OUTDOOR SUBSTATION AT WTP

1/2" Electrical Insulation Board
1" Insulat. Rod
1" Insulat. Box
2" Box

The following equipment will be placed in the indoor substation:
- Indoor substation:Indoor meter room 5X10'X6'0"Indoor plant room 20'x10'x6'0"
- 70kV Panel Switch Panel with Air
- LT Distribution Panel with Air
- 2FL 400/400Y/230V Y-Style Transformer (in 400V/240V/120V with 400V Neutral) Transformer
- LT LV 480V/230V Transformer
- LT LV 240V/120V Transformer
- Double substation or LT & SL& S Switchboard
- Metering Equipment in the meter room
- Incoming 12KV line 2 Pole Structure

MEDICAL INCOMING

Supply 1KV

LT DISTRIBUTION PANEL

MTR RM
11 – MS PIPELINE

DETAILED SPECIFICATION

General

Following specifications are in amplification OR in addition to the specifications for the respective item given in P.W.D. Hand Book Volume I and II (Latest Edition), Red Book of Government of Maharashtra and shall be strictly adhered to. Relevant ISS and latest amendments thereon shall also be referred.

Alignment

Alignments and line out for the work shall be carried out by the Contractor as per directions of the Engineer in charge and the work shall be carried out as per the alignment, for which Contractor has to provide at this cost all materials such as sight-rails, boning rods, peg nails, chunna, flags, etc and also the required labour for line outs. The cost of constructing pillars, platforms for temporary benchmarks is also to be borne by the Contractor.

Providing MS Pipes

The pumping main and gravity main pipes are to be manufactured from MS Plate / HRC of a grade Fe 410 factory lined by centrifugal spinning with controlled conditions for internal (lining) and shall have external coating (guniting) with appropriate grade of cement mortar as per Indian standard 3589-2001 or its latest edition. The length of pipe should not less than six meters. The thickness of internal cement mortar lining and the thickness of cement mortar out coating (guniting) and the proportion of mortar shall be as per the wording of item in schedule B.

1. Pipes to be supplied under this contract should be of spirally welded only and shall conform to IS 3589-2001 or its latest edition.
2. In case Supplier proposes to supply pipes to the standards superior to the above standards no weightage will be given while evaluating the bid and for payment.
3. Specific Requirements.

1) Method of Manufacture
i) Electric resistance welded (ERW)
ii) Submerge Arc Welded (SAW)

2) Applicable Standards (with latest editions)
ISO-1977 welded or seamless steel tubes for water, sewage and gas.
BS 3601-1974 steel pipes and tubes for pressure purposes, carbon steel, ordinary duties.
API 5L-1980 specification for gas line pipe.
IS 3589-2001 specification for steel pipes for water and sewage.
IS 4711-1964 methods of sampling of steel pipes, tube and fittings.
IS 1894-1972 methods of tensile testing of steel tubes.
IS 5822-1986 code of practice for laying and jointing MS pipes.

3) Inspection

Inspection of MS pipe is divided in two parts.

**Inspection during manufacturing**
- a) Identification of plate/strip material for manufacturing.
- b) Qualification of welding process to be used for manufacturing of pipes.
- c) Qualification of welders.
- d) Dimensional check before start of welding to avoid rejection at a later stage.

**Inspection of ready-built pipes**
- a) Visual inspection
- b) Dimensional check,
- c) Hydraulic tests for pressure,
- d) Mechanical Tests
  - a) Tensile test,
  - b) Flattening test (for ERW pipes only)

**Testing and Acceptance Criteria**

**Visual Inspection**
All pipes shall be free from defects such as cracks, surface flaws, laminations, etc. The ends shall be cleanly cut and reasonably square with axis of the pipe.

**Dimensions and Tolerances**
The dimensions such as ID / OD and thickness shall conform to the requirement of order and applicable specifications. **No negative tolerance in thickness is allowed.**

**Straightness**
Finished pipe shall not deviate from straightness by more than 0.2% of the total length or 6mm which is lower irrespective of the length of pipe.

