varieties.

8.3 Storage & Inspection

8.4 Moisture Content

8.5 Allowance for Bulk Timber
8.6 Flush Door Shutters, Shelves
8.7 Wood Particle Board
8.8 Veneered Particle Board
8.9 Plywood for general purpose
8.10 Veneered decorative plywood

9.0 FITTINGS FOR DOORS, WINDOWS ETC.

9.1 General
9.2 Hinges
9.3 Sliding Door Bolts
9.4 Door Rim Latch
9.5 Tower bolts
9.6 Door Handles
9.7 Mortice locks and Rebated Mortice locks
9.8 Floor door stopper
9.9 Hooks and eyes.
9.10 Casement window handles
9.11 Casement peg stays
9.12 Quadrant stays
9.13 Fan light pivots
9.14 Fan light catch
9.15 Steel Frames for doors
9.16 Putty
# 10.0 Metal Doors, Windows, Ventilators and Rolling Shutters

10.1 General

10.2 Steel doors, Windows, Ventilators

10.3 Aluminium Doors, Windows, Ventilators

10.4 Steel Rolling Shutter, Rolling Grills

10.5 M.S. Bolts etc.,

10.6 Hardware

10.7 Mastic

# 11.0 Glass

11.1 General

11.2 Plain Transparent Glass

11.3 Ground or Frosted Glass

11.4 Thickness

11.5 Inspection

# 12.0 Paint

12.1 General

12.2 Sampling & Testing

12.3 Storage

12.4 Paints for Priming

12.5 Paints for Finishing
12.6 White Wash
12.7 Colour Wash
12.8 Water proof cement Paint
12.9 Distemper
12.10 Varnish
12.11 Polish
12.12 Plastic acrylic emulsion paint
12.13 Creosote oil or Coal tar creosote
12.14 Coal Tar black paint
12.15 Floor polish paste

13.0 WATERPROOFING MATERIALS

13.1 Integral Cement water proofing compounds
13.2 Bitumen
13.3 Bitumen Primer
13.4 Bitumen Felt
13.5 Bitumen Mastic
13.6 Bituminous Compounds
13.7 Surface Application Materials
13.8 Polymer based paints
13.9 Fibre glass R.P. Tissue
13.10 P.V.C. Membrane/sheet
14.0 WATER BAR

14.1 General

14.2 Jointing

15.0 LEAD

15.1 General

16.0 BUILDING PAPER/GYPSUM MATERIALS

16.1 Building paper

17.0 FILLING MATERIAL

17.1 General

17.2 Mastic Bitumen

17.3 Flexible Boards

18.0 DRAINAGE AND SANITATION (INTERNAL)

18.1 General

18.2 P.V.C Waste Pipe

18.3 Stoneware Pipes

18.4 HCI Pipes and fittings

18.5 Cast Iron Pipes and AC pipes (Rain Water pipes)

18.6 Sanitary appliances (E.W.C. & I.W.C.)

18.7 Wash Hand Basin

18.8 Flat Back Lipped Urinal

18.9 Mirror Frames
18.10 Toilet Shelf
18.11 Towel rail
18.12 Soap Container
18.13 CP Flush Valves for E.W.C.
18.14 CP Flush Valves for urinals
18.15 Gully Trap
18.16 C.I. Manhole Cover and frame
18.17 Flushing cistern
18.18 Plastic seat & cover for water closets

19.0 WATER SUPPLY & PLUMBING (INTERNAL)

19.1 General
19.2 G.I. Pipes and Fittings
19.3 RCC, Asbestos, prestressed pipes and fittings
19.4 C.I. Pipes and fittings
19.5 Steel Pipes
19.6 Bib Tap and Stop Tap
19.7 Valves
19.8 Shower Rose
19.9 Storage Tank
19.10 Misc. items

20.0 EXTERNAL SEWERAGE & DRAINAGE
20.1 C.I. Pipes
20.2 Washers
20.3 Gaskets
20.4 Caulking Lead
20.5 Salt glazed stoneware Pipes
20.6 Steel pipes
20.7 Cast Iron Manhole Covers and frames

21.0 ROAD AND FENCING

21.1 General
21.2 Soling Stones
21.3 Coarse aggregate for Water Bound Macadam
21.4 Screenings
21.5 Stone Chips for Bituminous Surfacing
21.6 Sand
21.7 Binder
21.8 Kerbs
21.9 Barbed wire
21.10 Chain link fabric
21.11 Concertina Coil fencing

22.0 APPROVED BRAND AND/OR MANUFACTURER'S NAME FOR SOME OF THE IMPORTANT MATERIALS

23.0 MATERIALS NOT SPECIFIED
1.0 GENERAL

1.1 Scope

This part deals with the requirements of materials for use in construction 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 requirements of the Technical Specifications for civil works.

1.2 Standard

A high standard of quality is required for all materials used in construction 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 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 by the Engineer.

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 particular "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/ceased to be produced), 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 materials, subsequently approved, results in use of material of price lower than that of the material specified in the Schedule of Items or Technical Specifications, the rates of work affected by the substitution shall be proportionately reduced. Similarly, in case the substitution results in use of material of price higher than that specified in the Schedule of Items or Technical Specifications, the rates of work affected by the substitution shall be proportionately increased.

1.4 Codes

1.4.1 The years of publication against various standards, referred in this specification, correspond to the latest standards as on date of preparation of this specification. During use of this specification in future, the latest publication as on date shall be referred to. Where standards are not yet published by the BIS or IRC, adoptable British Standards or other International Standards shall apply.

1.4.2 In case of any conflict in meaning between these specifications and those of BIS or IRC, or British /International Standard; 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 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 or of I.S. Codes as applicable, then that material shall be rejected.

1.5.3 The Contractor at his own cost 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: 383-1970 "Coarse and Fine Aggregates for Concrete". They shall be hard, strong, dense, durable, clean and free from veins and adherent
coating, vegetable matter and other deleterious substances; and shall be obtained from approved sources. Aggregates shall not contain any harmful material such as pyrites, coal, lignite, shale or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of concrete. Aggregates which are chemically reactive with alkalies 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: 2386-1963 "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 carry out 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: 383-1970 and shall be within the limits of Grading Zone-III. The maximum size of particle shall be 4.75mm and shall be graded down. Sand containing more than 10% of fine grains passing through 150 micron sieve or having the fineness modulus less than 2 shall not be used for concrete work.

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: 456-1978. The aggregates shall be well graded and the grading shall conform to relevant requirements of IS: 383-1970 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: 383-1970.

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. In case of stockpiling, 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 Schedule 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, friable, thin, flat, elongated or laminated and flaky pieces and free from dirt, clay lumps, and other deleterious materials like coal, lignites, silt, soft fragments, and other foreign materials which may affect adversely the strength & durability of concrete. The total amount of deleterious /foreign materials shall not exceed 5% by weight according to relevant clause of IS: 383-1970. 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 / Brick aggregates

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

2.3 Fine Aggregates

2.3.1 Unless specified otherwise it shall either be 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 impurities which is likely to attack steel reinforcement. The percentage of all deleterious materials including silt, clay etc., shall not exceed 5% by weight. If directed, sand shall be screened or washed before use to the satisfaction of Engineer.

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 depending on the circumstances.

2.4 Lime

Lime for mortars and concrete shall conform to IS: 712-1984 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: 3182-1986. Surkhi shall be made from well burnt bricks or brickbats. Surkhi shall pass through I.S. sieve 3.35mm with at least 50% of it passing through I.S. sieve 1.70mm and be perfectly clean and free from foreign matter. Surkhi shall not be made from bricks which have come in contact with any mortar.

2.6 Cement

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

Other types of cement may be used depending upon the requirements of certain jobs with the approval of the Engineer. These shall conform to the following standards:

- Portland Pozzolana Cement
  IS: 1489-1991
- Rapid Hardening Portland Cement
  IS: 8041-1990
- 43 Grade Ordinary Portland Cement
  IS: 8112-1989
- 53 Grade Ordinary Portland Cement
  IS: 12269-1987
- Hydrophobic Portland Cement
  IS: 8043-1991
- High alumina cement for structural work
  IS: 6452-1989
- White portland cement
  IS: 8043-1989
- Sulphate Resisting Portland Cement
  IS: 12330-1988

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: 3535-1986. All tests shall be in accordance with the

2.6.2 Contractor's responsibility

From the time 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 and at his expense and risk. Any cement which deteriorates while in the Contractor's charge and is rejected as unsuitable by the Engineer, shall be removed from the site to outside the limits of work at the cost of contractor 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 at least such stock of cement as the Engineer may from time to time consider necessary. No cement shall be used upon the works until it has been accepted as satisfactory by the Engineer.

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 leaving a space of 60 cm around the exterior walls. The cement shall not be stacked more than 10 bags high. Each consignment of cement shall be stacked separately to permit easy access for inspection.

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: 456-1978. Water shall be obtained from an approved source.

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

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 carry out such test as the Engineer may require before any admixture is used in the work.

2.8.2 Types

2.8.2.1 Integral water proofer

Admixtures used as integral water proofer shall be free of chlorides and sulphates and shall conform to IS: 2645-1975. The application and doses shall be as per manufacturer's specification.

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 and in other respects generally as per IS: 2386 (Part 1 to 8)-1963.
- Cement: Fortnightly or for each consignment, within 4 days of delivery and in other respects generally as per IS: 4031-1988.
- Water: Once in two months for each source of supply and in other respects generally as per IS: 456-1978.
3.0 STEEL

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 : 432-1982 "Mild Steel & Medium Tensile Steel for Concrete Reinforcement".

ii) "High strength deformed steel bars conforming to IS : 1786-1985 for Concrete Reinforcement".

iii) Reinforcement fabrics conforming to IS:1566-1982 "Hard Drawn Steel Wire Fabric for Concrete Reinforcement"

All reinforcement bars shall be of uniform cross sectional area and be free from loose mill scales, dust, loose rust, coats of paint, oil or other coatings which may destroy or reduce bond. Unit weight of reinforcement bars conforming to I.S. 1786-1985 is as given below.

<table>
<thead>
<tr>
<th>Nominal Size (Dia) (mm)</th>
<th>Mass Per Metre Run (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0.222</td>
</tr>
<tr>
<td>8</td>
<td>0.395</td>
</tr>
<tr>
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<td>18</td>
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</tr>
<tr>
<td>20</td>
<td>2.470</td>
</tr>
<tr>
<td>22</td>
<td>2.980</td>
</tr>
<tr>
<td>25</td>
<td>3.850</td>
</tr>
</tbody>
</table>
3.2 Binding wire

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

3.3 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 - Specification."

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 in drawings or the schedule of items) and of grade YST 25 conforming to IS : 1161 - 1979 "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 : 5624-1970 "Specification for Foundation Bolts". Material for bolts, shall, unless otherwise mentioned in drawings or the schedule of items, be of steel conforming to IS : 2062-1992.

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

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

3.6 Steel Tubes for Non-structural use

3.6.1 Steel tubes for non-structural use shall conform to IS : 1239 (Part-I) -1990 "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) -1992 "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 (Part 1)-1980 "Technical Supply Conditions for Threaded Fasteners".

3.8 Testing


3.9 Cast Steel

3.9.1 Quality

Cast steel shall conform to IS : 1030-1989 "Carbon Steel Casting for General Engineering Purpose". Unless otherwise specified, it shall conform to Grade2.

3.10 Conduits

3.10.1 Steel for electrical wiring

Rigid steel conduits for electrical use shall conform to IS : 9537 (Part 2) -1981 for rigid pipes and to IS : 3480-1966 for flexible conduits. Fittings for conduits shall conform to IS : 2667-1988. All conduit pipes shall be finished with galvanised or stove-enamelled 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 conduit for electrical wiring

Bends shall be achieved by bending the pipes 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:5913-1989 "Method of Test for Asbestos Cement Products."

#### 4.2 Building Boards

These shall be of Class A, B and C with board thickness being 6.5mm, 5mm and 4mm respectively. The length shall be 2400, 1800 and 1200mm and width in all cases 1200 mm. Building boards shall conform to IS : 2098 - 1964 "Asbestos Cement Building Boards". They shall, when tested in two perpendicular directions, take a load of not less than 15 kgf for Class-A and 10 Kg for Class-B and Class-C 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 : 2096-1992 "Asbestos Cement Flat Sheets". They shall have a bending stress of not less than 225 kgf/cm2 & a density of 1.6 kg/dm3 for compressed sheets & a bending stress of not less than 160 kgf/cm2 and a density of 1.2 Kg/ dm3 for uncompressed sheets. Nominal thickness shall be 5,6,8,10 and 15 mm, length 2400, 1800 and 1200mm and width 1200mm. Water absorption shall not exceed 28% of dry wt.

#### 4.4 Pipes and fittings

Pressure pipes shall conform to IS : 1592-1989 "Asbestos Cement Pressure Pipes" and to IS : 9627 -1980 "Asbestos Cement Pressure Pipes (Light Duty)". Pipes for sewerage and drainage shall conform to IS
4.5 Corrugated and Semi-Corrugated Sheets

These shall conform to IS : 459 -1992 "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 load bearing capacity of not less than 5 N/mm width of specimen and shall not absorb more water than 28% of its dry weight. Overall width of corrugated sheets is 1050mm and of semi-corrugated sheet is 1100mm.

4.6 Asbestos Cement Roof fittings

These shall conform to IS : 1626 (Part 3)-1981. Shapes and dimensions shall be as given in the above mentioned code. All finished products shall be free from visual defects that impair appearance or serviceability. Surface of fittings shall be of uniform texture and shall have neatly trimmed edges. Mean water absorption shall not be more than 28% of dry mass of the material.

5.0 BRICK AND STONES

5.1 Bricks

Bricks for masonry in foundations, walls and other locations shall be common burnt clay building bricks having minimum crushing strength of 5 N/sq.mm., or such other strength as may be described in the Schedule of Items, when tested in accordance with IS : 1077-1992 "Common Burnt Clay Building Bricks". They shall be sound, hard and thoroughly well burnt, with uniform size having rectangular faces with parallel sides and sharp straight right angled edges and be of uniform colour with fine compact uniform texture. Bricks shall be of uniform deep red cherry or copper colour. They shall be free from flaws, cracks and nodules of free lime. Water absorption after 24 hours immersion in cold water shall be not more than 20% by weight. They shall not absorb more than 10% by weight of water after immersion for six hours. They shall emit a clear
metallic ringing sound when struck by a mallet and shall not break when dropped on their face, from a height of 60 cm. Fractured surface shall show homogeneous, fine grained uniform texture, free from cracks, air holes, laminations, grits, lumps of lime, efflorescence or any other defect which may impair their strength, durability, appearance and usefulness for the purpose intended. Underburnt or vitrified bricks shall not be used. Samples of bricks brought to the site shall be tested periodically for compression and other tests according to IS : 3495 (Parts-1 to 4) -1992 "Method of Test for Burnt Clay Building Bricks". Where the size of bricks is not specifically mentioned, it shall be taken to mean conventional sizes as is commonly available in the area. In case modular bricks are to be used, it shall be accordingly specified in Schedule of Items. The bricks shall be classified on the basis of average compressive strength as given in table 1 of IS : 1077-1992.

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 shall be to the approval of the Engineer who may reject such consignment as are considered by him to be inferior to the quality specified. The Contractor shall provide all labour and plant required for the inspection and conduct such test as shall be required by the Engineer without additional charges.

5.4 Brick Bats

Brick bats shall be obtained from well burnt bricks of approved quality.

5.5 Laterite Stone Blocks

These shall conform to IS : 3620 -1979 "Laterite Stone Blocks for Masonry". The laterite stone blocks shall have a minimum compressive strength of 30 kg/cm2 and to be tested as per IS : 1121-1974. The blocks shall be minimum 15 cm thick but not exceeding 30 cm. 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.

5.6 Stone (granite, trap, sandstone, quartzite etc.)

5.6.1 Stone 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.

5.6.2 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 -1974 "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 : 1126-1974 and IS : 1125-1974 respectively. The working of stones to required sizes and their dressing shall be as per IS : 1127-1970 "Recommendations for dimensions and workmanship of natural building stones for masonry work" and IS : 1129 -1972 "Dressing of Natural Building Stones". Stones especially limestone and sand stones shall be well seasoned by exposure to air before use in construction works.

5.6.3 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 or less than 15cm. The height of stone may be upto 30cm.

5.6.4 Dressing

5.6.4.1 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 4cm on all exposed faces and 2cm on a face to be plastered, nor shall it have depressions more than 1cm from the average wall surface.
5.6.4.2 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 at least 5cm back from the face, and side joints for at least 4cm such that no portion of the dressed surface is more than 6mm from a straight edge placed on it. The bushing on the face shall not project more than 4cm 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 2.5cm along the four edges of the face of the stone, when stone work is exposed.

5.6.4.3 Coursed rubble - Second sort

Dressing shall be as specified in 5.6.4.2 except that no portion of dressed surface shall exceed 10mm from a straight edge placed on it as against 6mm for first sort.

5.6.4.4 Stone for veneering

Stone lining up to 8cm 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 6mm, so that when checked with a 60cm straight edge, no point varies from it by more than 1mm. All edges shall be chisel dressed to be true, square and free from chippings. Top and bottom faces shall be dressed to within 3mm tolerance and vertical faces to within 6mm tolerance, when checked with a 60mm straight edge. Dressing at the back shall not be done.

5.7 Hollow and Solid Concrete Blocks

5.7.1 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 (Part 1)-1979. Physical properties such as density, compressive strength, water absorption etc., shall be determined in accordance with the procedure laid down in IS : 2185 (Part 1) - 1979 and shall conform to the requirement laid therein. When inspected visually all blocks shall be sound, free from cracks, broken edges,
honeycombing and other defects which would interfere with the proper placing of blocks or impair strength or permanence of construction.

### 5.7.2 Dimensions and tolerance

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.

5.7.2.1 The nominal dimensions of concrete block shall be as follows:

- **Length**: 400, 500 or 600mm
- **Height**: 200 or 100mm
- **Width**: 50, 75, 100, 150, 200, 250 or 300mm

In addition, blocks shall be manufactured in half and other suitable lengths and shapes to suit Architectural requirements.

5.7.2.2 The maximum dimensional tolerances shall be plus or minus 5mm in length and plus or minus 3mm in height and width.

### 5.7.3 Hollow blocks (open and closed cavity)

5.7.3.1 The blocks having solid material about 50% to 75% of total volume of the block calculated from the overall dimensions shall be termed as hollow blocks. 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.

5.7.3.2 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/mm2 or as specified.

5.7.3.3 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.

### 5.7.4 Solid blocks

The blocks having solid material more than 75% of the total volume of the block shall be termed as solid block. 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.

5.7.5 Mix proportion

The concrete mix used for blocks shall not be richer than one part by volume of cement to six parts by volume of combined aggregates before mixing.

5.7.6 Surface texture and finish

Surface texture, that is, very fine closed 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.

5.7.7 Marking and certificate

The blocks shall be marked permanently indicating the Grade of the unit, identification of the manufacturer and the year of manufacture. Manufacturers test certificate shall be supplied with the delivery of each lot.

5.8 Cement, Lime and Water

Cement, lime and water shall conform to the specification under the Section Concrete of this part.

5.9 Sand for Masonry Mortar

Sand for masonry mortars shall be natural sand, crushed stone sand or crushed gravel and shall comply with IS : 2116 - 1980 "Sand for Masonry Mortars". The sand shall be hard, durable, clean and free from adherent coatings and shall not contain amount of clay, silt and fine dust more than 5% by wt. Sand shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal, mica and organic matters. The particle size grading of sand for use in mortars shall be within the limits as specified in Table I of above code.

6.0 SAND FOR PLASTERING
Sand for use in mortars for internal wall, ceiling and external plastering and rendering shall conform to IS:1542 -1992. It shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal, mica and organic matters. Percentage of salt and dust shall not be more than 5% by weight. Grading of sand shall be within the limits specified in clause no. 5.1 of above code. Fineness modulus of naturally occurring sand shall not be less than 1.5.

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 as per clauses 2.1, 2.3, 2.6 and 2.7 of this part.

7.1.2 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 Coarse Aggregate

7.2.1.1 Coarse aggregate shall conform to the requirement as per clauses 2.1 and 2.2 of this part.

7.2.1.2 For granolithic floor the screeded bed shall comprise of aggregates size 15mm and down graded and topping shall comprise of clean fine stone chippings, size 4mm and down. For concrete floor with hardener treatment the topping shall comprise of stone chippings, size 6mm and down and for in-situ terrazzo flooring, chippings shall be within sizes 12mm to 6mm graded. The marble chips for topping of terrazzo floor shall be of 3-6mm size and shall conform to Grade-I of IS : 2114-1984 "CP for laying in-situ terrazo floor finish".

7.2.2 Common burnt clay bricks

Common burnt clay bricks shall conform to IS : 1077-1992 and comply with requirements under the section "Brick and Stones" of this part.
7.2.3 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 225mm, 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 20mm including a minimum of 6mm 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 - 1988 "Glazed Earthenware Tiles. They shall be true in shape, free from hair cracks, 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, normally shall be 149mm x 149mm or 99mm x 99mm size and shall not be less than 5mm thick or as specified. The tolerance on average facial dimension value shall be plus or minus 0.8 and on thickness plus or minus 0.5mm. 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.

7.3.4 Marble tiles

It shall conform to IS : 1130 -1960 "Marble (Blocks, Slabs and Tiles)". Marble for paving and facing work shall be of selected quality, hard,
sound, dense and homogeneous in texture (with crystalline texture) and free from cracks, decay, weathering and flaws and shall be of kind and quality, size and thickness as specified in schedule of items. The samples of tiles shall be got approved by the Engineer before use. The tiles shall be cut to the requisite dimensions.

7.4 Pigments

Pigments incorporated in mortar or used for grouting shall be subject to approval of Engineer and as per table I of IS : 2114-1984.

7.5 Red Oxide of Iron

Red oxide of iron where used for "Red Artificial Stone Flooring" shall be of quality approved by the Engineer, and shall be of uniform tint.

7.6 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.

7.7 Dividing Strips

Dividing strips shall be of aluminium, glass, brass, copper, plastic or similar materials as specified in the schedule of item and of quality approved by the Engineer. Strips shall be 1.5 mm thick unless otherwise specified penetrating to the full depth of the flooring. Aluminium strips when used shall have a protective coating of bitumen.

7.8 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 shall be uniform in colour and free from cracks, stains, decay and weathering and shall be obtained from approved source.

7.9 Marble Powder

It shall be clean, free from dust and other foreign materials and of approved quality, obtained from approved source. It shall pass through sieve 300 conforming to IS: 460- (Part-1)-1985.
8.0 TIMBER

8.1 General

All timber used for carpentry and joinery works shall be new. It shall be well seasoned by a suitable process conforming to IS : 1141-1973 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 (Part 1&2)-1983 to 1991. The finished components shall be given suitable preservative treatment wherever necessary.

8.2 Teak wood/Sal / Bija Sal / Deodar / Kail and other varieties of timber

8.2.1 Teak wood

The timber shall be of good quality and well seasoned. It shall be of fairly uniform colour and shall be free from defects such as cracks, dead knots, shakes etc. No individual hard and sound knot shall be more than 15 sq. cm. in size and aggregate area of all such knots shall not exceed 2 % of the area of the piece. Wood shall be generally free from sap wood but traces of the same shall be allowed. The timber shall be fairly grained having not less than 2 growth per cm width in cross section.

8.2.2 Sal / Bija Sal wood

Timber shall be of good quality and well seasoned. It shall have fairly uniform colour, reasonable straight grains and shall be free from all defects as mentioned in previous clauses. No individual hard and sound knot shall be more than 6 sq. cm. in size and aggregate area of all such knots shall not exceed 2 % of the area of the piece. There shall not be less than 5 growth rings per 2 cm of the width.

8.2.3 Deodar wood

The timber shall be of good quality and well seasoned. It shall have fairly uniform colour, reasonable straight grains and shall be free from all defects as mentioned in previous clauses. No individual hard and sound knot shall be more than 15 sq.cm. in size and aggregate area of
all such knots shall not exceed 2% of the area of the piece. There shall be at least 3 growth rings per cm width in cross section.

8.2.4 Kail wood

The timber shall be generally as specified in clause 8.2.3 for Deodar wood. However, there shall not be less than 2 growth rings per cm width in cross section.

8.2.5 Other varieties of timber

The timber as named in the item of work shall be used. It shall be well seasoned and generally free from defects such as dead knots, cracks, shakes, sap wood etc. However, traces of sap wood shall be allowed and sound and hard knots up to 2% of the area of the piece shall be allowed.

8.3 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.

8.4 Moisture Content

Timber shall be accepted as well seasoned if its moisture content does not exceed the permissible limit as per IS: 287-1973.

8.5 Tolerances for Timber

For timber allowance as specified in the IS: 1003 (Part 1&2) 1983 to 1991 shall be applicable.

8.6 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 (Part 1&2)-1983 to 1991 and cellular or hollow core shutters to IS : 2191 (Part 1&2)-1983. The resin used shall be phenol formaldehyde. A full size sample door shall be offered for inspection and approval.

8.7 Wood Particles Boards

Particle boards for general purposes shall be of medium density conforming to IS:3087-1985. These are of four types, Flat pressed single layer board (FPSI), Flat pressed three layer board (FPTh), Extrusion pressed solid board (XPSO) and Extrusion pressed tubular core (XPTU). Adhesive shall be BWR, WWR or un-extended CWR type. High density wood particle board shall conform to IS:3478-1966 and are in flat sheets or moulded forms. These shall be of type 1 (BWR type of resin) or Type 2 (WWR or CWR type of resin). Both types of boards shall be of Grade A (resin content 20 to 50 percent) and Grade : (resin content 8-12 percent).

8.8 Veneered Particle Board

These shall conform to IS : 3097-1980 and shall be of two grades. Exterior (grade-I with BWP or BWR type adhesive) & interior (grade-II with WWR or CWR type adhesive). Each grade of boards shall be of 4 types, solid core general purpose, solid core decorative, Tubular core general purpose and Tubular core decorative and accordingly designated.

8.9 Plywood for General Purpose

Plywood for general purpose shall conform to IS:303-1989. Depending on type of adhesive used for bonding veneers, it is of 4 grades, BWP (boiling water proof), B.W.R (boiling water resistant), WWR (warm water resistant) and CWR (Cold Water resistant). Any species of timber may be used for plywood manufacture. However list of species, for the manufacture of plywood is given in Annexure 'B' of the IS : 303-1989 for guidance.

Plywood is classified in 10 different types as per appearance of the surface. These are type AA,AB,AC,AD,BB, BC,BD,CC,CD and DD as detailed in IS : 303-1984. It is available from 3 ply to 11 ply with thickness from 3mm to 25mm.

8.10 Veneered Decorative Plywood
This quality of plywood shall conform to IS : 1328-1982. These plywood shall be of two types Type 1 and Type 2 as per details given in IS : 1328-1982. Species of timber for decorative face commonly used are given in Table 1 of IS : 1328-1982 but the purchaser shall specify the particular veneer to be used. Timber for cores and backs shall be either class I or II as specified in IS : 303-1989. Adhesive used shall be BWR or WWR synthetic resin.

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 oxidised or painted as specified. Brass fittings shall be finished bright, oxidised or chromium plated and aluminium fittings shall be finished bright or anodised 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, anodised cadmium/chromium plated M.S. screws of approved quality shall be used for fixing aluminium fittings.

9.2 Hinges

9.2.1 Butt hinges

These shall be mild steel but hinge (medium), brass butt hinges, extruded aluminium alloy butt hinges or as specified. Type (light/medium/heavy weight) and size shall be as specified in the drawing or schedule of items. Brass / Aluminium and M.S butt hinges shall conform to Indian Standard Specification for butt hinges IS : 205-1992 and IS : 1341-1992 respectively. Hinges shall be finished bright or satin polished or anodised.
9.3 Sliding Door Bolts

Mild steel sliding door bolts shall conform to IS : 281-1991 and are of 2 types, plate type and clip or bolt type. Plate type bolts shall have plates and straps stove enameled black with hasp and bolt finished bright or copper oxidized or nickel / chromium plated. Clip or bolt type are copper oxidized or plated. All screw holes in the M.S bolts shall be countersunk. Diameter of bolt for plate type is 12mm and for clip type is 16mm.

Non ferrous metal sliding doors are of brass or aluminium alloy and shall conform to IS:2681-1979. Brass sliding bolts are of 150 to 450mm size with bolt dia being 16mm for 150 to 300mm and 18mm for 375 and 450 size. Aluminium alloy sliding bolts are of size 200 to 450mm with 16mm bolt dia. Brass quality is finished satin, polished or plated and aluminium alloy bolts are anodised.

For both ferrous and non-ferrous metal bolts the size of the sliding bolt is determined by the length of the bolt.

9.4 Door Rim Latch

This shall be of mild steel, brass, aluminium alloy or as specified and of sizes 75, 100, 125 and 150mm denoted by overall length of the body measured from outside face of the fore end to the rear end. These are of type 1 and type 2 and shall conform to IS : 1019-1974.

9.5 Tower Bolts

Tower bolts may be of one of the following types and shall conform to IS : 204 (Part 1 and 2)-1991 and 1992.

i) Barrel tower bolts

These shall be of bright finished/stove enameled/ black painted mild steel tower bolts, brass barrel tower bolts with cast brass barrel and rolled or drawn brass bolt/brass barrel tower bolts with barrel of extruded sections of brass and rolled or drawn brass bolt/brass barrel tower bolts with brass sheet barrel and rolled or drawn brass bolt. Aluminium barrel tower bolts with barrel and bolt of extruded section of aluminium alloy-bolts and barrel anodised.
ii) Semi-barrel tower bolts

These shall be mild steel semi barrel tower bolts full cover/open type with mild steel sheet pressed barrel and cast iron/mild steel bolt. Bolt bright finished other parts stove enameled black.

iii) Rivetted or spot welded tower bolts

These shall be mild steel tower bolts rivetted type with black flat and mild steel/cast iron bolt and open staple.

iv) Skeleton tower bolts

These shall be of bright finished / stove enameled / black painted mild steel or brass bright finished skeleton tower bolts with cast brass/extruded sections plate and staples and rolled or drawn brass bolt or Aluminium skeleton tower bolts with plates staples and bolt or extruded sections of Aluminium alloy plate and staple anodised.

9.6 Door Handles

Door handles shall conform to IS : 208-1987 and shall be of 4 types. Type 1 is cast Iron / Brass / Aluminium or zinc alloy die casting and available in 75,100,125 150mm sizes. Type 2 is mild steel pressed oval in 75, 100,115 and 135mm sizes. Type 3 is mild steel present half oval in 75,90 and 100mm sizes. Type 4 is fabricated (brass / aluminium alloy) in 75,100 and 125mm sizes. The size of the handle shall be determined by inside (grip) size overall size and internal depth of the handles shall be as detailed in IS : 208-1987.

Finish for type 1 shall be satin/nickel plating, copper oxidising and bronze finish for cast-brass and zinc die cast handles and stove enamelled black or copper oxidized for cast iron handles. Aluminium handles shall be anodized. Type 2 and 3 handles shall be stove enamelled black. For type 4 it shall be satin finish, nickel plating, copper oxidized and bronze finish for brass handles and anodizing for aluminium handles.

9.7 Mortice Lock and Rebated Mortice lock

Mortice lock with latch and pair of lever handles shall have body of steel, Aluminium alloy or brass 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 / 6607-1976/1972. 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 oxidised. The locks shall be of 65, 75 and 100 mm sizes.

9.8 Floor Door Stopper

These are for the use of the door shutters of 30, 35, 40 & 45mm thickness. It is made of aluminium alloy/brass with springs of phosphor bronze or hard drawn steel wire and tongue of aluminium/brass/nylon/plastic. The floor door stoppers shall conform to IS : 1823-1980 and shall be best Indian make of approved quality. Width of cover plate is 40mm but its overall length is 140mm for 30 and 35mm thick shutters & 150mm for 40 and 45mm shutters. The body shall be cast in one piece and fixed to cover plate by brass or M.S screws. On the extreme end there shall be rubber cushion to absorb shocks. The extension of the door stopper shall be in flush with floor and be finished bright/satin/chromium plated or anodised.

9.9 Hooks and Eyes

These shall be of mild steel or hard drawn brass and shall generally conform to IS : 207-1964.

9.10 Casement Window Handles

These shall be made of cast brass, steel protected against rusting, aluminium, pressed brass or as specified. Casement handles for single leaf window shutter shall be left or right handed and shall weigh as specified.

9.11 Casement Peg Stays

These shall be made of cast brass, steel protected against rusting, aluminium, cast alloy or as specified. The stay shall be made from a channel section and shall be 300mm long with steel peg and locking bracket. The peg stay shall have three holes to open the window in three different angles. The shape and pattern of stays shall be
approved by the Engineer. The peg stay shall be minimum 2mm thickness in case of brass and aluminium and 1.25 mm in case of steel.

9.12 Quadrant Stays

These shall be made of cast brass, aluminium alloy, CP iron or as specified. The shape and pattern shall be approved by the Engineer. It shall weigh as specified.

9.13 Fan Light Pivots

These shall be made of mild steel, cast brass or aluminium alloy or as specified and shall generally conform to IS : 1837-1966.

The pattern and the shape of the catch shall be as approved by the Engineer and size and finish shall be as specified.

9.14 Fan light catch

These shall be made of mild steel, cast brass, aluminium alloy or as specified and shall generally conform to IS : 364-1993. 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 Steel Frames

These shall conform to IS:4351-1976. The frames shall be manufactured from commercial mild steel sheets of 1.25mm thickness and are suitable for door shutters 30 to 40mm thick. The door frames are designated as per profile A, B and C.

Profile A Size 105x60mm : rebated for one set of shutters
Profile B Size 125x60mm : rebated for one set of shutters
Profile C Size 165x60mm : rebated for two sets of shutters.

Miscellaneous Items :

9.16 Putty
The material shall be homogeneous paste and shall be free from dust and other visible impurities. Putty shall conform to IS : 419-1967 for wood work.

10.0 METAL DOORS, WINDOWS, VENTILATORS AND 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 and Ventilators

Steel sections used for fabrication of doors, windows and ventilators shall be standard rolled steel sections specified in IS : 1038, IS : 1977, IS : 1361 or IS : 7452 year 1983, 1975, 1978 and 1990 respectively as appropriate or as specified in drawing and Schedule of Items. Rivets shall conform to IS : 1148-1982.

10.3 Aluminium Door, Windows and Ventilators

Aluminium sections for fabricating doors, windows, ventilators, partitions etc., shall be extruded sections conforming to IS : 1948-1961 & IS : 1949-1961 or as manufactured by Indian Aluminium Company Limited or approved equivalent The alloy used shall conform to Designation HE 9 - WP of IS : 733-1983.

10.4 Steel Rolling Shutters, Rolling Grills

These shall conform to IS : 6248-1979.

10.5 M.S. Bolts etc.

M.S. bolts, nuts, screws, washers, peg stays and other mild steel fittings shall be treated for corrosion. Putty for glazing shall conform to IS : 419-1967. 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 1986 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: 1081-1960 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 and be of the best quality. All glass panes shall be free from flaws, specks, bubbles etc. Glass panes shall be of thickness 3mm or more as required. Weight of 3mm thick glass pane shall not be less than 7.5 Kg/sqm. The tolerance of glass panes, except wired glasses, in length and width shall be plus or minus 2 mm for 3 to 6.3 mm glass sheets. Tolerance in thickness of glass sheets shall be +/- 0.2mm for 3mm and 4mm thick glasses and +/- 0.3mm for 4.8, 5.5 and 6.3mm thick glasses.

11.2 Plain Transparent Glass

Plain transparent glass for glazing and framing shall conform to IS: 2835-1987. 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" or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.

11.4 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 and 4.8 mm
- Sheet glass for doors: 5.5 mm
- Rough cast wired: 6.4 +/- 0.4 mm

11.5 Inspection

All glasses 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. If there is more than one quality for one particular product, only first quality shall be used unless otherwise stated in the Schedule of Items.

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 (Part 1 to 8) - 1964 to 1993.

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 either comply with IS : 2074-1992 "Ready Mixed Paint", "Red Oxide Zinc Chrome Priming" or Red Oxide metal primer as specified. For wood work it shall be pink/white wood primer as specified by the manufacturer of the synthetic enamel paints, conforming to IS : 3536-1966.

12.5 **Paints for finishing**

Ready mixed oil synthetic enamel paint of approved manufacturers like Berger, Jenson & Nicholson, Shalimar, I.C.I., Asian, Garware and Goodlass Nerolac paints only shall be used unless otherwise specified. Paint shall be of first grade quality of the above manufacturers ie., Luxol Brolac, Superlac, Dulox gloss, Apocolite, Garcoat and Nerolac respectively.

If for any other reason, thinning is necessary, the brand of the thinner recommended by the manufacturer, shall only be used with the specific permission of the Engineer.

Aluminium paint for general purpose shall be in Duel Containers. It shall be of manufacturers as for synthetic enamel paints above.

12.6 **White wash**

White was shall be prepared from freshly burnt fat, white in colour lime slaked on spot, conforming to IS : 712-1984 mixed and stirred with sufficient water to make a thin cream. Best and approved quality gum and ultra marine blue only shall be used in lime wash.

12.7 **Colour wash**

Colour wash shall be prepared by adding mineral colours, not affected by lime, to white wash.

12.8 **Water proofing Cement Paint**
Cement paints shall comply with IS: 5410-1992 and shall be of approved brand and manufacture like Snowcem India Ltd., Berger, Jenson & Nicholson & Shalimar paints. The shade shall be approved by the Engineer before its application.

12.9 Distemper

Dry/synthetic washable distemper of approved brand and manufacture like Berger, Jenson & Nicholson, Asian, Shalimar, Garware & Goodlass Nerolac shall be used. The shade shall be approved by the Engineer before application of the distemper. and shall comply with IS : 427-1965 and IS : 428-1969.

12.10 Varnish

Varnish for the finishing coat shall be copal finish or synthetic class 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 satisfaction of the Engineer.

12.11 Polish

French spirit polish shall be of an approved make conforming to IS: 348-1968. In case it is 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. Shalac shall conform to IS : 5467-1986.

12.11.1 Wax polish for Wood work

The polish shall consist mainly of waxes and Organic solvents with or without water and shall be of smooth consistency, homogeneous, Semi-Solid mass and free from gritty materials. It shall not flow at ordinary temperature. It may be tinted with an oil soluble colour. The polish shall not crumble or dry too rapidly and shall produce non-tacky polished surface. The polish shall be amenable to smooth spreading on the furniture surface and the gloss shall appear on gentle rubbing with a soft polishing cloth.

The wax polish shall conform to IS : 8542-1977.
Where wax polishing is to be prepared at site, it shall be prepared by heating two parts of "Bee Wax" two parts of boiled linseed oil over a slow fire. When dissolved but still warm, one part of turpentine is to be added. The boiled linseed oil, bees wax and turpentine used shall be of approved quality and complying with IS : 77-1976, IS : 1504-1974 and IS : 533-1973 respectively.

**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 Creosote oil or Coaltar Creosote**

It is primarily used for preservation of wood. It shall be a homogeneous liquid and shall liquify completely on being warmed to 38 degree C with stirring and shall remain liquid on cooling down to 32 degree C and on standing at that temperature for 2 hours.

The material shall conform to IS : 218-1983. All persons handling the creosote oil should be fully aware of the hazards involved in handling . Skin should be protected from coming in direct contact and eyes should be protected by using safety goggles while handling the material.

**12.14 Coaltar Black Paint**

Coaltar paint film protects surfaces by serving as a barrier against the action of moisture and other corrosive agents. Coaltar black paint is generally used as a protective and anti corrosive paint of iron and steel as well as protection of other building surfaces. For this it has to be applied under proper condition and on suitably prepared surface. Coaltar should be applied by brush only and is not recommended for locations which are not likely to be well ventilated. Coaltar paint shall conform to IS : 290 1961.
The material is of two types: Type A Quickly drying and Type B Slow drying. It shall be a homogenous black solution type paint consisting of a base prepared by blinding suitable grades of Coltar pitch, washed free from ammoniacal liquor, tar acid bases etc. Consistency, permeability, thickness and surface preparation etc. shall be as per para 5 and A-2 of the above code.

12.15 Floor Polish - Paste

The polish shall consist mainly of waxes and organic solvents with or without water.

The paste floor polish shall be of smooth consistency, homogenous, 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 neither be slippery nor show any resistance to easy walking.

Floor polish paste shall conform to IS : 8591-1977.

13.0 WATER PROOFING MATERIALS

13.1 Integral Cement Waterproofing Compounds

Integral cement waterproofing compounds, i.e. admixture for waterproofing purposes shall fully comply with the requirements of IS : 2645-1975. 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 : 702-1988 or IS : 93-1992 or IS : 217-1988 or IS : 454-1961 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: 3384-1986 and pass tests in accordance with the procedure laid down in appropriate IS mentioned in Table-I of IS: 3384-1986. 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 waterproofing purposes shall be as specified in IS: 1322-1982. Physical properties shall conform to the requirements and tests shall be carried out as per procedure laid down in IS: 1322-1982. 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 waterproofing of roofs shall have the physical properties as mentioned in IS: 3037-1986 when tested with the procedure laid down in appropriate IS mentioned in IS: 3037-1986.

13.6 Bituminous Compounds

Bituminous compounds when used for waterproofing of porous masonry, concrete floors, walls and roofs shall conform to the requirements of IS: 1580-1991. 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 1981. 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 Polymer based 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.

13.9 Fibre glass R. P. Tissue

The fibre glass R.P. tissue is a thin flexible uniform mat, composed of glass fibre in an open porous structure bonded with a suitable inert material compatible with coal tar, asphaltic enamel and oil plastic based wall paint. The fibrous glass mat is reinforced with continuous filament glass yard at 3/8" (10mm) pitch in the longitudinal direction.

PHYSICAL PROPERTIES

i) Weight

The average weight of fibre glass R.P. tissue shall not be less than 50 gms/sq.sm.

ii) Thickness

The fibre glass R.P. tissue shall have a thickness not less than 0.4mm.

iii) Tear Strength

The tear strength shall be not less than 900 grams in the transverse direction.

iv) Breaking Strength

This shall have a minimum breaking strength of 13 lb/in (2.32kg/cm) in the longitudinal direction.

v) Porosity

This shall have a porosity when related to pressure difference across the sample of not less than 0.022" (0.56mm) and not more than 0.76" (1.92mm) of water guage at an air velocity of 200fpm.(100cm/sec.).

vi) Pliability

There shall be no cracking of the tissue mat when bent over a 1/8" (3.2mm) radius after immersing for 10-15min. through a 90 degree arc.

vii) Temperature

The fibre glass tissue shall be Resistance under a load of hot bitumen at 530 degree F (276 degree C) for one minute.
13.9.1 Primer
Primer shall conform to requirements laid down in IS : 3384-1986. It is to be prepared by blending turpentine and blown grade bitumen in the ratio of 60:40 by weight.

13.9.2 Blown Materials
Blown grade bitumen shall be conforming to IS : 702-1988 and residual grade bitumen conforming to IS:73 respectively. This shall be prepared by heating to correct working temperature.

13.9.3 Surface finish
Pea sized gravel/grit 6mm and down.

13.10 P.V.C. Membrane/Sheets
Polyvinyl chloride sheets for the purpose of water proofing and other underground use are specially developed sheets made from the compounded resin of grade MP/DP/CR-02 and shall be resistant to the passage of gross water and water vapour. It shall be corrosion resistant and resistant to a wide range of acidic and alkali reagents, saltpetre action, salt water and ultra violet rays etc. PVC sheets manufactured by approved and reputed firms like Maxlok Polymer Ltd. shall only be used.

The sheets shall consist of Knobs or Lugs jutting out of the sheets in a grid fashion so as to provide a perfect grip in the mortar and concrete. Sheet thickness, spacing of the knobs and their projection from the sheet shall be as specified in the item. The sheets shall be of maximum practicable length and width unless otherwise specified.

The adhesive used for jointing shall be of approved quality and of grade C-02.

The sample of the material shall be got approved before use.

13.10.1 Properties

i) Chemical Composition : Resin Plasticiser Inhibitor
Stabiliser UV Barrier.

ii) Thickness : Not less than 0.25 mm
### iii) Rupture/Tensile Strength
Not less than 225Kg/cm²

### iv) Adhesive bond Strength
: Not less than 7.1 Kg/cm [width]

### v) Elongation at Break
: 130%

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**14.0 WATER BAR**

**14.1 General**

Water bar for use in construction/expansion joints in concrete and reinforced concrete structures shall be of copper sheet, galvanised 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 watertight joint.

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**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 : 782-1978. "Caulking Lead". Where lead wool is allowed for caulking, it shall be equal to or better than Type-II of IS : 782-1978. Lead flashing shall conform to IS : 405 Part I&II-1992.

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**16.0 BUILDING PAPER**

**16.1**

Building paper shall be bitumen impregnated paper conforming to IS: 5134 1977, or such other as may be approved by the Engineer.

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**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 : 3037-1986 or IS : 5871-1987 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 the instruction of 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 till completion of works. Pipes and Specials may be any or combination of following types:-

i) PVC Pipes
ii) Stone Ware Pipes
iii) Sand Cast Iron Pipes for soil waste & Ventilation
iv) CI Pipes for rain water
v) AC Pipes for rain water
vi) R.C.C Pipes

18.1.1 High density PVC pipes and fittings
This shall conform to IS : 4984-1987 and IS : 8008 (Part 1 to 7)-1976 unless otherwise specified.

18.2 PVC Waste Pipe

This shall conform to IS : 4985-1988 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: 651-1992. These pipes shall be of grade AA unless otherwise specified.

18.4 Sand Cast Iron Pipes & Fittings conforming to IS : 1729-1979

All soil waste and vent pipes and fittings used in the work shall be cast iron and shall conform to IS: 1729-1979. 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 DR Angas smiths solution or other approved anti-corrosive paint.

The standard weights and thickness of pipe shall comply with the requirements of IS: 1729-1979. 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.

<table>
<thead>
<tr>
<th>Nominal size</th>
<th>Weight per piece in Kg. excluding ears</th>
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<tr>
<td></td>
<td>Overall length</td>
</tr>
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<td></td>
<td>1500 mm</td>
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<td>50</td>
<td>9.56</td>
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<td>75</td>
<td>13.83</td>
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<td>100</td>
<td>18.14</td>
</tr>
<tr>
<td>150</td>
<td>26.70</td>
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</tbody>
</table>
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. B.M. trap shall have water seal as per I.S. provisions.