**Hydraulic Pressure Test**
Each pipe shall be hydraulically tested at manufacture’s works. The hydraulic test pressure is calculated from the formula.

\[
P = \frac{2 \times ST}{D}
\]
Where,

\[ P = \text{Test pressure in MPa} \]
\[ S = \text{Stress in MPa which is taken as 60\% of the specified minimum yield stress. The maximum test pressure to be limited to 5 MPa wherever applicable.} \]
\[ T = \text{Specified thickness in mm} \]
\[ D = \text{Specified outside diameter in mm} \]

**Mechanical Test**

**Sampling**

The procedure for sampling of pipes for various tests and criteria for conformity shall be as given in IS 4711-1974.

**Tensile Test**

Tensile test shall be carried out as per IS 1894-1972. The parent metal of pipe is subjected for measurement of ultimate tensile and elongation properties. Another sample is taken for testing of strength of the weld, the ultimate tensile strength of which should normally be more than or equal to ultimate tensile of parent metal. However, the minimum mechanical properties for pipes as per IS 3589-1991 should be as under:

<table>
<thead>
<tr>
<th>Steel Grade (Fe)</th>
<th>Tensile Strength (Min. Mpa)</th>
<th>Percentage (Min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>410</td>
<td>410</td>
<td>18</td>
</tr>
</tbody>
</table>

**Flattening Test (for ERW pipes)**

A ring not less than 40 mm length taken from one end of each selected pipe shall be flattened between two parallel plates. The test shall be taken by keeping the weld at 90° to the direction of the force. No opening shall occur by fracture in the weld unit until the distance between the plates is less than 75\% of original O.D. of pipe and no cracks or breaks on the metal elsewhere than in the weld shall occur until the distance between the plate is less than 60\% of original O.D.

The approved pipes are stamped on one end for identification by inspecting authority.

<table>
<thead>
<tr>
<th>Steel Requirements</th>
<th>IS 2062-1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>Fe-410 W A grade Steel</td>
</tr>
<tr>
<td>Ultimate Tensile Strength</td>
<td>410 MPa</td>
</tr>
<tr>
<td>Yield Stress</td>
<td>2,500 Kg/cm²</td>
</tr>
</tbody>
</table>

**Design Requirements**

**Internal Pressure**

Design Pressure taken should be maximum of the following:

a) 1.5 times maximum working pressure
b) Sum of maximum working pressure plus surge pressure.

However, the design pressure should not exceed 5 MPa as per IS 3589-2001 specifications. Pipes to be supplied under this contract shall conform to IS-3589-2001 or latest version of Indian Standard.

**Factory test pressure will not be less than 15kg/sqcm.**

**Site test pressure will not be less than 10kg/sqcm.**

In case Supplier proposes to supply pipes to the standards superior to the above standards no weightage will be given while evaluating the bid and for payment.

**Marking:**

Each pipe shall be legibly marked with the following details:

a) Manufacturer’s name OR trade mark
b) Outside diameter and specified wall thickness; and
c) Pipe designation

Example: ABC - 508.0 – 8 – SAW 410

The pipes will be measured on length in meters, the thickness in mm by ultrasonic thickness gauge and diameter using steel tape. The payments will be made as below

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>On bringing the pipes to site duly stacking after completion of factory lining and all factory testing etc. complete etc.</td>
<td>70%</td>
</tr>
<tr>
<td>b)</td>
<td>Lowering, Laying, and jointing</td>
<td>15%</td>
</tr>
<tr>
<td>c)</td>
<td>Hydraulic testing complete</td>
<td>10%</td>
</tr>
<tr>
<td>d)</td>
<td>After successful completion of the assignment under the said tender i.e. After a trial run period of 03 months after commissioning</td>
<td>5%</td>
</tr>
</tbody>
</table>

The 70% payment against material received at site for first lot of pipe in which quantity of pipe shall not be more than 3Km, for every next lot (not more than 3km) payment against material received at site will be made provided that 70% quantity of earlier lot is laid & jointed in trenches.
12 – MS SPECIALS

MS SPECIALS

General

All specials like distance pieces, straps, tapers, saddles, branches, tees, etc. shall be generally fabricated in the factory. Only small kinks or bends may be fabricated on site, care being taken to see that the length of the fabricated fitting is at least equal to the diameter of the pipe to which it is being fixed. Such fabrication of specials on site shall be done only on approval of the Engineer in Charge and as per his directions.