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 & A.C. pipes : Rainwater pipe

18.5.1 Pipes shall be of approved manufacture, true, smooth and cylindrical, their inner and outer surfaces being as nearly as practicable concentric and shall conform to IS : 1230-1979. These shall be sound and uniform casting, free from laps, pin holes or other imperfections and shall be neatly finished inside and outside. The ends of pipes shall be reasonably square to their axis.

18.5.2 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 metres 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 unless specified otherwise.

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.
18.5.3 A.C. pipes and fittings shall be of approved manufacture and shall conform to IS:1626. These shall be homogeneous and free from cracks and other defects. The pipes shall be straight, smooth and regular in thickness.

The diameter of the pipe shall be as specified. The fittings like heads, bends of different degrees, offsets of different projections, shoes and junctions shall be of the type, diameter and size as required for the work. The pipes shall be used in full lengths as far as possible.

18.6 Sanitary appliances

Sanitary appliances like I.W.C/E.W.C pans, wash basin, urinals and sinks etc. shall be made of vitreous china or fire clay as specified. These shall be of Hindustan Sanitary ware or Parry ware make unless otherwise specified and to be approved by the Engineer. These shall conform to A class quality of IS : 2566 (Part 1 to 15)-1972 to 1985 and IS : 771 (Part 1 to 15) –1979 & 1985 respectively.

18.6.1 European Pattern W.C.

Unless otherwise specified, these shall comprise of:

a) White 'glazed earthenware wash down closet set with 'S' or 'P' trap of standard size.

b) 'Duco' spray painted 12.5 litres mosquito proof low level M.S or C.I flushing cistern with valveless siphon, 15 mm ball cock, C.P. brass unions & 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 G.I. telescopic flush pipe with buffer clamp, holder bat clamp and 38mm dia PVC pipe or 35/40mm O.D. high density polythene flush pipe with buffer clamp, holder bat clamp.

d) Approved quality solid plastic W.C. seat and cover, bar hinges, screws bolt, rubber buffers conforming to IS : 2548 (Part 1&2)-1983.

e) 15 mm PVC connection pipe with brass couplings at both ends and 15 mm brass CP cock.
f) Hard 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.

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 approved make mosquito proof M.S.high level flushing cistern with valveless siphon, 15 mm ball cock, galvanised iron chain 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 or 35/40 mm O.D high density PVC flush pipe with holder bat clamps.

e) One pair of white glazed earthen ware foot rest set in cement mortar 1:3.

f) 15 mm PVC connection pipe with brass couplings at both ends and 15 mm brass stop cock.

18.7 Wash Hand basin

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 tap.

c) 32 mm C.P. brass waste fitting, C.P. brass chain and rubber plug.

d) 32 mm PVC waste pipe with brass couplings/32 mm C.P. bottle trap.
18.8 Flat Back Lipped Urinal

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 CP brass 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.

18.9 Mirror Frames

Mirror frame where specified shall be of fibre glass of approved shape, size, colour and make.

18.9.1 Mirror shall be of superior glass with edges rounded off or leveled as specified. It shall be free from flaws, specks or bubble and its thickness shall not be less than 5.0 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.

18.10 Toilet Shelf

18.10.1 Glass shelf unit shall consist of an assembly of glass shelf, anodised aluminium / CP brass guard rail and supporting brackets. The shelf shall be of glass of best quality with edges rounded off and shall be free from flaws, specks, bubbles and of thickness not less than 5.0
mm. The shelf shall have guard rail, resting on rubber washers on glass plate.

18.10.2 Ceramics shelf shall be of shape, size and design as specified in the Schedule of Items.

18.11 Towel Rail

Towel rail shall be of CP brass / anodised aluminium with two brackets of same material, diameter and length as specified.

18.12 Soap Container

Soap container shall be of C.P brass, PVC with cp brass brackets of approved make and design.

18.13 CP Flush Valves for EWC

The CP flush valve for EWC shall be of "Jaquar" brand of Jaquar & Co., 'ACCO' brand of Asia Continental Metallwaren Fabric or equivalent quality.

18.14 CP Flush Valve for Urinals

CP flush valve for urinal shall be of "Jaquar" brand of Jaquar & Co., 'ACCO' brand of Asian Continental Metallwaren Fabric or of equivalent quality.

18.15 Gully Trap

Each gully trap shall have one C.I. grating 150 mm x 150 mm and one water tight pre-cast 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.

18.16 CI Manhole Covers & Frames

These shall be of light or medium duty (LD or MD) as specified in Schedule of Items and of cast iron with raised chequered design, lifting key and key hole and shall be coated with black bituminous base material,. Light duty covers and frames shall be of either rectangular type, single seal, pattern 1 and 2 having minimum weight of cover and frame 38 Kg and 25 Kg. respectively or with double seal, minimum
weight of cover and frame being 52 Kg. These may be of square type also. Single seal with clear openings of 455 and 610 mm with minimum weight of cover and frame being 20 Kg and 38 Kg respectively, double seal of same openings shall have minimum Wt. of cover and frame 30 Kg and 55 Kg respectively. Medium duty covers and frames shall be either of circular type with 500 and 560 mm clear openings and minimum Wt. of cover and frame 116 Kg and 128 Kg respectively or of rectangular type with minimum Wt. of cover and frame 144 Kg.


18.17 Flushing Cisterns

Manually operated high level and low level flushing cisterns are of 5 litre and 10 litre capacities, both single flush and dual flush type. The cisterns shall conform to IS : 774-1984 and be made of Cast Iron, Vitreous China or enamelled pressed steel. The cisterns shall be mosquito-proof.

The thickness of the body including cover shall be not less than 5 mm for Cast Iron and 6 mm for Vitreous China Cisterns. Steel and lead flush pipe shall have internal diameter of 32 plus or minus 1 mm for high level cisterns and 38 plus or minus 1 mm for low level cisterns. For high density polyethylene and unplasticised PVC pipes the outside diameter of the pipe shall be 40 mm. In case of PVC plumbing pipes the outside diameter of the pipes shall be 40mm for high level and 50mm for low level cisterns. Steel flush pipes shall be hot dip galvanized electroplated or vitreous enameled.


Cast Iron Cisterns shall be painted and finished in accordance with recommendation made in IS : 1477 (Part 1&2)-1971 or shall have a coating of enamel.

In general, Materials Construction and operational and performance requirements shall be as specified in para 3, 4 and 6 of IS : 774-1984.
These shall conform to IS : 2548 (Part 1&2)-1983 and shall be either of thermo-set or of thermo-plastic quality.

Thermo-set Seats and Covers are moulded from phenolic plastics (Type A) or Urea Formaldehyde (Type B). Thermo-plastic Seats and Covers are also of Type A, moulded from Polystyrene or Type B, moulded from Polyprophlene.

Underside of the seats may be either flat or recessed and colour shall be as agreed. Table Dimesions of the seats and covers shall be as per Table-I of the Code (both Part 1&2). Hinging device may be either of the following materials:

i) Bronze or Brass with Nickel Chromium Plating
ii) Mild Steel with Nickel Chromium Plating
iii) Aluminium alloy with anodic coating
iv) Suitable plastic with reinforcement.

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 and of the class specified in various clauses herein under. 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, fixtures for approval before being used in the works. Such approved samples shall be retained by the Engineer till completion of works.

Pipes and pipe fittings may be of any or combination of following types:

i) Wrought iron galvanised pipe
ii) PVC pipes
iii) Cast iron pipes
iv) Steel pipes coated with bitumen composition inside and galvanised outside.

v) Reinforced concrete pipes

vi) Asbestos cement pipes

vii) Pre-stressed concrete pipes

viii) Lead pipe (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 medium quality "B" class pipes and sockets regarding nominal bore thickness and weight in kg/m are given below:-

<table>
<thead>
<tr>
<th>Pipe Dia (Nominal Bore)</th>
<th>Dimension of Pipe</th>
<th>Thickness</th>
<th>Dimension of ordinary socket</th>
<th>Wt. of Pipe plain end</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max. (outside dia)</td>
<td>Min.</td>
<td>Outside dia (approx.)</td>
<td>Min. length</td>
</tr>
<tr>
<td>mm</td>
<td>mm</td>
<td>mm</td>
<td>mm</td>
<td>mm</td>
</tr>
<tr>
<td>15</td>
<td>21.8</td>
<td>21.0</td>
<td>2.65</td>
<td>26.90</td>
</tr>
<tr>
<td>20</td>
<td>27.3</td>
<td>26.5</td>
<td>2.65</td>
<td>33.70</td>
</tr>
<tr>
<td>25</td>
<td>34.2</td>
<td>33.5</td>
<td>3.25</td>
<td>42.00</td>
</tr>
<tr>
<td>32</td>
<td>42.9</td>
<td>42.0</td>
<td>3.25</td>
<td>51.00</td>
</tr>
<tr>
<td>40</td>
<td>48.8</td>
<td>47.9</td>
<td>3.25</td>
<td>57.00</td>
</tr>
<tr>
<td>50</td>
<td>60.8</td>
<td>59.7</td>
<td>3.65</td>
<td>70.00</td>
</tr>
<tr>
<td>65</td>
<td>76.6</td>
<td>75.3</td>
<td>3.65</td>
<td>88.00</td>
</tr>
<tr>
<td>80</td>
<td>89.5</td>
<td>88.0</td>
<td>4.05</td>
<td>101.60</td>
</tr>
</tbody>
</table>

*Note :-* Manufacturing tolerances shall be permitted on tubes and sockets in addition to above as per IS : 1239 (Part 1&2) 1990 to 1992.
The galvanised iron pipes shall be of approved make and conform to IS:1239 (Part 1&2) 1990 to 1992 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 R.C.C, Asbestos, Prestressed Pipes and Fittings


19.4 Cast Iron Pipes and Fittings

The cast iron pipes shall be of approved manufacture and quality and shall conform to IS: 1536 1989 “Centrifugally Cast (Spun) iron pressure pipe and/or IS : 1537 1976”. Vertically Cast Iron pressure pipe for water, gas and sewage. CI fittings shall conform to IS : 1538 (Part 1 to 23) 1976.

19.5 Steel Pipes

This shall conform to IS: 1239 (Part 1&2) 1990 to 1992) and IS : 3589-1991. Steel pipes shall be coated with bituminous composition inside and galvanised outside.

19.6 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:

<table>
<thead>
<tr>
<th>No. of size (mm)</th>
<th>Bib taps (kg)</th>
<th>Stop tap (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0.30</td>
<td>0.35</td>
</tr>
<tr>
<td>15</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>20</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>25</td>
<td>1.25</td>
<td>1.30</td>
</tr>
<tr>
<td>32</td>
<td>-</td>
<td>1.80</td>
</tr>
</tbody>
</table>
The taps shall be tested under internal hydraulic pressure of at least 20 kgf/cm² and maintained at the pressure for a period of at least two minutes during which period it shall neither leak nor sweat.

19.7 Valves

Unless otherwise mentioned in the Schedule of Quantities these shall be copper alloy gate, globe and check valve of nominal sizes 8 to 100mm and shall conform to IS : 778 1984. Valves shall be of class 1 and class 2, suitable upto a temp. of 45 degree C and can sustain non shock working pressure upto 1.0 and 1.6 MPA respectively. They shall have screwed or flanged ends. All the metal parts shall be of brass-brass alloy except hand wheel of Cast Iron or other approved quality.

19.8 Shower Rose

The shower rose shall be of heavy quality chromium plated brass with flat bottom, of diameter 100 mm or as specified with uniform perforations.

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.

19.10 Miscellaneous items

19.10.1 Half round channel

This shall be made of vitreous china channel with or without outlet/stop end as specified in Schedule of Items and shall be of approved manufacture.
19.10.2 Urinal partition

This shall be made of vitreous china or R.C.C. with mosaic finish or marble as specified and shall be of approved make and quality.

20.0 EXTERNAL SEWERAGE & DRAINAGE

Unless otherwise specified CI pipe and specials, caulking lead, SW pipe, RCC pipe shall conform to the following.

20.1 C.I. Pipes

i) C.I. pipe shall conform to IS : 1536 - 1989 or/and IS : 1537 – 1976 of class as specified in Schedule of Items.

ii) C.I. pipe fittings shall conform to IS : 1538 (Part 1 to 23) -1976 as specified in Schedule of Items.

iii) Bolts and nuts shall be hexagonal bolts and nuts conforming to IS : 1363 (Part 1 to 3) - 1992.

20.2 Washers

Spring washers conforming to IS : 3063 - 1972 shall be used near the pumps to take care of vibration. In other places plain washers conforming to IS : 2016 - 1967 shall be used.

20.3 Gaskets

Gaskets shall be reinforced rubber sheet or compressed fibre board conforming to IS : 638 - 1979 of thickness between 1.5mm to 3mm or as specified.

20.4 Caulking Lead

Lead for the spigot and socket joints shall conform to IS : 782 - 1978.

20.5 Salt Glazed Stone Ware Pipes

Salt glazed stone-ware pipes used shall conform to IS : 651 - 1992 and shall be laid as per IS : 4127 - 1983. The pipes shall be of grade AA unless otherwise specified.
20.6 **Steel Pipes**

Steel pipes and fittings used for encasing shall conform to IS : 1239 (Part 1&2) - 1990 to 1992 medium Class upto 150 mm dia and as per IS : 3589 - 1991 for pipes of dia 200 mm and above. For pipes of dia 200 mm and above fittings, if required shall be fabricated from pipes itself.

20.7 **Cast Iron Manhole Covers & Frames**

These shall be of medium or heavy duty (M.D. or H.D.) as specified in Schedule of Item and of Cast Iron with raised chequered design, lifting key and key hole and shall be coated with black bituminous base material. Medium duty covers and frames shall be either of circular type with 500 mm clear opening and minimum weight of cover and frame 116 Kg and 128 Kg respectively or of rectangular type with minimum weight of cover and frame 144 Kg.

Heavy duty covers and frames shall be either of circular type with clear openings of 500 and 560 mm and 170 and 208 Kg weight respectively or of double triangular type with clear openings of 500 and 560 mm and 229 and 255 Kg weight respectively.

The CI manhole cover and frames shall conform to IS : 1726 - 1991.

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. Stones for soling shall be of height equal to thickness of the soling with tolerance of plus or minus 25mm and shall not have a base area of less than 250 sq.cm. nor more than 500 sq.cm. and the smallest dimension of any stone shall not be less than half the largest dimension. 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 furnaces 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 1.12 gm/cc and glassy material shall not exceed 20%. Water absorption when determined in accordance with IS:2386 (Part-III) - 1963. "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) - 1963 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)-1963 "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 - 1981, "Standard Specification and Code of Practice for Water Bound Macadam". The grading number of the table shall correspond to the following layer thicknesses:

<table>
<thead>
<tr>
<th>Grading Number</th>
<th>Size Range</th>
<th>Layer Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>90 mm to 40 mm</td>
<td>More than 90 mm</td>
</tr>
<tr>
<td>2</td>
<td>63 mm to 40 mm</td>
<td>90 mm to 75 mm</td>
</tr>
<tr>
<td>3</td>
<td>50 mm to 20 mm</td>
<td>75 mm to 50 mm</td>
</tr>
</tbody>
</table>

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 - 1981. 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

Coarse 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, 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 - 1988 "Tentative Specifications for 4 cm Asphaltic Concrete Surface Course", having aggregate impact 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.

21.7.1 Paving Bitumen

It shall conform to IS : 73 - 1992 and shall be of the specified type and grade. The material shall be homogeneous and shall not foam when heated to 175 degree C. Various properties like specific gravity, flash point, softening point, penetration etc. shall be as given in the above code.
21.7.2 Bitumen Cut Back

Bitumen cut-back shall conform to specification given in IS : 217 - 1988. It shall be of three types, Rapid Curing (RC), Medium Curing (MC) and Slow Curing (SC). These shall comply with the requirements specified in Table - 1, 2 and 3 respectively of the above code.

The above three types of cutback bitumens shall be classified into different grades on the basis of Kinematic viscosity. Rapid curing type shall be used with aggregates containing practically no fine aggregates passing through 2.36 mm sieve. Medium curing bitumen shall be used with aggregates containing less than 20 per cent of fine aggregates passing through 2.36 mm sieve. Slow curing type shall be used with aggregates containing more than 20 per cent of fine aggregate passing through 2.36 mm sieve.

Medium curing bitumen of 30 grade i.e. MC 30 shall be used as primer. Manufacturer shall indicate source and type of the bitumen.

21.8 Kerbs

Kerbs may be of stone, concrete or brick as may be shown in drawing or otherwise directed by Engineer.

21.8.1 Stone kerbs

Stones shall conform to the dimensions and shapes given in drawing.

Exposed faces shall be dressed to lines.

21.8.2 Concrete kerbs

Shape and dimension shall conform to the drawing. They shall be pre-cast and the road side top corner shall be given a chamfer.

21.9 Galvanized Steel Barbed Wire for Fencing

These shall be of two types A&B. In both types Barbs shall have 4 points formed by twisting two point wires, each two turns. In type A (Iowa type) twisting is done around both line wings and in type B (Glidden type) around one line wire, in both cases making altogether four complete turns. It shall conform to IS : 278 - 1978 and shall have the diameter of
line and point wire as described in schedule of item. Galvanized mild steel wire shall conform to IS : 280 - 1978.

Line and point wire shall be circular in section, free from scales and shall be uniformly galvanized. Line wire shall be in continuous length and shall not contain any welds other than those in rod before it is drawn.

21.10 Galvanized Steel Chain Link Fabric

It will conform to IS : 2721 - 1979. It shall be of width, mesh and wire dia as per description of Item. For chain link fabric having width upto 2.00 M, of all mesh sizes, two line wires shall be provided. Whereas for width of 2.40 M and mesh size exceeding 50mm three line wires shall be provided. These shall be provided at top and bottom of the fabric, but wherever three line wires have been specified, these shall be provided at top, bottom and middle of fabric.

The mesh wire and line wire of the fabric shall be manufactured from Galvanised steel conforming to IS : 280 - 1978. It will have zinc coating of type medium as given in IS : 4826 - 1979. "Specification for Hot dipped galvanized coatings on round steel wires". Unless otherwise mentioned in the description of item fabric with both ends twisted shall be used.

The galvanised steel pipe posts shall consists of 80 mm and 50 mm nominal diameter. The pipe posts shall conform to IS : 1161 and shall be of medium grade and galvanised.

21.11 Concertina Coil fencing

Angle iron post and strut shall be as specified in Clause3.3 Part I of specification. Concertina Coil fencing shall be dia 600 mm (having 50 nos. round per 6 metre length), spring core(2.5mm thick) wire of high tensile strength of 165 kg/sq.mm with tape(0.52 mm thick) and weight 43.478 gm/metre.

22.0 LIST OF MATERIALS OF APPROVED BRAND AND/OR MANUFACTURE
Unless otherwise specifically mentioned in the Schedule of Items, Contractor has to use materials as listed below, of only these brand names/Company's names, which are mentioned in the approved list for civil, water supply and sanitary items thereon.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Items/Name of Products</th>
<th>Makes / Brands / Manufacturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reinforcement Steel</td>
<td>TATA, SAIL, RINL, IISCO, RATHI</td>
</tr>
<tr>
<td>2</td>
<td>Cement</td>
<td>Ambuja, ACC, JK, Grasim, Ultraceh, Birla, L&amp;T, Cement Corporation of India, Maihar</td>
</tr>
<tr>
<td>3</td>
<td>Structural Steel</td>
<td>TATA, SAIL, RINL, IISCO, ESSAR, ISPAT</td>
</tr>
<tr>
<td>4</td>
<td>Pre-engineered building (PEB) firms</td>
<td>Kirby Building System India Ltd, Interach Building Product Limited, Tata Blue Scope Steel, Lloyd Insulation India Ltd, Everest Industries Ltd. Modern Prefab System Pvt Ltd, Aster Building Solution Pvt Ltd, Octamec Engineering Ltd, Jindal Mectec Pvt Ltd, Fedders Lloyd Corporation Ltd.</td>
</tr>
<tr>
<td>5</td>
<td>Structural Steel Tubes (ISI Marked)</td>
<td>TATA, JINDAL, SURYA, SWASTIK</td>
</tr>
<tr>
<td>6</td>
<td>(a) Zincalume colour coated steel sheet (COIL)</td>
<td>(a) Tata Blue Scope, Dongbu Steel, Union Steel, JSW STEEL Ltd.</td>
</tr>
<tr>
<td></td>
<td>(b) Profile of Sheet (as per tender specification)</td>
<td>Kirby Building System India Ltd, Interach Building Product Limited, Tata Blue Scope Steel, Lloyd Insulation India Ltd, Everest Industries Ltd. Modern Prefab System Pvt Ltd, Aster Building Solution Pvt Ltd, Octamec Engineering Ltd, Jindal Mectec Pvt Ltd, Fedders Lloyd Corporation Ltd.</td>
</tr>
<tr>
<td>7</td>
<td>Polycarbonate Sheet</td>
<td>Sabic Innovative Plastic, Everest</td>
</tr>
<tr>
<td>8</td>
<td>Mineral wool for thermal insulation of ceilings (Under deck insulation)</td>
<td>Rock wool (India) Ltd, Minwool Rock Fibres Ltd., Lloyd Insulation,</td>
</tr>
<tr>
<td>9</td>
<td>Rolling shutters (ISI marked)</td>
<td>Swastic, Hercules, Shubdwar, M/s Bharat Rolling Shutters Industries Agra, Bengal Rolling Shutter Rama Rolling Shutter Works, Gandhi Entrance Automations Private Limited</td>
</tr>
<tr>
<td>10</td>
<td>Wind driven air Ventilators</td>
<td>Apurva Enterprises (Mumbai), SVS Wind Driven Turbo Ventilator (Ahmadnagar), Real Green Engineers Pvt Ltd, Bangalore, Sun Green Ventilation system Pvt Ltd. Mylapore-Chennai, Citadel</td>
</tr>
<tr>
<td>No.</td>
<td>Item</td>
<td>Supplier</td>
</tr>
<tr>
<td>-----</td>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td>11.</td>
<td>Synthetic Enamel Paint (1st quality only)</td>
<td>ICI Paint (Dulux), Asian Paint (Apcolite), Berger Paints (Luxol). Goodlass Nerolac Paints (Nerolac), Jenson &amp; Nicholson Paints Ltd (Borolac), Shalimar, Garware &amp; Goodlass</td>
</tr>
<tr>
<td>12.</td>
<td>G.I SHEET</td>
<td>ESSAR, JSW, SAIL</td>
</tr>
<tr>
<td>13.</td>
<td>Chemical for Antitermite treatment</td>
<td>DE- NOCIL Bombay, Pest Control of India, Trishul</td>
</tr>
<tr>
<td>16.</td>
<td>Fly proof doors (Made out of solid block marine grade)</td>
<td>M/S Laxmi Doors, Faizabad Road, Chinhut, Lucknow, Northern doors Kanpur</td>
</tr>
<tr>
<td>17.</td>
<td>Natural Fibre Thermo Composite door/window shutter &amp; frames, roofing sheets etc</td>
<td>Durosam</td>
</tr>
<tr>
<td>18.</td>
<td>PVC Panel Door (Solid Core)</td>
<td>Rajshri Plastiwood Limited, Sintex, Hindopan, Marino</td>
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<td>19.</td>
<td>Pressed steel door frames/ cupboard and window frames (manufacturers)</td>
<td>M/s SAIL, M/s TATA</td>
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<td>20.</td>
<td>Pressed steel door</td>
<td>M/s Loyal safe works Mayapuri, N/Delhi</td>
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<td>frames/ cupboard and window frames (fabricators)</td>
<td>MEC/ TS/ 05/ 11/ 001</td>
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<tr>
<td>M/s Multiwyn Industrial Corpn Calcutta</td>
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<tr>
<td>M/s Metal Window Corpn N/Delhi</td>
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<tr>
<td>M/s Chhabra Steel Udyog, 260 Sadar Bazar, Meerut Cantt</td>
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<tr>
<td>M/s Delite safe works, Rani Jhansi Road, N/Delhi</td>
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<tr>
<td>M/s Ishwar Industries, 175/A Bombay Bazar, Meerut Cantt</td>
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<tr>
<td>M/s Chandni Industries, J-142, Patel Nagar 1st, Ghaziabad</td>
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<td>22. Steel Windows, Ventilators(as per IS-1038 of 1983) &amp; frames pressed steel door/window</td>
<td>M/S Multiwyn Industrial Corpn Calcutta</td>
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<tr>
<td>M/S Metal Window Corp N/ Delhi</td>
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<tr>
<td>Govind Enterprises, Delhi</td>
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<tr>
<td>M/S Chhabra Steel Udyog 260, Sadar Bazar, Meerut Cantt</td>
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<td>Agent steel MFG Pvt Ltd, Ahmedabad, Godrej, M/S Chandni Industries, J-142, Patel Nagar 1st, Ghaziabad</td>
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<tr>
<td>23. AI Section for AI Door/ Window/ Partitions</td>
<td>Hindalco, Indal, Ajit India, Jindal</td>
<td></td>
</tr>
<tr>
<td>24. Aluminium Door/ Window/ Glazing Fabricated and Anodized</td>
<td>M/s Ahlcon</td>
<td></td>
</tr>
<tr>
<td>M/s Alumilite Pvt Ltd, M/s Ajit India Pvt Ltd, M/s Ramniklal S Raste Agra, Argent Industries, M/s Aluminium Tech Industries, I-2249 DSIDC Narela, Delhi, M/s VR Associates, GH-14/242 Paschim Vihar, Delhi</td>
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</tr>
<tr>
<td>26. Automatic Glass Door Ditec (Gandhi)</td>
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<td></td>
</tr>
<tr>
<td>27. Aluminium Grill Alu Grill, Arihant Aluminium Corporation, Decogrille</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. Door Closer Everite, Golden, Gandhi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. Floor Spring Prabhat,Everite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. Builders Hardware M/s Golden Industries Pvt. Ltd., Everite, Solo, Hardwyn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Description</td>
<td>Brands/Manufacturers</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>32.</td>
<td>Pre laminated Particle board</td>
<td>Kitply, Bhutan board, Ecoboard, Novapan, Archid ply, Merinova, Merino</td>
</tr>
<tr>
<td>33.</td>
<td>Laminated Sheets</td>
<td>Formica, Merino Lam, Greenlam, National</td>
</tr>
<tr>
<td>34.</td>
<td>Modular Partitions</td>
<td>Godrej, Blowplast</td>
</tr>
<tr>
<td>35.</td>
<td>False Ceiling (Mineral Fibre Board)</td>
<td>Armstrong, Daiken, Luxalon, Llyods, Gypboard, Trac, Aerolite</td>
</tr>
<tr>
<td>36.</td>
<td>False Ceiling (POP / Gypsum Board)</td>
<td>Gypboard, Anchor ceiling tiles, LA</td>
</tr>
<tr>
<td>37.</td>
<td>Aluminium False Ceiling</td>
<td>Lloyds, Armstrong, Luxion, Trac</td>
</tr>
<tr>
<td>38.</td>
<td>Flooring Tiles (Mosaic / Terrazzo / PCC) (1st quality only)</td>
<td>M/S Mehtab Tiles, NITCO, Royal Tiles, Gem Tiles, Hindustan Tiles, M/S National Tiles &amp; Industries, Ultra Tiles</td>
</tr>
<tr>
<td>39.</td>
<td>Glazed Ceramic Tiles, Non-Skid (Floor/Wall), (1st quality only)</td>
<td>Kajaria, Somany, NITCO. Murudeshwar Ceramic Ltd (Navin Diamond tile ), Johnson (Marbonite ), Marbito, Somany, Orient, Asian</td>
</tr>
<tr>
<td>40.</td>
<td>Vitrified/ Designer Vitrified Tiles (1st quality only)</td>
<td>Asian, Marbonite (Johnson), Kerrogres (Kajaria), NITCO, Orient</td>
</tr>
<tr>
<td>41.</td>
<td>PVC Tiles/Flooring (IS 3461) (1st quality only)</td>
<td>Marblex Tiles, Krishna Tiles, Polyfin, Armstrong, Wonder floor.</td>
</tr>
<tr>
<td>42.</td>
<td>False Flooring</td>
<td>Godrej or equivalent</td>
</tr>
<tr>
<td>43.</td>
<td>Glass Mosaic Tiles (1st quality only)</td>
<td>Paladio, Coral, Accura, Bisazza, Italia, Mridul.</td>
</tr>
<tr>
<td>44.</td>
<td>Designer Paver Tiles/ Interlocking tiles ISI marked/ Grass-jointed Tiles (1st quality only)</td>
<td>Pavit, Ultra, Hindustan, Eurocon, Vyara, National Tiles, Gem, Unistone, Konkrete, Unitile</td>
</tr>
<tr>
<td>45.</td>
<td>Glass reinforced Paver block</td>
<td>Unistone or equivalent</td>
</tr>
<tr>
<td>46.</td>
<td>Wall care Putty for Base preparation (1st quality only)</td>
<td>Birla Wall care putty, Berger, Jenson &amp; Nicholson, JK White</td>
</tr>
<tr>
<td>47.</td>
<td>White Cement (1st quality only)</td>
<td>Birla, JK</td>
</tr>
<tr>
<td>48.</td>
<td>Cement based Paints (1st quality only)</td>
<td>Super Snowcem, Duracem, Super Acrocem.</td>
</tr>
<tr>
<td>49.</td>
<td>Dry Distemper / Oil bound Distemper</td>
<td>Goodlass Nerolac Paint, Shalimar Paint, Jenson &amp; Nicholson, Asian Paint, Berger. ICI Dulux</td>
</tr>
<tr>
<td><strong>(1st quality only)</strong></td>
<td>Acrylic Washable Distemper (1st quality only)</td>
<td>Asian, Berger, ICI Dulux, Jenson &amp; Nicholson, Nerolac, Shalimar, Garware &amp; Goodlass</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>51.</strong></td>
<td>Plastic Emulsion Paint (1st quality only)</td>
<td>Asian, Berger, ICI, Nerolac, Jenson &amp; Nicholson, Shalimar, Garware &amp; Goodlass</td>
</tr>
<tr>
<td><strong>52.</strong></td>
<td>Exterior Acrylic Emulsion (1st quality only)</td>
<td>ICI (Weathercoat), Excel (Nerolac), Apex (Asian), Berger, Jenson &amp; Nicholson, Shalimar, Garware &amp; Goodlass</td>
</tr>
<tr>
<td><strong>53.</strong></td>
<td>Polymer based Paint</td>
<td>STP, CICO</td>
</tr>
<tr>
<td><strong>54.</strong></td>
<td>Textured Paint / Wall Tile (1st quality only)</td>
<td>Unitile, Heritage, Spectrum, Iokos, Acropaints, Asian</td>
</tr>
<tr>
<td><strong>55.</strong></td>
<td>Flexible board for Expansion joint</td>
<td>STP or equivalent</td>
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<tr>
<td><strong>56.</strong></td>
<td>Grout</td>
<td>Shrinkomp, Fosroc, Fairmate</td>
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<tr>
<td><strong>57.</strong></td>
<td>Integral water proofing compound</td>
<td>STP, Pidilite, Fosroc, CICO, Sika.</td>
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<tr>
<td><strong>58.</strong></td>
<td>Concrete Admixture</td>
<td>Pidilite, Fosroc, CICO, Sika.</td>
</tr>
<tr>
<td><strong>59.</strong></td>
<td>Water proofing for cementitious surface IS-2645</td>
<td>Acrocrete &amp; Acrocote, CICO, Fosroc, STP</td>
</tr>
<tr>
<td><strong>60.</strong></td>
<td>Bituminous Product</td>
<td>M/s Faridabad Spinning &amp; Woolen Mills Pvt Ltd, 837, SP Mukherjee Marg Delhi, M/s STP Ltd (Formerly Shalimar Tar Products) M/s Bitufelt Pvt Ltd 123/377 Fazalm Ganj Kanpur 208012, Texas, Texas India Ltd, Multiplas, IWL Chennai</td>
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<tr>
<td><strong>61.</strong></td>
<td>Hardeners</td>
<td>Ironite, Ferrok, Hardonate</td>
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<tr>
<td><strong>62.</strong></td>
<td>Construction Chemicals</td>
<td>Choksey, CICO, Fosroc, Sika</td>
</tr>
<tr>
<td><strong>63.</strong></td>
<td>Non Metallic Surface Hardners</td>
<td>CICO, Fosroc, STP, Sika</td>
</tr>
<tr>
<td><strong>65.</strong></td>
<td>GI Sheet ISI Marked</td>
<td>Multicolor, TATA, Bluescope, JSW, Colour Plus, Interarch, Lloyds, Jindal, Everest</td>
</tr>
<tr>
<td><strong>66.</strong></td>
<td>Sheet Glass / Structural Glazing</td>
<td>Hindustan Pilkington Glass Works, Saint Gobain, Modi Float, Triveni Float Glass, ASI, Fresca, Emirates.</td>
</tr>
<tr>
<td>#</td>
<td>Item</td>
<td>Supplier/Details</td>
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<td>----------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>67</td>
<td>Multiell / Multiwall Polycarbonate Panel</td>
<td>M/s Coxwell Domes Engineering, Delhi, M/s Lexan, M/s Gallina India Pvt. Ltd. M/s Vijaynath Interiors &amp; exteriors products</td>
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<tr>
<td>68</td>
<td>Stainless Steel Cladding</td>
<td>Jindal</td>
</tr>
<tr>
<td>69</td>
<td>Punch Tape Concertina Coil</td>
<td>Global Technocrat, S.G. Engineers Delhi</td>
</tr>
<tr>
<td>70</td>
<td>Punch Tape In Plastic Spool</td>
<td>Global Technocrat, S.G. Engineers Delhi</td>
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<tr>
<td>71</td>
<td>Stainless Steel Railing</td>
<td>Jindal</td>
</tr>
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<td>72</td>
<td>FRP/ HDPE Garbage Bins</td>
<td>Sintex, Swift, Nutech, Sheetal</td>
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<td>73</td>
<td>Thermoplastic Road Marking Paint</td>
<td>Shalimark (STP)</td>
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<td>74</td>
<td>Bollard</td>
<td>STP</td>
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<td>75</td>
<td>Cateye</td>
<td>TATA, STP</td>
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<td>76</td>
<td>Readymade Speed Breaker</td>
<td>STP</td>
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<td>77</td>
<td>Fountain</td>
<td>Ripples, Green Evolutions, Agritech Services, Premier</td>
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<td>78</td>
<td>Multi-Vent</td>
<td>Multicolor</td>
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<td>79</td>
<td>Sanitary ware</td>
<td>Neycer Kermag (standard), Hindustan Sanitary Ware (Ist quality), Parryware (superfine), Cera (Ist quality), Classica (Ist / standard)</td>
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<td>80</td>
<td>WC seat cover ISI Marked</td>
<td>Parryware, Neycer Kermag (standard), Hindustan Sanitary Ware (Ist quality), Cera (Ist quality), Classica (Ist / standard)</td>
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<td>82</td>
<td>Faucets &amp; Taps, Stop Valves &amp; Pillar Taps, Surgical basin mixer, Shower rose etc.</td>
<td>Gem, Parko, Parryware, HSW, Jaquar, Orient</td>
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<td>83</td>
<td>Kitchen Stainless Steel Sink</td>
<td>Diamond, Nirali, Neel Kanth, Jayna</td>
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<td>84</td>
<td>Looking Mirror</td>
<td>Saint Gobain, Modi Float, Triveni Float Glass, Crown, Atul, Ashai</td>
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<tr>
<td>85</td>
<td>Ready made Bathroom Cabinets</td>
<td>Commander GRATINGS (I) Pvt Ltd, Gratolite Cabinet, A-4 Sector Viii Noida-202701, Alpina, Cera.</td>
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<tr>
<td>Number</td>
<td>Item Description</td>
<td>Supplier Details</td>
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<td>86.</td>
<td>Float Valve</td>
<td>Leader, Bombay Metal &amp; Alloy Co, Bombay superflow.</td>
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<td>87.</td>
<td>SGSW Pipes (IS-651) ISI Marked</td>
<td>Perfect Agra, Devraj Ind Gaziabad, Buran, RK, Prince, Supreme pipe and Fittings.</td>
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<td>88.</td>
<td>CI (Centrifugally Cast) Pipes for sewage disposal ISI marked</td>
<td>NICCO, SRIF, A-1 Singhal Casting Co Agra, Jindal Saw, Kesoram, NECO</td>
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<td>89.</td>
<td>PVC rain water/sewage pipes (IS-4985)</td>
<td>Reliance, Finolex, Supreme, Kisan, Prince, Hindustan Plastic &amp; machine corporation, Polypack industries (P) Ltd.</td>
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<td>90.</td>
<td>HDPE Water storage tanks (Rotational Moulded)</td>
<td>Sintex, Swift, Nutech, Sheetal</td>
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<td>91.</td>
<td>Cast Iron Pipes and Fittings</td>
<td>Hindustan Engineering Products Company Calcutta, S.L.C., Standard approved manufacturers of any other brand of fittings having ISI marking, RIF, BIS</td>
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<tr>
<td>92.</td>
<td>RCC Pipes</td>
<td>Indian Hume Pipe Company, Delhi / Allahabad / Chandigarh / Lucknow; Hindustan Pressure Pipes, Kolhapur; Dhere Concrete Products, Pune or any other approved manufacturer conforming B.I.S. Standard</td>
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<td>93.</td>
<td>Brass Fittings</td>
<td>Leader Engineering Works, Jalandhar; L &amp; K Mathura; Luster Sanitary, Jalandhar; Annapurna Metal Works, Calcutta; Neta Metal Works, Jalandhar; Honey Industrial Corporation, Bombay.</td>
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<td>94.</td>
<td>C.P. Fittings</td>
<td>Ego Metal Works, Ballabghar; Jaquar Industries, Delhi; Soma Plumbing Fixtures Limited, Calcutta; Gem Sanitary Appliances Pvt. Ltd., Delhi; Essco Sanitations, Delhi; Bilmet, Bombay.</td>
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<tr>
<td>95.</td>
<td>Stone Ware (Salt-Glazed) Pipes</td>
<td>Hind Ceramics Limited, Orissa; Ceramic Industries Limited, Sambalpur; Shrikamakshi Agencies, Madras; Binary Udyog Pvt. Limited, Howrah; Tirumati Moulds Limited, Nagpur; Kiran Potteries, Hyderabad; Perfect Sanitary Pipes, Bharatpur.</td>
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<tr>
<td>97.</td>
<td>HDPE pipes and fittings</td>
<td>ORI-PLAST, HASTI</td>
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</table>
23.0 MATERIALS NOT SPECIFIED

Any materials not fully specified in these specifications and which may be offered for use in the works shall be subject to approval of Engineer, without which it shall not be used anywhere in the construction works.
SPECIFICATION FOR CIVIL WORKS

PART – II WORKMANSHIP
CONTENTS

1.0 GENERAL

1.1 Standard
1.2 Supervision
1.3 Temporary Works
1.4 Codes
1.5 Base Lines and Bench Marks
1.6 Setting Out
1.7 Dewatering
1.8 Safety of Existing Work
1.9 Protection of Existing Services
1.10 Handing Over of Work Site

2.0 EARTH WORK

2.1 Scope
2.2 General
2.3 Setting Out
2.4 Site Clearance and demolition
2.5 Classification of Soil
2.6 Method of Excavation
2.7 Excavation of Soils Other than Hard Rock
2.8 Excavation in Hard Rock
2.9 Cutting and Filling for Site Levelling
2.10 Excavation for Trenches
2.11 Excavations for Foundations
2.12 Excess Excavation
2.13 Disposal of Excavated materials
2.14 Backfilling of Trenches
2.15 Backfilling of Foundations
2.16 Filling Under Floors
2.17 Load Bearing Fills
2.18 Turfing

3.0 ANTI-TERMITE TREATMENT
3.1 Scope
3.2 Execution
3.3 Acceptance Criteria

4.0 CONCRETE (PLAIN & REINFORCED)
4.1 Scope
4.2 Materials
4.3 Grades of Concrete
4.4 Mix Design
4.5 Water/Cement Ratio
4.6 Workability
4.7 Durability
4.8 Trial Mixes
<table>
<thead>
<tr>
<th>TITLE</th>
<th>CIVIL SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.9</td>
<td>Nominal Mix Concrete</td>
</tr>
<tr>
<td>4.10</td>
<td>Volumetric Mix concrete</td>
</tr>
<tr>
<td>4.11</td>
<td>Batching of Concrete</td>
</tr>
<tr>
<td>4.12</td>
<td>Water</td>
</tr>
<tr>
<td>4.13</td>
<td>Mixing and Transportation of Concrete</td>
</tr>
<tr>
<td>4.14</td>
<td>Preparatory Works/Surface Preparation</td>
</tr>
<tr>
<td>4.15</td>
<td>Placing and Compaction of Concrete</td>
</tr>
<tr>
<td>4.16</td>
<td>Construction Joint &amp; Cold Joints</td>
</tr>
<tr>
<td>4.17</td>
<td>Requirements for Concreting in Special cases</td>
</tr>
<tr>
<td>4.18</td>
<td>Finishes to Exposed Surfaces of Concrete</td>
</tr>
<tr>
<td>4.19</td>
<td>Curing of Concrete</td>
</tr>
<tr>
<td>4.20</td>
<td>Testing of Concrete</td>
</tr>
<tr>
<td>4.21</td>
<td>Steel Reinforcement</td>
</tr>
<tr>
<td>4.22</td>
<td>Shuttering</td>
</tr>
<tr>
<td>4.23</td>
<td>Damp Proof Course Concrete</td>
</tr>
<tr>
<td>4.24</td>
<td>Grout</td>
</tr>
<tr>
<td>4.25</td>
<td>Concreting in Water Retaining Structures</td>
</tr>
<tr>
<td>4.26</td>
<td>Application of Live Load</td>
</tr>
<tr>
<td>4.27</td>
<td>Foam Concrete</td>
</tr>
</tbody>
</table>

### 5.0 MASONRY

5.1 General
5.2 Materials
5.3 Selection of Mortars
5.4 Cement Mortar
5.5 Brick work
5.6 Stone masonry
5.7 Hollow Concrete Block Masonary

6.0 PLASTERING AND POINTING
6.1 Materials
6.2 Plastering
6.3 Cement Pointing
6.4 Rough Cast Concrete Facing
6.5 Punning with Lime or Plaster of Paris

7.0 FLOORING, PAVING & FACING
7.1 Scope
7.2 Materials
7.3 General
7.4 Sub-base
7.5 Subgrade
7.6 Cement Concrete Flooring with Integral Finish
7.7 Concrete Flooring with Granolithic Finish (Artificial Stone Flooring)
7.8 Dado & skirting Work (Grey Cement Skirting / Dado)
<table>
<thead>
<tr>
<th>TITLE</th>
<th>Civil Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.9</td>
<td>Flooring &amp; Facing with Redoxide of Iron (Red Artificial Stone Flooring)</td>
</tr>
<tr>
<td>7.10</td>
<td>Terrazzo Flooring &amp; Facing</td>
</tr>
<tr>
<td>7.11</td>
<td>Glazed Tile Finished Flooring &amp; Facing</td>
</tr>
<tr>
<td>7.12</td>
<td>Marble Flooring</td>
</tr>
<tr>
<td>7.13</td>
<td>Marble in Facia or Dado</td>
</tr>
<tr>
<td>7.14</td>
<td>Flooring/Paving with Hardener like Ironite.</td>
</tr>
<tr>
<td>7.15</td>
<td>Chemical resistant tile flooring/facing</td>
</tr>
<tr>
<td>7.16</td>
<td>Chemical resistant In-Situ Finished Flooring / Facing</td>
</tr>
<tr>
<td>7.17</td>
<td>Acceptance Criteria</td>
</tr>
</tbody>
</table>

8.0 **WOOD WORK**

8.1 General
8.2 Joinery
8.3 Shrinkage & Tolerance
8.4 Fixing
8.5 Tarring
8.6 Fittings
8.7 Doors
8.8 Panelled Shutters
8.9 Glazed Shutters
8.10 Flush Door Shutters
8.11 Other type of shutters
8.12 Inspection

9.0 METAL DOORS, WINDOWS AND ROLLING SHUTTERS

9.1 General
9.2 Fixing
9.3 Fittings
9.4 Normal Steel Plate Doors
9.5 Pressed Steel Doors
9.6 Steel Windows, Sashes, Ventilators, etc.,
9.7 Collapsible Gate (Steel)
9.8 Steel Rolling Shutters and Grills
9.9 Guarantee
9.10 Aluminium Doors, Windows, Frames

10.0 GLAZING

10.1 General
10.2 Doors, Windows and Ventilators.
10.3 Northlight Glazing

11.0 WHITE WASHING, COLOUR WASHING & PAINTING

11.1 Scope
11.2 Materials
11.3 White Washing, Colour Washing
11.4 Cement Primer Coat
11.5 Water Proof Cement Paint
11.6 Oil Bound distemper
11.7 Dry Distemper
11.8 Plastic Emulsion Paint
11.9 Bitumen Painting
11.10 Tarring
11.11 Painting to Timber & Steel Surface

12.0 INTERNAL WATER SUPPLY, PLUMBING, DRAINAGE AND SANITATION

12.1 Scope of work
12.2 Water Supply & Plumbing
12.3 Drainage and Sanitation (Internal)

13.0 EXTERNAL SEWERAGE & DRAINAGE

13.1 Scope of work
13.2 Materials
13.3 Excavation of trenches and pits
13.4 Cast Iron pipes
13.5 Stone ware glazed pipelines (S.W.G)
13.6 Man holes
13.7 Marker plates

14.0 ROAD WORK

14.1 General
14.2 Trenching and Preparation of Subgrade
<table>
<thead>
<tr>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.3 Ash Carpet</td>
<td></td>
</tr>
<tr>
<td>14.4 Boulder Soling</td>
<td></td>
</tr>
<tr>
<td>14.5 Kerbs</td>
<td></td>
</tr>
<tr>
<td>14.6 Water Bound Macadam Surfacing</td>
<td></td>
</tr>
<tr>
<td>14.7 Preparation of Base and Shoulders</td>
<td></td>
</tr>
<tr>
<td>14.8 Spreading Coarse Aggregates</td>
<td></td>
</tr>
<tr>
<td>14.9 Rolling</td>
<td></td>
</tr>
<tr>
<td>14.10 Application of Screenings</td>
<td></td>
</tr>
<tr>
<td>14.11 Sprinkling and Grouting</td>
<td></td>
</tr>
<tr>
<td>14.12 Application of Binding Material</td>
<td></td>
</tr>
<tr>
<td>14.13 Setting and Drying</td>
<td></td>
</tr>
<tr>
<td>14.14 Surface Evenness</td>
<td></td>
</tr>
<tr>
<td>14.15 Bituminous Pavements</td>
<td></td>
</tr>
<tr>
<td>14.16 Berms</td>
<td></td>
</tr>
<tr>
<td>14.17 Kerbs</td>
<td></td>
</tr>
<tr>
<td>14.18 Bridges and Culverts</td>
<td></td>
</tr>
<tr>
<td>14.19 Boulder Pitching</td>
<td></td>
</tr>
<tr>
<td>14.20 Scarifying &amp; Dismantling</td>
<td></td>
</tr>
<tr>
<td>14.21 Diversions</td>
<td></td>
</tr>
<tr>
<td>15.0 Waterproofing to Roofs &amp; Basements &amp; Water Proofing Paints</td>
<td></td>
</tr>
<tr>
<td>15.1 Scope</td>
<td></td>
</tr>
<tr>
<td>TITLE</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>15.2</td>
<td>Material</td>
</tr>
<tr>
<td>15.3</td>
<td>General Workmanship</td>
</tr>
<tr>
<td>15.4</td>
<td>Painting with Hot Bitumen</td>
</tr>
<tr>
<td>15.5</td>
<td>Painting with Bitumen Emulsion</td>
</tr>
<tr>
<td>15.6</td>
<td>Waterproofing of Roof</td>
</tr>
<tr>
<td>15.7</td>
<td>Waterproofing for Basement</td>
</tr>
<tr>
<td>15.8</td>
<td>Surface Application</td>
</tr>
<tr>
<td>15.9</td>
<td>Guarantee</td>
</tr>
<tr>
<td>15.10</td>
<td>Waterproofing course with fibre glass R.P. tissue.</td>
</tr>
<tr>
<td>15.11</td>
<td>Waterproofing course with PVC sheets/membrane</td>
</tr>
<tr>
<td>15.12</td>
<td>Waterproofing with Non-shrink polymeric waterproof grouting compound.</td>
</tr>
<tr>
<td>16.0</td>
<td>MISCELLANEOUS</td>
</tr>
<tr>
<td>16.1</td>
<td>False Ceiling</td>
</tr>
<tr>
<td>16.2</td>
<td>Wall Panelling &amp; Wooden Partition</td>
</tr>
<tr>
<td>16.3</td>
<td>Expansion and Isolation Joints</td>
</tr>
<tr>
<td>16.4</td>
<td>Barbed Wire Fencing</td>
</tr>
<tr>
<td>16.5</td>
<td>Concertina Coil Fencing</td>
</tr>
</tbody>
</table>
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 their supervision and shall be capable of ensuring that work is executed efficiently and as per specification.

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.

1.4.0 Codes

1.4.1 The years of publication against various standards, referred in this specification, correspond to the latest standards as on date of preparation of this specification. During use of this specification in future, the latest publication as on date shall be referred to. Where standards are not yet published by the BIS or IRC, adoptable British Standards or other International Standards shall apply.

In case of any conflict in meaning between these specifications and those of BIS or IRC, or British/International Standards, 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
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 carry out 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 at no extra cost to the owner.

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 at no extra cost to the owner.

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 at no extra cost to the owner.

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 been recorded and accepted. Reference lines, bench marks and base lines shall be set out by the Contractor for control of earthwork operation. Setting out shall be done with pegs, blocks, bamboo poles or rails, marking boundaries or centre lines, as the case may be, and the same maintained for reference and future checking. Chainaie 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, if any, shall be the property of the owner and shall be stacked properly as directed by the Engineer. The areas to be covered with
embankments shall be stripped of top soil to required depths to expose acceptable founding strata. Top soil unsuitable for use in embankment construction and other fills shall be disposed off as directed. All combustible materials shall be stacked and burnt in locations sufficiently remote to eliminate all danger of fire hazards. All old concrete, brick works and drains which interfere with construction works shall be dismantled with the approval of the Engineer taking all necessary precautions prescribed in safety specification. Top soil which is suitable for use in construction work shall be stockpiled for later use. Other objectionable materials such as trash, debris, stones, brick, broken concrete, scrap metal etc., shall be disposed off as directed by the Engineer. 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 class of any particular soil. Classification of soil shall be as under and the decision of the Engineer shall be binding on the Contractor:

A) Ordinary Soil

Soils which yield to ordinary application of pick and shovel, phawra rake or other ordinary digging implements (including earth moving equipment such as bulldozer, shovels without resorting to blasting) without offering much resistance, shall be classified as ordinary soil. This includes organic soil, turf, sand, gravel, loam clay, mud, peat, black cotton soil, soft shale and loose moorum etc.

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 / Decomposed Rock
This comprises of rock or boulders which may be quarried or split with crow bars, pavement breakers etc. This include limestone, sandstone, weathered rocks and hard conglomerates etc. 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. Where blasting is prohibited, excavation has to be carried out by chiseling, wedging or any 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, 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 stepping and batter. To prevent entry of surface water and accumulation of subsoil water in excavated areas, suitable drainage arrangements as may be needed and directed by Engineer,
shall be provided and maintained. Pumped out water shall be drained off properly avoiding damage to other existing works. If any pipelines, cables or service lines are likely to be exposed, excavation around these services shall be carried out manually and all such services shall be adequately supported and protected at no extra cost.

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

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

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 by blasting or chiseling or by such other agreed methods as may be required. Levels of hard rock surface shall be taken and got approved by Engineer before start of excavation. Blasting shall be permitted only when proper precautions are taken for protection of persons, works and property. The Contractor shall obtain the necessary licence 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
As excavation approaches final stages, the depth of holes and the amount of explosives used shall be reduced progressively to avoid over breakage or damage to founding strata. Any fissures, cracks and voids below prescribed depth of excavation shall be corrected by removing loose pieces, shattered or affected rock and replaced by lean concrete of M-5 grade or (1:5:10) cement concrete 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 minimised. The sides of excavation and fills shall be maintained in stable condition by adequate batters, stepping and dewatering. Materials not desirable shall be disposed off in area indicated by Engineer. When it is required to blend the material, it shall be done by selective excavation and filling operation. Wells, ponds, cesspools and water logged areas shall be emptied of water and deslushed before filling. Filling shall be done in horizontal layers not exceeding 300mm in thickness as specified or as directed by the Engineer. All clods shall be broken before placing the fill. Earth moving equipment shall be allowed to ply over the fill to permit compaction. Adequate allowance shall be made for subsidence of fill material. Levels shall be taken and excess or shortfall shall be made good by appropriate cutting or filling.

2.10 Excavation for trenches

Excavation for trenches shall be carried out in materials encountered 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 sleepers or light rails shall be erected at uniform levels at places where changes of direction and gradients occur. Centre lines shall be marked on horizontal sleepers 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.

Timbering

In case of trenches, tunnels, channels, drains, manholes, chambers, basement and other places where the soil is not capable of being retained without the support, timbering as directed by the Engineer shall be resorted to. It shall be the responsibility of the Contractor to take all the necessary steps to prevent the sides from collapsing.

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 transported, 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 authorised 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, or (1:5:10) cement concrete if so ordered by the Engineer at no extra cost. Where the soil encountered at depths indicated in drawings is loose or weak, it shall be further excavated to levels of firm strata as may be directed by the Engineer and filled with lean concrete of M-5 grade/(1:5:10) cement concrete or sand as directed. 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/(1:5:10) cement concrete or sand as directed and 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, discernible 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 metres. 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/(1:5:10) cement concrete.

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 up to 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. Mechanical equipment like vibratory roller, vibro earth rammer or vibratory compactor shall be used for compaction.

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 compacted layers not exceeding 150 mm in thickness. Each layer shall be compacted to 95% Standard Procter Density. Sufficient soaking shall be done before compaction. The entire area to
be covered by flooring shall be finally dressed and trimmed to required levels. Mechanical equipment like vibratory roller, vibro earth rammer or vibratory compactor shall be used for compaction.

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 swelling 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 prescribed by the Engineer. Side slopes of embankments shall be formed along with 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. Subgrades 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 recompacted 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 ply 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 turf, slope shall be thoroughly wetted and kept wet for a sufficient period to assure plant growth. Watering shall be continued until the grass takes 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

Unless otherwise specified all work shall in general be executed as specified in IS : 6313 Part-II - 1981 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

Chemical like chlorpyriphos 20% EC (Conforming to IS 8963 - 1978) in 1% emulsion shall be applied by pressure pumps, uniformly over the area treated. (1 part chemicals + 20 parts water = 1% emulsion).

3.2.2.1 Treatment of pits, trenches & basement excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300mm) for column pits, walls, trenches and basements shall be treated with emulsion @ 5 liters per sq.m. of surface area. Backfills around columns, walls, etc., shall be treated @ 7.5 liters per sq.m. of the vertical surface. 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 centers closed to the wall surface and spraying the emulsion 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. Emulsion at the rate of 5 litres per sq.m 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 insecticidal 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 specialised 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: 456-1978 "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 unless otherwise specified 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:

<table>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>Characteristic Strength i.e. Compressive Strength of 15 cm cubes at 25 days (N/mm²)</th>
<th>Nominal Maximum Aggregate Size (mm)</th>
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<tr>
<td>M-10B</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>M-10C</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>M-10D</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Grade off Concrete</td>
<td>Characteristic Strength i.e. Compressive Strength of 15 cm cubes at 25 days (N/mm²)</td>
<td>Nominal Maximum Aggregate Size (mm)</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------------------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>M-15A</td>
<td>15</td>
<td>63</td>
</tr>
<tr>
<td>M-15B</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>M-15C</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>M-15D</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>M-20A</td>
<td>20</td>
<td>63</td>
</tr>
<tr>
<td>M-20B</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>M-20C</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>M-20D</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>M-25C</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>M-25D</td>
<td>25</td>
<td>12</td>
</tr>
<tr>
<td>M-30C</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>M-30D</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>M-35C</td>
<td>35</td>
<td>20</td>
</tr>
<tr>
<td>M-35D</td>
<td>35</td>
<td>12</td>
</tr>
<tr>
<td>M-40C</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>M-40D</td>
<td>40</td>
<td>12</td>
</tr>
</tbody>
</table>

Notes: A, B, C, D mentioned along with grade of concrete correspond to the maximum size of coarse aggregate being 63mm, 40mm, 20mm & 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:

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>For concreting in very narrow space or in very small thickness</td>
<td>12 mm</td>
</tr>
<tr>
<td>b)</td>
<td>For all reinforced concrete work except in massive foundations</td>
<td>20 mm</td>
</tr>
<tr>
<td>c)</td>
<td>For all ordinary plain concrete &amp; massive reinforced foundations</td>
<td>40 mm &amp; 63 mm</td>
</tr>
</tbody>
</table>

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 authorisation 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 I.S. 10262-1982 or any other approved standard methods.
4.4.3 The concrete made by designing the mix is termed hereinafter as "Design Mix Concrete".

4.4.4 The cement content for various grades of concrete shall be based on design mix. However, irrespective of requirement of cement found out from design mix, the minimum cement content & maximum cement content of concrete shall be in accordance with Clause No. 8.2.4.1 & Clause No. 8.2.4.2 of IS 456 -2000 respectively.

4.5 Water/Cement Ratio

4.5.1 Where a particular water/cement ratio is stipulated in the design or drawing along with 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 it 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 finalisation 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. The workability tests shall be carried out in accordance with IS:1199-1959.
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, in consistent with added water.

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 plasticiser 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.

4.6.5 The usual limits of consistency for various types of structures are given below:

**Limits of consistency**

<table>
<thead>
<tr>
<th>Degree of Workability</th>
<th>Slump in mm with Standard - Cone</th>
<th>Use for which concrete is suitable as per IS : 1199</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>Very low</td>
<td>0.0</td>
<td>25.0</td>
</tr>
<tr>
<td>Low</td>
<td>25.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Medium</td>
<td>25.0</td>
<td>75.0</td>
</tr>
<tr>
<td>High</td>
<td>75.0</td>
<td>125.0</td>
</tr>
</tbody>
</table>

**Note:** Not withstanding any thing mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer. With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in
trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

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: 456-1978 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 sieve analysis of the aggregates, determination of densities of different ingredients and moisture contents in the aggregates, shall be completed according to the I.S. Codes 383-1970 and 2386-1963.

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 Six 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. If the size and special requirement of the work so warrants, the trial may be extended to cover larger ranges of mix proportions as well as other variables such as alternative source of aggregates, maximum size and grading of aggregates and different type and brands of cement.
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 the design 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. 456-1978. The stipulations of Clauses 8.3.1 & 8.3.2 of IS: 456-1978 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 weigh-batching is not possible proportioning by volume batching may be allowed by the Engineer, provided the Contractor guarantees the uniformity of aggregates throughout 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 made for bulking in accordance with I.S. 2386 (Part-III)-1963.

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 fitted 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)-1963. Where tests are not conducted, the amount of surface water may be estimated from the following table:
### Aggregates

<table>
<thead>
<tr>
<th>Aggregates</th>
<th>% by weight</th>
<th>Lit / m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very wet sand</td>
<td>7.5</td>
<td>120</td>
</tr>
<tr>
<td>Moderately wet sand</td>
<td>5.0</td>
<td>80</td>
</tr>
<tr>
<td>Moist sand</td>
<td>2.5</td>
<td>40</td>
</tr>
<tr>
<td>Moist gravel &amp; stone chips**</td>
<td>1.25 - 2.5</td>
<td>20-40</td>
</tr>
</tbody>
</table>

** - 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 at least 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 be in accordance with IS: 1791-1985 but in no case less than 2 minutes or at least 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 such 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 identifiable at the place of final deposit.

4.13.3 Actions before placement of concrete

4.13.3.1 Programme of works

At the beginning of every fortnight, the contractor shall give his detailed concreting programme for that fortnight to the Engineer. Such programmes, shall specify all information such as the locations where concrete is to be poured, type/grade of concrete, volume of concrete to be poured, number and Type of vibrators proposed to be used as well as proposed to keep as standby, number of skilled technicians and supervisors proposed to be engaged, the proposed time and period of pouring etc.

4.13.3.2 Checking & approval

Before placement of concrete, the contractor shall get all the form works, reinforcements, inserts, conduits, openings, surface preparation etc., checked and approved by the Engineer. To facilitate such checking, the contractor shall complete all his works according to the drawings and specifications well in advance before placement of
concrete at least 36 hours for all major/important/complicated works and 24 hours for all minor/ordinary/simple works. The checks are purely in the interest of the work and to draw the contractor's attention to his contractual obligations to execute the works according to the drawings/specification and do not relieve the contractor from his responsibility in getting the end results for the quality & strength of concrete and for maintaining the shape, level & dimensions of the finished concrete, as well as the inserts, openings, other features within the tolerance limits.

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 extra 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 extra cost to the Owner.

4.14.2 For construction joints

All such joints shall have continuous square bond grooves to produce a substantial and water-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 freshly mixed 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 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 (a) 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.

b) Over walls

Building paper over average 12mm thick cement sand bearing plaster of 1:4 mix with neat cement finish shall be provided at the bearings of slabs over walls as directed by the Engineer.

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 dirts, grease/oil, foreign and deleterious materials etc. The reinforcement shall be completely clean and free from all sorts of dirts, grease/oil, rust, foreign/deleterious materials etc., Before placement of concrete, the form works coming in contact with concrete, shall be coated 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 & 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 over 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 in 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 the full width between shutterings and of such depth that each layer can be easily and effectively vibrated and incorporated with the layer below by means of compaction.

4.15.8 For member 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 results 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 at his own cost.

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) In Columns
(i) In case of Projection from basement slab, 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 facilitates formwork.

(iii) For columns under flat slabs 75 mm below the lowest soffit of the slab.

(b) In walls (horizontal construction joints)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Walls projecting from base slab</td>
<td>: 300 mm from top of base slab</td>
</tr>
<tr>
<td>(ii) Walls supporting the suspended slab</td>
<td>: 75 mm from the lowest soffit of the slab</td>
</tr>
</tbody>
</table>

*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 for 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 sq.m in area. The largest panel dimension shall be 5 m.

(ii) For nominally reinforced slab

The area of pour shall not exceed 40 sq.m and the maximum panel dimension shall not exceed 8m.

(i) 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 along with 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 in spite 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 2 M in columns and 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 proposes 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: 456-1978.

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)-1981.

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)-1975 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.

4.18 Finishes to Exposed Surfaces of Concrete

The Contractor is to include in 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 exceed 5 mm and the plastering shall be in cement and sand mortar.(1:3).

4.18.2 Exposed surfaces which need plastering

Surfaces of beams/columns flushing with the block work or other structures where intended to plaster, shall be hacked adequately as soon as the shuttering is stripped off so that proper bond with the plaster can develop.

4.18.3 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 and finished rough.

4.18.4 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 sloped with a screed, board and then floated with a wooden float. Steel troweling 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. Troweling 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 to prevent loss of moisture from the concrete itself so that the cement inside the concrete is sufficiently hydrated which of course is slow and prolonged process. As soon as the
Concrete has hardened sufficiently the curing shall be started. To cure the concrete properly and sufficiently is also the sole responsibility of the contractor.

4.19.2 Different methods of curing

Any one of the following methods 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.

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 after final setting.

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 at least 12 days after final setting.

4.20 Testing of Concrete

4.20.1 General

The Contractor shall carry out, 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. 1199-1959 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 4.20.2.3 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: 456-1978 or as directed by the Engineer.

4.20.3.2 The cubes shall be prepared, cured and tested according to IS: 516-1959. 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: 456-1978.

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: 456-1978, 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: 456-1978 respectively. In case of other types of special tests like ultrasonic impulse test etc., the stipulation of clause 16.6 of IS: 456-1978 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) Instruct the Contractor to carry out additional test and/or works to ensure the soundness of the structure at Contractor's expense.

2) 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 and the resultant structures affected due to such rejection shall be made good at contractor's expense.

3) Modification/remedial measures if approved by the engineer to be carried out at contractor's expense.

4) Accept the work with reduction in the rate in appropriate item subject to the provisions of clause 15 of IS 456-1978 provided it is technically acceptable. The reduction in the rate shall be as given below :-

   i) When test strength of the sample is above 90% of the characteristic strength, payment shall be made 10% less than the contract rate.

   ii) When test strength of the sample is between 80-90% of the characteristic strength, payment shall be made 25% below than the contract rate.

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: 456-1978 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 contact 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 at least 15 cm, and a coat of cement wash shall be given to prevent scaling and rusting at no extra cost of the owner.

4.21.3 Bending and placing

Bending and placing of bars shall be in conformity with IS: 2502-1963 "Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement" and IS: 456 -1978 "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)-1982 shall be done in accordance with IS: 2751 -1979 "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 at least 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: 1786-1985 shall be done using electric arc welding process using low hydrogen electrodes (Ferro Weld- I or Ferro Weld-II or equivalent). Oxy-acetylene welding shall not be used.
Butt welding of bars up to 32 mm diameter for vertical splices shall be done either by single bevel groove weld or double bevel groove weld, with bevel angle 45 degree. Butt welding of bars up to 32 mm diameter for horizontal splices shall be done either by single Vee-groove weld or double Vee-groove 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. Oxy-acetylene flame shall not be used for cutting. Chamfered faces shall be smooth finished by hand file if required.

Lap welding of bars up to 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 at least 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 at least 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: 2751-1979. The number of tests will be as laid down in IS: 2751-1979 or such larger number as the Engineer may decide having regard to the circumstances.

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 as required. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by 20G 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: 456-1978.

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 -1984 "Code of Practice for use of Structural Steel in General Building Construction". Workmanship shall match 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 interchangeable. Steel work shall be shop fitted and shop assembled as far as practicable to minimise 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 -

### 4.21.8.2 Transportation and Storages

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: 800-1984. 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 at least 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, grout, dust, rubbish or other foreign material into it, both during and after concreting. Opened conduits shall be plugged similarly. Where channels, Unshapely 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. If welding is to be done subsequently on the exposed surfaces of the embedded parts, the painting for a length of 50mm beyond each side of the weld line shall be cleaned off.

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/m² 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 and 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 seasoned 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 or 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 soffits 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 Special provision

**4.22.6.1** 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.

4.22.6.2 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.

4.22.6.3 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.

4.22.6.4 The joints in form work shall be sealed by adhesive tapes or by other means, to prevent any leakage of slurry or mortar if so directed by the engineer.

4.22.7 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.

4.22.8 Removing

4.22.8.1 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.

4.22.8.2 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.

4.22.8.3 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 & vertical faces  
24 to 48 hours as may be directed by the Engineer.

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.,

4.22.8.4 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.

4.22.9 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.

4.22.10 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.

4.22.11 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 or in the 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 it 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. course 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 equipments/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 at least 125 mm but not exceeding 225 mm. To this shall be added an expanding admixture approved by the Engineer and in accordance to the Manufacturer's instructions.

4.24.3 Grouting the 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.

4.24.4 Workmanship

4.24.4.1 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. Before grouting the surface shall be thoroughly cleaned with compressed air/water jet.

4.24.4.2 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.

4.24.4.3 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.

4.24.4.4 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. Neither "Dry" grout (having slump 6mm or less) nor expanding wet grout shall be grouted with any type of vibrating machine.

4.24.5 Curing

After 10 hours of grouting, the same shall be covered with wet gunny bags and the surface shall be kept continuously moist at least for 10 days.

4.25 Concreting in Water Retaining Structures

General requirements

The basic specifications as regards 'mix' design, placing, compacting, curing etc. shall conform to the requirements as specified herein before.
in this Chapter. Over and above the materials and workmanship shall conform to the stipulations of IS: 3370 (Part-I & II)-1965 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.

4.27 Foam Concrete

This shall be of average 50mm thickness or as specified or as shown on the drawings. This may be laid in in-situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m2h/degree C. The weight of the insulating material shall be from 0.5 to 0.75 gm/cm3, strength not less than 5 Kg/sq.cm or (0.5N/sq.mm.). In general, the main ingredients of Foam Concretes are cement, fly ash and foaming agent and the work shall be carried on by specialised Agencies/Companies. Before starting the laying of foam concrete sample shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to take the usual work loads and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, sample batches of mix shall be kept for test if so desired by the Engineer.

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: 2250-1981 "Code of Practice for Preparation and Use of Masonry Mortars", and proportion shall be as specified in the drawing or in the Schedule of Items.

5.4 Cement Mortar

5.4.1 Cement mortar shall be prepared by mixing cement and sand in specified proportion. It is convenient to take unit of measurement for cement as a bag of cement weighing 50 Kg equivalent to 0.035 cubic metre. Sand is measured in boxes of suitable size (say of 40 x 35 x 25 cm). It shall be measured on the basis of dry volume. In case of damp sand, the quantity shall be increased suitably to allow for bulkage in accordance with IS:2386-1963 (part-III) or by any approved method.

5.4.2 The mixing of the mortar shall be done preferably in a mechanical mixer. This condition may be relaxed by the engineer taking into account the nature, magnitude and location of the work.

If mixed in the mixer, cement and sand in the specified proportion shall be fed in the mixer and mixed dry thoroughly, water shall be then added gradually and wet mixing continued for at least 3 minutes. In case of hand mixing also after mixing dry on a water-tight masonry platform, water shall be added and the mortar turned over and over, backward and forward several times.

5.4.3 Fresh mixed mortar, in case becoming stiff due to evaporation of water may be retempered by adding water as frequently as needed to restore the requirement of the consistency but this shall be permitted only up to a maximum of 2 hours from the time of addition of cement in the mortar.

5.5 Brick Work

5.5.1 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.

5.5.2 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.

5.5.3 Setting out

The building lines shall be set out by the Contractor as per clause 7 of IS: 2212-1991 and got checked by the Engineer.

5.5.4 Laying of bricks

5.5.4.1 Brickwork in general shall be as per IS 2212-1991. Bricks shall be laid in English bond, unless otherwise specified, with frogs upward over a full bed of evenly laid mortar, and slightly pressed and tapped into final position to the lines levels and shape as shown in the drawing fully embedded in mortar. All joints including inside faces shall be flushed and packed. Not more than 8 courses shall generally be laid in a day. The first course itself shall be made horizontal by providing enough mortar in the bed joint to fill up any undulations. The horizontality of courses and the verticality of wall shall be checked very often with spirit level and plumb bob respectively.

5.5.4.2 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.
5.5.4.3 Walls coming in contact with R.C.C. structures shall perfectly be bonded with M.S. inserts or lugs where shown on drawings and the sides butting against the R.C.C structures neatly and efficiently flashed and packed with rich mortar & cement slurry at no extra cost (cost of M.S. 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.

5.5.4.4 Damaged or broken brick or brick bats shall not be used in brick work. Cut bricks may be used to complete bond or as closers or around irregular openings.

5.5.4.5 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.

5.5.4.6 Selected bricks of regular shape and dimension shall be used for face work.

5.5.4.7 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.

5.5.4.8 Fixtures, plugs, frames, pipes, inserts etc., if any, shall be built in at the right places to the lines & levels as shown in the drawings while laying the course and not later by disturbing the brick work already laid.

5.5.4.9 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.

5.5.4.10 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 one metre and the difference in height of adjoining wall/connecting wall shall be raked back according to bond by stepping at an angle not steeper than 45 degree, without sacrificing the necessary bond, horizontality of layers, verticality of joints and the wall. 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.

5.5.4.11 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, soffits of opening may be rebated and the sill shall be sloped slightly for drainage of rain water.

5.5.4.12 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.

5.5.5 Half-brick masonry

5.5.5.1 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 specified and shown in drawing, M.S. bars or hoop iron shall be provided as stipulated in the Schedule of Items or as directed by the engineer. 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.

5.5.6 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 wire mesh netting of approved variety as
specified in the item 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 brick on edge wall butts. The batching of mortar usually shall be in the proportion of 1:3 or as stipulated in the Schedule of Items.

5.5.7 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 soffits of openings are not damaged.

5.5.8 Curing

All brick works shall be kept moist for 10 days after laying.

5.5.9 Scaffolding

5.5.9.1 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.

5.5.9.2 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 metre 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.
5.5.9.3 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 if any shall have to be borne by him.

5.5.9.4 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 Stone masonry

5.6.1 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.

5.6.2 Mortar

The mortar used shall be as specified in the Schedule of Items or drawing.

5.6.3 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.

5.6.4 Random rubble masonry
5.6.4.1 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 course 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 20 mm 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.m. 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.

5.6.4.2 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 0.025cum (25dcum in volume and it shall also not be less than 300mm in length, 25% of them being not less than 500mm in length).

5.6.4.3 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 20 mm 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 20 mm by raking tool during the progress of work, when the mortar is still green.

5.6.5 Coursed rubble masonry - First sort

5.6.5.1 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 15 cm nor more than 30 cm.

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 up to the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting 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.

5.6.5.2 Bond Stones

Bond stone or a set of bond stones shall be inserted 1.5 to 1.8 metres apart, in every course.

5.6.5.3 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 stretchers and headers alternately. These shall be laid square on the beds, which shall be rough-chisel dressed to a depth of at least 10 cm. 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.

5.6.5.4 Joints

All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar, face joints shall 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 20 mm by raking tool during the progress of work, when the mortar is still green.

5.6.6  Coursed rubble masonry - Second sort

5.6.6.1  Laying

Shall be as specified in 5.6.5.1 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.

5.6.6.2  Bond stone, quoins

Shall be as specified for first sort respectively.

5.6.6.3  Joints

All bed joints shall be horizontal and all side joints vertical. All joints 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 20 mm by raking tool during the progress of work, when the mortar is still green.

5.7  Hollow concrete block masonry

5.7.1  Construction of hollow concrete masonry shall be done in accordance with procedures laid down in IS: 2572-1963. General procedures for construction shall conform to IS: 2212-1991 except for the following:

5.7.2  Storage, handling and preparation

The blocks shall be stored in stable stacks over planks or other supports with sufficient care taken to prevent ingress or moisture.

Blocks shall be handled carefully to avoid cracking. All damaged units shall be rejected and removed from site.
Blocks need not be wetted before or during placement. Unless the climatic condition so require, the top and sides may be slightly wetted.

5.7.3 Mortars

Mortar for use in hollow concrete block masonry shall be made from cement, slaked lime and sand unless otherwise specified. The mix preparation shall be as recommended in Table-I of IS: 2572-1963. Preparation of mortar shall be in accordance with IS: 2250-1981.

5.7.4 Laying

Laying of block for first and subsequent courses and requirements of horizontal and vertical joints shall be as described in IS: 2572-1963. Use of hollow blocks in foundations shall be avoided. Use of blocks filled with sand and blocks filled with 1:3:6 concrete for foundation courses, plinths and basements shall be done with approval of Engineer. Closure blocks of superstructure shall have all openings battered with mortar. A course of solid concrete block masonry shall be provided under door and window openings or a 10 cm thick precast concrete sill block shall be provided under windows. This course shall extend at least 20 cm beyond the openings on either side. Solid blocks or hollow blocks filled with 1:3:6 concrete shall be used for jambs or fixing of hold fasts etc., Similarly solid blocks or U-shaped blocks filled with 1:3:6 concrete shall be used for roof course. They shall be finished smooth at top with 1:3 cement mortar and covered with a coat of crude oil, craft paper or oil paper for free roof movement.

5.7.5 Bond

Wherever two walls intersect, bond between at least 50% of the units intersecting shall be provided. If intersecting walls are laid separately pockets shall be left in the first wall at a maximum vertical spacing of 20 cm for the corresponding course of second wall to be built into these pockets.

Pilasters shall be of twice the thickness. Hollow blocks shall not be used for isolated piers unless they are filled with 1:3:6 concrete.

6.0 PLASTERING AND POINTING

6.1 Materials
The specification of materials shall conform to the requirements as specified in Part-I.

6.2 Plastering

6.2.1 General

Plastering shall be done in accordance with provisions of IS: 1661-1972. 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. The thickness mentioned in the Schedule of Items shall be minimum thickness.

6.2.2 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. Trimming of projections on brick/concrete surfaces wherever necessary shall be done.

For one coat plastering the plaster shall be laid slightly thicker than the specified thickness and the surface then leveled 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.

If 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. The plaster shall be kept wet for at least seven days and protected from extreme temperature and weather during this period.

The arises 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.

6.2.3 Concrete beams, slabs, columns etc. framing into masonry are to be plastered along with masonry walls with these edges wrapped with chicken wire mesh of gauge 24. Overlapping of mesh shall be minimum 75 mm on either side of the edge of the concrete element. Minimum lap for chicken wire mesh shall be 50 mm.

6.3 Cement Pointing

6.3.1 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. 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.

6.3.2 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.

6.3.3 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.
6.3.4 Cut or weather struck pointing

The mortar shall first be pressed into joints. The top of the horizontal joints shall then be neatly pressed back by about 3mm with the pointing tool so that the joint is sloping from top to bottom. The vertical joint shall be ruled pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles.

6.3.5 Raised and cut pointing

This type of pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6mm raised and width 10mm or more as directed. The pointing shall be finished to a smooth but hard surface. The superfluous mortar then shall be cut off from the edges of the lines and the surface of the masonry shall also be cleaned off all the mortar.

Curing

The pointing shall be kept wet for 7 days. During this period it shall be suitably protected from all damages.

6.3.6 Pointing on brick flooring

Specification for this shall be conforming to under sub head "Pointing".

6.3.7 Pointing on random rubble stone masonry

In such pointing, the mortar shall be simply struck off with a trowel and the work left showing the natural irregularities in line and surface of the stones themselves. Other specifications shall remain same as per para 8.3 under sub head "Pointing".

6.4 Rough Cast Concrete Facing

6.4.1 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, when the backing coat is in plastic state, 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 dashing the mixture on top with trowel to produce uniform rough texture. The mix shall again be dashed over the vacant spaces if any. 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 wash shall then be applied, the cost of which shall be included in the rate of the item.

6.4.2 Rendered sand faced cement plaster

The surface shall be prepared as for cement plaster. 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. The surface afterwards shall be cured for 7 days.

6.4.3 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 dabbing 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.

6.4.4 Floating coat with neat cement

When the plaster has been brought to a true surface with the wooden straight edge, it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth so that whole surface is covered with neat cement coating. Smooth finishing shall be completed with a trowel immediately and in no case later than half an hour of adding water to cement.

6.4.5 Pebble dash plaster

Specification shall be same as that for rough cast concrete facing vide 8.4.1 except that pebbles or graded crushed stone, of size 10mm to 20mm or as specified/directed by the Engineer, shall be well washed and drained and then dashed/thrown wet on the plaster surfaces while it is still plastic, using strong whipping motion at right angles to the face of wall, pressed flat and filling uncover parts by hand so that finished surface represents homogeneous look. The finished surface shall be lightly tapped with a trowel to ensure good bond.
6.5 Punning with Lime or Plaster of Paris

6.5.1 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 troweled 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 punning shall be kept wet for a period of 7 days. 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. No portion of the surface shall be left out initially to be patched up later on.

6.5.2 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 as for lime punning shall be followed for getting uniform smooth finish.

7.0 FLOORING, PAVING & FACING

7.1 Scope
Flooring, Paving and facing includes flooring, skirting and dado of various types encountered in plants, buildings, pavements etc. as described under respective heads. For the items which have not been covered up in this chapter completely or covered up only partly, specifications suggested by the manufacturers for the materials, surface preparation, workmanship and all other byeworks etc., shall be strictly followed. In addition to this the entire job will have to be carried out as per direction of the engineer, which shall be final.

7.2 Materials
Materials shall conform to Part-I of this series.
7.3 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, toilet & other places and cutting to line and fair finish to top edge of skirting and dado. Thickness mentioned shall be the minimum.

7.4 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.

7.5 Subgrade

The surface shall be brought to the desired level before subgrade is laid, loose pockets shall be filled up and whole surface shall be consolidated by tamping. Vegetable growth and other decomposed matter, rubbish etc., shall be removed.

7.5.1 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.

7.5.2 **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.

7.6 **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 by trowel finishing 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.

7.7 **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 and finished according to IS : 5491-1967.

7.7.1 **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/Schedule of Items. 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 the item will be inclusive of this.

II-66
7.7.2 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 : 1 part coarse aggregated by volume or 1 part cement and 1 part stone chips. The coarse aggregate shall very hard like granite and well graded and size of chips shall be 3mm for 6mm topping & 6mm to 3mm for 10mm or more thick topping. Minimum quantity of water to get workability shall be added.

7.7.3 Laying

a) Laying of monolithic topping

The concrete base or underbed shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The surface shall remain sufficiently rough to take the finish.

To prevent construction cracks, the panels shall be divided in square or rectangular pattern. For floor finish of 40mm thickness or above, the maximum panel area shall be 2.5 sq.m. with none of the sides exceeding 2.5m, however for lesser thickness these shall be 1.5sq.m. and 2.5m respectively. The dividing strip may be aluminium or glass or as specified and shall have the same depth as that of floor. Within about 2 to 3 hours of laying the base while it is still fully 'green' the topping shall be laid evenly to proper thickness and grade. The topping shall be pressed firmly and rigorously to form full bond with the base/underbed.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly troweled to remove all marks and shall be left for sometime till moisture disappears from it. Fresh quantity of cement @ 2.2 Kg per sq.m. of the flooring shall be mixed to form a thick slurry and spread over the surface while concrete is still green. The cement slurry then shall be floated even & smooth. Polishing, if specified, shall be done with polishing machine and the portion where machine cannot be used manually to the satisfaction of the Engineer. If specified so the surface of the flooring shall be finished ribbed, chequered or laid in slope without any extra cost unless specified so in the item. On completion, the floor shall be kept flooded with water.
for 10 days and shall be adequately protected before it is sufficiently hard.

(b) **Laying of topping separately on hardened base**

The sub base shall be laid as in clause 7.7.3. The surface of the base concrete shall be thoroughly brushed and cleaned free from all dirt, mortar droppings and laitance etc. Where the surface has hardened too much, chipping or hacking of the surface may be necessary. The surface shall then be wetted with water for several hours and surplus water mopped. Neat cement slurry at 2.75Kg/sq.m. of surface shall be brushed into the clean surface. The topping then shall be laid as described in clause 7.9.3.

7.7.4 **General**

The junction of the floors with all plaster dado or skirting shall be rounded of with 1:1 cement sand mortar & polished, if specified or shown in drawing.

7.7.5 **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 at least 10 days by means of wet gunny bags or ponding of water on the surface. The floor shall not be exposed to use during this period.

7.7.6 **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.

7.8 **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) or as specified. Over this a top coat 6mm/7mm 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.

7.8 Flooring & Facing with Redoxide of Iron (Red Artificial Stone Flooring)

It shall consist of an underbed or base course and topping over already laid & matured concrete subgrade.

7.9.1 Thickness

Unless otherwise specified the total thickness of the flooring shall be either 40 mm or 25 mm of which the topping shall not be less than 6 mm (net) for 25 mm thickness and 10 mm (net) for 40 mm thickness. The topping shall be of uniform thickness, the underbed may vary in thickness to provide necessary slopes. For vertical surfaces the total thickness shall be 18 mm, of which the topping thickness shall be 6 mm (net). Where grinding (cutting) & polishing is specified a minimum allowance of 2 mm shall be kept for cutting & polishing so that the net specified top thickness is achieved. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm or as shown in the drawing.

7.9.2 Mix

i) Course or base course

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 pert cement, 2 parts coarse sand and 4 parts 10 mm down graded stone chips by volume. For vertical and similar surfaces the mix shall consist of 1 part cement to 3 or 4 parts coarse sand by volume as specified in the item.

ii) Topping course

For the topping white cement and red oxide of iron pigment powder shall be dry mixed thoroughly (generally 10:1 by weight) to produce the desired colour when laid. The mix shall then be prepared with 1 part white cement (mixed with pigment) and 3 parts coarse sand by volume. The whole quantity required for
each visible area shall be prepared in one batch to ensure uniform colour.

7.9.3 Laying

The underbed shall be laid in panels of maximum area 2.5 sq.m. each and no side shall be more than 1.5m long. For outdoor locations the maximum area shall be 2.0 sq.m. or as specified. The forms for the panels shall have perfectly aligned edges to the full depth of the total thickness of finish. Aluminium or glass dividing strips shall be used as forms. The underbed shall be laid compacted, levelled and brought to proper grade with a screed or float. The topping shall be placed after about 24 hours while the underbed is still somewhat 'Green' but firm enough to receive the topping. The surface of the underbed shall be roughhead for better bonding. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water to achieve a compact dense mass fully bonded with the underbed. The topping shall then be levelled up by troweling and finished smooth with a slurry made with already prepared cement and pigment mixture. About 2.0 kg of the mixture shall be consumed/per sq.m. for horizontal surface, and 1.0 kg for vertical surface.

7.9.4 Grinding & polishing

Where grinding & polishing specified, the same shall be done 36 hours after laying when the surface has hardened sufficiently. It shall be polished with polishing stone, in sequence of different grades of carborundum stones (first No. 60, then No. 80 & then No.120) till a smooth shiny surface to the satisfaction of the Engineer is achieved. After final polishing, the finished areas shall be rubbed with oxalic acid and then wax polished.

7.10 Terrazzo Flooring & Facing

General

The terrazzo work shall be done by approved firm or specialists. Marble chips used for facing coat of terrazzo work shall be of best quality (from Dehradoon 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, the thickness for cast-in-situ terrazzo work shall be 25 mm including base course and for tiles 20 mm excluding mortar bed.

7.10.1 Cast-in-situ terrazzo flooring

It shall consist of an underbed and a topping laid over an already matured concrete subgrade.

7.10.1.1 Thickness

Unless specified otherwise, the total thickness of the finished flooring shall be either 25 mm or 40 mm of which the topping shall be minimum 6 mm (net) for 25 mm and minimum 10 mm net for 40 mm flooring. A minimum allowance of 2 mm in the topping shall be kept for grinding and polishing so as to achieve the minimum specified thickness of topping. All junctions of vertical with horizontal planes shall be rounded neatly to uniform radius of 25 mm or as shown in the drawings.

7.10.1.2 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 of 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 shall be inclusive of any pigments added to the cement. The proportion to which pigments are mixed with grey or white cement to obtain various shades for the binder, shall be as specified in Table-I of IS : 2114-1984.
The proportion of marble chips and cement marble powder mix shall be 7 parts of marble chips to 4 parts of cement marble powder mix mixed by volume. Care shall be taken to ensure an even and uniform disposition of the marble chips.

7.10.1.3 Laying

i) Laying of underbed

The underbed shall be laid in panels in the same manner as that for artificial stone flooring. The panels shall not be more than 2 sq.m. in area of which no side shall be more than 2.0 m long. Cement slurry @ 2.75 kg/sq.m. 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 plus topping. 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.

ii) Laying of topping

After laying, the underbed shall be leveled 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 and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The terrazo surface shall be tamped, troweled and brought true to the required level by straight edge and steel floats in such a manner that maximum amount of marble chips come up and are spread uniformly over the surface and no part of the surface is left without the chips. Excessive troweling should be avoided in early stages lest too much cement may come up the surface leading to surface cracking and requiring more grinding to expose marble chip.
7.10.1.4 Curing

The surface shall be left dry for air 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 seven days.

7.10.1.5 Grinding & polishing

Grinding and polishing shall be done either by hand or by machine. In case of manual grinding, the process of grinding shall begin after 2 days while in case of machine grinding the process shall start after seven days after completion of laying. First grinding shall be done with carborundum stone of 60 grit size. 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 grit blocks (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. For good result, wax polishing shall be applied on the surface with the help of soft linen over a clean and dry surface and then the polishing machine fitted with bobs shall be run over it. Clean saw dust shall be spread over the floor surface and the polishing machine again operated so as to remove excess wax and leave glossy surface. Floor shall not be left slippery.

7.10.2 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 20 mm thickness for total thickness 18 mm or 21 mm or 26 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. 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.

7.10.3 Terrazzo tile finished flooring/facing

The work will consist of manufactured terrazzo tile and an underbed.

7.10.3.1 Thickness

Unless otherwise specified, 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.

7.10.3.2 Tiles : Terrazzo

The tiles shall, unless specifically permitted in special cases, be machine made under quality control in a shop and shall be subjected to minimum hydraulic pressure of 140 kg. per sq. cm.

The tiles shall be composed of a backing and topping. The finished thickness of upper layers shall not be less than 5mm for size of marble chips upto 6m size and not less than 6mm for size of marble chips upto 20mm size.

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.

7.10.3.3 Mix : Underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 1 part coarse sand or 1 part cement : 3/4 parts coarse sand mixed with sufficient water to form a stiff workable mass. The thickness of underbed for the flooring shall be 20mm unless
otherwise specified. 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.

7.10.3.4 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 cement slurry applied at 4.4Kg of cement per sq.m. 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. 7.10.1.3 may be used for dividing the work into suitable panels.

7.10.3.5 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.

7.11 Glazed Tile Finished Flooring & Facing

This finish shall be composed of glazed earthen tiles with an underbed laid over a concrete or masonry base.

7.11.1 Thickness
Unless specified the total thickness shall be 21 mm for flooring & 18 mm for dado/skirting for the underbed.

The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

7.11.2 Tiles : Glazed

These shall conform to the requirement of IS : 777. The tiles shall be of earthenware, covered with glazed white or coloured, plain or with designs, of 149 mm x 149 mm or 99mm x 99mm nominal sizes and 5,6 & 7 mm thick unless otherwise specified. 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.

7.11.3 Mix : Underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand mixed with sufficient water or any other mix if specified and shall be 12mm thick minimum or as specified.

7.11.4 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 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 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'. 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.
7.11.5 Curing & cleaning

After flush pointing the joints, the surface shall be 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 handing over.

7.12 Marble Flooring

7.12.1 Thickness

Unless specified otherwise the underbed shall be average 20 mm for flooring and 12 mm thick for vertical surfaces. The slabs may be 20 mm, 25 mm, 30 mm or 40 mm thick as specified.

7.12.2 Marble slab

The slabs shall be made from selected stock which are hard, sound, homogeneous and dense in texture and free from flaws, angles and edges shall be true, square, free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of plus or minus 5 mm in dimensions and plus or minus 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm. The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

7.12.3 Mix : Underbed

The underbed, unless specified otherwise for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 1 part coarse sand or 1 part cement : 4 parts coarse sand mixed with sufficient water to form a stiff workable mass and shall be on 20mm thick bed. For skirting and dado and all vertical surfaces it shall be 12 mm thick and composed of 1 part cement and 3 parts coarse sand.

7.12.4 Laying
The sides and top surface of the slabs shall be machine rubbed with coarse sand stone and washed clean before laying. The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, a thick cement slurry at 4.4 Kg of cement per sq.m. shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, grey/white/mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

7.12.5 Polishing, finishing

Fine chiseling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under terrazzo flooring. However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

7.13 Marble in Facia or Dado

Marble tiles of approved shade, variety, size and thickness as specified in the item shall be used. They shall be of selected quality, dense, uniform and homogeneous in texture and free from cracks or other structural defects. The exposed face shall have no unsightly stains, veins and defects. They shall have uniform milky white or coloured shade or patterns of colours approved by the Engineer before ordering the tiles. The surface shall be fine polished and sides machine cut, true to square.

When a single course of marble slab is to be fixed as in dado etc., the slabs shall be fixed as described below:

Mortar pads of 1:3 C.M. (1 cement : 3 coarse sand) of uniform width shall be stuck on to the wall at close intervals and the marble slabs shall be pressed on to them firmly. The remaining cavities if any shall then be filled with thin grout of cement mortar of the same proportion. The sound coming, on gently tapping of the slab, will indicate if there are hollows. When the hollow cannot be filled with grout and the finished slab continues to give a hollow sound on tapping, the slab shall
be removed and reset. For the facia work where more than one course is required the marble slabs shall be of matching stand and veins to form architectural pattern as per drawings and shall be fixed in the same way as described above except for the horizontal joints of the slabs, where adjacent slabs shall be held together by a brass pin passing through a hole drilled into the slabs. In addition, wrought iron/dowels shall be provided to anchor the slabs to the wall. The metal cramps shall be counter sunk into the joints of the slab and it shall be located about a metre apart subject to a minimum of one for each slab for each horizontal joint.