All specials shall necessarily be in steel and shall be laid in the same manner specified in pipe section. The rate for providing special shall be as mentioned in the schedule B of the tender. The length of bend shall be the mean length.

The main specials and appurtenances to be fabricated under this contract are as per list following which is inclusive. The typical drawings for these are to be provided by the contractor during execution. The contractor shall give working drawing for the specials and appurtenances for fabrication thereof depending on the site conditions.

One piece cut composite bends.
Loose flange rings.
Stiffener rings.
Pressure and non-pressure type blank flanges.
Y' Branches and tees.
Tapers and wearing plates, dished manholes.
All flanged and plain ended specials

Workmanship

Dished Manhole Cover

For fabrication of dished manhole covers, the Contractor shall use special dyes in the Hydraulic press to obtain the required shape. The plate shall be cold pressed and no heating shall be permitted.

Loose Flange Rings

Loose flange rings shall be cut from the plates of suitable thickness as directed by the Engineer. In order to avoid the wastage, steel plates shall be cut in maximum 4 segments, to form a complete ring when welded together. Both holes of required size at the exact c/c distance in required pitch circle shall be drilled through the flange rings. They shall be mounted and tack welded on pipes/specials, etc. as shown on the approved drawing whenever required.

Stiffener rings shall be cut from the M.S. channel of suitable size as required by the Engineer-in-
charge. In order to avoid wastage, these shall be cut in segments to form rings, when welded together. These shall be provided on site in segments and shall be welded on the pipes, as per instructions of Engineer-in-charge.

**Tapers**

The tapers shall be fabricated in one or more pieces as may be necessary according to their length and sizes of plates available. These shall be stiffening rings fixed on them as per details supplied by the Engineer-in-charge during fabrication.

Special care to be taken during fabrication of composite bends, tees and ‘Y’ Branches. The testing of these special is not envisaged at the fabrication stage. These shall be subjected to test when the completed pipeline is tested hydraulically. In view of this, the Contractor, in his own interest, shall fabricate these specials with all the care, so that there is no failure of any welded joint during testing of the completed pipeline, which will invite dewatering the main, repairing and retesting. If directed by Engineer-in-charge, the Contractor will have to manufacture M.S. bend from the available M.S. pipes by cutting and welding the pipe pieces as required, including painting of specials fabricated with epoxy paint.

**Measurement and payment**

Fabrication of the various specials shall be measured and paid under the relevant item in the bill of quantities on weight basis as stipulated in Schedule ‘B’. These items shall include the cost of supply of all labour, material (unless otherwise states) and machinery for fabricating these specials and appurtenances as per specifications and shall include all cost of conveying materials from store to factory and handling materials within the fabrication yard stacking them properly in the yard and other ancillary works involved.

**Welding**

All components of a standard shell, either straight or bent etc. shall be welded, wherever possible by use of automatic arc welding machine by metallic shielded arc process with alternating current. Hand welding shall not be permitted except for sealing runs and such other minor works at the discretion of the Engineer. The strength of the joint shall be at least equal to that of the parent material. The Contractor shall use electrodes of approved make and size, the size depending on the thickness of plate and type of joint. It shall also use with standard current and arc voltage required for the machine in use with such modifications as may be found necessary after experimental welding. For this purpose, samples of welded joints shall be prepared and tested in the presence of the Engineer. The values once determined shall be maintained throughout the work and if any modifications are to be made, a written permission of the Engineer shall be obtained.
All the shop and field welding shall conform to the requirements of IS: 4353. All longitudinal and circumferential joints shall be double welded butt joints. Due to non-accessibility of both sides welding, field girth joints shall be accomplished using back up plates.