The facing shall be fixed truly in plumb and in perfect line or curves as shown on the plans. The courses and joints shall be as directed by the Engineer. The surface shall be protected from sun and rain and cured for 10 days and shall be finally polished with carborundum stones as for skirting & dado of cast-in-situ terrazzo.

7.14 Flooring/Paving with Hardener like Ironite

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is 'Green'.

7.14.1 Thickness

Unless otherwise specified in the Schedule of Items, the total thickness of the floor with metallic hardener finish shall be 40 mm or 50 mm of which the topping shall be 10 mm (net) for 40 mm & 12 mm (net) for 50 mm

7.14.2 Material (metallic hardener)

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the Engineer, actual samples shall be tested.

7.14.3 Mix

Unless otherwise specified, the mix for underbed shall be of 1:2:4 concrete and stone chips shall be 12 mm down grade. For topping the proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry with 4 parts cement, by weight.
To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

7.14.4 Laying & finishing

The under bedding course of base course shall be laid as per specification of laying underbed for Red artificial stone flooring. The surface shall be roughened by wire brush as soon as possible. The finish top coat shall be laid while the concrete base is still fairly 'green' within about 3 hours of laying of the later. The finish shall be of uniform and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smooth with steel trowel.

7.14.5 Curing

The finished floor shall be cured for 7 days by keeping it wet.

7.15 Chemical Resistant Tiles Flooring / Facing (Either of natural stone or prepared tiles)

This shall include all varieties 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 its performance.

7.15.1 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 non-fading colour and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 kg/cm². The surface shall be abrasion resistant and durable.

7.15.2 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 same chemical resistant properties as that of tiles. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

7.16 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.

7.17 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
(b) Alignment of joints, dividing strip etc.
(c) Colour, texture
(d) Surface finish
(e) Thickness of joints including the workmanship in joints.
(f) Details at edges, junctions etc.
(g) Performance
(h) Precautions specified for durability.
(i) Effluent treatment plant

8.0 WOOD WORK

8.1 General

Wood work shall be neatly and truly finished to exact dimensions and details as per drawings, without patching or plugging of any kind. Rebates, roundings and mouldings as shown in drawings shall be
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 with a priming coat of approved 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.

8.2 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 I.S :848- 1974 and 851-1978.

8.3 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 (Part 1 & 2)-1983 to 1991.

8.4 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 holdfasts shall be left at the time of construction. 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 12mm 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 M.S. clamps fixed to the frame shall be inserted in the holes and jammed in cement concrete M-15 or (1:2:4 mix) with 20 mm down graded stone chips after holding the frame in proper position to the line, level and plumb.

The size of the concrete block shall be 250 x 125 x 85mm unless otherwise specified.

8.5 Tarring

Timber in contact with earth, concrete, plaster or masonry shall be treated with boiling coal tar or 2 coats of wood preservative treatment like hot solingnum or creosite oil etc. before fixing the frame in position.

8.6 Fittings

Unless otherwise specified, three holdfasts shall be fixed on each side of a door frame, one at the centre 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 225 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 centre 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.

8.7 Doors, windows & ventilators etc.

Dimensions of the various components of doors, windows and ventilators shall be in accordance with IS : 1003 (Part 1&2)-1983 to 1991 Table- III or as shown on the drawings. The work shall be carried out as per detailed drawing. The wooden members shall be planed, smooth and accurate. They shall be cut to the exact shape and size without patching or plugging of any kind. Mouldings, rebates, curves and roundings etc. shall be done as shown in the drawing before the pieces are assembled into the shutter.

The thickness of stiles and rails etc shall be as per IS: 1003 (Part 1&2)-1983 to 1991 unless otherwise specified in the item of works. These shall be properly and accurately mortised and tenoned. Rails which are more than 180mm in width shall have 2 tenons. Stiles and rails shall be made out of single piece upto 200mm in width. In case more than one piece of timber is used for members exceeding 200mm width, they shall be joined with a continuous tongued and grooved joint, glued together and reinforced with rust proof metal dowels or headless pins. The tenons shall pass clear through stiles. the stiles and rails shall have a 12mm groove, unless otherwise shown in the drawing, to receive the panel. In case of double shutters the rebate at the closing junction of the two shutters shall be as per clause 5.5 of IS: 1003-1991 or as shown in the drawing. Primer coat shall not be put before shutters are passed by the engineer.

8.8 Panelled Shutters

These shall conform to IS: 1003 (Part I)-1991. Timber panelled shutters shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, hard board or asbestos cement board.
Stiles, rails and panels in door shutters shall be of the same species of wood.

Timber panels shall be of minimum width of 150mm. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. No single panel shall exceed 0.5 m² in area. Timber panels shall be fixed only with grooves but additional beadings may be provided either on one side or both sides.

Unless otherwise specified thickness of panel for 35mm thick shutter shall be 15mm and for 40mm and above thick shutter, it shall be 20mm. For 25mm thick shutter, panel thickness shall be 12mm.

Apart from timber panels other materials like plywood, Block board, particle board, Hard board and Asbestos cement may also be used for panelling purpose and shall be fixed with grooves or beading or both as per provisions made in IS:1003 (Part-1)-1991.

Timber suitable for manufacture of door shutter have been grouped under class a,b,c & d in Table 1 of IS: 1003 (Part-1)-1991.

8.9 Glazed Shutters

The openings for glazed shutters shall be rebated and moulded out of solid timber. Plain sheet glass for panels shall be of approved quality as specified. Wherever specified, ground glass or frosted glass of approved quality shall be used in place of plain sheet glass. Unless otherwise specified glass panes shall be fixed by means of moulded beads and suitable MS panel pins. A thin layer of putty shall be applied between glass panes and sash bars and also between glass panes & beading.

8.10 Flush Door Shutters

Unless otherwise specified, flush door shutters shall have a solid/cellular core, a teak wood frame, and shall be 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 and heat. 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. Where specified flush doors shall be provided with vision panels, rectangular/ round or louvered.

If specified so, the flush door shall be solid block board core or solid particle board core construction. The workmanship and overall finish shall be of very high standard and shall conform to IS:2191 (Part 1&2)-1983 & 2202 (Part 1&2)-1983 to 1991. The shutters shall be procured from approved manufacturer bearing IS certification mark only.

8.11 Other types of shutters

8.11.1 Wooden hand rails

Wooden hand rails shall be of approved quality teak wood fixed to concrete or metal balustrade with concealed steel or metal lugs and bolts as per drg. Joints will be made with concealed crews and dowels. All bends, mitres, coves, moulds etc. will be strictly to proper profile and finally smoothed by sand paper. The hand rail shall be finished with wax or french polish or painting as per direction of the engineer.

8.11.2 Hardware fittings for door, 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 ventilators 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.

8.12 Inspection

The Contractor shall provide all facilities to the Engineer for the inspection of the goods at his premises. No primer shall be applied until the wood work 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 Schedule of Items.

9.0 METAL DOORS, WINDOWS AND ROLLING SHUTTERS

9.1 General

Doors, windows and ventilators etc., shall be truly square and flat, i.e. free from twist and warp. The general fabrication shall conform to IS:1038-1983 & IS : 1361-1978 as applicable.

9.1.1 Frames shall be constructed of sections which have been cut to length and mitred. 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 welding or any other suitable method which gives the desired requirement, with mitred 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.

9.1.2 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.

9.1.3 All steel doors, windows and ventilators shall be either galvanised 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 then shall be painted with one coat of an approved primer conforming to IS : 102-1962 before despatch. Alternatively they may be galvanised by the "Hot Dip" zinc spray or electro- galvanizing process as described in IS : 1361-1978.

9.2 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 : 1081-1960. 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)/(1:2:4) mix 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 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.

9.3 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 be approved by the Engineer.

9.4 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 or 1.25mm 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.
9.4.1 Double Plate flush door shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of two outer sheets or 18G or 1.25mm thick steel sheets, rigidly connected and reinforced inside with continuous vertical 20G or 0.99mm thick 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. Pairs of double doors shall have meeting style edges bevelled 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 hardwares 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, louvres etc. Glazing mouldings shall be of 18G or 1.25mm thick steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louvre blades shall be V or Z shaped sections.

9.4.2 Single sheet door shutters

Single sheet doors shall be made from best quality 18g/1mm mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with a semi-tubular 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, louvres etc., shall be made.

The manufacturing shall done as specified in "Double Plate Flush Door Shutters".

9.5 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.

9.6 Steel Windows, Sashes, Ventilators, etc.

These shall conform to IS : 1038-1983 and IS : 1361-1978 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.

9.6.1 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.

All welds at the corner of casement shall be done by flash butt welding process or any other suitable method which gives the desired requirement and dressed flush on all exposed and contact surfaces.

9.7 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 metre height shall generally have 3 sets of lattices and those over 3.0 metre 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.

9.8 Steel Rolling Shutters and Grills
9.8.1 Unless otherwise specified the shutters shall conform IS:6248-1979. Laths for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 3.5 M wide and not less than 1.25 mm thick for shutters above 3.5 M wide and machine rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

9.8.2 Rolling grills shall be constructed out of 6/8 mm dia rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated laths of approved design reinforced with 6 mm dia rods. End locks shall be heavy type and shall be provided at each end of alternate laths unless specified otherwise. Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown in drawings, a flexible weather strip shall be applied to make tight contact with the floor. Guides shall be of such depth as to retain the shutter under a wind pressure of 150 kg/sq.m. or as specified. Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360 th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation. Hoods shall be formed of not less than 20 gauge or 0.90 mm thick sheet mild steel, suitably, reinforced to prevent sag. Locks shall be slide bolt and hasp, or cylinder lock operable from both sides. Provision for securing hand chain with padlock, removable handle for hand cranks etc, shall be made as described in scheduled of items and as directed by the Engineer.

9.8.3 Laths for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 3.5 M wide and not less than 1.25 mm thick for shutters above 3.5 M wide and machine rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load. Rolling grills shall be constructed out of 6/8 mm dia rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated laths of approved design reinforced with 6 mm dia rods.

9.8.3 End locks shall be heavy type and shall be provided at each end of alternate laths unless specified otherwise. Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters.
When shown in drawings, a flexible weather strip shall be applied to make tight contact with the floor. Guides shall be of such depth as to retain the shutter under a wind pressure of 150 kg/sq.m. or as specified. Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360 th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation. Hoods shall be formed of not less than 20 gauge or 0.90 mm thick sheet mild steel, suitably, reinforced to prevent sag. Locks shall be slide bolt and hasp, or cylinder lock operable from both sides. Provision for securing hand chain with padlock, removable handle for hand cranks etc, shall be made as described in scheduled of items and as directed by the Engineer.

9.8.5 Manually operated shutters/grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 0.3 metres per second. In general, manually operated shutters shall be push pull type for openings upto 9 sqm in area. Larger shutters shall be either chain and gear operated or crank and gear operated. The crank/handle shall be removable. All shutters shall be lockable from one or both sides as described in Schedule of Item or as desired by the Engineer.

9.8.6 Priming coat of shop coat

Shutters shall be painted with one coat of red lead or zinc chromate primer after they are inspected and found in order and acceptable. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

9.8.7 Erection

Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc., shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with prevailing Indian Electricity Rules.

9.8.8 Inspection
After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

9.8.8.1 Field inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.

9.9 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

9.10 Aluminium Doors, Windows, Frames

9.10.1 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 drawing 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 300x150mm 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 anodized 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 @ 90 cm c/c maximum for fixing.

9.10.2 Aluminium windows

Aluminium 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, ventilators and fixtures shall not be less than 15 microns as per IS:1868 - 1982.

9.10.3 All work shall be fitted and shop assembled to a first job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce a uniform colour throughout 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 shape 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.

10.0 GLAZING

10.1 General

Glazing shall be done with plain, frosted, ground glass or wired cast glass, laminated safety glass or toughened glass etc. 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:1081-1960 "Code of Practice for Fixing and Glazing of Metal Doors, Windows & Ventilators". The material for putty shall consist of whiting and linseed oil, raw-mixed in such proportion as to form a paste conforming to IS:419-1967.

10.2 Doors, Windows and Ventilators

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 of 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 even spread over the glazing rebate and the glass pressed firmly against it. It shall be secured in position by means of teak wood beads for wooden shutters. Glass panes shall be set without springing & shall be bedded in putty and back puttied, except where moulding or gasket are specified. Putty 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.

10.3 Northlight Glazing

This shall consist of aluminium or 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 astragals with glazing clips and putty.

11.0 WHITE WASHING, COLOUR WASHING AND PAINTING

11.1 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. For the items which have not been completed or partly covered in this chapter, specifications suggested by the manufacturers for the materials, surfaces preparation, workmanship and all bye works shall be strictly followed and shall be carried out as per direction of the Engineer.

11.2 Materials

Materials shall conform to Part - I

11.3 White Washing, Colour Washing
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/painted. 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.

11.3.2 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 coarse cloth. 4 Kg of gum dissolved in hot water shall be added to each cubic metre 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/ultramarine blue 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. The white washing on ceiling shall be done prior to that on walls.

Each coat shall be allowed to dry before the next one is applied and shall be 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.

11.3.3 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.

11.3.4 White Washing with Whiting

Whiting (ground white chalk) shall be dissolved in sufficient quantity of warm 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.

11.4 Cement Primer Coat

The surface shall be thoroughly cleaned of dust, mortar, droppings etc., and shall be allowed to dry for at least 48 hours. It shall then be rubbed thoroughly by 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.

11.5 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 as far as possible on the surface which is on the shady side of the building so that direct heat of the sun on the surface is avoided. Painted surfaces shall be sprinkled with water 2 or 3 times a day. This shall be done between coats and for at least 2 days following the final coat. The curing shall be started as soon as paint has hardened so as not to damage by sprinkling of water say about 12 hours after the application. 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.

11.6 Synthetic washable distemper

The surface shall be prepared as for Cement Primer Coat. A primer coat of cement or distemper primer shall be applied as specified in the description of the item. Unevenness in the plaster shall be made good by applying plaster of Paris putty mixed with distemper of the colour to be used on the entire surface including filling up the undulations. The surface shall then be rubbed down with a fine grade sand paper and made smooth. 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 obtain 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. The finished surface shall be even and uniform without patches, brush marks, distemper drops etc. Sufficient quantity of distemper shall be mixed to finish one room for applying one coat in one operation.

11.7 Dry Distemper
The surface shall be prepared in the same manner as for synthetic washable distemper. A primer coat using approved whiting shall be applied over the prepared surface. 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.

11.8 Plastic emulsion paint

The surface on which plastic paint has to be laid must be thoroughly cleaned and prepared and all defects rectified and finally prepared in the same manner as for synthetic washable distemper. The surface shall be dry and rubbed smooth by means of sand paper to the satisfaction of the Engineer. One coat primer 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.

11.9 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 as specified 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.

11.10 Tarring

(i) Timber surfaces in contact with earth/concrete/plaster shall be treated with one coat of hot tar or as specified in schedule before fixing.

(ii) If required steel work in holdfasts and the like shall be treated as above and sanded in addition before being fixed in position.

11.11 Painting to Timber & Steel Surface

11.11.1 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 surfaces must be thoroughly dry before painting work is started and painting in exterior/exposed parts shall not be taken up in wet/humid or otherwise unfavourable weather.

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.

11.11.2 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 or as specified. Priming coat shall be of approved primer. In case the surface is to be polished or varnished, a priming coat as approved or specified 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.

(iii) French Spirit Polish

After preparation of the surface it will be well dusted and then the pores of the wood shall be filled up with a filler made of a paste of whiting in water or methylated spirit with a pigment if so required. The spirit polish shall be prepared by dissolving pure shellac in methylated spirit, @ 0.75 Kg of shellac to 5 litres of spirit, with the addition of pigment if so required.

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.

(iv) Wax Polishing

After preparation of surface wax polish will be applied. The polish shall be prepared by heating together 2 parts of pure bees wax and boiled linseed oil each over a slow fire. When the wax is completely dissolved the mixture shall be cooled till it is just warm and one part of genuine turpentine is to be added and entire mixture shall be well stirred.

Polish shall be applied in the same manner as specified for spirit polish.

11.11.3 Painting to Steel Surface

11.11.3.1 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.

11.11.3.2 Steel Structures

Unless otherwise specified all structures shall be painted with two coats of primer. 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 undercoat shall have different tint to distinguish from the finishing coat.

11.11.3.3 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.

11.11.3.4 Structures embedded

Exposed surfaces of embedded parts shall be given two coats of red 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 manufacturer's specification. Surfaces to be field welded shall have no paint applied within 100 mm of the welding zone.

12.0 INTERNAL WATER SUPPLY PLUMBING, DRAINAGE & SANITATION

12.1 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 specified in this chapter

v) Testing of pipe lines after laying as per standard tests specified in this chapter.

vi) Back filling of trenches after successful and 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.

12.1.1 Materials

The materials shall conform to Part-I of this series.

12.2 Water Supply & Plumbing

12.2.1 General

12.2.1.1 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

12.2.2 Installation

All works like earth work, masonry, concrete, steel work, cutting holes, chases in brick, concrete & RCC 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.

12.2.3 Laying

Before lowering down for laying in the trenches, the pipes 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 spacings 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. If situation requires, 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 so as not to allow 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 leveled with sand or soft soil or concrete as approved by the Engineer and the thickness of the layer shall not be less than 100mm.

12.2.4 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.

12.2.5 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 150mm 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.

12.2.6 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 pipes, supplement and make good after laying and testing of the concealed pipelines.

12.2.7 GI Piping

12.2.7.1 The pipes shall be fixed in longest lengths possible with all necessary bends, tees, couplings, reducing ockets, short piece, jamnut and tees etc. in perfect straight lines both vertically and horizontally.

12.2.7.2 All exposed GI pipes shall be fixed at least 15mm clear of wall face with holder bat clamps at suitable places not exceeding (2.5 metres) centre to centre. Where the pipes are laid in chases in walls as shown in the drawing, these shall be secured to walls by hooks. Chases 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.
12.2.7.3 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.

12.2.7.4 Unless otherwise specified the exposed portion of pipes and fittings shall be given two coats of approved synthetic enamel paint over a coat of approved priming. Pipes laid underground or concealed in walls/floors shall be treated with two coats of bituminous paint.

12.2.8 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 practices 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 insulating cover and other foreign materials particularly of oil, burning off materials from bells and smooth pipe ends. 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.

ii) Lead and Flanged Joint:

Lead joints shall be made as per Sl. 15.4.6.1 and flanged joints as per Sl. 15.4.6.2 of chapter 15.

(b) Steel Pipes

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove
burring from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer.

c) G.I 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 recleaned and new compound applied.

d) Asbestos cement pipes

Socket and spigot ended pipes shall be jointed by caulking with tarred gaskets and grouted with 1:3 cement sand mortar.

12.2.9 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 purposes.

d) Fittings and fixtures liable to be stolen shall be fitted and fixed just before testing and handing over.

12.2.10 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, G.I. pipes shall be given a coat of zinc chromate primer, C.I. & M.S. pipes shall be given one coat of red lead or zinc chromate primer over which at least 2 coats of paint of best quality and manufacture as approved by the Engineer shall be provided or as specified in the schedule of item.

12.2.11 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 25cm x 25cm inside shall be with half brick wall in cement mortar 1:4 over a cement bed concrete of 75mm thick in proportion 1:4:8 with stone chips. The inside wall faces shall be plastered with 12mm 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.

12.2.12 Inspection, Testing and Acceptance

12.2.12.1 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.

12.2.12.2 Testing of pipes after laying

General
a) The contractor shall ensure the safety of the pipe work 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 pipe work 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 are found 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 25mm 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 re-calibrated 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.

12.2.12.3 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 taps are closed, the service pipes shall be absolutely watertight. All pipings, fittings and appliance shall be checked for satisfactory support and protection from damage, corrosion and frost.

12.2.13 Storage Tank
12.2.13.1 Pressed steel tank

Pressed steel 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 and manholes shall be arranged and provided as shown in drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50mm above the bottom of the tank and there shall be 150mm 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 450mm diameter. Tanks deeper than 1.00 Metre shall be provided with M.S. internal access ladder adjacent to the manhole. Meter level indicator shall be provided if asked for. Two coats of anticorrosive paint over a suitable primer shall be applied to both internal and 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.

12.2.13.2 G.I. Water Tank

G.I. 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. Unless otherwise specified 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 rivetting shall be drilled and not punched. Lead shall be applied to the joints before rivetting.

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 40 mm dia. G.I. overflow pipe and 25 mm washout with plug. If specified 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 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 over-flow pipe, and above the maximum water filled level shall be as per the standard norms for GI water tank.

12.2.13.3 Water reservoirs made of concrete or masonry shall be governed by the specification in 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.

12.3 Drainage and Sanitation (Internal)

12.3.1 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 connectins, 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-
1983 "Code of Practice for Building Drainage" unless otherwise specified.

12.3.1.1 Installation

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumbs, 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 are 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.

12.3.2 Rainwater Downcomers

Rainwater downcomers shall be standard cast iron or asbestos cement pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paint over a coat of primer. Rain water 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 of 1 in 100.

12.3.3 Gutter

The gutters shall be made of G.I. or A.C. Gutters shall be supplied by reputed specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. GI gutters shall have the edges strengthened by suitable means. The joints may be made by rivetting, bolting or soldering.
Unless specified 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 rivetting, 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 downcomers shall be made fully watertight and secured.

12.3.4 Soil and Drainage Pipes

12.3.4.1 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

12.3.4.2 Relation with water supply pipe lines

Unless specifically cleared by the Engineer, under no circumstances shall drainage and soil pipes be allowed to come close to water supply pipelines.

12.3.4.3 Laying

Each separate pipe shall be individually set for lines and levels. 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.

12.3.4.4 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 jointings.

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 metre and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased surrounded with concrete as per IS:4127-1983.

- b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipes, the sewer shall be bedded on concrete 1:4:8 mm with 20mm down aggregates as per IS:4127-1983.

- 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 1:4:8 mm with 20mm down aggregates as per IS:4127-1983.

- d) Where maximum water table is likely to rise above the top of the barrel the pipe sewers shall be completely encased/surrounded with 1:4:8 concrete with 20mm down aggregate as per IS:4127-1983.
Vitrified clay pipes shall be laid on a bed of 150mm 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. At least one support shall be located close to ends. Spacing of intermediate supports 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.

12.3.4.5 Entry into structures

For entry of the pipes 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.

12.3.4.6 Traps and Ventilating pipes

a) Pipes carrying the sewage from water closets and waste water and overflow water from baths, wash basins, sinks shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50mm 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 600mm above the outer covering of the roof top of the building or as shown on drawings. All vertical ventilating, anti-siphonage 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.

b) Sand Cast Iron Spigot and Socket pipe and fittings
All soil waste and vent pipes and fittings used in the work shall be cast iron and shall conform to IS:1729-1979. 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 pipes and fittings shall be clean and smooth and painted inside and outside with Dr. Angus Smith's solution or other approved anticorrosive paint. 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 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 3mm thick rubber insertion packing, and when closed and bolted they shall be watertight. The access doors shall have MS studs and bolts or screws or bolts and nuts.

Fixing

The pipes and fittings shall be fixed to wall by means of MS holder bats clamp of approved type and steel bolts or by pipe nails, bobbins etc. as the case may be, keeping the pipe clear from the finished surface of the wall. The holder bat nails shall be fixed to the wall in wooden block. The soil pipe shall be supported at the foot upon a bed of cement concrete of proportion 1:3:6 and firmly attached to the wall.

The pipes shall be laid truly vertically or along the line as shown in the drawing. Connection between main pipe and branch pipe shall be made by using branches and bends with access door for cleaning.

All vertical soil waste, ventilating and anti-siphonage pipes shall be carried up above the roof and provided with suitable C.I. cowl on top.

Pipes outside the building shall be laid underground for which trenches shall be excavated as required for the work. The trenches shall be back-filled with excavated material after the drainage system has been tested and passed.

Jointing (Lead Caulked Joint)
Unless otherwise specified, the pipes and fittings shall be jointed with lead joints as described below:

The annular space between the socket and spigot will be first well packed in with tarred gasket or hemp yarn leaving 25mm from the lip of the socket for the lead. The joint may be leaded by using proper leading rings or if they are not available by wrapping a ring of hemp rope covered with clay round the pipe at the end of the socket, leaving a hole through which lead shall be poured in (for pipes with sockets facing a upwards 15mm high small clay band on socket edge may be used).

The lead shall be rendered thoroughly fluid and each joint filled in one pouring. Before caulking, the projecting lead shall be removed by flat chisels and then the joint caulked round with proper caulking tools and a hammer of 2 to 3 pounds in weight in such manner as to make the joint quite sound. After being well set up the joint is to be left flush neat and even with the socket.

Lead for caulking shall conform to IS:782-1978.

**Painting**

All the exposed CI pipes and fittings shall be painted to match the colour of the surroundings. The surface of the pipes and fittings to be painted shall be cleaned thoroughly and painted 2 coats with approved paint over and including 1 coat of approved primer. Pipes laid underground shall be painted with 2 coats of anti-corrosive paint.

**12.3.4.7 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.

**12.3.4.8 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 man- holes shall be gas tight when above ground and watertight when underground. Method of
jointing shall be as per instructions of the 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) Sand Cast Iron Pipes

Jointing of cast iron pipe shall be done as described in Sl. No. 12.3.4.7(b).

(b) Concrete pipes

i) Spigot & Socket Joint

The opening of the joint shall be filled with stiff mixture of cement mortar 1:2 (1 cement : 2 fine sand) which shall be rammed with caulking tool.

ii) Collar Joint

Joint shall be done by slipping the collar over and clear of the end of the pipe. The recess at the end of the pipe shall be filled with jute braiding dipped in hot bitumen. Care shall be taken that no off-set of the jute braiding shall be visible either outside or inside the pipe. The collar shall be then set up over the joint covering equally both the pipes and leaving an even caulking space all round. cement and sand mortar (1:1.5) shall then be well punched or pressed home with a caulking tool.

(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.

12.3.5 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. The spoil bank shall not be allowed to 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 for packing with selected material in areas 300 mm around the pipe. 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 minimise inconvenience or traffic where applicable.

12.3.6 Installation of fittings & fixtures
12.3.6.1 General

All fittings & fixtures shall be laid out as per drawings and 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 be used for fixing sanitary fittings to wall plugs and floors.

12.3.6.2 European pattern WC

Water closet shall be fixed with floor by means of 75 mm long, 6.5 mm diameter counter sunk bolts & nuts embedded in floor using rubber or fibre washers so as not to allow any lateral displacement.

12.3.6.3 Indian Pattern W.C.

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 about 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 C.M. 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 foot rest shall be set in cement mortar 1:3 (1 cement : 3 sand).

The cast iron cistern, brackets and flush pipe etc. shall be painted with two coats of approved paint, over and including a coat of approved priming.

12.3.6.4 Wash basin

Wash basin shall be fixed to C.I./R.S. brackets fixed in cement mortar 1:3 (1 cement :3 sand). The brackets shall be fixed to approved wooden wall plugs with screws. C.P. brass trap and union shall be connected to waste pipe if specified.

12.3.6.5 Urinals

The urinal shall be fixed to the walls with C.P. Brass screws fixed to wooden wall plugs. Urinal partitions shall be fixed to walls by making chases in walls and grouting the same in 1:2:4 cement concrete.
12.3.6.6 **Mirror**

Fixed type mirror shall be screwed to wall plugs with CP brass screws and shall have a backing of asbestos or similar material as specification in the item.

Swivel type mirror shall be fixed with C.P. brackets which shall be fixed to wall plugs with CP brass screws.

12.3.6.7 **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 unless otherwise specified. All other fittings shall be fixed with screw or as per manufacturer's specification.

12.3.6.8 **Towel rail & Toilet glass-shelf unit**

This shall be fixed with CP Brass screws which shall be fixed to wall plugs.

12.3.6.9 **Gully trap**

This shall be fixed on 100 mm thick bed and encasement of size 600mm x 600mm x full height of trap shall be provided with cement concrete of proportion 1:4:8 with 40mm stone aggregate. The gully outlet shall be jointed to the branch drain as specified or directed by the Engineer.

12.3.6.10 **Masonry chamber for Gully Trap**

After fixing and testing gully and branch drain, a brick masonry chamber 300mm x 300mm x 450mm 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. Brick wall exposed to outside shall be finished with 12 mm thick cement plaster 1:4. P.C.C. (1:2:4) band 100 mm thick shall be provided over the brick work with suitable grooves for accommodating R.C.C. cover.
to be supplied as per drawing and made water tight by providing suitable beading in the band.

12.3.6.11 High level flushing cistern - (fixing flush pipe & cistern)

The W.C. pan shall be connected to the cistern by G.I. 32mm dia or 40mm (O.D) high density polythene flush pipe with holder clamp and brass coupling.

12.3.6.12 Low level flushing cistern

Unless otherwise specified, it shall be connected to the closet by means of 40mm dia white porcelain enameled flush bend using rubber adaptor joints.

12.3.7 Septic tank and effluent disposal

12.3.7.1 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 100mm dia whose top shall be provided with a suitable mosquito proof wire mesh and cowl. Generally ventilating pipe shall extend to a height of about 2 metres when the septic tank is at least 15 metres away from the nearest building and to a height of 2 metres above the top of building when it is located closer than 15 metres. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

12.3.7.2 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 approves or into a soak 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.

12.3.7.3 Soak Pit

Shall be complete as shown on drawing. In absence of a detailed drawing it shall consist of a 900mm dia pit 1000mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or
concrete blocks with dry open joints backed with at least 75 mm of clean coarse aggregate. The lining above the inlet level shall be set in cement mortar (1:6). The pit shall be filled with brick bats. Inlet pipe shall be taken down to a depth of 900mm from the top as an anti-mosquito measure.

12.3.7.4  Open jointed S.W pipes

Minimum dia of the S.W pipes shall be 200mm nominal. The trench for laying the pipes shall be minimum 600x600mm. The joints of the pipes shall be left unsealed.

12.3.7.5  Commissioning septic tank

After the septic tank has been proved water-tight 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 cow dung may be introduced.

12.3.8  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 C.M. 1:4 with minimum one brick thick on a base of 100mm thick cement concrete 1:4:8 with 40mm down aggregate or as specified. The concrete bed shall extend beyond the external face of brick work on all sides by at least 75mm. The thickness of wall shall be as indicated. The work shall be carefully built in English bond, the jointing faces of each brick being wall buttered with cement mortar before laying so as to ensure a full joint.

The inside of the walls shall be plastered with 15mm thick cement mortar 1:4 and finished with a floating coat of neat cement and outside shall be plastered with 12mm thick C.M. 1:4.

The channels and benching shall be done in cement concrete 1:2:4 with 20mm down stone aggregate and finished with 12mm 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 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 an appropriate fall suitably
rounded off in the direction of flow of the main channel shall be given.
The benching at the sides shall be carried up in a slope of 1 in 3.

All angles shall be rounded to 75mm 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 weighting
25 kg. will be provided in each RCC cover.

12.3.9 Testing and acceptance

12.3.9.1 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.

12.3.9.2 Testing of pipelines

Comprehensive tests of all pipe lines shall be made by simulating
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:

12.3.9.3 Smoke Test

Soil, waste, vent and all other pipes, when above ground, shall be
tested for gas tightness by a smoke test conducted under a pressure
of 25mm water gauge 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.

12.3.9.4 Water Test
For pipes other than cast iron Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimetre of diameter per kilometre 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 end 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 funnel which could be raised or lowered till 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.

12.3.9.5 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.

12.3.9.5.1 For straightness

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13mm 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;
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.

12.3.9.6 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 15mm.

12.3.9.7 Fixtures etc.

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

13.0 EXTERNAL SEWERAGE & DRAINAGE

13.1 Scope of Work

The work comprises supply, laying, testing, commissioning etc., of 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 including erection.

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, brick / concrete manholes, preparation of concrete bedding and covering for pipe laying wherever required etc.

iv) Laying and jointing of the pipelines as specified in this chapter

v) Testing of the pipelines after laying as per standard tests as specified in this chapter.
vi) Back filling of the trenches after successful and satisfactory completion of tests for the pipeline laid.

vii) Cleaning, painting/coating and wrapping etc of pipes and fittings etc.

viii) Commissioning of entire network laid.

ix) Safe custody of pipes/material/equipment/work and other obligations stated elsewhere in the specification.

x) Any other activities which are not mentioned above but essential and required.

xi) If specified, at road crossing the pipe shall be laid in encasing pipes, wrapped & coated M.S pipes shall be used as encasing pipes. The encasing pipe shall project beyond the berm or both sides of the road. The encasing pipe shall be supported on P.C.C saddles if the site condition warrants so.

13.2 Materials

The materials shall conform to part-I of this series. Sewerage network in Township shall generally be of R.C.C/S.W.G pipes, R.C.C pipes being used normally for pipe sizes of 400mm dia and above. In plant area, at road crossings etc Cast Iron Pipes may be used.

13.3 Excavation of trenches & pits

Excavation shall be carried out according to Chapter of 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. 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 as specified in clause 2.12.

13.4 Cast Iron Pipes

I.S 3114-1985 has to be followed in general for Laying and jointing of pipes unless otherwise specified.

13.4.1 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 of the pipe.

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, at least from the bottom of the trench to the level of the center line 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 should 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 up to 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 metaling 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 all at his cost.

13.4.2 Custody of pipes

The Contractor shall remain responsible for the safe custody of pipes, specials 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.

13.4.3 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.

13.4.4 Pipeline erection
All the underground pipelines shall be laid in accordance with IS: 3114-1985.

13.4.5. Handling of pipes & fittings

Unloading of pipes & fittings

While unloading, pipes shall not be dropped down from trucks on hard surface. This should be done with the help of a steadying rope and timber skids. Pipes should not be dragged, specially to the spigot end along hard surface.

Lowering of pipes & fittings

Proper implements, tools etc. shall be provided and used by the contractor while lowering pipes & fittings in the trenches and in no case these should be dropped. Pipes over 300mm dia shall be handled with the help of chain pulley blocks with tripod supports.

Detection of cracks in pipes and fittings

The pipes and fittings shall be inspected for defects and cracks by ringing with a light hammer preferably while suspended. Smearing the outside with chalk dust helps location of the crack. If doubt persists, pouring a little Kerosene on the inside of the pipe at the suspected spot will confirm it as it will seep through.

Cleaning of pipes and fittings

All foreign materials shall be cleaned from the socket and spigot ends both from inside and outside. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being laid. When pipe laying is not in progress, the open ends of the pipe shall be closed suitably.

Cutting of pipe

The cutting of pipe for inserting valves, fittings or closure pieces shall be done in a neat manner without damage to the pipe. Pipe cutting machine may be used for this purpose and in case it is not available, for large diameter pipes electric arc cutting method using a carbon or steel rod may be adopted. The pipes can be cut by using chisels also depending on the circumstances.
Permissible deflection at socket and spigot joints

Direction

On level ground the socket ends should face the upstream. When the line runs uphill the socket ends should face the upgrade.

Permissible deflection

In case it becomes necessary to deflect pipe from a straight either in the vertical or horizontal plane, due to obstructions or where long radius curve is permitted, the following norms shall be adhered to:-

- Lead joint 2.5 degrees
- Rubber joints for nominal bore 80 to 300mm 5 degrees
- Rubber joints for nominal bore 350 to 400mm 4 degrees
- Rubber joints for nominal bore 450 to 750mm 3 degrees

Anchor and thrust blocks

Suitable concrete thrust blocks shall be installed, wherever the thrust is appreciable, specially at dead ends and bends. In case of unbalanced also this may be required. In case of steep gradients and under influence of temperature change also thrust blocks may be required for rigidly joined pipes.

It is advisable to avoid sharp bends above 45 degrees. In soft ground as far as possible two bends should not be put together and be separated by at least one length of straight pipe.

Anchor or thrust blocks shall be generally as per IS : 5330-1984 and thrust resistant design pressure shall be equal to the test pressure.

13.4.6 Pipe jointing

The type of jointing will be defined in the detailed working drawing and Schedule of items i.e. whether they should be (i) socket and spigot with molten lead or lead wool joint or (ii) flanged joint.

13.4.6.1 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 hampen 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 hemp 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 laid, lead 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 : 3114-1985 are given in the Table-I.
### TABLE – I

**QUANTITY OF LEAD AND SPUN YARN FOR DIFFERENT SIZES OF PIPES**

<table>
<thead>
<tr>
<th>Nominal of pipe mm</th>
<th>Lead / Joint kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>1.8</td>
</tr>
<tr>
<td>100</td>
<td>2.2</td>
</tr>
<tr>
<td>125</td>
<td>2.6</td>
</tr>
<tr>
<td>150</td>
<td>3.4</td>
</tr>
<tr>
<td>200</td>
<td>5.0</td>
</tr>
<tr>
<td>250</td>
<td>6.1</td>
</tr>
<tr>
<td>300</td>
<td>7.2</td>
</tr>
<tr>
<td>350</td>
<td>8.4</td>
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<td>400</td>
<td>9.5</td>
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<tr>
<td>450</td>
<td>14.0</td>
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<tr>
<td>500</td>
<td>15.0</td>
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<tr>
<td>600</td>
<td>19.0</td>
</tr>
<tr>
<td>700</td>
<td>22.0</td>
</tr>
<tr>
<td>750</td>
<td>25.0</td>
</tr>
<tr>
<td>800</td>
<td>31.5</td>
</tr>
<tr>
<td>900</td>
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<td>1000</td>
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<tr>
<td>1100</td>
<td>46.0</td>
</tr>
<tr>
<td>1200</td>
<td>50.0</td>
</tr>
<tr>
<td>1500</td>
<td>66.5</td>
</tr>
</tbody>
</table>
Note: The quantities of lead given are provisional and a variation of 20% is permissible either way.

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:

Hempen 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 full within 3 mm and the wool of the lead wool is compressed 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 Table-2

TABLE – 2

<table>
<thead>
<tr>
<th>Nominal Internal dia</th>
<th>Lead wool weight</th>
<th>Spun yarn weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>in mm</td>
<td>in kg</td>
<td>in kg</td>
</tr>
<tr>
<td>80</td>
<td>1.30</td>
<td>0.17</td>
</tr>
<tr>
<td>100</td>
<td>1.70</td>
<td>0.23</td>
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<tr>
<td>150</td>
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<tr>
<td>175</td>
<td>2.89</td>
<td>0.37</td>
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<td>200</td>
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<td>0.74</td>
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<tr>
<td>300</td>
<td>4.82</td>
<td>0.82</td>
</tr>
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<td>350</td>
<td>6.04</td>
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</tr>
<tr>
<td>375</td>
<td>6.52</td>
<td>1.25</td>
</tr>
<tr>
<td>400</td>
<td>7.00</td>
<td>1.33</td>
</tr>
<tr>
<td>450</td>
<td>9.64</td>
<td>1.84</td>
</tr>
<tr>
<td>500</td>
<td>10.86</td>
<td>1.99</td>
</tr>
</tbody>
</table>
### Nominal Internal dia Lead wool weight Spun yarn weight

<table>
<thead>
<tr>
<th>Dia (in mm)</th>
<th>Lead wool weight (in kg)</th>
<th>Spun yarn weight (in kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>12.79</td>
<td>2.83</td>
</tr>
<tr>
<td>750</td>
<td>15.68</td>
<td>3.52</td>
</tr>
<tr>
<td>825</td>
<td>17.12</td>
<td>3.88</td>
</tr>
<tr>
<td>900</td>
<td>18.80</td>
<td>4.25</td>
</tr>
<tr>
<td>1200</td>
<td>28.44</td>
<td>6.01</td>
</tr>
</tbody>
</table>

**Note:** Higher tolerance may be permitted under special circumstances depending upon site condition for quality of lead wool and spun yarn.

### 13.4.6.2 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 sheet or compressed fibre board 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 checked carefully so as to be 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 material during progress of the work.

### 13.4.7 Inspection & testing

a) If required all materials shall be inspected by the Engineer before dispatch 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 at least two weeks in advance for any such
inspection / testing. All facilities for inspection / testing including necessary test certificates shall be provided by the Contractor at his own cost.

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 and arranged by the Contractor at his own cost.

13.4.8 Painting

i) All equipment, valves and other exposed steel parts shall be given a coat of red oxide, zinc chromate or red lead and two coats of final approved quality 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.

13.4.9 Commissioning

After pressure testing the main, it should be flushed with water of sufficient velocity to remove all dirt and foreign materials.

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 at no extra cost. 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 at his cost.

13.5. Stoneware Glazed Pipelines (S.W.G)

13.5.1 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 a depth equal to 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 900 mm.

13.5.2 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 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.

Bedding, haunching or encasing of the pipes during laying shall be in accordance with IS : 4127-1983 and shall be done with cement 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 cut 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.

13.5.3 Jointing of pipes

(a) Cement joint

The stoneware pipes shall be cement jointed normally. In case, if specified so, bituminous joints shall be used. In each joint, spun yarn soaked in neat cement slurry or gasket of tarred yarn shall be passed round the joint and inserted in it by means of suitable jointing tools. More skeins of spun yarn or gasket shall then be added and well rammed home. The yarn shall be moistened to avoid absorbing moisture from cement mortar.

The yarn should be so placed as to centre 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.
Yarn or gasket (cemented or tarred) so rammed shall not occupy more than one-fourth of the depth of socket.

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 for jointing. The cement mortar joints shall be cured at least for seven days before testing.

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.

(b) Bituminous joints

If specified so this joint will be used. Asphalt and sand in the ratio of 1:7 shall be boiled together and filled into the socket in a molten state with the aid of special moulds.

13.5.4 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 : 4127-1983.

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 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 metre, 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.

13.5.5 Concrete bedding, haunching & encasing

Unless otherwise specified in the Schedule of Quantities, all SW pipes shall be laid in accordance with IS: 4127-1983 As per site condition haunching or/and encasing of pipes with cement concrete may be required as per clause 4.2 & 4.3 of IS 4127-1983. The concreting shall be done with 1:4:8 cement sand concrete.

Where sewers have less than 1.2 m cover at places of heavy traffic, these shall be surrounded with mass concrete if directed by the Engineer.

13.5.6 Handling of pipes

While unloading, pipes shall not be dropped from the trucks/carts on the ground. Timber skids and steadying rope should be used while unloading or lowering in trenches. To avoid damage specially to spigot end, pipes should not be dragged on the hard surface.

13.6 Manholes
All manholes shall be of the size and type as given in the Schedule and shall be provided as per drawing or as directed by the Engineer. All the manholes shall be circular or other shape as shown in drawing. The bed shall be in cement concrete of Mark-10B (or 1:3:6 mix) (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 or as shown in the drawing. The working part including channeling, benching etc., made of P.C.C. shall be of grade-15C (or 1:2:4 mix). All manholes shall be plastered inside with 1:3 cement plaster 20 mm thick and finished with a floating coat of neat cement unless otherwise specified.

Concrete used for precast RCC cover slabs shall be of grade 20C (or 1:1.5:3 mix) 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.

Circular medium duty Cast iron water sealed manhole cover and frames, 560 mm dia (clear opening) and nominal weight 128 kg shall be provided for each manhole and shall be in accordance with IS:1726-1991 Manhole covers with double seals (Light duty) with wt. as specified in schedule of item shall be provided within compound near the buildings if specified so. If specified heavy duty cover and frames, either circular or double triangular type, shall be provided. 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

13.7 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 be set 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.

14.0 ROAD WORK

14.1 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.

14.2 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 by the contractor at his cost.

In slushy soil or in areas where water logging is frequent, adequate arrangement shall be made for drainage of the area so that the sub-soil water level is kept as low as possible.

The sub-grade shall then be consolidated with a power road roller of 8-10 tonne capacity by rolling with minimum of 5 numbers of passes till it is densely consolidated to the satisfaction of the Engineer.

Surplus earth shall be disposed of as directed by the Engineer and the areas where it is disposed of shall be neatly dressed.

All undulations of the sub-grade surface that might develop due to rolling shall be made good with earth and sub-grade re-rolled.
14.3 Ash / Moorum 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 sub-grade. If decided by the Engineer, a bed of moorum of specified thickness shall be provided for to form a sub-grade.

14.4.1 Boulder Soling

The width of the soling coat shall be 30cm (15cm on either side) more than that of the wearing coat. Its depth shall be 15cm in cutting and 23cm in filling and made up soil, unless otherwise specified in the schedule of quantities or shown in the drawing.

The edges of the soling shall be marked out by strings and stakes. Soling stone shall be hand packed and set on edge with greatest length across the road. This shall be laid closely in position on the sub-grade, firmly set with their broadest side downwards. The joints shall be staggered. All interstices between the stones shall be wedged in with locking smaller stones well driven into gaps to ensure tight packing and complete filling of interstices. Such filling shall be carried out simultaneously with the placing in position of soling stones and shall not lag behind.

After packing, surface shall be checked with template of approved shape and high and low spots corrected by removing soling and re-packing. The top surface of the soling coat shall be perfectly true to camber and grade.

The soling shall then be thoroughly consolidated with power roller of 8-12 tonne weight depending upon the type of soling stones, starting at "edges" and working towards the centre. In case of super-elevated curve the rolling shall commence from the inside edge of the curve to the outside edge. The roller shall run over the same surface of soling at least 10 times or more till the soling coat is well consolidated to the satisfaction of the Engineer. The surface shall be checked by templates and any disturbance in grade or camber corrected after every rolling and finally consolidated. After that, at least 50mm thick moorum shall be laid on top of soling coat and rolled with water to proper compaction so that the top surface seems smooth. The rate for soling coat shall be
inclusive of the cost of the moorum as blinding materials for which no separate payment shall be made.

14.4.2 Laterite soling

In case of laterite soling the thickness of soling shall be as follows:

(i) For road width of 7m and above the sub-base shall consist of two layers of laterite stones 150mm maximum size. The sub-base shall be rolled to a thickness of 230mm after compaction.

(ii) For road width of 4m to 7m, the sub-base shall consist of one layer of laterite stone of 150mm maximum size consolidated to 115mm thick.

(iii) A layer of moorum, 33.3% in volume of laterite, shall be spread over the laterite to a uniform thickness and rolled with 8 tonne roller with constant watering until the mixture penetrates into the voids of laterite layer. Care shall be taken to maintain the camber and slopes.

Other steps for laying, compacting etc. of the laterite soling shall be same as given under clause 14.4.1 "Boulder soling".

14.5 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 in position by approved means.

14.6 Water Bound Macadam Surfacing

The construction of water bound macadam shall be carried out according to IRC : 19-1981 "Standard Specification and Code of Practice for Water Bound Macadam".

14.7 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 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 centre line of the carriageway, before laying of coarse aggregates. Necessary arrangements shall be
made for the lateral confinement of aggregates by constructing shoulders in the form of two parallel mud walls 20 x 15cm which shall be made along the outer edges of the wearing course.

14.8 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 6m apart. Where possible, mechanical devices shall be used to spread the aggregates uniformly.

The water bound macadam course 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.

14.9 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 centre, parallel to the centre line of the road, uniformly lapping each preceding 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, and 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.

14.10 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.

14.11 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 forms ahead of the wheels of the roller.

14.12 Application of Binding Material

After the application of screenings, approved 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.

14.13 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.

14.14 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.

14.15 Bituminous Pavements

14.15.1 Bitumen premix carpet with seal coat

The consolidated thickness of this type of treatment shall be 2cm/2.5cm/4cm or as specified.

14.15.1.1 Surface preparation

Water bound 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 about 6mm 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.

14.15.1.2 Tack coat

Just before the application of tack coat, the surface shall be thoroughly cleaned by brooms and then by fanning with gunny bags.

Bitumen of specified grade heated to a temperature of 177 to 188 degree 'C' shall be spread on the prepared surface uniformly at the rate of 0.75 kg/sq.m. by means of sprayers. It shall be applied just ahead of and keeping pace with, laying of premix carpet.

14.15.1.3 Preparation of mix, laying & consolidation
The stone grit (aggregate) shall be surface dry and contain not more than 2% moisture before use. It shall be first screened of dust and measured in boxes and then loaded into the drum mixer according to the capacity of the mixing drum in the proportion given in the table below. The aggregate shall be heated to facilitate mixing with the binder in cold weather, where so directed by the Engineer.

The binder heated in boilers, to a temperature of 149 to 177 degrees C or as specified for the grade used and maintained to that temperature, shall be drawn off from the boiler into a suitable container or in bucket gauged to show the weight of bitumen in it. This shall then be poured over the aggregate in the mixer at the correct rate of 64 Kg/cum of aggregate or as specified and mixing started and continued till aggregate is uniformly coated with bitumen.

Immediately after applying the tack coat, the hot mix shall be discharged from the mixer, carried to the road surface and spread to a thickness sufficient to achieve after consolidation the specified thickness. Rakes or drag spreaders shall be used for spreading the mixture. When the premix has been laid for a length of 15-20 metres it shall be rolled. Rolling shall commence from edges and proceed towards the centre. The roller wheels shall be moistened continuously so as to prevent metal chips sticking to it. Any high spot or depression which become apparent shall be corrected by addition or removal of premix materials.

Further the prepared finished surface shall be protected from the traffic for 24 hrs or such period as may be specified by the Engineer.

14.15.1.4 Materials

Quantity of materials required per 100 sqm of road surface shall be as given in the table below, unless otherwise specified.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Consolidated thickness of premix carpet (cum)</th>
<th>Stone chips (cum)</th>
<th>Sand (cum)</th>
<th>Tack coat (kg)</th>
<th>Binder Carpet (kg/cum)</th>
<th>Seal coat (kg/cum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Priming tack coat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Using Paving bitumen 80/100 or 30/40 grade
### Civil Specification

**Title:** Civil Specification  MEC/ TS/ 05/ 11/ 001  
**Revision:** 0  
**Edition:** 1  
**Document No.:** MEC/ TS/ 05/ 11/ 001  
**Page:** 149 of 180

#### Sl. Consolidated Stone chips Sand Binder

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Stone chips</th>
<th>Sand</th>
<th>Binder</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>on a water bound macadam surface</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>on an existing black top surface</td>
<td>65</td>
<td></td>
</tr>
</tbody>
</table>

#### 2. Carpet

<table>
<thead>
<tr>
<th></th>
<th>2 cm</th>
<th>2.4 (10 mm nominal size)</th>
<th>64</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.5 cm</td>
<td>3.0 (10 mm nominal size)</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>4.0 cm</td>
<td>4.8 (12 mm nominal size)</td>
<td>64</td>
</tr>
</tbody>
</table>

#### 3. Seal Coat

<table>
<thead>
<tr>
<th></th>
<th>0.6</th>
<th>68</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Dry area (Premixed sand seal coat)</td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>Wet area (Liquid seal coat with chips)</td>
<td>0.9</td>
</tr>
</tbody>
</table>

#### 14.15.2 Seal coat

In dry areas where rainfall is under 150cm per year a premix sand seal coat shall be applied immediately after laying the carpet. The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen. The aggregates shall be dry and suitably heated to a temperature directed by Engineer before the same are placed in the mixer of suitable design. Mixing of binder with aggregates to the specified proportions shall be continued till the latter are thoroughly coated with binder. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with premix materials, the surface shall be rolled with 6 to 8 tonne power roller. Rolling shall be continued till the premix material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.
In wet areas where rainfall is above 150cm per year a liquid seal coat with chippings (not sand) shall be applied after laying the carpet. The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen and spread on the surface preferably using mechanical sprayers. Immediately following the application of the binder, stone chippings in a perfectly dry condition shall be uniformly spread on the surface. Immediately after the application of the cover material, the entire surface shall be rolled with 8-10 tonne road roller.

14.15.3 Surface dressing

The surface shall be prepared in the same way as that for premix carpet work as per 14.15.1.1. Depression or pot holes, if any, shall be repaired as indicated.

After the surface has been prepared and is in perfectly dry condition, bitumen heated in the same manner as for premix carpet, shall be sprayed over the surface preferably using mechanical sprayers. It shall be ensured that there is even and uniform distribution of bitumen on the surface. Spraying shall be carried out parallel to the centre line of the road.

Immediately following the application of bitumen, stone chippings in a perfectly dry condition, shall be uniformly and evenly spread as specified in the item, over the entire sprayed surface. Spreading may be done preferably by means of mechanical gritter. Finally the entire surface shall be broomed to ensure perfect uniform spreading.

The final surface shall be checked by means of camber board etc. The spread surface shall be rolled with 6 to 8 tonne roller till there is sufficient boundage of chippings with bitumen. The finished surface shall be thrown open to traffic on the following day.

14.15.4 Premixed Bitumen Concrete

14.15.4.1 General

In this type of road carpet a mixture of sand and stone aggregate is used as aggregate producing a dense mixture. Seal coat is not necessary as the sand used in the mix works up to the surface and forms a seal by itself. The consolidated thickness of this type of treatment shall vary from 4cm to 7.5cm as specified.
14.15.4.2 Surface Preparation

Same as in para 14.15.1.1 above.

14.15.4.3 Tack Coat

Same as in para 14.15.1.2 above.

14.15.4.4 Preparation of Mix, Laying & Consolidation

Para 14.15.1.3 shall generally apply except that the mixing shall be done in two stages. The stone aggregate of the correct specified size and in the proportion shown in the table above shall be fed into the mixer to which 2/3rd of the total specified quantity of bitumen heated to the appropriate temperature shall be added. When the stone metal is well coated, the sand in the specified proportion and the balance 1/3rd quantity of total bitumen shall be fed into the mixer. Mixing shall be continued until a homogeneous mix is produced and all particles are uniformly coated with bitumen.

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 road surface with rakes or drag spreaders immediately after applying the tack coat to a thickness sufficient to achieve after consolidation the specified thickness. When the premix has been laid for a length of 15-20m it shall be rolled. Rolling shall commence from edges and proceed towards the centre.

The roller wheels shall be moistened continuously so as to prevent metal chips sticking to it. After preliminary rolling, all honeycombs, any high spot or depression which become apparent shall be corrected by addition or removal of premix materials. Camber and grade shall be checked at every stage to ensure correctness and any defect found shall be rectified.

14.15.4.5 Materials

Quantity of materials required per 100 sqm of road surface shall be as given in the table below unless otherwise specified.
## Binder

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Thickness of consolidated bitumen concrete surfacing</th>
<th>Tack coat (kg)</th>
<th>Hot Bitumen (cut back)/ Paving Bitumen 80 / 100 grade Bitumen concrete Stone aggregate (kg / cum)</th>
<th>Sand (kg / cum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>4 cm, 5 cm, 6 cm &amp; 7.5 cm</td>
<td>75</td>
<td>560</td>
<td>128</td>
</tr>
</tbody>
</table>

### Aggregate

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Thickness of compacted bitumen concrete surfacing</th>
<th>Stone aggregate (cum / 100 sqm)</th>
<th>Coarse sand (cum / 100 Sq.m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>4 cm</td>
<td>3.8 (12mm nominal size)</td>
<td>1.90</td>
</tr>
<tr>
<td>2.</td>
<td>5 cm</td>
<td>4.8 (20mm nominal size)</td>
<td>2.40</td>
</tr>
<tr>
<td>3.</td>
<td>6 cm</td>
<td>5.8 (60% 40mm nominal size)</td>
<td>2.90</td>
</tr>
<tr>
<td>4.</td>
<td>7.5 cm</td>
<td>7.3 (60% 50mm nominal size)</td>
<td>3.65</td>
</tr>
</tbody>
</table>

The nominal size of Coarse Aggregate herein shall mean as defined below:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Nominal size of coarse aggregate</th>
<th>Designation of IS sieve through which the aggregate shall wholly pass</th>
<th>Designation of IS sieve through which the aggregate shall be retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>40 mm</td>
<td>50 mm</td>
<td>25 mm</td>
</tr>
<tr>
<td>ii)</td>
<td>25 mm</td>
<td>40 mm</td>
<td>20 mm</td>
</tr>
</tbody>
</table>

II-152
### 14.15.5 Surface evenness

The finished surface of premix carpet and bituminous concrete shall be tested with a straight edge 4.5 m long and any irregularity greater than 6mm shall be corrected.

### 14.16 Berms

Shoulders and berms shall be prepared as shown on the drawings. Work on making berms shall not lag more than 100 metres 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.

### 14.17 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. Setting 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.

### 14.18 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.
14.19 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.

14.20 Scarifying & Dismantling

Where a new carriage-way abuts or includes an existing carriage-way 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, water-bound 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.

14.21 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.
15.0 WATERPROOFING TO ROOFS & WATERPROOFING PAINTS

15.1 Scope

This chapter deals with different types of waterproofing on roof.

15.2 Material

The materials shall conform to Part-I.

15.3 General Workmanship

The waterproofing to roofs being specialised works the Contractor shall get these done by specialised firms/agencies.

15.4 Painting with Hot Bitumen

The surface to be painted shall be thoroughly dried and then 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) or as specified 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.

15.5 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.
15.6 Waterproofing of Roof

15.6.1 With bitumen felt

Prior to laying the insulation, roof gradient shall be checked. If necessary, the roof shall be re-graded 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 : 1346-1991. 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 : 1346-1991. 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 or as specified 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.

15.6.2 With bitumen mastic

The work shall be carried out generally in accordance with IS : 4365-1967 "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. Bitumen melting shall be done in a mechanical mixer by gradu-
ally 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.

15.6.3 Waterproofing of RCC roof with Lime concrete and Pressed clay titles.

Lime concrete shall consist of broken brick aggregates and lime. Proportion of brickbat coba shall be 2.5 parts of brick jelly to one part of lime. The brick jelly shall be hard, well burnt and of size varying from 12mm to 25mm.

The lime concrete is then laid over roof to slope to give specified thickness and in slope of 1 in 80 or as shown on the drawing for proper roof drainage as per roof drainage plan. The lime concrete is then to be beaten in the manner approved by the Engineer for 48 hours or as directed with hand beaters.

If the surface during the process of compaction becomes so uneven that water lodges in pools, the surface shall be pricked up, and fresh concrete spread and consolidated as necessary to obtain an even surface.

The concrete shall then be cured by sprinkling water and allowed to harden for a period of not less than six days before laying the roof finish.

Roof shall be finally finished with one coarse of machine pressed clay titles 20 mm thick laid over a 12mm thick of 1:3 mix cement mortar mixed with 5% crude oil by weight of cement mixed in mortar. The pressed clay tiles shall be immersed in water for two hours before being used. The side joints of the tiles shall be more than 60 mm thick set full in mortar. Before the work dries up completely, the tile joints shall be raked out and pointed with cement mortar 1:3 mixed with crude oil which shall be 5% by mass of cement. The joints shall be well rubbed over with thin bar trowel and excess of mortar scrapped off until the surface of the pointing attains a black polish and becomes hard. As
the work proceeds, it shall be kept thoroughly wetted until the mortar has set firm and hard. Watering shall be continued for three weeks after construction.

Lime concrete and tiles shall be taken up the parapet walls to a height of 150 mm or as shown in the drawing.

The specification of pressed clay titles shall be as given in IS:2690-1975 (Part-I). The specification of crude oil shall be as per IS:2119-1980.

The areas around drain pipes shall be properly finished with provision of adequate slope.

The contractor shall give guarantee for any/all types of waterproofing for a period of 7 years against bad of faulty material and construction and shall rectify the same at his own cost during the guaranteed period.

15.7 Waterproofing for Basement

15.7.1 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 : 1322-1982, 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 metres below ground : 2 layers.

ii) For depths beyond five metres : 3 layers.

The method of laying the bitumen felts and workmanship shall in general conform to IS : 1609-1991.

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 : 702-1988 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 flat bricks in cement mortar 1:3 or 6 cm thick cement concrete type M15B or a coat of cement sand 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 shall be laid as for the floor ensuring that the surface to be treated is dry and then a protective brick wall, half-brick 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 groove 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 grade M10C, 7.5 cm thick.

15.7.2 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.

Precaution should be taken that during the process of rod binding if any damages happens it should be immediately rectified by making patch painting on the affected portion only 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 all through the floor area and all through the vertically raised walls of four sides which shall remain underground upto a depth of 8 metre 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.

15.8 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.

15.9 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/specialised 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.

15.10 Water proofing course with Fibre glass R.P. tissue

15.10.1 Scope

This section covers the furnishing of all labour, equipment and performing all operations necessary to complete to provide water proofing course of Fibre glass R.P. tissue all in accordance with the drawing and these specifications.

15.10.2 Terminology

For the purpose of these specifications the following definitions detailed hereinafter shall apply.

15.10.3 Preparation of surfaces

Surface to receive waterproofing shall be dry, free from dirt, loose particles and foreign materials. Projections which might puncture the membrane shall be removed and voids and crevices shall be filled in prior to the start of work.
Adequate covering shall be provided during this work to avoid splashing or staining of the adjacent work and surfaces. Any work or surface splashed or stained shall be thoroughly cleaned to the satisfaction of the Engineer. Joints in the tissue felt in the different layers shall be staggered.

15.10.4 In built-up roofing

Application

i) Suitable slope shall be provided in the roof as per manufacturers specifications. Heat insulation may also be provided if necessary.

ii) Prime the plastered surface primer at the rate of 0.4 Kg/sqm. This should properly impregnate the surface and should be left till the time it is touch-dry.

iii) Apply first coat of hot bitumen @ 1.8 Kg/sqm.

iv) Embed first layer of fibre glass RP tissue. Overlaps shall be 100mm between the layers in either direction.

v) Apply second coat of hot bitumen @ 1.8 Kg/sqm.

vi) Embed second layer of fibre glass RP tissue after the surface of the first layer has become dry.

vii) Apply third coat of hot bitumen @ 1.8 Kg/sqm.

viii) Embed third layer of fibre glass RP tissue.

ix) Apply fourth coat of hot bitumen @ 1.8 Kg/sqm.

x) Finish with gravel grit @ 0.006 cum per sqm.

Guarantee
A written guarantee for the water tightness shall be taken for a minimum period of 10 years.

15.10.5 Specification

Water proofing medium

i) By impregnation into the fibre glass reinforcement membrane forms a monolithic mass.

ii) Prevents the penetration of water/moisture.

iii) Acts as a top dressing.

Layer

A single thickness of fibre glass tissue impregnated with bituminous compound.

Multiple layer

2 or more layers of fibre glass tissue laid consecutively with overlapping joints and impregnation with bitumen.

Bitumen/primer

A liquid bitumen of low viscosity which penetrates into a prepared surface upon application.

Half-brick masonry shall be of approved quality 50 class brick work in cement mortar 1:4 (1cement : 4 sand). Plaster should be in cement mortar 1:4 (1cement : 4 sand). Sand should be fine sand conforming to IS 383

Application

Suitable slope may be provided in lean concrete, if necessary. Over this, 12mm thick plaster with cement mortar 1:4 (1cement : 4 coarse sand) is to be laid.
Prime the plastered surface with primer at the rate of 0.4 Kg/sqm. This should properly impregnate the surface & then should be left till the time it is touch dry.

Water proofing shall be as follows :-

i) Apply first coat of hot bitumen @ 2.4 Kg/sqm.

ii) Embed first layer of fibre glass RP tissue. Overlaps shall be 100mm between the layers in either direction.

iii) Apply second coat of hot bitumen @ 2.4 Kg/sqm.

iv) Embed second layer of fibre glass RP tissue after the surface of the first layer has become dry.

v) Apply third coat of hot bitumen @ 2.4 Kg/sqm.

vi) Embed third layer of fibre glass RP tissue after the surface of the second layer has become touch-dry.

vii) Apply fourth coat of hot bitumen @ 2.4 Kg/sqm.

viii) Embed fourth layer of fibre glass RP tissue after the surface of the third layer has become touch-dry.

ix) Apply fifth coat of hot bitumen @ 2.4 Kg/sqm.

x) A layer of 12mm thick fine sand is to be laid after completing the above operations. The layer of sand will not be applied on vertical walls.

The surface should be finished with half-brick masonry in cement mortar 1:4 (1cement : 4 coarse sand).

Guarantee

A written guarantee for the water tightness shall be taken for a minimum period of 10 years.
The work will be carried out by specialists in the trade. Workers shall be provided with gum boots and hand gloves. There shall be no air pockets. Corners shall be treated flush without any air pockets or voids.

**Measurement**

The unit will include supply of materials, transport, preparation of surface, application of waterproofing treatment, plastering, masonry work etc., as specified herein. The measurement of the item will be in square metres nearest to the second decimal of the concrete surface which is to be damp-proofed.

15.11 Water proofing course with P.V.C sheets/ membranes

15.11.1 Jointing

The adjacent lengths of the P.V.C sheets shall be jointed by giving an overlap of 25mm, one over another by sealing with the approved adhesive. A minimum width of the sheet, as specified in the item, shall be used without any joint. Jointing of the sheets, to the extent possible and practicable, shall be done at the site workshop.

15.11.2 Laying

i) Horizontal areas: The base concrete shall be rendered smooth by cement sand plaster 1:6 mix of 20mm thick unless otherwise specified. It shall be ensured that there are no sharped crivices, projections etc which may puncture and damage the sheet. P.V.C sheets shall then be evenly laid over the smooth rendered surface while it is green.

After laying of sheets a protective cover shall be laid over it. This cover may be of 1:6 cement sand mortar bed of thickness 20mm and above, flat brick/tile soling over cement sand mortar bed, any other suitable layer or thermal insulation cover as specified in the item. However care is to be taken that sheets do not get damaged while laying the protective cover. The horizontal layer of P.V.C sheets shall be carried over to a minimum of 150mm height and tucked in to the connecting vertical walls as in the case of roof parapets, if there is no provision of continuous laying of the sheets in the adjacent vertical surface.

ii) Vertical surfaces
On vertical concrete surfaces the P.V.C sheets shall be fixed along with the form work with the knobs projecting toward concrete. The sheets shall be clamped on the top of the form work to keep it in position. Concrete is then poured and knobs are locked in it. After the forms have been stripped off, all the tie bolt holes, cuts and other damages are sealed with additional patches of sheets as per manufacturer's specification.

In case good quality of soil, completely free from foreign materials like stone piece, hard lumps and rubbish etc, is available, it can be used directly as a back fill. Otherwise a half brick wall or any other measure as specified shall be provided as a protection barrier over the projecting base of the concrete/mud mat. The top edge of the sheet shall be tucked into a chase to be subsequently sealed with cement sand mortar of 1:4 mix.

In case of sheets being laid both on horizontal and adjacent vertical surfaces, the horizontal sheets shall be carried on the vertical portion as one monolithic layer.

15.11.3 Agency

The execution work including jointing, laying and testing etc. shall be done by a specialised agency duly approved by the Engineer.

15.11.4 Testing

After laying is complete, the sheets shall be tested by an Electronic Pin hole detector for pin holes, cuts and other damages etc. All such portions shall be patched suitably with additional sheets as directed and again test checked.

15.11.5 Expansion joints

All Expansion Joints etc of dimensions as specified, shall be filled up by Polymer Sealant of pourable grade as per manufacturer's specification on the P.V.C sheets locked in the joint.

15.11.6 Guarantee

The contractor shall guarantee the water tightness and leak proofing of the structure for a period of ten years after certified completion and
handing over of the jobs by furnishing a free maintenance guarantee as per prescribed format and as specified.

15.12 Waterproofing with Non-Shrink Polymeric Waterproof Grouting Compound

15.12.1 Work Included

The Contractor shall furnish materials, labour, plant, equipment and tools to complete the work as specified and/or as shown in drawings.

15.12.2 Materials

Cement

Ordinary portland cement shall conform to IS : 269-1989 and portland blast furnace cement shall conform to IS : 455-1989.

Aggregates

All aggregates shall conform to IS : 383-1970 Fine aggregates shall be approved river or pit sand.

Cement waterproofing compound

All cement waterproofing compound shall conform to IS : 2645-1975 and shall be of approved quality.

Solvent less resin

High build polymeric surfacing which forms a thick resilient and flexible membrane on concrete with high resistance to oil and water.

Nozzle

15 mm dia threaded G.I. pipes of suitable length plugged at both ends.

Super plasticiser

### 15.12.3 Waterproofing of underground structures

Waterproofing shall be carried out as per the approved manufacturer's specification and as stated below:

#### 15.12.3.1 Raft

The sub-base (PCC) of the underground structure shall be cleaned of all dirts and kept dry by continuous pumping of water. 20 mm thick plaster with cement-sand mortar (1:3) mixed with approved cement waterproofing compound as per manufacturer's specification shall be laid on top of the sub-base. The plaster shall be finished smooth with a steel trowel.

The plastered surface shall then be painted with two (2) coats of approved solvent less resin to form a thick resilient and flexible resinous membrane over the plastered surface.

Threaded nozzles of 15 mm dia and of suitable length shall be placed and fixed in a grid pattern of maximum 1.5 m centre to centre over the whole raft, prior to casting of RCC raft. Similar nozzles will also be placed along the construction joint, if any, at regular intervals not exceeding 1.5 m c/c. Adequate precaution shall be taken to keep the nozzles plugged at both ends to prevent them from getting clogged by concrete. Similar nozzles shall also be post fixed at critical points, if required. Approved super plasticiser-cum-cement waterproofer shall be added to the concrete which shall be at least M20 grade as defined by IS : 456-1978 and the water cement ratio of the concrete shall not exceed 0.45. Adequate precaution shall be taken to keep the nozzles vertical while concreting.

Approved non-shrink polymeric waterproof grouting compound mixed with cement slurry shall be injected through the nozzles under pressure by pump as per the instructions of the manufacturer. When the injection operation is over the nozzles shall be sealed with a sealing compound as per manufacturer's specification and instruction.

#### 15.12.3.2 Vertical wall
15 mm dia threaded nozzle of suitable lengths shall be placed and fixed in a grid pattern of maximum 1.5 m centre to centre over the entire surface prior to concreting of the vertical wall. Similar nozzle are to be also fixed at construction joints, if any, at regular intervals not exceeding 1.5 m c/c. Adequate precaution shall be taken to keep the nozzles plugged at both the ends to avoid clogging of the nozzles by concrete. Similar nozzles shall also be post fixed at critical points, if required.

The concrete for the vertical wall shall be at least M20 grade as defined by IS:456-1978 having a maximum water cement ratio of 0.45. Approved super plasticiser-cum-cement waterproofer shall be added to the concrete as per the manufacturer's specification. Adequate precaution shall be taken to keep the nozzles horizontal during concreting. The exterior surface of the concrete shall be plastered with 12 mm thick cement sand mortar (1:3) mixed with approved cement waterproofing compound conforming to manufacturer's specification. The plastered surface shall then be finished smooth with a neat coat of cement slurry and painted with two coats of approved solventless resin to form a thick resilient and flexible resinous membrane over the plastered surface. Approved non-shrink polymeric waterproof grouting compound mixed with cement slurry shall be injected through the nozzles under pressure by pump as per the manufacturer's specification and shall be sealed with a sealing compound as per manufacturer's specification and instruction.

16.0 MISCELLANEOUS

16.1 False ceiling

16.1.1 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) A.C. 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.

16.1.2 General

16.1.2.1 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.

16.1.3 Openings for installation of light fittings

Openings in the ceiling for installation of A/C grills, light fittings shall be provided as per drawings.

16.1.4 Recess for pelmet

Recess for the installation of pelmets shall be provided where shown in drawings along the windows/doors.

16.1.5 Grills

Grills made of wooden, M.S., Aluminium, PVC or any other material as necessary shall be provided as indicated in the drawing.

16.1.6 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.

16.1.7 Wooden framing for false ceiling

Unless otherwise specified in schedule of items the wooden frame work shall be of following description:
The framework for false ceiling shall be of approved quality teak wood scantlings, the runners shall be 75 x 50 mm size and shall be spaced at 1200 mm c/c and the battens shall be 50 x 50 mm size spaced at 600 mm c/c (approx) forming a grid of 600 x 600 mm or 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 6 mm 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 joints using 2 nos. 6 mm dia counter sunk bolts with washer. Heading lap joints between battens shall be made with suitable size screws. The wall ends of the runners shall be embedded in the wall (50 mm deep) and shall be grouted with 1:2:4 cement concrete. The soffit of framework 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 1200 mm c/c (approx), the top end of the hangers 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.

16.1.8 Metal framing

16.1.8.1 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 900 mm 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 450 mm c/c as per "Galvolock" system of M/s
Eastern Interior Pvt Limited 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.

16.1.8.2 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 600 mm, 1200 x 600 mm or as per drawings. Ceiling materials, shall be fixed to frames strictly as per manufacturers specification.

16.1.9 Fixing of Ceiling

16.1.9.1 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 100 mm to 150 mm and shall be planed true on the exposed surface. The maximum length of the finished board shall be 1800 mm. 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.

The false ceiling shall finally be checked for line and level, sand papered and polished with colourless polish to achieve matt satin natural finish.

16.1.9.2 Decorative ply ceiling

These shall be with decorative selected group matched ply of 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. framework 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 is 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.

16.1.9.3 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 (3 mm to 6 mm) 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 drawing.

16.2. Wooden partitions

16.2.1 Scope

All materials for the wooden partitions shall be of respective class as specified in the part (I) and as mentioned in schedule of items.

16.2.1.2 Frame work

Unless otherwise specified in the schedule of items, framing for partitions shall be made of approved quality teak wood scantlings of
sizes as mentioned in schedule of items and drawing. The spacing of frames shall not exceed 1200 mm c/c in both direction. The joints of the frame shall be made as per standard joinery practice using standard adhesive as described in wood work chapter. The faces of the frames to receive ply/wooden board shall be true to line, level and plumb. The frames shall be firmly secured to walls, ceilings, floors by making chases and grouting the frames in 1:2:4 cement concrete or fixing the frames with metal clamps/flats screwed to above elements. The frame shall be treated with 2 coats of wood preservative. Where the panelling material is of decorative ply of 3.5 mm to 4 mm thickness, commercial ply of 6 mm thickness shall be fixed to the frame work for backing purpose. Where sunk (coffered) panels are to be made, combination of single and double layers ply shall be used for backing to achieve level difference for sunk panels.

16.2.3 Boarding/facing for partition

a) Wooden plank/board

These shall be of class of wood and thickness as specified in the schedule of item and drawings. These shall be fixed to backing wooden frame work with counter sunk brass screws in pattern and designs, with groves, joints, beads, fillets, cover moulds as shown in drawings. The exposed surfaces shall be sand papered and polished as specified.

b) Decorative ply wood facing

These shall be with decorative teak wood/rose ply/white cedar 3.5 to 4 mm thickness of selected pieces with matching colour, texture and grains and shall be fixed to the backing ply with panel pins in pattern, design, with uniform width of joints, beads, fillets, cover mould as shown in drawings. The exposed surfaces shall be lightly sand papered finished with colourless polish to achieve matt satin finish.

c) Jolly pan (laminated) board

Where specified Jolly pan boards shall be fixed to teak wood frame work strictly as per manufacturer's specification. The boards after fixing shall be cleaned of all adhesives etc.

d) Formica facing
Formica facing shall be fixed to the backing ply with standard adhesive as described for panelling works.

16.3 Expansion and Isolation Joints

16.3.1 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 approval, for the method of forming the joints, should be obtained from the Engineer before starting the work.

16.3.2 Bitumen impregnated board

Bitumen impregnated fibre board of approved manufacturer as per IS: 1838 (Part 1)-1983 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.

16.3.3 Joint sealing strips

16.3.3.1 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 G.I., Aluminium or Copper, or Non-metallic like rubber or P.V.C.
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.

16.3.3.2 Metal sealing strips

Metal sealing strips shall be either G.I., 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 leak proof, 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) G.I. Strips

G.I. 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 50mm

b) Aluminium strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS : 737-1986. A minimum lap of 50 mm length is required at the joints.

c) Copper strips

The copper strips shall be minimum 18 SWG in thickness and 300 mm width.

It should be cleaned thoroughly before use so as to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.
16.3.3.3 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 be resistant to corrosion, abrasion and attacks from the acids, alkalies 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/mm²
- Maximum Safe Continuous Temperature : 75 Degree 'C'
- Ultimate Elongation : Not less than 350%

b) P.V.C. 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 contact 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/mm²  
Maximum Safe Continuous Temperature : 70 Degree 'C'  
Ultimate Elongation : Not less than 275%

16.3.4 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 of approved manufacture and shall conform to the requirements of IS: 1834-1984.

16.4 Barbed Wire Fencing

16.4.1 Materials

16.4.1.1 Galvanised barbed wire

Barbed wire shall be properly galvanised and shall be obtained from the approved manufacturer as specified in detail in Part-1.

16.4.1.2 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.

16.4.2 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 and 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 spacings 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.

16.5 Chain link fencing

16.5.1 Scope

The work under this specification covers the supply and fixing of galvanised steel chain link fencing with galvanised steel posts chain link fabric.

16.5.2 Material

Galvanised steel chain link fabric and galvanised steel pipe posts shall be obtained from the approved manufacturer as specified in detail in Part - I.

16.5.3 Workmanship
The GI pipe posts shall be embedded in plain cement concrete not leaner than 1:4:8 foundations. The height of posts above top of foundations and spacing of post shall not be more than 3 m. The chain link fabric shall be fixed to the fencing posts with the help of stretcher galvanised bars (25 x 6 flats) which will be bolted to the lugs welded to the posts. The stretcher bars shall be provided in the lapping of fabric also.

16.6 Concertina Coil fencing

The spacing of posts and strut shall be 3.0m apart centre to centre, unless otherwise specified or as per Engineer-in-charge to suit the dimension of the area to be fenced. Every 15th last but one end posts and corner posts shall be strutted on both sides and end posts on one side only.

Fixing of posts and struts shall be as specified in clause 4.21.8 Part II of specification.

Concertina coil fencing shall be fixed on angle iron shaped with 9 horizontal reinforced barbed tape (RBT) stud tied with GI staples and GI clips to retain horizontal including necessary bolts or GI barbed wire tied to angle iron all complete as per direction of Engineer-in-charge with reinforced barbed tape.
SPECIFICATION FOR CIVIL WORKS

PART – III  NORMS OF CEMENT CONSUMPTION
CONTENTS

1. MASONRY WORK
2. PLAIN/REINFORCED CONCRETE WORK
3. FINISHING WORK
4. FLOORING WORK
5. MISCELLANEOUS ITEMS
6. WATER SUPPLY/DRAINAGE & SANITARY WORKS
GENERAL

For calculating the requirements of cement in various items of work the following standards will be adopted. Over the above theoretical quantity of cement, additional allowance upto plus or minus 3% shall also be allowed as certified by the engineer.

For items not covered in this standard, CPWD standards shall be followed or calculated as per uses/requirement in absence of standard norms. Cement required for enabling work and cement required for testing purposes will be taken into account for consumption purpose. However, in no case such quantity should exceed 5% of the total cement used in the work or as certified by the engineer based on actual observation whichever is less.

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description of Item</th>
<th>Cement Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Random rubble masonry with CM 1:4</td>
<td>1.255 quintals per cum</td>
</tr>
<tr>
<td>2.</td>
<td>Random rubble masonry with CM 1:6</td>
<td>0.825 quintal per cum</td>
</tr>
<tr>
<td>3.</td>
<td>Coursed rubble masonry in CM 1:6</td>
<td>0.75 quintal per cum</td>
</tr>
<tr>
<td>4.</td>
<td>Brick work in CM 1:4</td>
<td>0.950 quintal per cum of BW</td>
</tr>
<tr>
<td>5.</td>
<td>Brick work in CM 1:6</td>
<td>0.625 quintal per cum of BW</td>
</tr>
<tr>
<td>6.</td>
<td>Half brick work in CM 1:3</td>
<td>1.43 quintals per 10 sqm of area</td>
</tr>
<tr>
<td>7.</td>
<td>Half brick work in CM 1:4</td>
<td>1.06 quintals per 10 sqm of area</td>
</tr>
<tr>
<td>8.</td>
<td>75mm thick brick in CM 1:4</td>
<td>0.65 quintal per 10 sqm of area</td>
</tr>
<tr>
<td>9.</td>
<td>75mm thick brick in CM 1:3</td>
<td>0.81 quintal per 10 sqm of area</td>
</tr>
</tbody>
</table>
10. Projected brick bands, Drip course etc. in CM 1:6 finished with 12mm thick cement plaster 0.165 quintal per 10 RM

11. Half brick thick, Honey combed brick work in CM 1:4 0.064 quintals per sqm

**PLAIN/REINFORCED CONCRETE**

1. RCC/PCC of nominal mix 1:5:10 complete (excluding finishing with CP) 1.30 quintals per cum of concrete
2. RCC/PCC of nominal mix 1:4:8 complete (excluding finishing with CP) 1.70 quintals per cum of concrete
3. RCC/PCC of nominal mix 1:3:6 complete (excluding finishing with CP) 2.23 quintals per cum of concrete
4. RCC/PCC of nominal mix 1:2:4 complete (excluding finishing with CP) 3.18 quintals per cum of concrete

**Controlled Concrete - Plain and Reinforced**

5. Concrete grade (i) M -5A (ii) M -5B (iii) M -7.5A (iv) M -7.5B

6. Concrete grade (i) M -10A (ii) M -10B (iii) M -10C To be mutually agreed based on mix design to be prepared by contractor & approved by the Engineer

7. Concrete grade (i) M -15B (ii) M -15C (iii) M -15D
8. Concrete grade
   (i) M -20B
   (ii) M -20C
   (iii) M -20D

9. Concrete grade
   (i) M -25B
   (ii) M -25C
   (iii) M -25D

10. Concrete grade
    (i) M -30C
    (ii) M -30D

11. Applying cement slurry on RCC slab for receiving cement concrete flooring.
    2.75 kg/sqm

**FINISHING**

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Colour</th>
<th>Quantities</th>
</tr>
</thead>
<tbody>
<tr>
<td>6mm thick C.P. 1:4</td>
<td></td>
<td>0.280 quintal per 10 sqm area</td>
</tr>
<tr>
<td>10mm thick C.P. 1:5</td>
<td></td>
<td>0.370 quintal per 10 sqm area</td>
</tr>
<tr>
<td>10mm thick C.P. 1:4</td>
<td></td>
<td>0.430 quintal per 10 sqm area</td>
</tr>
<tr>
<td>10mm thick C.P. 1:6</td>
<td></td>
<td>0.300 quintal per 10 sqm area</td>
</tr>
<tr>
<td>12mm thick C.P. 1:3</td>
<td></td>
<td>0.734 quintal per 10 sqm area</td>
</tr>
<tr>
<td>12mm thick C.P. 1:4</td>
<td></td>
<td>0.547 quintal per 10 sqm area</td>
</tr>
<tr>
<td>12mm thick C.P. 1:6</td>
<td></td>
<td>0.360 quintal per 10 sqm area</td>
</tr>
<tr>
<td>15mm thick C.P. 1:4</td>
<td></td>
<td>0.655 quintal per 10 sqm area</td>
</tr>
<tr>
<td>15mm thick C.P. 1:6</td>
<td></td>
<td>0.440 quintal per 10 sqm area</td>
</tr>
<tr>
<td>20mm thick C.P. 1:4</td>
<td></td>
<td>0.850 quintal per 10 sqm area</td>
</tr>
<tr>
<td>20mm thick C.P. 1:6</td>
<td></td>
<td>0.560 quintal per 10 sqm area</td>
</tr>
<tr>
<td>12mm thick bearing plaster in CM 1:4 with neat cement finish</td>
<td></td>
<td>0.590 quintal per 10 sqm area</td>
</tr>
</tbody>
</table>
### Civil Specification MEC/TS/05/11/001

<table>
<thead>
<tr>
<th>Title</th>
<th>Erection</th>
<th>Edition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neat cement punning</td>
<td>0.200 quintal per 10 sqm area</td>
<td></td>
</tr>
<tr>
<td>Flush or ruled or cut or weather pointing on brick work with CM 1:3</td>
<td>0.155 quintal per 10 sqm area</td>
<td></td>
</tr>
<tr>
<td>Flush or ruled or cut out or weather pointing on brick work with CM 1:2</td>
<td>0.200 quintal per 10 sqm area</td>
<td></td>
</tr>
<tr>
<td>Raised and cut pointing on brick work with cement mortar 1:3</td>
<td>0.235 quintal per 10 sqm area</td>
<td></td>
</tr>
<tr>
<td>Flush or ruled pointing on brick flooring with cement mortar 1:4</td>
<td>0.075 quintal per 10 sqm area</td>
<td></td>
</tr>
<tr>
<td>Flush or ruled pointing on brick flooring with cement mortar 1:6</td>
<td>0.050 quintal per 10 sqm area</td>
<td></td>
</tr>
</tbody>
</table>

### FLOORING

<table>
<thead>
<tr>
<th>Title</th>
<th>Erection</th>
<th>Edition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brick on edge flooring in cement mortar 1:4</td>
<td>1.100 quintal per 10 sqm area</td>
<td></td>
</tr>
<tr>
<td>Brick on edge flooring in cement mortar 1:6</td>
<td>0.800 quintal per 10 sqm area</td>
<td></td>
</tr>
<tr>
<td>25mm thick (IPS) cement concrete flooring 1:2:4 (1 cement : 2 sand : 4 graded stone chips 12mm nominal size) finished with a floating coat of neat cement.</td>
<td>1.020 quintal per 10 sqm area</td>
<td></td>
</tr>
<tr>
<td>40mm thick (IPS) cement concrete flooring 1:2:4 with 20mm and down stone chips finished with a floating coat of neat cement.</td>
<td>1.500 quintal per 10 sqm area</td>
<td></td>
</tr>
<tr>
<td>25mm thick (IPS) flooring with base coat 19mm thick 1:2:4 using stone</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
chips 10mm nominal size and 6mm topping coat 1:1 (1 cement : 1 stone chips 3mm size) with a floating coat of neat cement.

6. 40mm thick (IPS) flooring with base coat 30mm thick 1:2:4 using stone chips 10mm nominal size and 10mm topping coat 1:1 (1 cement : 1 stone chips 3 to 6mm size) with a floating coat of neat cement.

2.320 quintal per 10 sqm area

25mm thick cast-in-situ grey terrazzo flooring, under layer 19mm thick cement concrete 1:2:4 with 10mm nominal size chips and 6mm thick topping laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 4:7 (4 cement marble powder mix : 7 marble chips) by volume.

1.370 quintal per 10 sqm area

8. 40mm thick cast-in-situ grey terrazzo flooring, under layer 30mm thick cement concrete 1:2:4 with 10mm nominal size chips and 10mm thick topping laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 4:7 (4 cement marble powder mix : 7 marble chips) by volume.

1.575 quintal per 10 sqm area

9. 40mm thick cast-in-situ terrazzo flooring, under layer 31mm thick cement concrete 1:2:4 with 10mm nominal size chips and top layer 9mm thick with marble chips of size 4 to 7mm nominal size laid in cement
marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 4:7 (4 cement marble powder mix : 7 marble chips) by volume.

a) Dark or light shade pigment with grey cement

b) Light shade pigment or without any (grey cement) pigment with white cement

c) Medium shade pigment with 50% grey cement and 50% white cement

10. 40mm thick cast-in-situ terrazzo flooring, under layer 28mm thick cement concrete 1:2:4 with 10mm nominal size chips and top layer 12mm thick with marble chips of size 7 to 12mm nominal size laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 2:3 (2 cement marble powder mix : 3 marble chips) by volume.

a) Dark or light shade pigment with grey cement

b) Light shade pigment or without any (grey cement) pigment with white cement

c) Medium shade pigment with 50% grey cement and 50% white cement
11. Terrazzo cast-in-situ skirting and dado, top layer 6mm thick marble chips laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 4:7 (4 cement marble : 7 marble chips) by volume.