The welding shall be of the best workmanship free from flaws, burns, etc. and the Contractor shall provide for his own electrodes and equipment, over to keep the electrodes at the desired temperatures and dry. In order to maintain a good standard in welding, welders shall be tested by the Contractor in presence of engineer before they are entrusted with the job. Qualification standard for welding procedures, welders and Welding operation shall confirm to the requirements of IS 7307 and IS 7310 (latest). Periodical tests as regards their efficiency shall also be taken at intervals of about 6 months and those found inefficient shall be removed from the job. Only those who pass the test, shall be posted on the job. If an incompetent welder has already welded some pipes, all welding done by him previously shall be rejected. The defects if any, shall be set right to the satisfaction of the Engineer. All such check tests and rectifications of defects shall be entirely at the cost of the Contractor. No pipes or steel sections shall be erected unless the work of the welder concerned has been proved to be satisfactory. Site welds shall be done by specially selected welders.

A record shall be maintained showing the names of welders and operators who have worked on each individual joint. Hand-welding shall preferably be carried out by a pair of welders so that, by observing proper sequence, distortion can be avoided. A joint entrusted to a particular individual or a pair shall be as far as possible, completed by them in all respects, including sealing run. No helper or other unauthorized person shall be permitted to do any welding whatsoever. In case of infringement of above, the persons shall be punished as directed by the Engineer.

The welded joint after welding should not become brittle or sensitive to blows and there should be no loss of toughness due to welding or heat treatment. The material after welding and heat treatment is to be tougher than the base metal and is to retain its original ductility. No allowance will be made for thinning of weld and the weld should in no point be less than the nominal thickness of plate. Upon receipt of the order and prior to the start of fabrication, the Contractor shall submit to the Engineer for his approval the “welding procedure” he intends to use in the shop work. Similarly, prior to the start of the field welding, procedure for the field welding must be submitted to the Engineer for his approval. Manual welding shall be adopted only when machine welding is not possible.

**Electrodes**

The Contractors shall use standard electrodes depending on the thickness of plate and the type of joint. They shall also use standard current and voltage required for the machine in use as per
manufacturer’s directions. Welding electrodes shall conform to IS : 814 “Specifications for covered electrodes for metal arc welding of mild steel. Contractor shall used electrodes of Advani and Premier Brand, depending on the thickness of the plates to be welded and the type of joint. The Indian made or equivalent foreign made electrodes of the required quality approved by the Engineer, shall be used wherever possible. After welding joints shall be gauged to remove irregular penetration till even surface is exposed. Gauging shall be resorted when the plate thickness is above 6 mm.

Testing of Welded Joints

i. The welded joints shall be tested in accordance with the procedure laid down in IS:3600 “Code of procedure for testing of fusion welded joints and weld metals in steel”.

ii. Test pieces shall be taken out by the Contractor from the welded joint in the field at the positions pointed out by the Engineer. This must be done without any delay and in any case within 3 days time. Any further delay in this case is liable to cause Contractor’s payment to be withheld till proper compliance on their part. The sample so taken out shall then be cut to the exact shape and dimensions and machined as described hereunder, before the same is handed over to the Engineer for testing. This shall be done within a week. All the work upto machining and testing shall be done by the Contractor at their own cost.

iii. The shape of the test piece removed from the pipe shall be such as to give specimen of the required dimensions, and at the same time leave a hole in the pipe with rounded corners, this hole shall be patched up immediately by inserting and welding a piece of steel plate of the same thickness and curvature. Great care shall be taken in preparing these patch plates so as to get a good butt weld.

iv. The entire cost of the tests including taking out test samples, machining the test pieces, transport to and from the laboratory and testing them in a laboratory, the cost of patching up the test piece hole in the pipe, payment of all testing fees, cleaning and painting etc. shall be borne by the Contractors. The tests shall be carried out in some Government or Semi-Government Institute approved by the Engineer. This shall be arranged by the Engineer entirely at the Contractor’s cost.

v. The following tests shall be carried out:

1) Tensile test: The test specimen taken perpendicularly across the weld shall be shaped in accordance with IS:1663 (Part I and II). The specimen shall be taken from the end of the pipe or at any point in the pipe as directed by the Engineer and shall be cut with the weld approximately in the middle of the specimen. The tensile test specimen shall be flattened and the sides shall be machined. The protruding welded portion from both inside and outside shall be removed by machining before the specimen a handed over to the Engineer for testing. At least one test specimen shall be taken out from every 200 meters length of pipes
welded. If a test specimen shows defective machining or develops flaws not associated with welding, it may be discarded and another specimen submitted. The welded joint shall show strength of not less than the minimum tensile strength specified for the plate. (IS: 2062).