(A) 18mm thick with under layer 12mm thick cement plaster 1:3

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark or light shade pigment with grey cement</td>
<td>1.490 quintal</td>
<td>10 sqm area</td>
</tr>
<tr>
<td>Light shade pigment or without any pigment with white cement.</td>
<td>1.090 quintal</td>
<td>10 sqm area</td>
</tr>
<tr>
<td>Medium shade pigment with 50% grey cement and 50% white cement</td>
<td>1.290 quintal</td>
<td>10 sqm area</td>
</tr>
</tbody>
</table>

(B) 21mm thick, with under layer 15mm thick cement plaster 1:3

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark or light shade pigment with grey cement</td>
<td>1.640 quintal</td>
<td>10 sqm area</td>
</tr>
<tr>
<td>Light shade pigment or without any pigment with white cement.</td>
<td>1.230 quintal</td>
<td>10 sqm area</td>
</tr>
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<td>TITLE</td>
<td>Civil Specification</td>
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<td>DOCUMENT NO. MEC/TS/05/11/001</td>
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</tr>
</tbody>
</table>

| 12. Precast terrazzo tiles 20mm thick with marble chips of sizes upto 6mm laid in 25mm thick bed of lime mortar, jointed with neat cement slurry mixed with pigment |
|---|---|---|
| a) Dark shades using grey cement | 0.88 quintal per 10 sqm area |
| b) Light shade using white cement | 0.44 quintal per 10 sqm area |
| c) Medium shade using 50% grey cement and 50% white cement | 0.66 quintal per 10 sqm area |

<p>| 13. Precast terrazzo tiles 20mm thick with marble chips of sizes upto 6mm in skirting or on walls, laid on 12mm thick cement plaster 1:3 jointed with neat cement slurry |
|---|---|---|
| a) Dark shades using grey cement | 1.395 quintal per 10 sqm area |
| b) Light shade using white cement | 1.175 quintal per 10 sqm area |
| c) Medium shade using 50% grey cement | 1.285 quintal per 10 sqm area |</p>
<table>
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<td>DOCUMENT NO. MEC/TS/05/11/001</td>
</tr>
</tbody>
</table>

and 50% white cement  
(grey cement)  
0.11 quintal per  
(white cement)  
10 sqm area

14. White glazed tiles 5, 6 or 7 mm thick in flooring, skirting and dado on 12 mm thick cement plaster 1 : 3 in base and joined with white cement, slurry etc.  
0.942 quintal per  
(grey cement)  
0.25 quintal per  
(white cement)  
10 sqm area

15. Marble stone slab flooring over 20mm thick base of lime mortar 1:1:1 (1 lime : 1 surkhi : 1 sand) and jointed with white cement slurry etc.  

a) 20 mm thick / 30 mm thick / 40 mm thick  
0.075 quintal per  
(white cement)  
10 sqm area

16. Marble stone slab flooring over 20mm thick base of cement mortar 1:4 & jointed with white cement slurry etc.  

a) 20 mm thick  
1.275 quintal per  
(grey cement)  
0.075 quintal per  
(white cement)  
10 sqm area

b) 30 mm thick  
1.290 quintal per  
(grey cement)  
0.075 quintal per  
(white cement)  
10 sqm area

c) 40 mm thick  
1.310 quintal per  
(grey cement)  
0.075 quintal per  
(white cement)  
10 sqm area

17. Marble tiles 18 to 24 mm thick in risers  
1.16 quintal per  
10 sqm area
<table>
<thead>
<tr>
<th>TITLE</th>
<th>DOCUMENT NO.</th>
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<tbody>
<tr>
<td>Civil Specification</td>
<td>MEC/TS/05/11/001</td>
</tr>
</tbody>
</table>

18. Extra for each additional thickness of 5 mm granolithic layer of 1:2:4 for flooring
   - 0.016 quintal per 10 sqm of area

19. 12mm thick cement plaster skirting, dado risers of steps and edges of ground sink with CM 1:3 finished with a floating coat of neat cement.
   - 0.800 quintal per 10 sqm of area

20. 15mm thick cement plaster skirting, dado risers of steps and edges of ground sink with CM 1:3 finished with a floating coat of neat cement.
   - 0.995 quintal per 10 sqm of area

21. 19mm thick cement plaster skirting and dado with 12mm thick backing with CM 1:3 and 7mm topping 1:1 (1 cement : 1 stone chips 3mm size) finished with a floating coat of neat cement.
   - 1.35 quintal per 10 sqm of area

22. 25mm thick cement plaster skirting and dado with 18mm thick backing with CM 1:3 and 7mm topping 1:1 (1 cement : 1 stone chips 3mm size) finished with a floating coat of neat cement.
   - 1.85 quintal per 10 sqm of area

**MISCELLANEOUS**

1. Marble work for wall lining (Veneer work) 1.8 to 2.4 cm thick in CM 1:3 including pointing with white cement mortar 1:2 (1 white cement : 2 marble)
   - 0.715 quintal per 10 sqm of area

   - 0.170 quintal per 10 sqm of area
2. Marble work for wall lining (Veneer work) 4 cm thick in CM 1:3 including pointing with white cement mortar 1:2 (1 white cement : 2 marble dust) 1.020 quintal per 10 sqm of area (grey cement) 0.170 quintal per 10 sqm of area (white cement)

3. Grading roof for water proofing treatment with :-
   a) CC 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20mm nominal size) 3.2 quintal per cum of Concrete
   b) CM 1:3 5.1 quintal per cum of mortar
   c) CM 1:4 3.8 quintal per cum of mortar

4. Providing and fixing MS fan clamps of standard shape and size in existing RCC slab including cutting chase and making good. 0.016 quintal each

5. Making plinth protection 50mm thick of CC 1:3:6 (1 cement : 3 sand : 6 graded stone aggregate 20mm nominal size) over 75mm bed of dry brick ballast 40mm nominal size well rammed and consolidated and grouted with fine sand including finishing the top smooth. 1.1 quintal per 10 sqm of area

6. Grouting with
   a) CM 1:2 7.18 quintal per cum
   b) CM 1:3 5.40 quintal per cum
<table>
<thead>
<tr>
<th>TITLE</th>
<th>Civil Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>DPC 25mm thick (1:2:4)</td>
</tr>
<tr>
<td>8.</td>
<td>Making plinth protection with bricks on edge in CM 1:6 over 7.5cm bed of dry brick aggregate 40mm nominal size rammed, consolidated and grouted with fine sand and top of bricks pointed with CM 1:2.</td>
</tr>
<tr>
<td>9.</td>
<td>Providing and fixing 25mm dia GI pipe outlet in CM 1:3 including cutting and making good the walls.</td>
</tr>
<tr>
<td>10.</td>
<td>Providing and fixing 40mm dia GI pipe outlet in CM 1:3 including cutting and making good the walls.</td>
</tr>
<tr>
<td>11.</td>
<td>Providing chases 75mm wide 50mm deep in walls for conduit pipe and filling the same with CC 1:3:6</td>
</tr>
<tr>
<td>12.</td>
<td>Fixing steel windows with 1:2:4 concrete blocks</td>
</tr>
<tr>
<td>13.</td>
<td>Cement-sand mortar :</td>
</tr>
<tr>
<td>a)</td>
<td>1:1(cement :1sand)</td>
</tr>
<tr>
<td>b)</td>
<td>1:2(cement : 2sand)</td>
</tr>
<tr>
<td>c)</td>
<td>1:3(cement : 3sand)</td>
</tr>
<tr>
<td>d)</td>
<td>1:4(cement : 4sand)</td>
</tr>
<tr>
<td>e)</td>
<td>1:5(cement : 5sand)</td>
</tr>
<tr>
<td>f)</td>
<td>1:6(cement : 6sand)</td>
</tr>
</tbody>
</table>
DRAINAGE/SANITARY & WATER SUPPLY INSTALLATIONS

1. 100mm dia AC rain water pipe
   I/c fittings with CM 1:2  
   0.725 quintal per 100 RM of pipe

2. 150mm dia AC rain water pipe
   I/c fittings with CM 1:2  
   0.82 quintal per 100 RM of pipe

3. Fixing IWC pan with traps, pair of footrests, and flushing cistern complete  
   0.125 quintal each

4. Fixing EWC pan with trap and flushing cistern complete  
   0.01 quintal each

5. Fixing wash basin and kitchen sink  
   0.025 quintal each

6. Fixing urinal cistern including pipes  
   0.025 quintal each

7. Fixing & finishing floor trap  
   0.015 quintal each

8. Fixing HCl pipes and specials, 100mm dia and 75mm dia including making good the walls  
   0.135 quintal per 10 RM of pipe

9. Fixing GI pipes of all dia with clamps (for inside work only)  
   0.015 quintal per 10 RM of pipe

10. Jointing glazed stoneware pipe with CM 1:1

    a) 100 mm dia  
       2.17 quintals per 10 RM of pipe

    b) 150 mm dia  
       3.23 quintals per 10 RM of pipe
11. Laying cement concrete 1:5:10 all round SW pipe including bed concrete as per standard design
   a) 100mm dia SW pipe  19.24 quintals per 100 RM of pipe
   b) 150mm dia SW pipe  23.53 quintals per 100 RM of pipe

12. Gully chamber as per specification.  0.385 quintal each

13. Stopcock chamber as per specification
    0.185 quintal each

14. Inspection chambers as per specification
    a) 600x600x600mm deep  1.43 quintals each
    b) 750x600x600mm deep  1.435 quintals each
    c) 900x900x600mm deep  1.885 quintals each

15. Extra depth of inspection chambers as per specification
    a) 600x600mm  0.805 quintal per RM of depth
    b) 750x600mm  1.295 quintal per RM of depth
    c) 900x900mm  1.460 quintal per RM of depth
    d) 1200x900mm  1.835 quintal per RM of depth
SPECIFICATION FOR CIVIL WORKS

PART – IV DIMENSIONAL TOLERANCE
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. Tolerance for materials and workmanship not covered in this part as mentioned hereinafter will be in accordance with the relevant IS code.

<table>
<thead>
<tr>
<th>Description</th>
<th>Permissible tolerance</th>
</tr>
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<tbody>
<tr>
<td>Building bricks, in length width and height</td>
<td>As per IS 1077 - 1992</td>
</tr>
<tr>
<td>Laterite stone, in length, width &amp; height</td>
<td>Plus or minus 5 mm</td>
</tr>
<tr>
<td>Natural building stone</td>
<td></td>
</tr>
<tr>
<td>a) For stones required in ashlar masonry</td>
<td></td>
</tr>
<tr>
<td>Length &amp; Breadth</td>
<td>Plus or minus 5mm</td>
</tr>
<tr>
<td>Height</td>
<td>Plus or minus 3mm</td>
</tr>
<tr>
<td>b) For stones required other than in ashlar</td>
<td></td>
</tr>
<tr>
<td>masonry :</td>
<td></td>
</tr>
<tr>
<td>Length &amp; Breadth</td>
<td>Plus 5mm, minus 10mm</td>
</tr>
<tr>
<td>Height</td>
<td>Plus 5mm, minus 5mm</td>
</tr>
<tr>
<td>Description</td>
<td>Permissible tolerance</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Concrete and reinforced concrete pipes:</td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>Plus or minus 1% of standard length</td>
</tr>
<tr>
<td>Internal diameter, up to 300 mm</td>
<td>Plus 3 mm Minus 1.5 mm</td>
</tr>
<tr>
<td>Cast iron spigot &amp; socket pipes and fittings:</td>
<td></td>
</tr>
<tr>
<td>Length of fittings</td>
<td>Plus or minus 10 mm</td>
</tr>
<tr>
<td>Length of pipe</td>
<td>Plus or minus 20 mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>minus 1 mm</td>
</tr>
<tr>
<td>Internal dia of socket</td>
<td>Plus or minus 3 mm</td>
</tr>
<tr>
<td>Depth of socket</td>
<td>Plus or minus 10 mm</td>
</tr>
<tr>
<td>External dia, up to 75 mm</td>
<td>Plus or minus 3 mm</td>
</tr>
<tr>
<td>100 mm</td>
<td>Plus or minus 3.5 mm</td>
</tr>
<tr>
<td>150 mm</td>
<td>Plus or minus 4 mm</td>
</tr>
<tr>
<td>Stoneware pipes, in length</td>
<td></td>
</tr>
<tr>
<td>Upto 75 cm</td>
<td>Plus or minus 10 mm</td>
</tr>
<tr>
<td>Upto 90 cm</td>
<td>Plus or minus 15 mm</td>
</tr>
<tr>
<td>In thickness of barrel and socket not exceeding 450mm</td>
<td>Plus or minus 2 mm</td>
</tr>
</tbody>
</table>
Description

Permissible tolerance

In thickness of barrel and socket between 500 to 600mm : Plus or minus 3mm

Glazed tiles, length of all 4 sides : Plus or minus 0.8mm

Individual dimensions and thickness : Plus or minus 0.5 mm

Metal doors, windows and ventilators - In overall dimension : Plus or minus 1.5 mm

Wooden doors, windows, ventilators Overall dimension of door, window, ventilators : Plus or minus 3 mm

All components of shutter except glazing bar

Width : Plus or minus 3 mm

Thickness : Plus or minus 1 mm

Glazing bar, width & thickness : Plus or minus 1 mm

**Mild steel tubes, tubulars and other wrought steel fittings**

a) Thickness

i) butt welded light tubes : Plus not limited minus 8%

medium and heavy tubes : plus not limited minus 10%

ii) seamless tubes : plus not limited minus 12.5%

b) Weight

i) single tube (irrespective of the quantity) : + 10%, - 8%
<table>
<thead>
<tr>
<th>TITLE</th>
<th>DOCUMENT NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil Specification</td>
<td>MEC/ TS/ 05/ 11/ 001</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ii) for quantity of less than 150m of one size</td>
<td>+10%, -8%</td>
</tr>
<tr>
<td>iii) for quantity of 150m and over of one size</td>
<td>+4%, -4%</td>
</tr>
</tbody>
</table>

**Earth work**

- Finished level of site levelling in 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 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

Deviation of planes and lines of their intersection from vertical or inclination along full height : Plus or minus 20 mm

Deviation of horizontal plane from horizontal line

for 1 m of the plane in any direction : Plus or minus 5mm

for the whole plane : Plus or minus 20mm

Sizes of cross section : Plus or minus 8mm

Surfaces of inserts to support loads : Plus or minus 5mm

Length of elements : Plus or minus 20 mm

Equipment foundations :

Top level of bolt : Plus 20mm

Top level of foundation before grouting : Minus 20mm
<table>
<thead>
<tr>
<th>Axes of anchor bolts in plan</th>
<th>Plus or minus 5mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axis of foundation in either direction</td>
<td>Plus or minus 10mm</td>
</tr>
<tr>
<td>Deviation in vertical line along height</td>
<td>Plus or minus 10mm</td>
</tr>
<tr>
<td>Sizes of pits in plan</td>
<td>Plus or minus 20 mm</td>
</tr>
<tr>
<td>Sizes of steps in plan</td>
<td>minus 20 mm</td>
</tr>
<tr>
<td>Levels of steps, benches and pits</td>
<td>minus 20 mm</td>
</tr>
<tr>
<td>Axes of inserts in plan</td>
<td>Plus or minus 10 mm</td>
</tr>
<tr>
<td>Basic dimensions in plan</td>
<td>Plus or minus 10mm</td>
</tr>
</tbody>
</table>

**Deviation of horizontal plan from horizontal line**

- for 1 m of plane in any direction: Plus or minus 5mm
- for the whole plane: Plus or minus 20mm

**Local deviations of top surface when checked with a 2 m long straight edge**

- Plus or minus 8mm

**Buildings:**

- Surfaces when checked with a 2 m long straight edge: Plus or minus 8mm
- Sizes of cross section: Plus 8mm Minus 0 mm
- Length of elements: Plus or minus 20mm
- Deviation from horizontal plane, for whole building: Plus or minus 10mm
- Plumb in verticality: 1 in 1000 of height
for columns supporting floor beams : Plus or minus 10mm

for framed columns linked with crane girders and beams : Plus or minus 10mm

Reinforced concrete walls : Length : Plus or minus 20mm

Flatness of surface when checked with a 2 m long straight edge : Plus or minus 8mm

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 8mm

**Placing of reinforcement :**

Length of bar upto 75 cm long (Other than straight bars) : 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 and above : 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 |
| Threaded length | Plus 30 mm |

### Masonry

<table>
<thead>
<tr>
<th>For Walls</th>
<th>For Pillars</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Width</strong></td>
<td>Plus or minus 10 mm</td>
</tr>
<tr>
<td><strong>Shift in axes</strong></td>
<td>Plus or minus 10 mm</td>
</tr>
<tr>
<td><strong>Deviation in row from horizontal line for every 10m length</strong></td>
<td>Plus or minus 15 mm</td>
</tr>
<tr>
<td><strong>Flatness of surface when checked with a 2 m long straight edge</strong></td>
<td>Plus or minus 10 mm</td>
</tr>
<tr>
<td><strong>Deviation in lines separating storeys</strong></td>
<td>Plus or minus 15 mm</td>
</tr>
<tr>
<td><strong>Deviation of surface from vertical and at angles and corners</strong></td>
<td>Plus or minus 10 mm</td>
</tr>
<tr>
<td><strong>for 1 storey</strong></td>
<td>Plus or minus 30 mm</td>
</tr>
<tr>
<td><strong>for whole building</strong></td>
<td></td>
</tr>
</tbody>
</table>

IV-8
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, in any 3 m length: 3 mm
in large open area: 15 mm

Wall tiling - surface should not vary from general plane by more than 1 in 200. 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: 5 mm

Over full heights: 10 mm

Metallic Inserts on assembled components length and width: Plus or minus 3 mm

Road work
The levels of the sub-grade and different pavement courses should not vary from those calculated with reference to the longitudinal and cross-sections of the road as shown on the drawing beyond the tolerance given below:

- Sub-grade: plus or minus 25mm
- Sub-base: plus or minus 20mm
- Base: plus or minus 15mm
- Wearing course: plus or minus 6mm
SPECIFICATION FOR CIVIL WORKS

PART – V  METHOD OF MEASUREMENT
## CONTENTS

1.0 GENERAL  
2.0 EARTHWORK  
3.0 ANTI - TERMITE TREATMENT  
4.0 CONCRETE (PLAIN & REINFORCED)  
5.0 MASONRY  
6.0 PLASTERING  
7.0 WHITE WASHING, COLOUR WASHING & PAINTING  
8.0 FLOORING, PAVING & FACING WORKS  
9.0 WOODWORK  
10.0 METAL DOORS, WINDOWS & VENTILATORS  
11.0 GLAZING  
12.0 WATER SUPPLY, DRAINAGE, SEWERAGE & SANITATION  
13.0 WATER PROOFING, DAMP PROOFING  
14.0 CEILING AND LINING  
15.0 ROAD WORK
1.0 GENERAL

1.1 The method of measurement of the various items of work shall be in accordance with IS : 1200 (Part 1 to 28) - 1971 to 1993 unless otherwise mentioned in this part or in the schedule of items or in preamble or in the specification.

1.2 If there is any contradiction in meaning between any portion of this part and that of IS :1200 (Part 1 to 28) - 1971 to 1993, the stipulation of this part shall prevail.

1.3 The descriptions and explanations given herein have as much forces as though they are incorporated into the description of the items themselves in the schedule of items.

2.0 EARTH WORK & SAND FILLING

2.1 General

2.1.1 Each dimension upto 25 m shall be measured to nearest 0.01 m and to nearest 0.1 m for dimensions over 25 m. Areas shall be worked out to the nearest 0.01 m² and cubical contents to the nearest 0.01 m³.

2.1.2 Shoring and strutting shall not be measured separately unless otherwise specified.

2.1.3 Dewatering for earth work and sand filling work shall not be measured separately unless otherwise specified.

2.1.4 For classification of soils, relevant clauses of Technical specification (workmanship and other requirements ) is to be followed.

2.2 Requirements for particular works

2.2.1 Site levelling
2.2.1.1 For site levelling levels shall be taken jointly before start & after completion of work and the quantity computed based on the levels. Measurements shall be made only for excavation and no separate measurement for filling shall be made except where earth, borrowed from elsewhere for site levelling work, will be measured separately only for that borrowed portion of earth.

2.2.1.2 In cases where it is not possible or convenient to take measurements from excavated cuts or borrow pits, excavation shall be worked out from filling based on the levels to be taken before and after completion of works. Deduction of 10 percent will be made for voids, however for consolidated fills done through heavy mechanical means, the deduction for voids shall be 5% in place of 10%.

2.2.1.3 In exceptional cases where the quantity is measured on the lorry measurement, loose stacks, boxes or any other similar method with the approval of the Engineer the deduction for voids shall be 20 per cent from the actual quantity.

2.2.2 Excavation

2.2.2.1 Before commencing excavation of foundations for buildings and structures, the initial ground levels shall be jointly recorded. The depth of excavation and the calculation of lift shall be based on this. Normally the initial ground level shall be considered as the level of the site as handed over to the contractor. In case excavation is planned and approved to be taken up subsequent to terracing, the terrace level shall be treated as initial ground level.

2.2.2.2 Excavation of foundations, trenches, basements, pits etc., shall be measured to the dimensions shown in the excavation plan, if any, or of the lowest concrete or masonry course, as the case may be and the actual depth. Working space and slopes shall not be measured.

2.2.2.3 Excavation of rock shall be measured from stacks of excavated rock with a deduction of 50 per cent for voids or measured in the solid based on levels.
2.2.2.4 In case of following works, no measurement will be recorded for the excavation beyond drawing / specification.

(a) In work which will be covered externally with damp proof covering.

(b) In work which requires formwork.

(c) In work which requires workmen to operate from the outside and for guniting and post tensioned concrete, ground beams etc.

However, if there is a specific provision otherwise in the item/specification/preamble, for authorised working, it shall be measured accordingly. This working space may be 60 cm. measured from the face of the structure at lowest level, unless otherwise mentioned.

2.2.2.5 Surface Dressing

Trimming of natural ground, excavated surface and filled up area to remove vegetation and/or small inequalities not exceeding 15 cm deep shall be described as surface dressing and measured in square metres unless otherwise specified in the schedule of items/ preamble.

2.2.2.6 Lead

The distance for removal shall be measured over the shortest practicable route and not necessarily the route actually taken.

The description of the item shall include loading and unloading.

For the purpose of the measurement of the lead, the area excavated shall be divided in suitable block and for each block the distance from the centre of the block to the centre of the placed earth pertaining to this block shall be taken as lead.

2.2.3 Back filling/filling

2.2.3.1 In foundations, trenches, basements, pits, etc. and in other like areas, the measurements shall be the theoretical volume of the filling computed from
drawings i.e. the volume measured under excavation minus the volume occupied by the structure and part filling if any, done otherwise.

2.2.3.2 In filling under floors the measurements shall be the theoretical volume as per drawings after deducting the part filling if any, done otherwise.

2.2.3.3 In embankments, the work shall commence only after recording jointly the initial ground levels and the measurements shall be made on the basis of finished cross section and initial ground levels. Where controlled compaction by mechanical compaction is done, 5% deduction for voids shall be made. In case controlled compaction by mechanical means is not done then deduction for voids shall be 10%.

2.2.3.4 Filling/Back filling shall not be measured separately for items of excavation, where filling/back-filling is a part of the composite item and as such is included in excavation item itself.

3.0 ANTI-TERMITE TREATMENT

Measurement shall be the plinth area of the ground floor of the building treated. Dimensions shall be measured to the nearest 0.01 m and area to nearest 0.01 m2.

4.0 CONCRETE (PLAIN & REINFORCED)

4.1 Concrete

4.1.1 Dimensions shall be measured to nearest 0.01 m except for the thickness of slab, which will be to nearest 0.005 m. Areas shall be worked out to nearest 0.01 m2 and cubic contents to nearest 0.01 m3.

4.1.2 The concrete shall be measured as per drawings except in the cases of approved variations which will be measured separately.

No deductions shall be made for the following:

i) Ends of dissimilar materials such as beams, rafters, purlins etc., upto 500 cm2 in cross section.
4.2 REINFORCEMENTS

4.2.1 Norms for Steel Consumption

The requirement of mild and high strength deformed bars for various works like reinforcement, guard bars, fan hooks etc. shall be calculated as mentioned below:

i) As per drawing including

(a) Authorised laps, bends, standard hooks and deviations etc.

ii) Openings up to 0.1 m² in area (In calculating area of an opening, the thickness of any separate lintel or sill shall be included in the height. No extra labour for forming such opening or voids shall be measured).

iii) Volume occupied by reinforcement or other embedments such as anchors, inserts, conduits or volume occupied by pipes, sheathing etc. not exceeding 100 sq. cm. each in cross sectional area or as specified.

iv) Small voids not exceeding 40 cm² each in cross section.

v) Moulds, drip moulding, chamfer, splay, beds, grooves and rebates up to 10 cm in width or 15 cm in girth.

4.1.3 Columns shall be measured from top of column base to underside of first floor slab and from top of floor to underside of floor slab above thereafter. Beams shall be measured from face to face of columns and will include haunches. Depth of beam shall be measured from bottom of slab and in the case of inverted beams from top of slab. Chajjas and other cantilevers shall be measured from the face of the projection. Where vertical fins are combined with chajja, the latter shall be measured clear between fins. In case chajja is not combined with lintel, beam or slab, it shall be measured inclusive of bearing.
(b) Spacer bars, chairs, hangers, supports, spacer blocks dowels etc. are to be considered for wastage only and not to be measured for payment purpose.

ii) Quantity upto 0.5% of (i) above towards unaccounted wastages, plus

iii) Quantity upto 3% of (i) above towards cut pieces, which shall be pieces below 2m. length. These cut pieces shall not be taken back even though steel has been issued by the client/owner.

4.2.2 Reinforcements shall be measured in lengths to the nearest 0.01 m for various diameters of bar and converted into weight in tonnes to the nearest kg. on the basis of standard weights as per IS : 1786-1986. No allowance shall be made in the weight for rolling margin.

4.2.3 Authorised laps, standard hooks, bends shall be measured.

4.2.4 Sapacer bars, chairs, hangers, supports, spacer blocks and unauthorised laps etc. shall not be measured unless otherwise specified.

4.2.5 Dowels neither shown on the drawings nor instructed by the Engineer, but required for construction facilities shall not be measured for payment.

4.2.6 Modification of already embedded reinforcement, if required due to faulty fabrication or placement, shall not be measured for payment.

4.2.7 The measurements of reinforcements (including authorised laps, hooks, bends) shall be taken only from Bar bending lists or from the drawings except in the cases of approved variations which will be measured as per 4.2.2.

4.2.8 Wire netting and fabric reinforcement shall be described (including meshes and wire/strands) and measured in square metre, unless otherwise specified in the schedule of item. Authorised laps shall be measured. Raking or circular cutting and waste shall be included in the description of item.
4.2.9 Hoop iron shall be fully described and measured in running metres unless otherwise specified in the schedule of item.

4.2.10 Binding wire for the reinforcement shall not be measured separately and shall be included in the item of reinforcement.

4.3 **ADMIXTURE**

Admixture will be measured separately as specified or on the basis of the requirement as approved by the Engineer.

4.4 **FORMWORK**

Each dimension shall be measured to the nearest 0.01 m and area to the nearest 0.01 sq.m.

4.4.1 Formwork shall be measured as the actual surface in contact with concrete and paid in sq.m. unless included in the rate for concrete in specific item of work.

4.4.2 All the measurements shall be computed from the drawings except in the cases of approved variations which will be measured separately.

4.4.3 Formwork shall not be measured separately for precast concrete work, grouting and damp proof course which shall be included in the concrete rates.

4.4.4 No measurement for formwork in construction joints shall be made.

4.4.5 Openings upto 0.1 sq.m. shall be neglected, as if non-existent, for the purpose of formwork measurement.

4.4.6 No extra measurement or payment shall be made for making the formwork water proof or for supports, scaffolding, staging, centering, approaches etc.

4.4.7 No measurement shall be taken for the formwork in pockets, openings, chambers, chases etc., in concrete if the cross sectional area is less than or
equal to 0.1 sq.m. in each case. If the cross section area of any opening exceeds 0.1 sq.m. the actual area of the formwork shall be measured for payment.

4.5 EMBEDDED PARTS

4.5.1 These shall be measured on the basis of standard theoretical weight of the complete insert according to the drawing/direction.

4.5.2 Embedded steel, which are the integral parts of the embedment according to drawing and are required for anchoring the embedded parts in concrete shall be measured on the basis of the theoretical standard weight. In case of anchor bolts the theoretical weights of the nuts, lock nuts, check nuts and washers shall be added in the measurement for payment.

4.5.3 All bye-works such as jigs, fixtures, templates and other arrangements which are not integral parts of the embedded parts, but necessary to secure those (embedded parts) in position shall not be measured for payment.

4.5.4 Anti-corrosive paint over the exposed surfaces and protection of the anchor bolts with grease tc., shall not be measured for payment.

4.5.5 Modification works necessary to rectify the mistake of already placed embedded parts shall not be measured.

4.6 GROUTING

4.6.1 Grouting shall be measured in volume except in the cases of grouting by special cement compound or epoxy compound which will be measured by number.

4.6.2 Measurement shall be computed from the drawings except in the cases of approved variations which shall be measured separately and subsequently added to or deducted from.

4.6.3 Necessary formwork shall not be measured for payment.

4.7 DAMP PROOF COARSE
4.7.1 Measurement shall be in sq.m. stating thickness and computed from the drawings except in the cases of approved variations which will be measured separately.

4.7.2 Necessary formwork shall not be measured for payment.

5.0 MASONRY

5.1 Dimensions shall be measured to nearest 0.01 m, areas to nearest 0.01 m² and cubic contents to nearest 0.01 m³.

5.2 No deduction shall be made for:

(i) Ends of dissimilar materials such as joints, beams, posts, girders, trusses, lintels, purlins etc., upto 0.1 m² in section.

(ii) Openings upto 0.1 m² in area.

(iii) Wall plates, bed plates, bearing of slab etc., thickness not exceeding 10 cm. and bearing not extending over the full thickness of wall.

(iv) Cement concrete blocks for holdfasts and the like.

(v) Iron fixtures such as pipes etc. upto 300 mm. dia. and hold fasts for doors and windows.

5.3 Dressed stonework such as in sills, cornices, column caps, copings etc., shall be measured as the smallest rectangular block from which the finished stone can be worked.

5.4 Honeycomb openings shall not be deducted from the area of honeycomb brickwork.

5.5 Brickwork of full brick width or more shall be measured in cu.m. while of thickness of half brick or less shall be measured in sq.m., unless otherwise specified.
5.6 Reinforcements for reinforced brick work shall be measured separately, unless otherwise specified and no deduction for reinforcement shall be made from brickwork.

6.0 PLASTERING & POINTING

6.1 All plastering and pointing shall be measured in sq.m. unless otherwise described. Dimensions shall be measured to nearest 0.01 m and areas to 0.1 sq.m.

6.2 Ceiling shall be measured between walls or partitions (dimensions before plastering) shall be taken. Measurement of wall plastering shall be taken between walls or partitions for length (dimension before plastering) and from top of floor or skirting to ceiling for height.

6.3 The methods of measurement including the deductions for openings etc., shall be according to the relevant part of IS : 1200 (Part 1 to 28) - 1971 to 1993.

7.0 WHITE WASHING, COLOUR WASHING, PAINTING & OTHER FINISHES.

The method of measurement shall be according to the relevant part of IS : 1200 (Part 13 & 15) - 1987.

8.0 FLOORING, PAVING & FACING WORKS

8.1 The work shall be measured as a complete finished item including necessary underbed, adhesives, dividing strips, joint sealing and necessary grinding, polishing and finishing where specified. The subgrade or the base course shall be measured separately against respective item unless otherwise specified.

8.2 All works shall be measured net, dimensions being measured to nearest 0.01 m and areas to nearest 0.01 sq.m. Any opening less than 0.1 sq.m. in area shall not be deducted nor any extra payment made for that.
8.3 Building paper or water proofing by bituminous felts/mastic asphalt treatment, where specified to be laid below floor, shall be measured separately for payment unless otherwise specified.

8.4 Laps and seams in sheet finishing (linoleum, cork, PVC, rubber & like) shall be deemed to be included in the item itself even if not described explicitly and shall not be measured and paid separately.

9.0 WOODWORK

9.1 All work shall be measured net for finished dimensions as fixed, that is no extra measurement or allowance shall be made for shape, joints, wastage etc. subject to specific provision made in the IS : 1200 (Part 21) - 1973 and for dimensions supplied beyond those specified in the drawing.

9.2 Wooden frame

Rought, finished and fixed shall be measured net for overall length nearest to 0.01 m, width and thickness to the nearest 2mm or as specified in the drawing and cubic contents calculated in cubic metres to the nearest three places of decimals.

Wooden shutters of all types

Length and width of the shutters shall be measured net as fixed to the nearest cm. in closed position covering the rebates of the frame but excluding the gap between the shutter and the floor and the area calculated in square metre upto two places of decimal.

Over lap of two leaves of shutter shall not be measured separately.

Hand rails

Hand rails of finished width and depth as specified in the item shall be measured in running metres upto two places of decimal.

9.3 Painting and polishing, unless otherwise described in the schedule of items, shall be measured separately for payment.
9.4 Builder's hardware and fittings for doors windows and ventilators shall be measured separately, unless stated otherwise in the Schedule of Items. Hardware and fittings shall be measured according to IS : 1200 (Part-VII) - 1972.

9.5 Hold fasts for door, window and ventilator frames shall be measured separately.

9.6 **Timber Partitions**

This shall be measured in area calculated in sq. m. to the nearest two places of decimal.

9.7 **Glazed shutters and glazed partitions (Wooden)**

Glazed shutters/glazed partitions with wooden frames shall be measured as a single item in area calculated in sq.m. to the nearest two places of decimal. No separate measurement for glazing/glass panes shall be made.

9.8 Provision of making holes/opening/chases in masonry/ concrete flooring etc. for fixing and making good of the same shall not be measured separately for payment.

9.9 Bitumen painting or approved wood preservative of the timber surfaces in contact with masonry/concrete floor etc. shall not be measured for payment.

**10.0 METAL DOORS, WINDOWS & VENTILATORS**

10.1 Door, window and ventilator/louvers as fixed, shall be measured net as clear width between jambs and clear height between floor/sill and underside of lintel, but excluding the gap between door shutters and floor. Dimensions shall be calculated to the nearest 0.01 m., area calculated in sq.m. upto two places of decimal.

10.2 For MS collapsible shutter/gate, rolling shutter sliding folding door, length and breadth shall be measured to the nearest cm. for the clear area of
opening as per drawing in which they are installed and calculated in sq.m. to the nearest two places of decimal.

10.3 M.S. Rolling grills, doors of steel plate, sliding door louvered ventilators, gates, grills, as fixed, shall be measured and computed to weight from the size as per drawing unless otherwise specified.

10.4 Glazed doors, windows, louvers, partitions (both steel and aluminium) shall be measured in sq.m. to the nearest two places of decimal. No separate measurement for glazing/glass panes shall be made for payment.

11.0 GLAZING

11.1 Glazing shall not be separately measured for doors, windows and ventilators unless otherwise specified.

11.2 North light and roof glazing shall be paid as the area from outside to outside of glazing including frames, to the nearest 0.01 sq.m.

11.3 Glazing, where shown in the schedule of items as a separate item, shall be measured from edge to edge of glass as fixed.

12.0 WATER SUPPLY, DRAINAGE, SEWERAGE & SANITATIONS

12.1 All the pipelines buried under soil/masonry/floors/ concrete, laid over/underground/along masonry/along under floor shall be measured in metres along the centreline together with fittings/specials upto two places of decimal against respective schedule of items for different diameter (the diameter as specified shall mean nominal bore except PVC pipe) unless otherwise specified.

12.2 All necessary earth work in trenches for laying pipe lines including dewatering, levelling and trimming to the gradient, sand filling in the trenches before laying the pipe, back filling either by sand or by approved borrowed soil after laying the pipe lines including necessary compaction by spraying water and levelling/dressing the same shall not be measured separately for payment unless otherwise specified.
12.3 All required specials, i.e. bends tees, shoes cowls, plug, elbows, unions, caps, checkout and the like excluding valves shall not be measured separately for payment unless otherwise specified.

12.4 All fixing and supporting arrangement of the pipes like the supports, saddles, brackets, clamps, cleats, covering the pipes with concrete in case of pipes laid over ground, special arrangement for supporting the pipe like while coming out from the building to the trenches etc. shall not be measured separately for payment, unless otherwise specified.

12.5 All the arrangement in road crossing like cutting the road, diverting the road and drains, concealing the pipes with suitable approved measures, backfilling the area, covering and making good of the road with similar materials/design shall not be measured separately for payment, unless otherwise specified.

12.6 Septic tanks, inspection pits, manholes etc., shall be considered as a composite single item including excavation, dewatering, concrete, masonry, back filling, protection of other service lines and all the like works unless otherwise specified.

12.7 All the valves and all the bathroom/W.C./Kitchen fixures like bib tap, stop cock, shower, all sanitary wares, towel rails, mirrors etc., shall be measured separately under respective item in the schedule, unless otherwise specified.

13.0 WATER PROOFING, DAMP PROOFING

13.1 Water proofing for roofs

13.1.1 Length and breadth shall be measured in metre upto two places of decimal and area calculated in sq.m. upto two places of decimal.

13.1.2 Measurement shall be made for the net covered area. No measurement shall be made for overlapping for end and side joints and for bends around/along the corners, ends and for special treatment around pipes, rain water gulleys, steel structure and the like etc. No deduction shall be made
in the measurement for the opening of area less than 0.1 m² each and no extra payment shall also be made for any special works made around such openings.

13.1.3 Water proofing treatment shall be considered as a single composite item including priming painting coat, water proofing felts, binding bituminous coats, top bituminous coat and pea size gravel or sand finishing etc.

13.1.4 For lime concrete terracing the consolidated thickness shall be considered for measurement.

13.2 For Water proofing treatment in basement

13.2.1 With bituminous felts

13.2.1.1 Length and breadth shall be measured in metre upto two places of decimal and area calculated in sq.m. up to two places of decimal.

13.2.1.2 Measurement shall be made for the net covered area. Measurement shall be made from the drawing, except in certain special cases where it is impossible to compute from drawing and the measurement shall be made as executed. No measurement shall be made for overlaps, special measures around projected pipes, sealing the bends/rounds and in other cases, necessary projection/ overlap for the connection between vertical and horizontal junction etc.

13.2.1.3 Water proofing treatment shall be considered as a single composite item, including priming painting coat, water proofing felts, binding bituminous coats and top bituminous coat etc.

13.3 Mastic Treatment

13.3.1 Length and breadth shall be measured in metres up to two places of decimal and area calculated in sq.m. up to two places of decimal.

13.3.2 Measurement shall be made for the net covered area. No deduction in measurement shall be made for opening of area up to 0.1 sq.m. each and no extra payment shall be made for any special treatment around such
openings. No measurement shall be made for extra payment for the special works necessary for junctions, corners, roundings, bends for the works around pipes and the like.

14.0 CEILING & LININGS

14.1 Dimensions shall be measured to the nearest 0.01 m., areas to be worked out to the nearest 0.01 sq.m.

14.2 Work formed to circular surfaces shall be measured separately unless otherwise specified.

14.3 All work unless otherwise described shall be measured as flat in sq.m.

14.4 No deduction in measurement shall be made for openings not exceeding 0.4 sq.m. and no extra measurement shall be made for forming such openings.

15.0 ROAD WORK

15.1 Dimensions shall be measured to nearest 0.01 m. Where the thickness is less than 20 cm., it shall be measured to nearest 0.005 m. Areas shall be worked out to nearest 0.01 sq.m. and cubic contents to the nearest 0.01 cu.m.

15.2 Where thickness is measured, it shall be the minimum thickness after compaction.

15.3 Cement concrete bases and roads shall be measured either in sq.m. or cu.m. as specified.

15.4 Unless otherwise specified, expansion and dummy joints shall be described and measured separately and given in running metres stating the thickness and depth of the joints.
1.0 GENERAL

This specification deals with the subject matter of safety and protection to be observed in the Civil Construction. This shall be followed along with all related statutory requirements/obligation including Governmental byelaws, codes, ordinance of local or central authorities related to the construction work.

In case of complicated work like deep excavation, intricate shuttering and formwork, excavation in loose soil and below water table, stacking of excavated earth etc., work plan with necessary drawings and documents have to be prepared by the Contractor and got approved by the Engineer.

Necessary reference shall be made to the following Indian Standard Codes on safety requirements for various type of work:

**Indian Standard**

- **4081 - 1986** Blasting & Drilling.
- **5916 - 1970** Construction with Hot Bituminous Materials.
- **4130 - 1991** Demolition of Buildings.
- **3764 - 1992** Excavation Work
- **5121 - 1969** Piling & Other Deep Foundations.
- **4014 - (P-II) - 1967** Scaffolding, Steel Tubular.
- **3696 - (P-I & P-II)** Scaffolds and Ladders.
- **6922 - 1973** Structures Subject to Underground Blasts.
- **4756 - 1978** Tunneling Work.
- **5499 - 1969** Underground Air-raid Shelters in Natural Soil.
2.0 BLASTING

2.1 Detonators and other explosive for blasting shall be taken to the blasting area in the original container or any separate non-metal container. This shall not be carried loose or mixed with other materials. Detonators and explosives must be kept separately.

2.2 No shot for blasting shall be fired except by persons licensed to do so.

2.3 Drilling shall not be resumed after a blast has been fired unless a thorough examination has been made to make sure that there is no unexploded charge.

2.4 Before firing a shot, sufficient warnings by means of whistling and/or otherwise shall be given to get men off the danger area. Blasting areas shall be cordoned off & red flags during day time and red lights during night time displayed prominently marking off the cordoned area.

2.5 All people except those who have actually to light the fuses must be removed to a safe distance of not less than 200 metres as a rule.

2.6 Wherever possible, blasting mats should be used.

2.7 Contractors doing blasting work must have licence and an approved magazine to store explosives.

2.8 Blasting operations shall be carried out during fixed hours of the day which shall be notified in writing.

2.9 Provisions in explosives Rules 1940 as amended from time to time, Indian Explosives Act 1844 (IV of 1884), and others shall be strictly followed.

3.0 EXCAVATIONS
3.1 Sides of all excavations must be sloped to a safe angle, not steeper than the angle of repose of the particular soil. If it is not possible to give a proper slope, the sides of the excavation where there is a danger of fall or dislodgement of earth or any material, shall be securely supported by timber or other type of shoring.

3.2 No excavation or earth work below the foundation level of an adjoining building shall be taken up unless adequate steps are taken to prevent damage to the existing structure or fall of any part.

3.3 Every accessible part of an excavation, pit or opening in the ground into which there is a danger of persons falling shall be suitably fenced with a barrier upto a height of one metre suitably placed from the edge of the excavation as far as practicable.

3.4 No material or load shall be placed or stacked near the edge of the excavation or opening in the ground. The excavated material shall not be placed within 1.5 m of the trench or half of the depth of the trench whichever is more.

3.5 Cutting shall be done from top to bottom. No undercutting of sides of excavation shall be allowed.

3.6 All narrow trenches 1.2 m or more depth, shall at all times be supplied with atleast one ladder for each 30m in length or fraction thereof. Ladder shall be extended from bottom of the trench to atleast one metre above the surface of the ground. The side of the trenches which are 1.5 m or more in depth shall be stepped back to give suitable slope, or securely held by planking, strutting and bracing so as to avoid the danger of side collapse.

3.7 Materials shall not be dumped against existing walls or partition to a height that may endanger the stability of the walls.

3.8 While withdrawing piled materials like loose earth, crushed stone, sand, etc., from the stock piles, no over hanging shall be allowed to be formed in the existing dump.
3.9 No material on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or public or any other agency at work.

4.0 DEMOLITION

4.1 On every demolition job, danger signs shall be conspicuously posted all round the structure and all doors, openings giving access to the structure shall be kept barricaded or marked except during the actual passage of workmen or equipment. However, provision shall be made for at least two independent exits for escape of workmen during any emergency.

4.2 During night, red lights shall be placed on or about all the barricades.

4.3 Where in any work of demolition it is imperative, because of danger existing to ensure that no unauthorised person shall enter the site of demolition outside working hours, a watchman should be employed. In addition to watching the site he shall also be responsible for maintaining all notices, lights and barricades.

4.4 All the necessary safety appliances as per IS ;4130 shall be issued to the workers and their use explained. It shall be ensured that the workers are using all the safety appliances while at work.

4.5 The removal of a member may weaken the side wall of an adjoining structure and to prevent possible damage, these walls shall be supported until such time as permanent protection is provided. In case any danger is anticipated to the adjoining structure the same shall be got vacated to avoid any danger to human life.

4.6 The power on all electrical service lines shall be shut off and all such lines cut or disconnected at or outside the property line, before the demolition work is started. Prior to cutting of such lines the necessary approval shall be obtained from the electrical authorities concerned. The only exception will be any power line required for demolition work itself.
4.7 All gas, water, steam and other service lines shall be shut off and capped or otherwise controlled at or outside the building line, before demolition work is started.

4.8 All the mains and meters of the building shall be removed or protected from damage.

4.9 If a structure to be demolished has been partially wrecked by fire, explosion or other catastrophe, the walls and damaged roofs shall be shored or braced suitably.

4.10 Walkways and passage ways shall be provided for the use of the workman who shall be instructed to use them and all such walkways and passageways shall be kept adequately lighted, free from debris and other materials.

4.11 All nails in any kind of lumber shall be withdrawn, hammered or bent over as soon as such lumber is removed from the structure being demolished, and placed in piles for future cleaning or burning.

4.12 All the roads and open area adjacent to the work site shall either be closed or suitably protected.

4.13 No electric cable or apparatus which is liable to be a source of danger or a cable or apparatus used by the operator shall remain electricity charged.

4.14 All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render it unsafe.

5.0 VEHICLE

5.1 No person shall board any vehicle or equipment when it is in motion.

5.2 Suitable blocks shall be placed against the wheels of a vehicle when it is used for tipping materials into excavation or a pit or over the edge of any embankment or earthwork to avoid the danger of its running over the edge.
| 5.3 | All workers shall stand clear of the vehicle while it is dumping. If the material being dumped is very heavy or sticky, dump hooks shall be used or dumper shall be clamped to prevent any danger of its tripping. |
| 5.4 | Materials shall not be allowed to be loaded in a vehicle so as to project horizontally beyond the sides of the body of the vehicle. All materials projecting beyond the front or rear shall be indicated by a red flag in the day and with red light in the night. |
| 5.5 | Driver of the truck or any heavy vehicle shall not reverse it unless assisted by a signal man who shall have a clear view of the driver and the area beyond the truck during reversing operation. |
| 5.6 | Maximum speed of a heavy vehicle must not exceed 15 km. per hour. |
6.0 SCAFFOLDING, GANGWAYS, LADDERS & SHUTTERING

6.1 For all work that cannot be done from the ground level or from part of any permanent structure or from other available means of support, soundly constructed scaffoldings of adequate strength shall be used as a safe means of access to places of work.

6.2 All scaffolding shall be securely supported or suspended and wherever necessary be properly braced to ensure stability.

6.3 Chains, ropes or other lifting materials used for the suspension of scaffoldings must be of adequate strength and shall be of tested quality.

6.4 All such chains and ropes used for the suspension of scaffoldings shall be properly fastened to safe anchorage points.

6.5 The platform of a suspended scaffolding shall be sufficiently wide. Suspended scaffolding shall have hand rail on 3 sides of about 1.0 m height.

6.6 All working platform and stages from which workers are liable to fall shall be of adequate width depending on the type of work done and closely boarded and planked.

6.7 Scaffolding or staging more than 3.5 m above the ground or floor, suspended from an overhead support or erected with stationary support shall have a guard rail properly attached, bolted, braced and otherwise secured atleast 1 m high above the floor or platform of such scaffolding or staging and extending along the entire length of the outside ends thereof with only such opening as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure. The platform shall also be provided with toe boards of atleast 150 mm high so placed as to prevent the fall of materials and tools from there.

6.8 All platforms or gangways, runways and the stairs shall be kept free from unnecessary obstructions, materials or junk.
6.9 Working platforms, gangways & stairways shall be so constructed that they shall not sag unduly or unequally, and if the height of the platform or the gangway or the stairway is more than 3.5 m above ground level or floor level they shall be closely boarded, shall be of adequate width and shall be suitably fenced.

6.10 Every opening in the floor of a building or in a working platform shall be provided with suitable fencing or railing whose minimum height shall be 1 m to prevent the fall of persons or materials.

6.11 Every ladder shall be securely fixed at top and bottom. A ladder more than 5 m long shall have a prop.

6.12 All ladders used shall be of good construction, sound materials and adequate strength. Ladders with defective or missing rungs shall not be brought into use. The spacing of rungs shall not exceed 30 cms and these shall be recessed at least 12 mm into rails.

6.13 All ladders or rungs used for vertical height of more than 10 m shall have an intermediate landing. All such intermediate landings shall be provided with guard rails to a height of at least 1 m.

6.14 Every ladder shall be securely placed so that it cannot move either at the top or at the bottom and it shall rise to a height of at least 1.2 m above the place of landing.

6.15 No portable single ladder shall be over 8 m in length.

6.16 Spacing between the side rails of the ladder shall not be less than 300 mm for ladders up to 3 m in length. For longer lengths, this shall be increased at 6 mm for each additional 0.3 m of length.

6.17 Metal ladders must not be used for electrical work or near electric circuit of equipments.

6.18 All scaffolds, ladders and other safety devices mentioned or described herein shall be maintained in safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use.
6.19 Unfinished scaffolding which is under construction shall be prominently marked as unsafe and any access points shall be closed.

6.20 All Planking and Decking on walkways and scaffolds should be adequately supported at each end of the plank and intermediately if necessary. Planks should not be allowed to cantilever beyond the last support but should be overlapped if necessary on to the next plant.

6.21 Shuttering

The above remarks shall be applicable for this also. Shuttering, particularly for slabs, should be treated as a scaffold. Unfinished shuttering should be marked as dangerous similarly the finished formwork should be adequately supported, care being taken to avoid trap door effects.

7.0 MOBILE LIFTING APPLIANCES

7.1 No mobile lifting appliances shall used on a sloping surface unless adequate precautions are taken to ensure stability.

7.2 Adequate precautions shall be taken to see that jib of the mobile crane does not come in contact with overhead electric transmission line.

7.3 Only one person shall give signals to the operator of mobile lifting appliances.

7.4 Maximum load to be lifted by lifting appliances shall be marked in a position where it can be clearly seen by the crane driver and the operator.

7.5 No load shall be raised, lowered or suspended from a chain or rope having a knot in any of the part.

7.6 No chain which is joined to another chain by means of bolt and nut shall be used for raising, lowering or suspending any load.