2) Bend test: Bend test shall be carried out by the Contractor at the discretion of the Engineer. A bend test specimen shall be prepared in the same way as for tensile test and tested in the factory by the Contractor at their cost in the presence of the Engineer. The specimen shall be taken from the same pipe from which a specimen for tensile test is taken out. The specimen shall stand being bent cold through 180 degrees round a pin, the diameter of which is equal to 4 times the thickness of plate, without developing cracks. In making the bend test the body of the welded metal should be on the outside and the root should be placed next to the pin.

Procedure to be adopted in case of failure of the above tests

a) Re-Test: If results of tensile and or bend test of any lot do not conform to the requirements specified, re-tests of two additional specimens from the same lot shall be made, each of which shall conform to the required specifications. In case of a failure of one or both, extensive gauging and repairing shall be carried out to the lot of joints from which the samples have been taken as directed by the Engineer before the lot can be accepted.

In case both the samples yield satisfactory results in the re-test described above, gauging and repairing will be required to be carried out on the joint which has failed in the initial test only.

b) Expenses for re-testing: All charges in connection with re-testing of the welded sample including machining, testing etc. shall be borne by the Contractor.

Shop Testing

After fabrication, but before application of protective coatings all pipes and specials shall be subjected to a shop hydraulic test. Standard lengths of pipes shall be directly subjected to test and non-standard pipe and elbows can be tested as standard pipe before being cut to size.

The test pressure shall be as specified above. Each pipe shall be filled with water and the pressure slowly and uniformly increased until the required test pressure is reached.

The pipe to be tested shall be given a serial no. which shall be painted on its inside together with details such as pipe no. shell thickness, diameter, length etc. as directed. It shall be entered in the register to be maintained by the manufacturer at his factory.

Prior to testing, the pipe shall be inspected thoroughly and all the apparent defects in welding such as jumps, porosity etc. shall be repaired by gouge and re-welding.
The hydraulic test shall be carried out under cover at the factory in the presence of and to the satisfaction of the Engineer or the inspection agency appointed by the Employer.

For indicating the pressure inside the pipe an accurate pressure gauge of approved make duly tested and calibrated for the accuracy of readings shall be mounted on one of the closures which close the pipe ends.

The pressure shall be applied gradually by approved means and shall be maintained for at least 10 minutes or till the inspection of all welded joints is done during which time the pipe shall be hammered throughout its length with sharp blows, by means of a 1 kg hand hammer.

The pipe shall withstand the test without showing any sign of weakness, leakage, oozing or sweating. If any leak or sweating is observed in the welded joints, the same shall be repaired by gouging and re-welding after dewatering the pipe. The repaired pipe shall be re-tested to conform to the specified pressure.

If any leak or sweating is observed in pipe shell the pipe under test shall be rejected temporarily. The manufacturer shall stack such rejected pipes separately in his yard. The Engineer shall inspect the same and after taking cuts if necessary, shall determine the nature of repairs to be carried out thereon and shall then decide as to how and where they shall be used. No payment shall be made for handling or carrying out repairs, but, payment for the procurement of plates, fabrication and shop hydraulic testing of the pipe shall be released only after acceptance of the pipe with necessary repairs and subsequent testing etc. are carried out by the Contractor to the satisfaction of the Engineer. The Engineer shall be supplied with two copies of the results of all the tests carried out.

No pipe shall be transported out of the factory to the site unless they are hydraulically tested except permitted by the Engineer in writing to do so.

A register shall be maintained in suitable format giving the following information for each pipe tested:
   a) Serial No.
   b) Shell No.
   c) Date of Test
   d) Thickness and specification of steel
   e) Weight of steel
   f) Maximum test pressure tested
   g) Details of test performance
   h) Name of Engineer's representative witnessing tests

A copy of these details shall be furnished to the Engineer.
**Specials and Appurtenances**

**General**

The specials and appurtenances to be fabricated and supplied under this Contract are as follows, they shall conform to the details as shown in the drawings:

A – One piece cants, composite bends, pipe pieces with fixed out diameter.
B – Flat and dished manhole covers
C – Flange rings
D – Stiffener rings
E – Pressure and non-pressure type blank flanges
F – Plug plates
G – Saddle pieces
H – Tapers – concentric and eccentric i.e. level invert tapers etc.
I – pipes with spigot end and pipes with socket end
J – Split collars etc.
K – Protective covers for expansion joints, butterfly valves etc.
L – Bypass assembly
M – Way branches – symmetrical as well as unsymmetrical etc.
N – Miscellaneous specials and appurtenances such as domes, tees, manhole covers or any sized or shaped specials not covered by above items.
O – Manholes
P – Kinetic air valves
Q – Scour valves
R – Butterfly valves
S – Telescope expansion joint with cover.

In addition to the above, other structural fixtures like ladders, platforms, walkways etc. shall have to be fabricated and erected for which the payment shall be made as per the relevant items.

**Specials**

a) **General**

Specials, such as tees, Y-pieces, bends (single or composite), tapers, etc. shall necessarily be in steel and shall be manufactured as per standards and tested and laid in the same manner as the pipes. Small branches, single piece bends, etc. may be fabricated at site, care being taken to ensure that the fabricated fittings have at least the same strength as the pipeline to which they are to be jointed.

b) **Bends**

i. Bends shall be fabricated taking into the account the vertical and horizontal angles for each case.
ii. The bends shall have welded joints and the upstream and downstream ends of each bend shall have a straight piece of variable lengths as required.
iii. Bends shall be designed with deflection angle of maximum 10 deg. between segments.
iv. When the point of intersection of a horizontal angle coincides with that of a vertical angle, or when these points can be made to coincide, a single combined or compound bend shall be used, designed to accommodate both the angles. The combined bend should have a pipe angle equal to the developed angle, arrived at from appropriate formula.

v. All joints in bends shall be thermally stress relieved as specified.

vi. Details of thrust collars anchor bolts, holding down straps, saddle plate etc. should be furnished together with full specification in Contractor’s fabrication drawing.

c) Manholes

i. Manholes shall be placed at locations as shown in drawing and as directed by the Engineer. Manholes in the pipeline shall be placed in suitable position in the top quadrant.

ii. The Contractor shall fabricate different parts of manhole in conformity with relevant IS specification, well established practices and as directed by the Engineer.

d) Closing or Make up Sections

Closing or make up sections shall be furnished at appropriate locations on the line to permit field adjustments in pipeline length to compensate for shrinkage in field welded joints, differences between actual and theoretical lengths and discrepancies in measurements.

e) Test Heads

Test heads may be ellipsoidal, standard dished as per ASME code or hemispherical heads. They shall be welded in the shop and removed after the test. Allowance should be made in the length of the pipe section receiving the test head for the welding and removal of the head and preparation of the plate edges for the final weld after testing. No separate payment will be made for such test heads. The rate quoted for the hydraulic test shall be deemed to cover the cost of such installations.

f) Flanges

Flanges shall be provided at the end of pipes or special where sluice valves, blank flanges, tapers, etc. have to be introduced. The flanges received from the manufacturers will have necessary bolt holes drilled. The Contractor shall assemble the flanges in the exact position by marginal cutting if necessary, so as to get the desired position of the sluice valves, etc. either vertical or horizontal and shall then fully weld the flanges from both sides in such a way that no part of the welding protrudes beyond the face of the flanges. In case the welding protrudes beyond the flanges and if the Engineer orders that such protrusions shall be removed, the Contractor shall file or chip them off. If required and when ordered by the Engineer, the Contractor shall provide and weld gusset stiffeners, as directed on site.
g) Blank Flanges
Blank flanges shall be provided at all ends left unattended for the temporary closure of work and also for commissioning a section of the pipeline or for testing the pipeline laid. For temporary closure, non-pressure blank flanges consisting of mild steel plates, tack welded at the pipe ends may be used. For pipes subjected to pressures, the blank flanges or domes suitably designed as per Engineer's requirements shall be provided.