7.7 All chains, ropes and lifting gears shall be carefully examined and tested by a competent Maintenance Engineer atleast once in every quarter.
7.8 When the work is stopped or when the mobile lifting equipment is not in operation, the boom must be lowered to the horizontal position and tied securely in place to prevent accidental drop.

7.9 No person shall walk under a load which is swinging by a lifting equipment.

Guide rope must be attached to the load to prevent its swinging.

7.10 The foot blocks of the crane before starting work shall be securely supported and firmly anchored to prevent its movement in any direction.

7.11 Use of Hoisting machines and tackle including their attachments, anchorage and supports shall conform to the following standards of condition.

7.11.1 These shall be of good mechanical construction, sound material and adequate strength and free from defect and shall be kept in good working order.

7.11.2 Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength and free from patent defects.

7.11.3 Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years shall be in charge of any hoisting machine or give signals to the operator.

7.11.4 In case of every hoisting machine and every chain ring hook shackle swivel and pulley block used in hoisting or lowering or as means of suspension the safe working load shall be ascertained by adequate means, every hoisting machine and all gears referred to above shall be plainly marked with the safe working load. In case of hoisting machine having a variable safe working loading, each safe working load of the conditions under which it is applicable shall be clearly indicated. No part of any machine or of any gear referred to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing. Mobile cranes shall have the working load and the radius of jib for the load marked on it.
7.11.5 The top pulley for hoisting a load shall be opened monthly and the spindle inspected to see if any undue wear has taken place and for greasing.

7.11.6 In case of departmental machine, the safe working load shall be notified by the Engineer concerned. As regards contractor's machines the Contractor shall notify the safe working load of the machine to the Engineer whenever he brings any machinery to site of work and get it verified by the Engineer concerned.

7.12 Motors, gearing, transmission, electric wiring and other dangerous part of hoisting appliances shall be provided with efficient safeguards. Hoisting appliances shall be provided with such means as will reduce to the minimum, the risk of accidental descent of the load. Adequate precautions shall be taken to reduce to the minimum, risk of any part of a suspended load becoming accidentally displaced.

8.0 RIVETTING, WELDING & GAS CUTTING & STEEL ERECTION

8.1 Rivetting

8.1.1 Bolts covered with wet or slippery compounds shall not be used in fabricating structural work.

8.1.2 The rivet heater must keep the rivet heating equipment as near as possible to the place of work.

8.1.3 A pail of water shall always be kept ready for quenching fire when stopping rivetting work.

8.1.4 Hot rivet shall not be thrown across aisles and shaftways.

8.1.5 Metal buckets for catching hot rivets must have false wooden bottoms to prevent rivets from rebounding.

8.1.6 All rivets, bolts, nuts, and other tools must be kept in boxes and not left loose, (For any further safety measures relevant Indian Standards and safety specifications of structural section shall be referred to).
### 8.2 Welding & Gas Cutting

8.2.1 All cylinders must be used and stored in upright position only.

8.2.2 Cylinders must be stored away from open flames and other source of heat.

8.2.3 Oxygen cylinders must not be stored near other cylinders containing gas or oil, grease or other combustible materials.

8.2.4 While the cylinder is in use, the cylinder valve key or wrench must be placed on the valve spindle.

8.2.5 Before a cylinder is moved, the cylinder valve must be closed.

8.2.6 Gas cutting torches must be lighted by means of friction flames or similar other methods and not with matches.

8.2.7 When torches are being changed or welding stopped for some time valves for all cylinders must be closed.

8.2.8 The coloured lenses used for welding or gas cutting must be of proper shade for the work being done.

8.2.9 Suitable eye protection equipment such as goggles, hand shields etc., must be used by persons engaged in welding or gas cutting operations.

8.2.10 Before any heavy structural member is gas cut, make sure that it is cleared and supported by ropes, cables, chains or any other means to prevent its dropping or swinging.

8.2.11 Cylinder valves and connections are not to be lubricated. All oily or greasy substances must be kept away from cylinders.

8.2.12 Substantial and incombustible screen must be used below or near the welding operations, if there is a possibility of a spark falling on other workmen engaged in work closely.
8.2.13 All air pipe lines and air hoses must be frequently inspected. Air hoses shall not be used for dusting or for cooling purposes.

8.3 Steel Erection

8.3.1 All persons shall stand clear when a crane is sorting or shifting steel girders or other structural materials.

8.3.2 No person shall stand, walk or work beneath any suspended load.

8.3.3 Guide rope must be used for guiding lifting loads.

8.3.4 When guiding a beam or fabricated structure or erection it shall be so held that the employees hands do not get jammed against other objects.

8.3.5 Safety belts equipped with suitable life lines must be used by persons working at heights and standing on structural members. Life line must be tied to an independent support. For any further safety measures, for Structural Steel Works, IS : 7205 - 1974 shall be referred to.

9.0 SAFETY APPLIANCES

9.1 Workers employed on mixing asphaltic materials, cement and lime mortars, shall be provided with protective footwear and protective goggles.

9.2 Those engaged in white washing and mixing or stacking of cement bags or any materials which is injurious to the eyes, shall be provided with protective goggles.

9.3 Those engaged in welding works shall be provided with welder's protective eye-shields.

9.4 Stone breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.
9.5 When workers are employed in sewers and manholes which are in use, the Contractor shall ensure that the manhole covers are opened and chambers are ventilated at least for an hour before the workers are allowed to get into the manholes, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to the public.

9.6 The Contractor shall not employ men below the age of 18 and women on the work of painting with products containing lead in any form. Whenever men above the age of 18 are employed on the work of lead painting the following precautions shall be taken:

9.6.1 No paint containing lead or lead products shall be used except in the form of paste or ready made paint.

9.6.2 Suitable face mask should be supplied for use by them when paint is applied in the form of spray on a surface having lead paint dry rubbed and scraped.

9.6.3 Overalls shall be supplied by the Contractors to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.

9.7 The workers going into inspection chamber shall have gas masks, gum boots and rubber gloves while working inside. After coming out they shall have some disinfectant from the first aid box for proper washing.

9.8 All necessary personnel safety equipment such as safety helmets, safety boots, safety belts, leather gloves for welders, clear glass safety goggles etc., as considered adequate by the engineer have to be kept available for the use of persons employed at the site of work and maintained in condition suitable for immediate use and Contractor shall take steps to ensure proper use of equipment by the workers.

9.9 All the persons entering the tunnel shall be provided with protective wear, such as helmets, steel toe safety shoe, gum boots or other suitable type of protective foot wear. In the case of steeply inclined tunnels and inshafts, safety belts shall also be provided.
9.10 Sign boards 1 x 1.5 m in size with the following wording shall be erected at the access to these areas. "CONSTRUCTION AREA, HELMET REQUIRED BEYOND THIS POINT"

9.11 No loose garments or ragged clothing shall be worn by the personnel engaged in tunneling operation.

9.12 A telephone system shall provided to ensure a positive and quick method of communication between all control location inside tunnel and portal of the tunnels when longer than 500 m and for shafts when longer than 50 m

9.13 Irrespective of length and bends in the tunnel, arrangements shall be made for transmitting of warning signals by any one of the following means.

9.13.1 By electrically operated bells, operated by battery/dry cells with the bell placed outside the tunnel and the position of the switch shifting with the progress of the tunneling work. The position of the operating switch although temporary shall be so chosen as to ensure proper accessibility and easy identification.

9.13.2 By the use of two field (magnet type) telephone.

9.13.3 Any other suitable arrangement like walkie-talkie.

9.14 Arrangement for rendering prompt and adequate first aid to the injured persons shall be maintained at every work site under the guidance of a medical officer-in-charge of the project. Depending upon the magnitude of the work the availability of an ambulance at a very short notice (at telephone call) shall be ensured.

9.15 First-aid arrangements commensurate with the degree of hazard and with the number of workers employed shall be maintained in a readily accessible place throughout the working hours. At least one experienced first-aid attendant with his distinguishing badge shall be available on each shift to take care of injured persons. Arrangements shall be made for calling the medical officer, when such a need may arise. It is recommended that foreman/assistant foreman/supervisor/permanent workmen who are normally present at each working phase in each shift
are given adequate training on first-aid methods to avoid employment of a separate attendant.

9.16 Stretchers and other equipment necessary to remove injured persons shall be provided at every shift.

9.17 Where there are more than 50 persons working in a shift, effective artificial respiration arrangements shall be provided, with trained men capable of providing artificial respiration.

10.0 ELECTRICAL

10.1 Only authorised persons shall handle or otherwise interfere with electrical equipment. Any person detecting electrical apparatus being handled by an unauthorised person or equipment in unsafe condition must report the matter to the Engineer concerned.

10.2 No person shall work on any live electric conductor or apparatus and no person shall assist such person on such work, unless he is authorised in that behalf.

10.2.1 After isolating the equipment from the source of supply before the work begins, a sign 'DON'T SWITCH ON' must be hung on or near the switch to avoid its being accidentally or inadvertently switched on when persons are working.

10.2.2 Take out the fuses and keep in safe custody.

10.2.3 The switch may be locked if locking arrangement exists.

10.2.4 Earth the equipment, before work, to discharge it and short the terminals as a precautionary measure against accidental switching ON.

10.2.5 After the work is finished take out Earthing and shorting link.

10.2.6 Remove all tools and materials from the site of work. Replace the fuses and unlock the switch.
10.2.7 The switch shall only be put 'ON' by the person who switched it 'OFF' or by the person authorised by him in writing.

10.3 When working on live equipment use one hand only whenever possible, it is advisable to keep the other hand behind the back. Shocks from hand to hand are most dangerous.

10.4 All persons handling electrical gear in elevated position must use safety belts. Even a slight shock may cause loss of balance and fall.

10.5 No one shall attempt to extinguish a fire on or near a live electrical apparatus with water. Water is a good conductor of electricity. Use extinguishers wherever provided. Use sand and blankets etc., if available.

10.6 No person shall use any part of electrical equipment for storing or hanging clothes, umbrellas or other articles. Serious accidents occur from this practice.

10.7 For attending the work on O.H. lines or equipment use wooden ladders. Metallic ladders shall not be used.

10.8 Use insulated tools and ensure the insulation is in proper condition periodically at least once in three months. Use rubber gloves wherever possible.

10.9 As far as possible verbal instructions shall be avoided in case of pre-arranged shut-down of electrical apparatus.

10.10 When workers are employed for electrical installations which are already energised, insulating mats, wearing apparel such as gloves, sleeves and boots as may be necessary shall be provided. The workers shall not wear any rings, watches and carry keys or other materials which are good conductors of electricity.

11.0 MISCELLANEOUS

11.1 The Contractor shall provide necessary fencing and lights to protect the public from accident.
11.2 Fire extinguishers adequate in number shall be kept by the Contractor at the site of works where there is risk of fire hazard.

11.3 Adequate washing facilities shall be provided near the place of work.

11.4 When the work is done near any place where there is risk of drowning, all necessary equipments shall be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provisions shall be made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.

11.5 These safety provisions shall be brought to the notice of all concerned by displaying on a Notice Board at a prominent place at the work spot. The persons responsible for compliance of the code shall be named therein by the Contractor.

11.6 To ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangements made by the Contractor shall be open to inspection by the Engineer and Owner.

11.7 Notwithstanding the above clauses there is nothing in those to exempt the Contractor from the operations of any other Act or Rule in force in the Republic of India.

11.8 All storage, handling and use of flammable liquids shall be under the supervision of qualified persons. Flammable liquid shall not be stored inside the tunnel.

11.9 All sources of ignition shall be prohibited in areas where flammable liquids are stored, handled and processed. Suitable warning and 'NO SMOKING' signs shall be posted in all such places. Receptacles containing flammable liquids shall be stacked in such a manner as to permit free passage of air between them.

11.10 All combustible materials shall be continuously removed from such areas where flammable liquids are stored, handled and processed. All spills of flammable liquids shall be cleared up immediately. Containers of flammable liquids shall be tightly capped.
12.0 REPORTING OF ACCIDENT

All accidents, major or minor must be reported immediately. The Contractor, will provide first aid to the injured person immediately and the injured person shall report to the first aid station along with the 'INJURED ON WORK' form duly filled in quintuplicate and submit to the Medical Officer of the First Aid Station”.

Serious Injury

In case of serious injury, the following procedure shall be adopted by the Contractor:

1. Provide First Aid at his own First Aid Station.
2. Take the injured person to the Hospital along with the "INJURED ON WORK" form duly filled in.
3. Reporting the accident to the Owner/Engineer by the Contractor.

Fatal Accident

Fatal accident must be reported immediately to the Engineer/Owner as well as to the Police.

Penalty

Failure to observe the Safety Rules will make the Contractor liable to penalty by way of suspension of work, fine and termination of contract.
SPECIFICATION FOR CIVIL WORKS

ANNEXURE- A

LIST OF IS & IRC CODES REFERRED
LIST OF IS & IRC CODES REFERRED

IS 383 : Specification for coarse & fine aggregates from natural sources for concrete.

IS 2386 (Part 1 to 8) : Method of Test for aggregates for concrete


IS 712 : Specification for building limes.

IS 3182 : Specification for broken brick (burnt clay ) fine aggregate for use in lime mortar.


IS 8041 : Specification for rapid hardening Portland Cement.

<table>
<thead>
<tr>
<th>TITLE</th>
<th>Civil Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 8043</td>
<td>Specification for Hydrophobic Portland Cement</td>
</tr>
<tr>
<td>IS 6452</td>
<td>Specification for high alumina cement for structural use.</td>
</tr>
<tr>
<td>IS 3535</td>
<td>Methods of sampling Hydraulic Cement.</td>
</tr>
<tr>
<td>IS 4031 (Part 1 to 15)</td>
<td>Methods of test for Hydraulic Cement.</td>
</tr>
<tr>
<td>IS 4032</td>
<td>Method of Chemical Analysis of Hydraulic Cement.</td>
</tr>
<tr>
<td>IS 2645</td>
<td>Specification for Integral Cement Waterproofing Compounds.</td>
</tr>
<tr>
<td>IS 1599</td>
<td>Method of Bend Test.</td>
</tr>
<tr>
<td>IS 1608</td>
<td>Method of Tensile Testing of Steel Products.</td>
</tr>
<tr>
<td>IS 6925</td>
<td>Method of test for determination of Water Soluble Chlorides in concrete admixtures.</td>
</tr>
<tr>
<td>IS 432</td>
<td>Specification for mild steel and medium...</td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------</td>
</tr>
<tr>
<td>IS 1786</td>
<td>: Specification for high strength deformed steel bars and wires for concrete reinforcement.</td>
</tr>
<tr>
<td>IS 280</td>
<td>: Mild steel wire for general engineering purposes.</td>
</tr>
<tr>
<td>IS 2062</td>
<td>: Structural steel (Standard Quality).</td>
</tr>
<tr>
<td>IS 1161</td>
<td>: Steel Tubes for Structural purposes.</td>
</tr>
<tr>
<td>IS 5624</td>
<td>: Foundation bolts.</td>
</tr>
<tr>
<td>IS 1363 - (Part 1 to 3)</td>
<td>: Hexagon Head bolts, screws, nuts.</td>
</tr>
<tr>
<td>IS 2016</td>
<td>: Plain washers.</td>
</tr>
<tr>
<td>IS 3063</td>
<td>: Single coil rectangular section spring washers.</td>
</tr>
<tr>
<td>IS 1239 (Part 1&amp;2)</td>
<td>: Mild Steel Tubes and other wrought steel pipe fittings.</td>
</tr>
<tr>
<td>IS 1367</td>
<td>: Technical supply conditions for threaded steel fasteners.</td>
</tr>
<tr>
<td>IS 1030</td>
<td>: Carbon steel castings.</td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>IS 3480</td>
<td>Flexible steel conduit for electrical wiring.</td>
</tr>
<tr>
<td>IS 2667</td>
<td>Fittings for rigid steel conduits for electrical wiring.</td>
</tr>
<tr>
<td>IS 9537 (Part 3)</td>
<td>Conduit for electrical installations - Rigid Plain conduits of insulating material.</td>
</tr>
<tr>
<td>IS 6946</td>
<td>Flexible non-metallic conduits for electrical installations.</td>
</tr>
<tr>
<td>IS 3419</td>
<td>Fittings for rigid non-metallic conduits.</td>
</tr>
<tr>
<td>IS 5913</td>
<td>Methods of tests for Asbestos Cement Products.</td>
</tr>
<tr>
<td>IS 2098</td>
<td>Specification for asbestos cement building boards.</td>
</tr>
<tr>
<td>IS 2096</td>
<td>Specification for asbestos cement flat sheets.</td>
</tr>
<tr>
<td>IS 9537 (Part 2)</td>
<td>Conduit for electrical installations - Rigid steel conduits.</td>
</tr>
<tr>
<td>IS 2614</td>
<td>Method for sampling of fasteners.</td>
</tr>
<tr>
<td>IS 1592</td>
<td>Specification for asbestos cement pressure pipes.</td>
</tr>
<tr>
<td>IS 9627</td>
<td>Specification for asbestos cement pressure pipe (Light duty).</td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>IS 6908</td>
<td>Specification for asbestos cement pipes and fittings for sewerage and drainage.</td>
</tr>
<tr>
<td>IS 1626 (Part 1 to 3)</td>
<td>Specification for asbestos cement building pipes &amp; pipe fittings and roofing fittings</td>
</tr>
<tr>
<td>IS 459</td>
<td>Specification for unreinforced corrugated and semi corrugated asbestos cement sheets</td>
</tr>
<tr>
<td>IS 1077</td>
<td>Specification for common burnt clay building bricks.</td>
</tr>
<tr>
<td>IS 3495 (Part 1 to 4)</td>
<td>Method of Test for burnt clay building bricks.</td>
</tr>
<tr>
<td>IS 3620</td>
<td>Specification for laterite stone block for masonry.</td>
</tr>
<tr>
<td>IS 1121</td>
<td>Method of test for determination of strength properties of natural building stone.</td>
</tr>
<tr>
<td>IS 1124</td>
<td>Method of test for determination of water absorption Sp. Gr. etc. of building stones</td>
</tr>
<tr>
<td>IS 1125</td>
<td>Method of test for determination of weathering of natural building stones.</td>
</tr>
<tr>
<td>IS 1126</td>
<td>Method of test for determination of durability of building stone.</td>
</tr>
<tr>
<td>IS 1127</td>
<td>Recommendation for dimensions and</td>
</tr>
</tbody>
</table>
workmanship of natural building stones for masonry work.

IS 2185 (Part-1) : Specification for concrete masonry unit Hollow and solid concrete blocks.

IS 2116 : Specification for sand for masonry mortar

IS 1542 : Specification for sand for plaster.

IS 2185 (Part-2) : Specification for concrete masonry unit- Hollow and solid light weight concrete blocks.

IS 2185 (Part-3) : Specification for concrete masonry unit - Auto claved Cellular Aerated concrete blocks.


IS 6441 (Part 1 to 9) : Method of Test for Auto claved Concrete Products.

IS 3068 : Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete.

IS 2114 : Code of practice for laying in-situ terrazo floor finish.

IS 460 (Part 1 to 3) : Specification for Test Sieves.

IS 1237 : Specification for cement concrete flooring
<table>
<thead>
<tr>
<th>TITLE</th>
<th>DOCUMENT NO.</th>
<th>EDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil Specification</td>
<td>MEC/ TS/ 05/ 11/ 001</td>
<td>1</td>
</tr>
<tr>
<td>IS 777 : Specification for glazed earthen ware wall tiles.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 1129 : Recommendation for dressing of natural building stone.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 1130 : Specification for Marble (blocks, slabs and tiles).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 809 : Specification for rubber flooring materials for general purposes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 3462 : Specification for unbacked flexible PVC flooring.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 3461 : Specification for PVC asbestos floor tiles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 2818 : Indian Hessians.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 653 : Linoleum sheets and tiles.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 210 : Grey Iron Castings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 2114 : Code of practice for laying in-situ terrazzo finish.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 1198 : Code of practice for laying of linoleum flooring.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>IS 1003 (Part-2)</td>
<td>Specification for timber panelled &amp; glazed shutters, windows and ventilator shutters.</td>
<td></td>
</tr>
<tr>
<td>IS 1141</td>
<td>Code of practice for seasoning of timber.</td>
<td></td>
</tr>
<tr>
<td>IS 1003 (Part-1)</td>
<td>Specification for timber panelled &amp; glazed shutters - Door shutters.</td>
<td></td>
</tr>
<tr>
<td>IS 287</td>
<td>Recommendation for maximum permissible moisture content of timber used for different purposes.</td>
<td></td>
</tr>
<tr>
<td>IS 2202 (Part-1)</td>
<td>Specification for wooden flush door shutters (Solid core type).</td>
<td></td>
</tr>
<tr>
<td>IS 2191 (Part-1&amp;2)</td>
<td>Specification for wooden flush door shutters (cellular and hollow core type).</td>
<td></td>
</tr>
<tr>
<td>IS 3087</td>
<td>Specification for wood particle boards (Medium density) for general purposes.</td>
<td></td>
</tr>
<tr>
<td>IS 3478</td>
<td>Specification for high density wood particle boards.</td>
<td></td>
</tr>
<tr>
<td>IS 3097</td>
<td>Specification for veneered particle boards</td>
<td></td>
</tr>
<tr>
<td>IS 303</td>
<td>Specification for plywood for general purposes.</td>
<td></td>
</tr>
<tr>
<td>IS 1328</td>
<td>Specification for veneered decorative plywood.</td>
<td></td>
</tr>
<tr>
<td>IS 205</td>
<td>Specification for non-ferrous metal butt</td>
<td></td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>IS 1341</td>
<td>Specification for steel butt hinges.</td>
<td></td>
</tr>
<tr>
<td>IS 362</td>
<td>Specification for parliament hinges.</td>
<td></td>
</tr>
<tr>
<td>IS 453</td>
<td>Specification for double acting spring hinges.</td>
<td></td>
</tr>
<tr>
<td>IS 3818</td>
<td>Specification for continuous (Piano) hinges.</td>
<td></td>
</tr>
<tr>
<td>IS 206</td>
<td>Specification for Tee and Strap hinges.</td>
<td></td>
</tr>
<tr>
<td>IS 281</td>
<td>Specification for mild steel sliding door bolts for use with padlocks.</td>
<td></td>
</tr>
<tr>
<td>IS 1019</td>
<td>Specification for rim latches.</td>
<td></td>
</tr>
<tr>
<td>IS 2681</td>
<td>Specification for non-ferrous metal sliding door bolts for use with padlocks.</td>
<td></td>
</tr>
<tr>
<td>IS 204 (Part 1&amp;2)</td>
<td>Specification for tower bolts - Ferrous and Non-ferrous metals.</td>
<td></td>
</tr>
<tr>
<td>IS 208</td>
<td>Specification for door handles.</td>
<td></td>
</tr>
<tr>
<td>IS 2209</td>
<td>Specification for mortice locks (vertical type).</td>
<td></td>
</tr>
<tr>
<td>IS 6607</td>
<td>Specification for rebated mortice locks (vertical type).</td>
<td></td>
</tr>
<tr>
<td>IS 1823</td>
<td>Specification for floor door stoppers.</td>
<td></td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>IS 1837</td>
<td>Specification for fan light pivots.</td>
<td></td>
</tr>
<tr>
<td>IS 207</td>
<td>Gate and shutter hooks and eyes.</td>
<td></td>
</tr>
<tr>
<td>IS 6343</td>
<td>Specification of door closers (pneumatically regulated) for light door weighing upto 40 Kg.</td>
<td></td>
</tr>
<tr>
<td>IS 8756</td>
<td>Specification for ball catches for use in wooden Almirah.</td>
<td></td>
</tr>
<tr>
<td>IS 6315</td>
<td>Specification for floor springs (hydraulically regulated) for heavy doors.</td>
<td></td>
</tr>
<tr>
<td>IS 7197</td>
<td>Specification for Double action floor spring (without oil check) for heavy doors</td>
<td></td>
</tr>
<tr>
<td>IS 364</td>
<td>Specification for fan light catch.</td>
<td></td>
</tr>
<tr>
<td>IS 3828</td>
<td>Specification for ventilator chains.</td>
<td></td>
</tr>
<tr>
<td>IS 363</td>
<td>Specification for hasp and staples.</td>
<td></td>
</tr>
<tr>
<td>IS 9899</td>
<td>Specification for hat, coat and wardrobe hooks.</td>
<td></td>
</tr>
<tr>
<td>IS 729</td>
<td>Specification for drawer locks, cup-board locks and box locks.</td>
<td></td>
</tr>
<tr>
<td>IS 3564</td>
<td>Specification for door closers (Hydraulically regulated).</td>
<td></td>
</tr>
<tr>
<td>IS 4351</td>
<td>Specification for steel door frames.</td>
<td></td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------</td>
<td></td>
</tr>
<tr>
<td>IS 419</td>
<td>Putty for use on window frames.</td>
<td></td>
</tr>
<tr>
<td>IS 5187</td>
<td>Specification for flush bolts.</td>
<td></td>
</tr>
<tr>
<td>IS 3847</td>
<td>Specification for mortice night latches.</td>
<td></td>
</tr>
<tr>
<td>IS 4621</td>
<td>Specification for indicating bolts.</td>
<td></td>
</tr>
<tr>
<td>IS 1038</td>
<td>Specification for steel doors, windows and ventilators.</td>
<td></td>
</tr>
<tr>
<td>IS 1977</td>
<td>Structural steel (ordinary quality).</td>
<td></td>
</tr>
<tr>
<td>IS 1361</td>
<td>Specification for steel windows for industrial buildings.</td>
<td></td>
</tr>
<tr>
<td>IS 7452</td>
<td>Hot rolled steel sections for doors, windows and ventilators.</td>
<td></td>
</tr>
<tr>
<td>IS 1948</td>
<td>Specification for aluminium doors, windows and ventilators.</td>
<td></td>
</tr>
<tr>
<td>IS 1148</td>
<td>Specification for hot rolled rivet bars for structural purposes.</td>
<td></td>
</tr>
<tr>
<td>IS 1949</td>
<td>Specification for aluminium windows for industrial buildings.</td>
<td></td>
</tr>
<tr>
<td>IS 733</td>
<td>Wrought aluminium and aluminium alloy bars, rods and sections (for general use).</td>
<td></td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>IS 6248</td>
<td>Specification for metal rolling shutters and rolling grills.</td>
<td></td>
</tr>
<tr>
<td>IS 1081</td>
<td>Code of practice for fixing and glazing of metal doors, windows and ventilators.</td>
<td></td>
</tr>
<tr>
<td>IS 2339</td>
<td>Specification for Aluminium Paint for general purpose in dual containers.</td>
<td></td>
</tr>
<tr>
<td>IS 2835</td>
<td>Flat Transparent sheet glass.</td>
<td></td>
</tr>
<tr>
<td>IS 5437</td>
<td>Wired and figured glass.</td>
<td></td>
</tr>
<tr>
<td>IS 101 (Part 1 to 8)</td>
<td>Method of sampling and test for paints, varnishes and related products.</td>
<td></td>
</tr>
<tr>
<td>IS 2074</td>
<td>Ready mixed paint, air drying, red oxide zink chrome, priming.</td>
<td></td>
</tr>
<tr>
<td>IS 5410</td>
<td>Cement paint, colour as required.</td>
<td></td>
</tr>
<tr>
<td>IS 427</td>
<td>Distemper, dry, colour as required.</td>
<td></td>
</tr>
<tr>
<td>IS 428</td>
<td>Distemper, oil emulsion, colour as required.</td>
<td></td>
</tr>
<tr>
<td>IS 348</td>
<td>French polish.</td>
<td></td>
</tr>
<tr>
<td>IS 5411 (Part 1&amp;2)</td>
<td>Plastic emulsion paint.</td>
<td></td>
</tr>
<tr>
<td>IS 702</td>
<td>Industrial Bitumen.</td>
<td></td>
</tr>
<tr>
<td>IS 73</td>
<td>Paving Bitumen.</td>
<td></td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>---------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>IS 217</td>
<td>Cut Back Bitumen.</td>
<td></td>
</tr>
<tr>
<td>IS 454</td>
<td>Specification for Digboi type cutback bitumen.</td>
<td></td>
</tr>
<tr>
<td>IS 5467</td>
<td>Specification for shellac Wax.</td>
<td></td>
</tr>
<tr>
<td>IS 3384</td>
<td>Specification for Bitumen primer for use in water proofing and damp proofing.</td>
<td></td>
</tr>
<tr>
<td>IS 290</td>
<td>Specification for Coal Tar Black Paint.</td>
<td></td>
</tr>
<tr>
<td>IS 341</td>
<td>Specification for Black Japan, Type A, B &amp; C.</td>
<td></td>
</tr>
<tr>
<td>IS 1322</td>
<td>Specification for bitumen felts for water proofing and damp proofing.</td>
<td></td>
</tr>
<tr>
<td>IS 218</td>
<td>Specification for creosote oil for use as wood preservative.</td>
<td></td>
</tr>
<tr>
<td>IS 3037</td>
<td>Specification for Bitumen mastic for use in water proofing of roofs.</td>
<td></td>
</tr>
<tr>
<td>IS 1580</td>
<td>Specification for Bituminous compound for water proofing and caulking purposes.</td>
<td></td>
</tr>
<tr>
<td>IS 8542</td>
<td>Specification for polish for wooden furniture paste.</td>
<td></td>
</tr>
<tr>
<td>IS 9862</td>
<td>Ready mixed paint, brushing etc.</td>
<td></td>
</tr>
<tr>
<td>IS 782</td>
<td>Specification for caulking lead.</td>
<td></td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>IS 405 (Part 1&amp;2)</td>
<td>Lead sheet and strips.</td>
<td></td>
</tr>
<tr>
<td>IS 5134</td>
<td>Bitumen impregnated paper.</td>
<td></td>
</tr>
<tr>
<td>IS 2849</td>
<td>Specification for non load bearing gypsum partition blocks.</td>
<td></td>
</tr>
<tr>
<td>IS 8591</td>
<td>Specification for floor polish paste.</td>
<td></td>
</tr>
<tr>
<td>IS 2095</td>
<td>Specification for gypsum plaster boards.</td>
<td></td>
</tr>
<tr>
<td>IS 77</td>
<td>Specification for linseed oil, boiled for paints.</td>
<td></td>
</tr>
<tr>
<td>IS 533</td>
<td>Gum Spirit of turpentine (oil of Turpentine).</td>
<td></td>
</tr>
<tr>
<td>IS 1504</td>
<td>Bees Wax.</td>
<td></td>
</tr>
<tr>
<td>IS 3536</td>
<td>Ready mixed paint, brushing, wood primer pink.</td>
<td></td>
</tr>
<tr>
<td>IS 8273</td>
<td>Specification for gypsum plaster for use in the manufacture of fibrous plaster board.</td>
<td></td>
</tr>
<tr>
<td>IS 5871</td>
<td>Specification for bitumen mastic for tanking and damp proofing.</td>
<td></td>
</tr>
<tr>
<td>IS 651</td>
<td>Specification for salt glazed stoneware pipe and fittings.</td>
<td></td>
</tr>
<tr>
<td>IS 1729</td>
<td>Sand cast iron spigot and socket soil pipe.</td>
<td></td>
</tr>
<tr>
<td>IS 771 (Part 1 to 7)</td>
<td>Specification for glazed fire clay appliances.</td>
<td></td>
</tr>
<tr>
<td>TITLE</td>
<td>Specification</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>IS 1230</td>
<td>Cast iron rain water pipes and fittings.</td>
<td></td>
</tr>
<tr>
<td>IS 774</td>
<td>Flushing cisterns for water closets and urinals.</td>
<td></td>
</tr>
<tr>
<td>IS 2548 (Part 1&amp;2)</td>
<td>Specification for plastic seats and cover for water closet.</td>
<td></td>
</tr>
<tr>
<td>IS 1726</td>
<td>Specification for cast iron manhole cover and frames.</td>
<td></td>
</tr>
<tr>
<td>IS 1239 (Part 1&amp;2)</td>
<td>Mild steel Tubes and fittings.</td>
<td></td>
</tr>
<tr>
<td>IS 4984</td>
<td>Specification for high density polyethylene pipes for potable water supplies: Sewerage and industrial effluents.</td>
<td></td>
</tr>
<tr>
<td>IS 2556 (Part 1 to 15)</td>
<td>Specification for vitreous sanitary appliances (vitreous china).</td>
<td></td>
</tr>
<tr>
<td>IS 7328</td>
<td>High density polyethylene materials.</td>
<td></td>
</tr>
<tr>
<td>IS 4985</td>
<td>Specification for unplasticised PVC pipes for potable water supplies.</td>
<td></td>
</tr>
<tr>
<td>IS 3076</td>
<td>Specification for low density polyethylene pipe for potable water supplies.</td>
<td></td>
</tr>
<tr>
<td>IS 9762</td>
<td>Specification for polyethylene floats for ball valve.</td>
<td></td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>IS 3395</td>
<td>Code of practice for fire safety of industrial buildings.</td>
<td></td>
</tr>
<tr>
<td>IS 7834 (Part 1 to 8)</td>
<td>Specification for injection moulded PVC fittings with solvent cement joint for water supplies.</td>
<td></td>
</tr>
<tr>
<td>IS 8008 (Part 1 to 7)</td>
<td>Specification for injection moulded HDPE fittings for potable water supplies.</td>
<td></td>
</tr>
<tr>
<td>IS 8360 (Part 1 to 3)</td>
<td>Specification for fabricated high density polyethylene fittings for potable water.</td>
<td></td>
</tr>
<tr>
<td>IS 784</td>
<td>Specification for prestressed concrete pipe.</td>
<td></td>
</tr>
<tr>
<td>IS 1703</td>
<td>Specification for copper alloy float valves (horizontal plunger type) for water supply fittings.</td>
<td></td>
</tr>
<tr>
<td>IS 12234</td>
<td>Specification for plastic equilibrium float valve for cold water services.</td>
<td></td>
</tr>
<tr>
<td>IS 778</td>
<td>Specification for copper alloy gate, globe and check valves for water works purposes.</td>
<td></td>
</tr>
<tr>
<td>IS 1536</td>
<td>Centrifugally cast (spun) iron pressure pipes.</td>
<td></td>
</tr>
<tr>
<td>IS 1537</td>
<td>Vertically cast iron pressure pipes for water, gas and sewage.</td>
<td></td>
</tr>
<tr>
<td>IS 1538 (Part 1 to 23)</td>
<td>Sand cast iron spigot and socket soil, waste</td>
<td></td>
</tr>
</tbody>
</table>
and ventilating pipes, fittings and accessories.

<table>
<thead>
<tr>
<th>Title</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 3589</td>
<td>Electrically welded steel pipes for water, gas and sewage.</td>
</tr>
<tr>
<td>IS 781</td>
<td>Specification for cast copper alloy screw down bib taps and stop valves for water services.</td>
</tr>
<tr>
<td>IS 1239 (Part 1&amp;2)</td>
<td>Mild steel tubes and fittings.</td>
</tr>
<tr>
<td>IS 779</td>
<td>Specification for water meters.</td>
</tr>
<tr>
<td>IS 1795</td>
<td>Specification for pillar taps for water supply purposes.</td>
</tr>
<tr>
<td>IS 1363 (Part 1 to 3)</td>
<td>Dimensions for screw thread run-outs and undercuts.</td>
</tr>
<tr>
<td>IS 2016</td>
<td>Plain washers.</td>
</tr>
<tr>
<td>IS 638</td>
<td>Sheet rubber jointing and rubber insertion jointing.</td>
</tr>
<tr>
<td>IS 4127</td>
<td>Code of practice for laying of glazed stoneware pipes.</td>
</tr>
<tr>
<td>IS 458</td>
<td>Specification for precast concrete pipes.</td>
</tr>
<tr>
<td>IRC 19</td>
<td>Standard specification and code of practice for water Bound macadam.</td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>IRC 29</td>
<td>Tentative specification for 4 cm Asphaltic concrete surface course.</td>
</tr>
<tr>
<td>IRC 15</td>
<td>Standard specification and code of practice for construction of concrete roads.</td>
</tr>
<tr>
<td>IS 6313</td>
<td>Code of practice for antitermite measures in building.</td>
</tr>
<tr>
<td>IS 1054</td>
<td>Dieldrin emulsifiable concentrates.</td>
</tr>
<tr>
<td>IS 1308</td>
<td>Aldrin dusting powders.</td>
</tr>
<tr>
<td>IS 6439</td>
<td>Hepta chlor emulsifiable concentrates.</td>
</tr>
<tr>
<td>IS 2632</td>
<td>Crotonaldehyde.</td>
</tr>
<tr>
<td>IS 1791</td>
<td>Specification for batch type concrete mixers.</td>
</tr>
<tr>
<td>IS 10262</td>
<td>Recommended guidelines for concrete mix design.</td>
</tr>
<tr>
<td>IS 1199</td>
<td>Methods of sampling and analysis for concrete.</td>
</tr>
<tr>
<td>IS 516</td>
<td>Method of test for strength of concrete.</td>
</tr>
<tr>
<td>IS 7861 (Part 2)</td>
<td>Code of practice for extreme weather</td>
</tr>
<tr>
<td>TITLE</td>
<td>Document Number</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------</td>
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<tr>
<td>Civil Section</td>
<td>MEC/TS/05/11/001</td>
</tr>
</tbody>
</table>

- **IS 2502**: Code of practice for bending and fixing of bars for concrete reinforcement.
- **IS 2751**: Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
- **IS 800**: Code of practice for general construction in steel and deformed bars.
- **IS 816**: Code of practice for use of metal arc welding.
- **IS 814**: Covered electrodes for manual metal arc.
- **IS 2911 (Part 1 to 4)**: Code of practice for design and construction of pile foundations.
- **IS 1343**: Code of practice for prestressed concrete.
- **IS 1785 (Part 1&2)**: Specification for plane hard drawn steel wires for prestressed concrete.
- **IS 2250**: Code of practice for preparation and use of masonry mortars.
- **IS 1635**: Code of practice for field slaking of building materials.
<table>
<thead>
<tr>
<th>TITLE</th>
<th>Civil Specification</th>
<th>DOCUMENT NO.</th>
<th>Page 20 of 25</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 2212</td>
<td>Code of practice for brick work.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 4101 (Part 1 to 3)</td>
<td>Code of practice for external facing and veneer.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 737</td>
<td>Wrought aluminium and aluminium alloys, sheet and strips (for general engineering purposes).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 2572</td>
<td>Code of practice for construction of hollow connect block masonry.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 1661</td>
<td>Code of practice for application of cement finishes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 5766</td>
<td>Code of practice for laying of burnt clay brick flooring.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 3316</td>
<td>Specification for structural granite.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 1196</td>
<td>Code of practice for laying bitumen mastic flooring.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 1195</td>
<td>Specification for bitumen mastic for flooring.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 3462</td>
<td>Specification for unbacked flexible PVC flooring.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 1198</td>
<td>Code of practice for laying fixing and maintenance of linoleum floor.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 848</td>
<td>Specification for synthetic resin adhesive for plywood.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 4457</td>
<td>Specification for ceramic unglazed vitreous acid resisting tiles.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 851</td>
<td>Specification for synthetic resin adhesive for construction work (non structural) for wood.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 2202 (Part 1&amp;2)</td>
<td>Specification for wooden flush door shutters.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 102</td>
<td>Ready mixed paint.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 1081</td>
<td>Code of practice for fixing and glazing of metal doors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 6248</td>
<td>Specification for metal rolling shutters and rolling grills.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 1868</td>
<td>Anodic coatings on aluminium and its alloys.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 2065</td>
<td>Code of practice for water supply in buildings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 2064</td>
<td>Code of practice for selection, installation and maintenance of sanitary appliances.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 7634 (Part 1 to 3)</td>
<td>Code of practice for plastic pipes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 1742</td>
<td>Code of practice for building drainage.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 5330</td>
<td>Criteria for design of anchor blocks for penstocks with expansion joints.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 3114</td>
<td>Code of practice for laying of cast iron pipes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 783</td>
<td>Code of practice for laying of concrete pipes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRC-63</td>
<td>Tentative guidelines for use of low grade aggregates and soil aggregate mixtures in road pavement construction.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRC-60</td>
<td>Tentative guidelines for use of Lime Fly Ash Concrete as pavement base or sub-base.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRC-74</td>
<td>Tentative guidelines for use of Lean Cement Concrete and lean concrete Fly Ash Concrete as pavement base or sub-base.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS 6509</td>
<td>Code of practice for installation of joints in</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
concrete pavement.

IS 1838 (Part 1) : Specification for performed filler for expansion joint in concrete pavements and structures.

IRC-43 : Recommended practice for Tools, Equipment and appliances for concrete pavement construction.


IS 1346 : Code of practice for water proofing of roofs with bitumen felts.

IS 1609 : Code of practice for laying damp proofing treatment using bitumen felt.


IS 9103 : Specification for admixtures for concrete.

IS 2645 : Specification for integral cement water proofing compounds.

IS 1834 : Specification for hot applied sealing compound for joint in concrete.
<table>
<thead>
<tr>
<th>TITLE</th>
<th>Civil Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 278</td>
<td>Specification for Galvanized barbed wire for fencing.</td>
</tr>
<tr>
<td>IS 2721</td>
<td>Specification for Galvanized steel chain link fabric.</td>
</tr>
<tr>
<td>IS 280</td>
<td>Specification for Mild steel wire.</td>
</tr>
<tr>
<td>IS 4826</td>
<td>Specification for hot dipped galvanized coating on round steel wires.</td>
</tr>
<tr>
<td>IS 1200 (Part 1 to 28)</td>
<td>Method of measurement of building and Civil Engineering Works.</td>
</tr>
<tr>
<td>IS 4081</td>
<td>Safety code for blasting.</td>
</tr>
<tr>
<td>IS 5916</td>
<td>Specification for cast iron gratings for drainage purposes.</td>
</tr>
<tr>
<td>IS 4130</td>
<td>Safety Code for demolition of building.</td>
</tr>
<tr>
<td>IS 3764</td>
<td>Safety code for excavation work.</td>
</tr>
<tr>
<td>IS 5121</td>
<td>Safety code for piling.</td>
</tr>
<tr>
<td>IS 4014 (Part 2)</td>
<td>Code of practice for steel tubular scaffolding.</td>
</tr>
<tr>
<td>IS 3696 (Part 1&amp;2)</td>
<td>Safety code of scaffolds and ladders.</td>
</tr>
<tr>
<td>IS 6922</td>
<td>Criteria for safety and design of structures subject to underground blast.</td>
</tr>
<tr>
<td>TITLE</td>
<td>Civil Specification</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------</td>
</tr>
<tr>
<td>IS 5499</td>
<td>Code of practice for construction of underground raid shelter.</td>
</tr>
<tr>
<td>IS 4138</td>
<td>Safety code for working in compressed air.</td>
</tr>
<tr>
<td>IS 7293</td>
<td>Safety code for working with construction machinery.</td>
</tr>
<tr>
<td>IS 8989</td>
<td>Safety code for erection of concrete framed structures.</td>
</tr>
<tr>
<td>IS 4756</td>
<td>Safety code for Tunneling work.</td>
</tr>
<tr>
<td>IS 7205</td>
<td>Safety code for erection of structural steel works.</td>
</tr>
</tbody>
</table>
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. SCOPE
2. REFERENCE DOCUMENTS
3. MATERIALS
4. COATING REQUIREMENTS
5. APPLICATION METHOD
6. EQUIPMENT
7. MEASUREMENTS & LOGGING
8. PROCEDURE QUALIFICATION
9. APPLICATION OF REINFORCEMENT & CONCRETE COATING
10. TOLERANCES
11. WEIGHING
12. INSPECTION & TESTS
13. COATING OF FIELD WELDS
14. REPAIRS
15. MARKING
16. UNLOADING, TRANSPORT, STORING & HAULING
17. CONCRETE SADDLE WEIGHT
1.0 **SCOPE**

This specification covers requirements for the materials, workmanship, quality assurance and handling for anti buoyancy measures covering the external concrete weight coating of pipelines and concrete saddle weight installation.

1.1 **PART-A : EXTERNAL CONCRETE WEIGHT COATING**

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

1.3 CONTRACTOR shall, execute the work in conformity with all standard practices, specifications, drawing and direction by the COMPANY and provide all services, labour, supervision, all materials, excluding the materials indicated as COMPANY supplied materials in the CONTRACT, equipment, appliances etc. required in or about the execution of the work, whether of a temporary or permanent nature.

1.4 All relevant specifications shall be referred to as per requirement, whether specifically mentioned or otherwise.

2.0 **REFERENCE DOCUMENTS**

2.1 Reference has been made in this specification to the following codes and standards:


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.

g) IS:3370 : Indian standard Code of practice for concrete structures for storage of liquids.