h) Stiffener Rings
The Contractor shall provide stiffener rings wherever directed by the Engineer. The Contractor shall weld the same to the pipes with one circumferential run on each side.

i) Straps
Wherever pipe laying work is done from two faces and/or has to be done in broken stretches due to any difficulty met with at site, the final connection has to be made by introducing straps to cover gaps up to 30 cm length. Straps shall also be provided as per the procedure of fixing expansion joints by the method described under Clause No.2.7.8.3. Such straps shall be fabricated in the field by cutting pipes, slitting them longitudinally and slipping them over the ends to be connected in the form of a collar. The collar shall be in two halves and shall have the inside diameter equal to the outside diameter of the pipe to be connected. A minimum lap of 8 cm on either ends of the pipe shall be kept and fillet welds shall be run both internally and externally in circumferential joint. The longitudinal joints of the collar shall be butt welded. All fillet welds shall have a throat thickness of not less than 0.7 times the width of welding.

j) MS Rose Piece
Rose pieces shall be fabricated from MS plate of required thickness and diameter. The holes shall be drilled on circular portion and front portion of the rose piece as specified or as directed by Engineer-in-Charge. The rose pieces shall be painted with 3 coats of epoxy paint (food grade) from inside and outside. Rose pieces shall be fixed at appropriate level in the masonry of intake well extending into the submergence of water. The measurement shall be done on number basis and will be paid accordingly.

Storing & Stacking
The pipes shall be delivered, unloaded and stacked where they are required as stipulated in the supply order, or the accepted agreement. Unloading: The pipes of dia, upto 600 mm shall be unloaded from the wagon or truck by holding them in loops framed with wire/hemp ropes and sliding over planks set not steeper than 450. The plank shall be sufficiently strong and two ropes shall always be used to roll the pipes down to the planks or these pipes shall be unloaded from the Truck/lorry or wagon with the help of tripod with chain pulley block. The pipes of dia above 600 mm shall be unloaded
from the Truck/Trailers or wagon with the help of crane or mechanical handling facility by using belts. Hooks not allowed. Only one pipe shall be unloaded at a time. Under no circumstances the pipes shall be thrown down from the carriers or dragged or rolled along hard surface. The pipes shall be checked by the consignee for any visible damage (such as damaged edges, crack or spalling) while unloading and only good pipes shall be sorted out and kept along the alignment of the pipeline. Any pipe, which shows any damage shall be discarded, stacked separately so that the same does not get mixed with good pipes. Stacking: The pipes shall be stacked separately for each type and diameter at the location as directed. If required the stacking pile of pipes may be supported by wooden bullies. While unloading the pipes along the alignment of pipe line the following safety precautions shall be taken by the contractor.

1) The pipe and specials unloaded along the alignment shall not obstruct the traffic.
2) The signal arrangement during day and night shall be provided.
3) Guarding of pipes wherever necessary.
4) Any other precautionary measures as directed by the Engineer-in-Charge as deem-fit without any extra cost.
16 – CEMENT MORTAR LINING

INTERNAL CEMENT MORTAR LINING (SHOP APPLIED)

General
The inside of the pipes shall be provided with specified thickness of cement mortar lining in proportion of 1:1 by weight, applied by centrifugal spinning method. The lining shall be applied in shop (Factory application) and shall be in conformity with AWWA C205. The lining work for the pipes shall be started only after the inspecting agency, appointed by the employer, has issued the certificate regarding the pipes for satisfactory tests as per requirements. No in Situ lining is allowed.

Material
Cement
Portland cement shall confirm to the requirements of IS: 269, IS: 1489, IS: 8112. Cement containing lumps shall be rejected and shall immediately be removed from the work site.

Sand
Sand shall consist of inert granular material having hard, strong, durable uncoated grains confirming to the requirements of IS: 2116. The sand shall be well graded and 100% of the sand shall pass a US standard sieve number No. 4.