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, deteriorous 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/m³ and the compressive strength shall not be less than 350 kg/cm² in 28 days and 235 kg/cm² 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(m³)  Number of Samples

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<thead>
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<th>Quantity</th>
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<tbody>
<tr>
<td>Upto 25</td>
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<tr>
<td>26 to 50</td>
<td>4</td>
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<tr>
<td>51 and above</td>
<td>4 plus one additional sample for each additional 50m³ or part thereof.</td>
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`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 metre. 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 $32^\circ$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.
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 0.3m², 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 / STANDARD SPECIFICATION FOR CATHODIC PROTECTION WORKS
SPECIFICATION
FOR
TEMPORARY CATHODIC PROTECTION SYSTEM

SPECIFICATION NO.: - MEC/ TS/ 05/ E9/ 016A

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
# CONTENTS

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>SCOPE</td>
</tr>
<tr>
<td>2.0</td>
<td>CODES AND STANDARDS</td>
</tr>
<tr>
<td>3.0</td>
<td>CORROSION DATA</td>
</tr>
<tr>
<td>4.0</td>
<td>CATHODIC PROTECTION DESIGN PARAMETERS</td>
</tr>
<tr>
<td>5.0</td>
<td>CATHODIC PROTECTION DESIGN CRITERIA</td>
</tr>
<tr>
<td>6.0</td>
<td>SYSTEM DETAILS</td>
</tr>
<tr>
<td>7.0</td>
<td>INSTALLATION</td>
</tr>
<tr>
<td>8.0</td>
<td>CIVIL WORKS</td>
</tr>
<tr>
<td>9.0</td>
<td>TESTING AND INSPECTION AT WORKS</td>
</tr>
<tr>
<td>10.0</td>
<td>PACKING AND TRANSPORT</td>
</tr>
<tr>
<td>11.0</td>
<td>SYSTEM TESTING COMMISSIONING AND INTERFERENCE MITIGATION</td>
</tr>
<tr>
<td>12.0</td>
<td>SYSTEM MONITORING</td>
</tr>
<tr>
<td>13.0</td>
<td>DRAWINGS AND DOCUMENTS</td>
</tr>
<tr>
<td>14.0</td>
<td>INSTRUMENTS, TOOLS AND SPARES</td>
</tr>
<tr>
<td>15.0</td>
<td>INFORMATION REQUIRED WITH BID</td>
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PREPARED BY: (Amit Lavania)  
CHECKED & APPROVED BY: (D.K. Pande)  
ISSUE DATE: Feb. 2009
## AMENDMENT STATUS

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<thead>
<tr>
<th>Sl. No.</th>
<th>Clause / Paragraph / Annexure / Exhibit / Drawing Amended</th>
<th>Page No.</th>
<th>Revision</th>
<th>Date</th>
<th>By (Name)</th>
<th>Verified (Name)</th>
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<td>AM</td>
<td>DGM</td>
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<tr>
<td>3</td>
<td>Revised &amp; Issued as standard specification</td>
<td>-</td>
<td>2</td>
<td>Oct-15</td>
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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
   - CIPL 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 :-

   i) NACE Standard SP-0169 : Standard Practice Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
   ii) NACE Publication 10A190 : Measurement technique related to criteria for CP of Underground or Submerged Steel Piping System (as defined in NACE Standard RPO169-83)
   iii) NACE Standard SP-0177 : Standard Practice Mitigation of Alternating Current and Lightning Effects on Metallic
iv) NACE Standard SP-0286 : Standard Practice the electrical isolation of Cathodically Protected Pipelines.
v) NACE Publication No. 54276 : Cathodic Protection Monitoring for Buried Pipelines
vii) NACE Standard SP-200 : Standard Practise for Steel Cased Pipeline Crossings
viii) NACE Standard SP-0104 : The Use of Coupons for Cathodic Protection Monitoring Applications
ix) BS 7361 Part I : Code of Practice for Cathodic Protection for land and Marine applications
x) VDE 0150 : Protection against Corrosion due to Stray Current from DC Installations.
xi) IS : 7098 Part I : XLPE insulated cables.
xii) IS: 8062 : Code of practice for cathodic protection of steel structures
xiii) NACE TM 0497 : Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems

- Peabody book on control of pipeline corrosion

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
- Schedule of rates & Scope of work/PJS
- 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 Pipeline 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 underground 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

<table>
<thead>
<tr>
<th>Pipeline surrounding Resistivity</th>
<th>Minimum Protection current density* Temporary CP (µA/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Soil (10-100 Ohm-Mtr)</td>
<td>60</td>
</tr>
<tr>
<td>Marshy Area/ HDD (&lt;10 Ohm-Mtr)</td>
<td>90</td>
</tr>
<tr>
<td>High Resistivity Area (more than 100 ohm-mtr. Resistivity)</td>
<td>40</td>
</tr>
</tbody>
</table>
(ii) Pipe lines having polyethylene coatings

<table>
<thead>
<tr>
<th>Pipeline surrounding Resistivity</th>
<th>Minimum Protection current density* Temporary CP (µA/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Soil (10-100 Ohm-Mtr)</td>
<td>40</td>
</tr>
<tr>
<td>Marshy Area/ HDD (&lt;10 Ohm-Mtr)</td>
<td>75</td>
</tr>
<tr>
<td>High Resistivity Area (more than 100 ohm-mtr. Resistivity)</td>
<td>25</td>
</tr>
</tbody>
</table>

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-CuSO₄, 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 during the TCP.

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 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.

6.1.12 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.
6.1.13 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:

<table>
<thead>
<tr>
<th>Element</th>
<th>Weight</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Low Potential type)</td>
<td>(High Potential type)</td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>0.15%</td>
<td>0.5 – 1.3%</td>
</tr>
<tr>
<td>Copper</td>
<td>0.02% max.</td>
<td>0.02% max.</td>
</tr>
<tr>
<td>Silicon</td>
<td>0.1% max.</td>
<td>0.05% max.</td>
</tr>
<tr>
<td>Zinc</td>
<td>2.5% - 3.5%</td>
<td></td>
</tr>
<tr>
<td>Aluminium</td>
<td>5.3% - 6.7%</td>
<td>0.01% max.</td>
</tr>
<tr>
<td>Iron</td>
<td>0.003% max.</td>
<td>0.03% max.</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.002% max.</td>
<td>0.001% max.</td>
</tr>
</tbody>
</table>

Other metallic elements
- Each 0.05% max.
- Total 0.3% max.

(ii) Anode closed circuit potential
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:

<table>
<thead>
<tr>
<th>Element</th>
<th>Weight</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type-I</td>
<td>Type-II</td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td>0.1% to 0.5%</td>
<td>0.005% max.</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.025 – 0.07%</td>
<td>0.003% max.</td>
</tr>
<tr>
<td>Copper</td>
<td>0.005% max.</td>
<td>0.002% max.</td>
</tr>
<tr>
<td>Iron</td>
<td>0.005% max.</td>
<td>0.0014% max.</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypsum</td>
<td>75%</td>
</tr>
<tr>
<td>Bentonite</td>
<td>20%</td>
</tr>
<tr>
<td>Sodium Sulphate</td>
<td>5%</td>
</tr>
</tbody>
</table>

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 ± 5%. The total weight of the anodes shall not have negative tolerance.

Recommended dimensional tolerance shall be as follows:

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>± 2.5%</td>
</tr>
<tr>
<td>Width/thickness</td>
<td>± 5%</td>
</tr>
</tbody>
</table>

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 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 all insulating joints
c. At vulnerable locations with drastic changes in soil resistivity
d. At connections of surge diverters, grounding cells and polarisation cells
e. At HV AC/DC overhead line crossings and selected locations where HT overhead line is in the vicinity of the pipeline & running parallel.
f. At location of cable crossing.
g. At tap-off stations, at receipt station.
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, at both sides of railway line 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 high quality shunt & resistor at required locations as a means to monitor and control current flow between the pipeline and foreign pipelines / structures /
6.4.3 Test stations used for sacrificial anodes shall have high quality shunt for measurement of anode current, and provision for resistance insertion to limit the anode current output & anode disconnecting link.

6.4.4 Sealing of Test stations shall be carried out by solid foam sealant or other solid sealing compound as approved by the engineer-in-charge.

6.4.5 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.

6.4.6 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.

6.4.7 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

6.4.8 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.

6.4.9 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 (Solid State) & zinc anodes of minimum 20 kg net wt. each. Grounding shall be done at regular intervals of maximum 0.5 km where transmission lines run parallel within 25 meter of the pipeline through polarisation cell 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 electrified railway tracks etc. that crossing and running parallel to the pipeline in common ROW or within 25 metre from the pipeline.
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) Polarisation cell
   - Type : Solid state (Min. 3.7 kA @ 30 Cycle) or as per scope of work/PJS
   - Rating : Suitable to pass Min 5KA or more surge

(ii) Surge Diverter (Spark Gap Arrester)
   - Type : Spark gap, Explosion Proof Type
   - Current, 8/20 wave : 100 kA
   - Spark over AC voltage : 1 kV
   - 50 Hz : 2.2 kV
   - Impulse (1.2/50) micro sec)

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 2-3 ohms max.

6.6 Polarisation Coupons

The coupon shall have one side exposed area of 10 mm x 10 mm (or as decided in detail engineering to simulate the discharge current from coating holiday) unless otherwise 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/rapid disconnection switch. The magnetic reed switch shall be rated to carry and break minimum 10 mA at 50 V DC.

Polarisation coupons shall be provided as per the requirement of NACE SP104:2014.

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.
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 painted with corrosion resistance paint as per approved procedure.

6.11 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, polarisation 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.

6.12 Cathode Junction Box

Cathode junction box shall be provided as required for Pipe to soil potential measurement circuit & cathode connection. Junction boxes shall have sheet steel enclosure of minimum 3 mm thickness and hinged lockable shutters & Allen key locks. They shall be weatherproof with degree of protection IP-55. Junction boxes shall have cathode bus and terminal plate with adequate number of anti-loosening type of identified terminals.

Cathode junction boxes shall be epoxy coated (Both inside & outside surface).

The negative of the CP power supply source shall be connected to the incoming circuit of the cathode junction box. The junction box shall have separate out going circuit one for each pipeline...
to collect the negative drainage currents from each of the parallel pipelines.

The incoming circuit shall have a current measurement facility. Each outgoing circuit shall have provision for measurement and control of current.

Anodised Al name plate shall be provided inside the CJB with black background with white letters with information same as test station (TLP) Cl. No. 6.4.7 except test station no.

CJB shall be full welded, joint welded CJB shall not be acceptable.

6.13 Permanent Reference Cells

i) High purity copper / copper sulphate reference cells with proven high reliability shall be provided for stable pipe to soil potential measurement reference for existing TR unit with replaced pipeline and along ROW.

ii) Three numbers reference electrodes shall be installed at each cathodic protection station location.

iii) The reference cell for high resistivity areas shall be suitable for the prevailing dry soil conditions to give maximum service life.

iv) Permanent reference cells shall be installed with backfill material.

v) Silver/ Silver Chloride reference cells in place of copper / copper sulphate cells shall be provided at marshy area locations where water table is high and sub-soil water or soil shows chlorine concentration more than 300 PPM.

vi) The cable from reference cells shall be provided upto CP power source at CP stations. The cable shall be routed through cathode junction box near pipeline.

The life of reference cell shall be minimum 10 years under installed condition.

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 Hume pipe 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:

<table>
<thead>
<tr>
<th>Checking</th>
<th>Inspection</th>
<th>Testing</th>
<th>Cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual inspection, comparison with drawings and specifications.</td>
<td>Detailed physical inspection</td>
<td>Simulation tests of equipment to determine its operational fitness.</td>
<td></td>
</tr>
</tbody>
</table>
- 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 energisation 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
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.

<table>
<thead>
<tr>
<th>Submission</th>
<th>No. of Copies</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. For review/approval</td>
<td>4</td>
</tr>
<tr>
<td>b. Drawings issued for execution construction</td>
<td>5+1</td>
</tr>
<tr>
<td>c. Final / As built drawings execution/construction</td>
<td>5+1</td>
</tr>
<tr>
<td>d. Operation/Maintenance manual, vendor data</td>
<td>5+1</td>
</tr>
</tbody>
</table>
13.2 Contract drawings and documents

13.2.1 As a part of the contract, drawings and documents shall be furnished which shall include but not be limited to the following:

   a. Report on corrosion survey
   b. Basis of system design calculations, equipment selection criteria and sizing calculations.
   c. Bill of material, material requisitions, purchase requisitions

13.2.2 Detailed construction drawings (including as built drawings)

   a. Sacrificial anode fabrication drawings
   b. Typical layout drawing for anode ground bed installation and connection
   c. Equipment layout, cable layout and schedules
   d. Fabrication, installation and connection scheme drawing for different types of test stations.
   e. Fabrication and installation details of surge diverter, grounding cell and polarisation cell with its enclosure and housing
   f. Cable-to-pipe joint details for charged and non-charged pipelines.
   g. Incorporation of anode beds, polarisation cell, surge diverters, test stations, etc., and other relevant features of CP system design in Pipeline alignment sheet and other related drawings
   h. Identification of section of pipeline affected by interference, source of interference and details of interference mitigation arrangements provided. various measurement data at all relevant test stations with and without mitigation measures provided.
   i. Detailed commissioning report including various measurement data at all test stations, etc.
   j. Vendor drawings and catalogues, test certificates
   k. Operation and maintenance manual
   l. Miscellaneous

      - Equipment inspection and testing procedure
      - Construction, installation procedures
      - Field testing and commissioning procedures
      - Procedure for monitoring of cathodic protection after commissioning
      - Quality control procedures

14.0 INSTRUMENT, TOOLS AND SPARES

14.1 CONTRACTOR shall supply all instruments, tools and tackles necessary for proper operation and maintenance of complete cathodic protection system and associated equipment.

14.2 CONTRACTOR shall provide a list of spares and consumables required for proper operation and maintenance of part of cathodic protection system to be integrated with permanent CP system
designed on the basis of permanent CP design parameters and associated equipment, for two years operation of the system.

15.0 INFORMATION REQUIRED WITH THE BID

Bidders are advised in their own interest to provide the following information along with the bid without which the bids are liable for summary rejection.

a. Basis and calculations for preliminary system design for cathodic protection system.

b. List of formulas to be used for detailed system design calculations.

c. Basis of system design, design calculations, equipment selection criteria, sizing calculations along with characteristics curves for various equipments.

d. Preliminary bill of material for major equipment.

e. Details of the equipment/material offered along with technical leaflets/related literatures/catalogues, make, rating, type test certificates.

f. Dimensions, weight and general arrangement drawings for each offered equipment.

g. List of instruments, tools and tackles offered for maintenance and operation.

h. List of recommended maintenance/operation spares.

i. Clause-wise deviations, if any, to the specifications along with justifications.

-X-X-X-
SPECIFICATION
FOR
CORROSION SURVEY

SPECIFICATION NO.: MEC/ S/ 05/ 21/ 016C

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092
**CONTENT**

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1.0</td>
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<td>CODES AND STANDARDS</td>
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<tr>
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<td>GENERAL</td>
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<tr>
<td>4.0</td>
<td>SOIL RESISTIVITY SURVEY</td>
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<tr>
<td>5.0</td>
<td>TESTS ON SOIL SAMPLES</td>
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<td>ADDITIONAL DATA COLLECTION</td>
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<td>7.0</td>
<td>REPORT</td>
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<tr>
<td>8.0</td>
<td>INFORMATION REQUIRED AFTER AWARD OF CONTRACT</td>
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<tr>
<td>Sl. No.</td>
<td>Clause / Paragraph / Annexure / Exhibit / Drawing Amended</td>
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<tr>
<td>1</td>
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<tr>
<td>2</td>
<td>Revised &amp; Issued as standard specification</td>
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</table>
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 TM0106:2006 [Detection, Testing, and Evaluation of Microbiologically Influenced Corrosion (MIC) on External Surfaces of Buried Pipelines]
- NACE standards
- Peabody book on control of pipeline corrosion

3.0 **GENERAL**

This specification defines the basic guidelines for carrying out the corrosion survey. Contractor shall be responsible for providing necessary data interpretation based on corrosion survey measurement which is intended to form a basis for design of cathodic protection system for the pipeline to be buried along ROW.

4.0 **SOIL RESISTIVITY SURVEY**

4.1 Unless otherwise specified the soil resistivity measurements shall be carried out at intervals of approximately 500 mtr. along the ROW & at water body crossing. 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 tootography 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 beds two or more ground bed plots may be required to be selected for soil resistivity survey at proposed anode bed location. Depth of soil resistivity shall be as per type of anode ground bed.

For shallow type-1.5, 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 Soil layer resistivity shall be calculated from soil survey results to enable to know the layer resistivity and to compensate the averaging effect of wenner's four pin method.

4.6 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.

4.7 Observations shall be made enclosing the soils adjoining the trench wherever pipeline trenching has already been done.

4.8 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.

4.9 All measurement shall be taken at right angles to the right of way unless otherwise asked by Owner or his representative at site.

4.10 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.

4.11 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.

4.12 Wherever possible/ advised by Owner or his representative depth of water table shall be determined by resistivity observations.

4.13 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 5 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 depth at each location for Tempory CP system & for shallow type anodebed location for Permanent CP system.

The collected soil/ water samples shall be analysed to determine presence and percentage of corrosive compounds i.e. chloride, sulphate, including moisture content, oxygen activity, MIC, presence of bacteria and pH value at NABL accredited laboratories as per NACE TM 106:2006.

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 along with various drawings, graphs etc. prepared in connection with the work shall be submitted along with six prints by the contractor.

8.0 INFORMATION REQUIRED AFTER AWARD OF CONTRACT

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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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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CONTENTS

1.0 GENERAL INFORMATION

2.0 SCOPE OF WORK

3.0 MATERIAL, LABOUR, PLANT AND EQUIPMENT
   3.1 Supplied by Contractor
      3.1.1 Plant and Equipment
      3.1.2 Imported Backfill and Material
      3.1.3 Other Materials

4.0 PROGRESS OF WORK

5.0 APPROVALS

6.0 REFERENCE SPECIFICATION, CODES AND STANDARDS

7.0 SAFETY

8.0 ROUTE SURVEY

9.0 ORGANISATION OF WORK

10.0 STRUCTURES, SERVICES AND OTHER PROPERTY
   10.1 Location of underground Utilities
   10.2 Protection of Structures and Utilities
   10.3 Interference with Traffic, Street Drainage and General Public

11.0 TRENCHING
   11.1 Depth of Trench
   11.2 Width of Trench
   11.3 Trench Base
   11.4 Clearances
   11.5 Underground Interference
   11.6 Others
   11.7 Bedding

12.0 LAYING

13.0 LAYING OF OPTICAL FIBER CABLES/ CONDUIT

14.0 JOINTING OF PE PIPE

15.0 BACK FILLING
<table>
<thead>
<tr>
<th></th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.0</td>
<td>MOLING</td>
</tr>
<tr>
<td>17.0</td>
<td>BORING /RAMMING /DIRECTIONAL DRILLING</td>
</tr>
<tr>
<td>18.0</td>
<td>CASING PIPE</td>
</tr>
<tr>
<td>19.0</td>
<td>RESTORATION</td>
</tr>
<tr>
<td>20.0</td>
<td>TESTING</td>
</tr>
<tr>
<td>21.0</td>
<td>PURGING</td>
</tr>
<tr>
<td>22.0</td>
<td>VALVE PIT</td>
</tr>
<tr>
<td>23.0</td>
<td>PERMANENT MARKER</td>
</tr>
<tr>
<td>24.0</td>
<td>ASSISTANCE IN COMMISSIONING</td>
</tr>
<tr>
<td>25.0</td>
<td>STANDARD OF WORK</td>
</tr>
<tr>
<td>26.0</td>
<td>INSURANCE</td>
</tr>
<tr>
<td>27.0</td>
<td>RECORDING (AS-BUILT DRAWINGS)</td>
</tr>
</tbody>
</table>
TECHNICAL SPECIFICATION

1.0 GENERAL INFORMATION

1.1 INTRODUCTION

1.2 GOA NATURAL GAS PVT. LTD. (GNGPL), a joint venture (JV) of Bharat Petroleum Corporation Limited (BPCL), a Govt. of India Enterprise and GAIL Gas Limited, a fully owned subsidiary company of GAIL (India) Limited has been set up 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 in North Goa GA.

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 GNGPL 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

2.1 Generally the following shall constitute the Contractor’s scope of work:

Plan and prepare a schedule for execution and work implementation as per QA/QC plans to be issued by GNGPL /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 GNGPL/MECON for approval.

2.4 Receipt of free issue items from GNGPL’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 up to 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 trench. Pits to be similarly barricaded along the warning sign.

2.10 To make trenches with stable slopes but restricting minimum disturbance to above ground/underground services/ installation as per specifications and approved route plans; keep the trenches free from water and soil till placement of pipes;

2.11 Uncoiling/ stringing the PE pipes of required sizes (i.e. 20, 32, 63, 90, 125) pipes into trenches as per specification.

2.12 Joining the pipe ends with fittings and valves by approved electro fusion 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, along with 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 up to the entire satisfaction of GNGPL/MECON/ any other third party agency designated by GNGPL 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 GNGPL stores, reconciliation of free issue material/consumables if supplied by GNGPL and obtaining 'no objection certificates' from GNGPL/MECON.

2.23 Handing over the completed works to GNGPL 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 GNGPL.
3.0 MATERIAL, LABOUR, PLANT AND EQUIPMENT

3.1 Owner’s Scope of Supply (Free Issue Item)

Owner’s scope of supply shall be limited to the following:

- MDPE Pipes of sizes from 32 mm Dia to 20 mm dia
- Regulators (Service, Domestic & Commercial)
- Meters (Domestic and Commercial)

In order to speed up the project, Free Issue Materials shall be issued to the Contractor from the designated store(s) of GNGPL. 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 HDPE casing pipe, GI fittings and PE fittings 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 GNGPL / MECON informed. The inspection of bought out items would be carried out by GNGPL / MECON / Third Party Inspection or as instruction by EIC.

In general PE pipe shall be of the following lengths indicated.

<table>
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<th>Size</th>
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<tr>
<td>20mm/32mm</td>
<td>100 to 300 Mtrs. coils</td>
</tr>
<tr>
<td>63 mm</td>
<td>100 Mtrs. Coils</td>
</tr>
<tr>
<td>90 mm</td>
<td>50 Mtrs Coils</td>
</tr>
<tr>
<td>125 mm</td>
<td>50 Mtrs. Coils</td>
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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. In case there is non availability of approved equipments, tools and tackles during the work at site, suitable penalties, as per special terms and condition of the contract, will be levied and deducted from the running bills.

3.2.2 Imported Backfill and Material

The Contractor shall be responsible to arrange the supply of approved soft soil / Coarse Sand free from any impurities like clay,mica and soft flaky pieces as per the instruction of EIC/Owner.

For supply of sand in trench for rocky terrain ,no separate charges are payable and is included in SOR item for excavation of hard rock/Morrum. Also supply of sand in valve chambers ,Normal chambers & Built up surface ,if required ,as per the instruction of EIC,is not separately payable.

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.
- Permanent markers as shown in the drawings enclosed in the tender.
- Material required for installation of valve chambers.
- GI ,Half Round concrete sleeves
- 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.

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 GNGPL 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 be noted and forwarded to stores for replacement immediately with P.O reference and only with written approval of EIC. The contractor shall ensure that no defective material shall be returned to store at the time of closure of contract.

The contractor shall maintain permanent locked store preferably near site 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 a n 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, GNGPL will pay the departmental charges and Bank Guarantees for getting the clearances. It is the contractor's responsibility to inform and co-ordinate the concerned local authorities and also other utility agencies before commencement of work at site. To ensure smooth execution of the work on a day to day basis, the contractor has to liaison with respective authorities and obtains necessary approvals.

6.0 **REFERENCE SPECIFICATION, CODES AND STANDARDS**

The contractor shall carry out the work in accordance with the requirement of latest relevant applicable standards, specification, GNGPL's Engineering Standards; relevant Oil India Safety Directorate (OISD) norms,

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 a sketch of the agreed pipe routes if necessary.

8.3.2 The contractor will be responsible for contacting the customer and making the necessary arrangements for access, and appointments to carry out the work. Contractor shall maintain job card and complaint books at site. GNGPL 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 GNGPL on site. All work will be issued and sanctioned through the EIC and site control exercised by Site Engineer GNGPL/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 GNGPL 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/ GNGPL as is required. The normal day to day issue of work instructions, communication between MECON/ GNGPL and the contractor's supervisor and the SE. No deviation from the approved technical specification / issued construction drawings shall be undertaken without written approval of EIC.

9.5 Contractor shall maintain a Project site office, Material store with following facilities:

- Telephone, Mobile phones, Fax machine, printers/Scanning/Xerox machines, Computer with e-mail facility
- 1 No. four wheeler with driver for suit survey, meetings etc, with Owner/Owners representative. Also it shall be well equipped with tools and tackles for attending any emergency complaints and ongoing execution work.

On award of the contract, The contractor shall establish and submit documentary evidence for above Which will be verified by owner before of the work order. Any delay and non-compliance of above may result into the termination of contract.

10.0 STRUCTURES, SERVICES AND OTHER PROPERTY

10.1 Location of Underground Utilities

The contractor shall locate all buried utility pipes, underground cables, water mains and other obstructions intersecting or adjacent to the Works, and shall make available the necessary labour to expose and record the depth of cover over all obstructions in advance of excavation. This shall be done far enough in advance of excavation to facilitate gradual change in grade or position found necessary to clear any obstructions.

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.

It is contractor's responsibility to interact with other utility agencies regarding their existing utilities and finalize the route along with these agencies and Owner/Owner's representative.

There will be no additional payments in respect of a 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 landslides, the pipeline trench shall be maintained open only for the time strictly necessary. GNGPL 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:

* Refer PJS clause No. 17.0 SPECIAL POINTS PERTAINING TO SPECIFICATION.

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 GNGPL.

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.

- **150-300 mm** 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 GNGPL 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 GNGPL. 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/ GNGPL.

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 GNGPL.

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 GNGPL.

The Contractor shall excavate all such aforesaid depths as may be required at no extra cost of GNGPL.

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 GNGPL or relevant authorities.
Where the pipeline crosses underground utilities/structures, Contractor shall first manually excavate to a depth and in such a manner that the utilities/structures are located, then proceed with the conventional methods.

The locations, where the pipeline has to be laid more or less parallel to an existing pipeline cable and/or other utilities in the Right-of-way the Contractor shall maintain proper distances and perform the work to the satisfaction of GNGPL 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 conform 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 nullah. 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 PE 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 GNGPL/ 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 GNGPL/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 GNGPL.

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 GNGPL. 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 up to 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/GNGPL 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 up to 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 GNGPL/ MECON, and approved procedures. The contractor has to carry out thorough survey of the underground utilities before going for the Moling, to avoid the damage to the other utilities.

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 / GNGPL. 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.**

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 pipe.

Any damages occurred to other utilities during the Moling operation shall be immediately notified and rectified by the contractor without any cost implication to GNGPL.
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/ GNGPL. Execution of the work shall be based on the MECON/ GNGPL approved drawings. The contractor has done the thorough survey of the underground utilities before commencement of BORING/ RAMMING/ DIRECTIONAL DRILLING to avoid the damage to the other utilities. No extra payment will be made for any trail/ abandoned pits made during the survey. The supply of all equipments is in Contractors scope. Work to be carried out in accordance with API - 1102.

Once the work is allotted, Any delay in mobilizing / non - availability of HDD machines as per site requirement and conditions shall result in levying of penalties on daily basis as per SCC.

The type of HDD to be carried out i.e. conventional (with or without casing) shall be at the discretion of GNGPL/ 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 GNGPL.

The length of the HOLE (excluding the sizes of the pits on both ends) shall be considered of HDD length.

**18.0 CASING PIPE**

The tentative sizes of the HDPE casing pipe for Moling/ HDD shall be as follows:-

<table>
<thead>
<tr>
<th>Size of MDPE pipe</th>
<th>Size of HDPE pipe</th>
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<tbody>
<tr>
<td>20 mm</td>
<td>75 mm</td>
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<tr>
<td>32 mm</td>
<td>75 mm</td>
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<tr>
<td>63 mm</td>
<td>125 mm</td>
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<tr>
<td>90 mm</td>
<td>180 mm</td>
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<td>125mm</td>
<td>250mm</td>
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<tr>
<td>180 mm</td>
<td>315 mm</td>
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</table>
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 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 slabs or blocks should be tamped 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 initial-satisfactory restoration, and where the sites has been cleared of all surplus materials, etc.**

Contractor has to obtain the clearance certificate from the concerned local authorities after completion of the restoration work. The restoration specification specified in the tender is only a typical specification and the contractor has to carry out restoration as per latest version of the (PWD/ IRC) specification to its original condition and also to the entire satisfaction of land owner (Private/Public).
The expenditure incurred towards testing of the material used for restoration as per applicable standards, shall be 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 6.0 bar(g), and there shall be no unaccountable pressure loss during the test period.

Test procedure with sketches showing the pipeline to be tested, vent points, gauge location, and inlet pressure print is to 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 relevant SOR item.

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 respective Item in 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 GNGPL’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 GNGPL/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 execute / supervise the work. However, the assessment on the qualification of the personal shall be at the discretion of EIC.
Fusion operators and other skilled personnel shall be approved by GNGPL/ 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 clearly mentioned in the as laid.

Gas objects (off valve, tees, elbows, couplers, T.F, etc) shall be shown as block objects (which from a single node to connect) with respect owners symbol and legend. The as laid drawing shall be as per the legends provided by EIC.

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 hydias/ 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 GNGPL. 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

HDPE PIPES

MECON LIMITED
(A Govt. of India Undertaking)
15th Floor, SCOPE Minar, North Tower
Laxmi Nagar District Centre,
DELHI – 110 092
<table>
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<th>Description</th>
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<td>2.0</td>
<td>SCOPE OF WORK</td>
<td>1</td>
</tr>
<tr>
<td>3.0</td>
<td>INSTRUCTION TO THE TENDERER</td>
<td>1</td>
</tr>
</tbody>
</table>
1.0 **INTENT OF SPECIFICATION**

The intent of this specification is to establish minimum requirements to manufacture and supply of HDPE Pipes used for casing purpose of carrier pipe, supplying natural gas.

2.0 **SCOPE OF WORK**

2.1 The scope of the tendered will include manufacture/ supply, inspection/ testing/ marking/ packaging/ handling and despatch of HDPE Pipes of ratings and grades as indicated in the Material Requisition & Schedule of Rates, as per IS:4984 (Specification for HDPE Pipes for water supply).

2.2 All codes and standards for manufacture, testing, inspection etc. shall be of latest edition.

2.3 Purchaser reserves the right to delete or order additional quantities during execution of order, based on unit rates and other terms & conditions in the original order.

3.0 **INSTRUCTION OF TENDERER**

3.1 Length of the Pipes and their supply will be as per following :-

- DN 50 – In each coils of 100 mtrs. length
- DN 90 – Each pipe of 12 mtrs. length minimum
- DN 110 – Each pipe of 12 mtrs. length minimum
- DN 250 – Each pipe of 12 mtrs. length minimum
- DN 315 – Each pipe of 12 mtrs. length minimum

3.2 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.

3.3 The successful bidder shall submit following for approval of Purchaser/ Consultant after placement of order

a) The Quality Assurance Plan (QAP & Sampling Plan)

b) Material test report as per clause 5 of IS:4984.
c) Performance Requirements (clause 8 of IS:4984)

d) Type Test (clause 9.1 of IS:4984).

3.4 The bidder shall submit following documents at the time of bidding,

a) BIS Certification

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.
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

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>SCOPE AND FIELD OF APPLICATION</td>
<td>02</td>
</tr>
<tr>
<td>2.0</td>
<td>EQUIPMENT</td>
<td>02</td>
</tr>
<tr>
<td>3.0</td>
<td>SYMBOLS &amp; DEFINITIONS</td>
<td>09</td>
</tr>
<tr>
<td>4.0</td>
<td>DESIGNATION</td>
<td>16</td>
</tr>
<tr>
<td>5.0</td>
<td>DESIGN</td>
<td>19</td>
</tr>
<tr>
<td>6.0</td>
<td>ELECTRICAL CHARACTERISTICS</td>
<td>20</td>
</tr>
<tr>
<td>7.0</td>
<td>DIMENSIONAL</td>
<td>21</td>
</tr>
<tr>
<td>8.0</td>
<td>PERFORMANCE REQUIREMENTS</td>
<td>24</td>
</tr>
<tr>
<td>9.0</td>
<td>MARKING</td>
<td>26</td>
</tr>
<tr>
<td>10.0</td>
<td>PACKAGING</td>
<td>27</td>
</tr>
</tbody>
</table>
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 from 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 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.
**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, \[ SDR = \frac{dn}{en} \]
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 overall 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 continuous use. It takes into account the physical and the mechanic characteristics of the components of a piping system.

\[ MOP = \frac{20 \times \text{MRS}}{C \times (\text{SDR}-1)} \]

Note: It is given by the equation.
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>
<thead>
<tr>
<th>Material</th>
<th>M.R.S. Mpa</th>
<th>1 cl (20° C, 50 Yrs 97.5%) Mpa</th>
<th>Maximum Allowable Operating Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE 80</td>
<td>8.0</td>
<td>8.00 ≤ 1 cl ≤ 9.99</td>
<td>5.5 Bar</td>
</tr>
<tr>
<td>PE 100</td>
<td>10.0</td>
<td>10.00 ≤ 1 cl ≤ 11.19</td>
<td>7.0 Bar</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Units</th>
<th>Requirements</th>
<th>Test Parameters</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Density</td>
<td>Kg/m³</td>
<td>≥ 930 (base polymer)</td>
<td>23 °C</td>
<td>ISO 1183 - ISO 1872/1</td>
</tr>
<tr>
<td>Melt Mass-flow Rate</td>
<td>g/10 min</td>
<td>± 20% of value nominated by compound producer</td>
<td>190 °C condition 18</td>
<td>ISO 1133</td>
</tr>
<tr>
<td>Thermal Stability</td>
<td>Minutes</td>
<td>&gt; 20</td>
<td>200 °C (2)</td>
<td>ISO TR 10837</td>
</tr>
<tr>
<td>Volatile Content at Extrusion</td>
<td>mg/kg</td>
<td>≤ 350</td>
<td></td>
<td>ISO 4437 Annex. A</td>
</tr>
<tr>
<td>Water Content (3)</td>
<td>mg/kg</td>
<td>≤ 300</td>
<td></td>
<td>ASTM D 4019</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>% (m/m)</td>
<td>2.0 ≤ ... ≤ 2.5</td>
<td></td>
<td>ISO 696</td>
</tr>
<tr>
<td>Carbon Black Dispersion (4)</td>
<td>Grade</td>
<td>≤ 3</td>
<td></td>
<td>ISO DIS 11420</td>
</tr>
<tr>
<td>Pigment Dispersion (5)</td>
<td>Grade</td>
<td>≤ 3</td>
<td></td>
<td>ISO DIS 13949</td>
</tr>
<tr>
<td>Resistance to Gas Constituents</td>
<td>h</td>
<td>≥ 20</td>
<td>80 °C 2 Mpa</td>
<td>ISO 4437 Annex. B</td>
</tr>
<tr>
<td>Resistance to rapid crack propagation (RCP) (6)</td>
<td>Mpa</td>
<td>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</td>
<td>0°C</td>
<td>ISO DIS 13478</td>
</tr>
<tr>
<td>Full Scale (FS) test : d ≥ 250mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Or</td>
<td>Mpa</td>
<td>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)</td>
<td>0°C</td>
<td>ISO DIS 13477</td>
</tr>
<tr>
<td>S4 Test : in principle according to all diameters (7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance to slow crack growth en &gt; 5mm</td>
<td>h</td>
<td>165</td>
<td>80 °C, 8.0 bar (f) (9)</td>
<td>ISO DIS 13479</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>80 °C, 9.2 bar (f) (10)</td>
<td></td>
</tr>
</tbody>
</table>

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 male 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 $23 \pm 2^\circ$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 $30 \pm 2^\circ$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**

<table>
<thead>
<tr>
<th>Pipe Size d mm</th>
<th>Limits for average diameter d on each fitting measured over apparent fusion length L mm</th>
<th>Apparent fusion length L mm</th>
<th>Penetration depth L mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum</td>
<td>Minimum</td>
<td>Minimum</td>
</tr>
<tr>
<td>16</td>
<td>16.6</td>
<td>16.4</td>
<td>15</td>
</tr>
<tr>
<td>20</td>
<td>20.6</td>
<td>20.4</td>
<td>16</td>
</tr>
<tr>
<td>25</td>
<td>25.6</td>
<td>25.4</td>
<td>18</td>
</tr>
<tr>
<td>32</td>
<td>32.9</td>
<td>32.5</td>
<td>18</td>
</tr>
<tr>
<td>40</td>
<td>41.0</td>
<td>40.6</td>
<td>18</td>
</tr>
<tr>
<td>50</td>
<td>51.1</td>
<td>50.7</td>
<td>20</td>
</tr>
<tr>
<td>55</td>
<td>56.1</td>
<td>55.7</td>
<td>21</td>
</tr>
<tr>
<td>63</td>
<td>64.1</td>
<td>63.7</td>
<td>23</td>
</tr>
<tr>
<td>75</td>
<td>76.3</td>
<td>75.9</td>
<td>25</td>
</tr>
<tr>
<td>90</td>
<td>91.5</td>
<td>91.1</td>
<td>28</td>
</tr>
<tr>
<td>110</td>
<td>111.3</td>
<td>111.1</td>
<td>32</td>
</tr>
<tr>
<td>125</td>
<td>126.7</td>
<td>126.2</td>
<td>35</td>
</tr>
<tr>
<td>140</td>
<td>141.7</td>
<td>141.2</td>
<td>38</td>
</tr>
<tr>
<td>160</td>
<td>162.1</td>
<td>161.4</td>
<td>42</td>
</tr>
<tr>
<td>180</td>
<td>182.1</td>
<td>181.5</td>
<td>46</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>Major Diameter mm</th>
<th>Maximum Length mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>90</td>
</tr>
<tr>
<td>32</td>
<td>90</td>
</tr>
<tr>
<td>63</td>
<td>120</td>
</tr>
<tr>
<td>90</td>
<td>180</td>
</tr>
<tr>
<td>125</td>
<td>215</td>
</tr>
<tr>
<td>180</td>
<td>280</td>
</tr>
<tr>
<td>200</td>
<td>245</td>
</tr>
<tr>
<td>225</td>
<td>260</td>
</tr>
<tr>
<td>250</td>
<td>280</td>
</tr>
<tr>
<td>280</td>
<td>300</td>
</tr>
<tr>
<td>315</td>
<td>320</td>
</tr>
</tbody>
</table>

### TABLE 5: BRANCH SADDLE ASSEMBLY OUTLET LENGTH

<table>
<thead>
<tr>
<th>Off-take Size mm</th>
<th>Shut-off method</th>
<th>Dimension from flange face to crown of main</th>
<th>Dimension from pipe end to crown of main</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Class B fitting mm</td>
<td>Class B fitting mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Class B fitting mm</td>
<td>Class B fitting mm</td>
</tr>
<tr>
<td>63</td>
<td>Valve</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>63</td>
<td>Squeeze</td>
<td>-</td>
<td>260*</td>
</tr>
<tr>
<td>90</td>
<td>Valve</td>
<td>-</td>
<td>400</td>
</tr>
<tr>
<td>90</td>
<td>Squeeze</td>
<td>400</td>
<td>180**</td>
</tr>
<tr>
<td>125</td>
<td>Valve</td>
<td>-</td>
<td>550</td>
</tr>
<tr>
<td>125</td>
<td>Squeeze</td>
<td>360</td>
<td>180***</td>
</tr>
<tr>
<td>180</td>
<td>Valve</td>
<td>-</td>
<td>750</td>
</tr>
<tr>
<td>180</td>
<td>Squeeze</td>
<td>360</td>
<td>180+</td>
</tr>
<tr>
<td>250</td>
<td>Valve</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>250</td>
<td>Squeeze</td>
<td>360</td>
<td>180++</td>
</tr>
</tbody>
</table>

* 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**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Units</th>
<th>Requirements I</th>
<th>Test</th>
<th>Parameters</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrostatic strength at 20°C</td>
<td>H</td>
<td>Failure time ≥ 100</td>
<td>End caps orientation conditioning time. Type of test circumferential (hoop) stress pipe PE 80, PE 100, Test temperature.</td>
<td>Type a) free 1 h, 9 Mpa, 12.4 Mpa, 20°C</td>
<td>ISO DIS 9356</td>
</tr>
<tr>
<td>Hydrostatic strength at 80°C</td>
<td>H</td>
<td>Failure time ≥ 165</td>
<td>End caps orientation conditioning time. Type of test circumferential (hoop) stress pipe PE 80, PE 100, Test temperature.</td>
<td>Type a) free 12 h water-in-water, 4.6 Mpa 5.5 Mpa 80°C</td>
<td>ISO DIS 9356</td>
</tr>
<tr>
<td>Hydrostatic strength at 80°C</td>
<td>H</td>
<td>Failure time ≥ 1000</td>
<td>End caps orientation conditioning time. Type of test circumferential (hoop) stress pipe PE 80, PE 100, Test temperature.</td>
<td>Type a) free 12 h water-in-water, 4 Mpa, 5 Mpa, 80°C</td>
<td>ISO DIS 9356</td>
</tr>
<tr>
<td>Cohesive resistance</td>
<td>mm</td>
<td>Length of initiation of brittle fracture L/3</td>
<td>Test temperature choice of method</td>
<td>23°C</td>
<td>ISO 13954 (A), ISO 13955 (A), ISO 13956 (B)</td>
</tr>
<tr>
<td>Impact strength (B)</td>
<td></td>
<td>No failure, No leakage</td>
<td>Test temperature&lt;br&gt;Falling height&lt;br&gt;Mass of the striker</td>
<td>20°C, 23°C&lt;br&gt;5m&lt;br&gt;5kg</td>
<td>ISO DIS 13957</td>
</tr>
</tbody>
</table>
(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**

<table>
<thead>
<tr>
<th>PE-80</th>
<th>PE-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress Mpa</td>
<td>Minimum Failure Stress Mpa</td>
</tr>
<tr>
<td>4.6</td>
<td>165</td>
</tr>
<tr>
<td>4.5</td>
<td>219</td>
</tr>
<tr>
<td>4.4</td>
<td>293</td>
</tr>
<tr>
<td>4.3</td>
<td>394</td>
</tr>
<tr>
<td>4.2</td>
<td>533</td>
</tr>
<tr>
<td>4.1</td>
<td>727</td>
</tr>
<tr>
<td>4.0</td>
<td>100</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Property</th>
<th>Units</th>
<th>Requirements</th>
<th>Test Parameters</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Stability</td>
<td>Minutes</td>
<td>&gt; 20</td>
<td>200 °C (1)</td>
<td>ISO TR 10837</td>
</tr>
<tr>
<td>Property</td>
<td>Units</td>
<td>Requirements</td>
<td>Test Parameters</td>
<td>Test Method</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------</td>
<td>------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Melt Mass-flow Rate (MFR)</td>
<td>g/10 min</td>
<td>0.2 ≤ MFR ≤ 1.4 and after processing maximum deviation of ± 20% of the value measured on the batch compound</td>
<td>Condition 18</td>
<td>ISO 4440.1</td>
</tr>
</tbody>
</table>

(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
**CONTENTS**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>INTENT OF SPECIFICATION</td>
<td>2</td>
</tr>
<tr>
<td>2.0</td>
<td>INSTRUCTION TO THE TENDERER</td>
<td>2</td>
</tr>
</tbody>
</table>
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 along with 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.
TECHNICAL SPECIFICATION

FOR

ISOLATION & APPLIANCE BALL VALVES

MECON LIMITED
(A Govt. of India Undertaking)
15th Floor, SCOPE Minar, North Tower
Laxmi Nagar District Centre,
DELHI – 110 092
<table>
<thead>
<tr>
<th>Sl.No.</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>INTENT OF SPECIFICATION</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>MATERIAL SPECIFICATION FOR ISOLATION VALVES</td>
<td>1</td>
</tr>
<tr>
<td>3.0</td>
<td>MATERIAL SPECIFICATION FOR APPLIANCE VALVES</td>
<td>2</td>
</tr>
</tbody>
</table>
1.0 INTENT OF SPECIFICATION

The intent of this specification is to establish minimum requirements to manufacture and supply of Isolation & Appliance Ball Valves used for supply of natural gas.

2 MATERIAL SPECIFICATION FOR ISOLATION VALVES

2.1 Technical Data Sheet
2.1.1 Item-Isolation Ball Valve with Full Bore, NPT Female (Confirming to ANSI B1.20.1) ends for natural gas application).
2.1.2 Sizes : ½”, ¾” ..
2.1.3 Body : Hot Pressed/ Forged Brass, Nickel/ Chrome Plated.
2.1.3.1 Ball : Hard Chrome/ Nickel Plated Hot Pressed/ Machined Brass Bar with Teflon Seat.
2.1.5 With operating Knob and locking arrangement with sealing wire and lead seal (Without Key). Valve full open/ close position shall be at 90°.
2.1.6 Maximum Operating Pressure : 4.0 Bar (g)
2.1.7 Hydrostatic Test Pressure : 6.0 Bar (g)
2.1.8 Markings

Markings shall be provided & shall include :

Manufacturer’s name or trade mark Model designation.
Rate working pressure in Bar.
Direction of flow, if necessary.

2.1.9 Leakage : The permissible external/ internal leakage shall be specified by the vendor, with reference to relevant code. However, in no case the leakage in both the cases shall exceed 1 ml/ min at maximum working pressure specified.

2.1.10 Mechanical Strength

i) The body of the valves shall be capable of with standing without deformation or leakage 125 Nm torque, as applied to a pipe being connected to the valve.
ii) Valve shall be capable of withstanding without deformation or leakage 340 Nm bending moment or an angular displacement of 10° whichever occurs first, if applied to a pipe connected to the valve.

iii) The valves shall be capable of withstanding 25 Nm impact without breakage or leakage.

3.0 MATERIAL SPECIFICATION FOR APPLIANCE VALVES

3.1 Technical Data Sheet

3.1.1 Item

Application Ball Valve of Full Bore with 1/2” NPT (Confirming to ANSI B1.20.1) Female as an inlet and the outlet shall be having Ni/ Cr plated brass or steel a nozzle (Serrated to suit 1/4” rubber tubing/ hose connection) and the material is required for Domestic Natural Gas Service.

3.1.2 Body: Total body including the nozzle shall be of Hot Pressed/ Forged Brass, Nickel/ Chrome Plated.

3.1.3 Ball - Hard Chrome/ Nickel Plated Hot Pressed/ Machined Brass Bar with Teflon Seat.

3.1.4 With a metallic operating/ knob/ lever for full open/ close at 90° position.

3.1.5 Maximum Operating Pressure: 35 milli Bar (g)

3.1.6 Hydrostatic Test Pressure: 1.0 Bar (g)

3.1.7 Markings

Markings shall be provided & shall include:

i) Manufacturer’s name or trade mark

ii) Model designation

iii) Rate working pressure in Bar

iv) Direction of flow, if necessary

3.1.8 Leakage

The permissible external/ internal leakage shall be specified by the vendor, with reference to relevant code. However, in no case the leakage in both the cases shall exceed 1 ml/ min at maximum working pressure specified.
3.1.9 Mechanical Strength

i) The body of the valves shall be capable of withstanding without deformation or leakage 75 Nm torque, as applied to a pipe being connected to the valve.

ii) Valve shall be capable of withstanding without deformation or leakage 125 Nm bending moment or an angular displacement of 10° whichever occurs first, if applied to a pipe connected to the valve.

iii) The valves shall be capable of withstanding 25 Nm impact without breakage or leakage.