Admixtures
A water reducing, set-controlling admixtures confirming to ASTM C494 may be used to improve the workability, density, and strength of the mortar. No admixture shall contain injurious amounts of chlorides. The ratio of admixture to cement shall not exceed that used in the qualification tests of ASTM C494. No admixtures shall be used that would have a deleterious effect on potable water flowing through the pipeline.

Water
Water shall be clean, colorless, and free from injurious quantities of organic matter, salt, alkali, or other impurities that might reduce the strength, durability, or other desirable qualities of the mortar.

Cement mortar
Cement mortar shall be composed of cement, sand and water, well mixed and of proper consistency to obtain a dense, homogenous lining that will adhere firmly to the pipe surfaces. Mortar proportion shall be with 1 part of sand and 1 part of cement by weight. The soluble chloride-ion (Cl) content of the cement mortar mix shall not exceed 0.15 percent, expressed as percentage of cement weight. Maximum water / cement ratio shall not exceed 0.45:1.
Mixing
The mortar shall be mixed in batches. The amount of cement and sand entering into each batch shall be measured by weight. The quantity of water entering the mixer shall be measured automatically by an adjustable device, or it shall be otherwise measured to ensure that the correct quantity of water is being added. The mortar shall be mixed long enough to obtain maximum plasticity and shall be used before initial set.

Equipment
Straight sections of pipe shall be lined by using a spinning machine specifically designed and built for the purpose of rotating the pipe section and centrifugally applying cement mortar lining to the interior of steel pipe or by method known to provide equivalent results.

Lining thickness
Thickness of lining (12 mm) shall be uniform throughout except at joints and other discontinuities in the pipe wall. Ends of lining shall be Left Square and uniform with regard to the longitudinal axis of the pipe. The lining shall be terminated at 10 to 15 cm at the end of pipe for joint welding. The lining thickness requirements shall be maintained by mechanical end retaining rings and verified by physical measurements. Positive tolerance of 3 mm in thickness is permissible; however, no negative tolerance is allowed.

Surface preparation
Before application of the lining, the internal surface shall be cleaned thoroughly. The pipe interior surface shall be free of oil and grease etc. Shot or sand blasting shall be done if necessary. Loose mill scale, dirt, rust, shall be removed from the interior surface, so that the surface is thoroughly clean and dry to receive the lining.

Machine lining
Bracing / Struts
When required to prevent distortion or vibration during the spinning, each section of pipe shall be suitably braced with external or internal supports, appropriate to the equipment to maintain the circular shape of pipes. The manufacturer / contractor may provide adjustable steel struts of the approved design for this purpose before application of lining. Minimum two struts at ends shall be provided for each pipe. The struts shall not be removed till the pipes are laid and jointed. The cost of providing struts with material and labour required is supposed to be covered under the item of lining with cement mortar and laying and jointing of MS pipeline and hence shall not be payable extra.
Placement
In application of lining by spinning machine, the entire quantity of mortar required for completion of the lining of the section of pipe shall be placed without interruption.

Finish
After the cement mortar has been distributed to a uniform thickness, the rotation speed shall be increased to produce a dense mortar with a smooth surface.

Surplus water
Provision shall be made for removal of surplus water by air blowing, or tilting of the pipe.

Lining for specials
The application of lining to MS specials such as bends, reducers etc, the shape of which precludes application by the spinning process, shall be done by mechanical / pneumatic placement or hand application and finished to produce a smooth, dense surface.

Hand application
Cement mortar for hand application shall in 1 part of sand and 1 part of cement by weight and plaster sand confirming to ASTM C35 shall be used in place of sand confirming to ASTM C 33. Areas shall be cleaned to remove loose or other foreign matter that would interfere with the adherence of cement mortar and, if necessary, shall be moistened with water just before the placing of the cement mortar.

Curing
Immediately after completion of spinning, the pipe sections shall be moved to the curing area. Care shall be taken at all levels to prevent damage to the lining. The lining may be accelerated cure, moist cured, or cured by a combination of accelerated and moist curing. Accelerated curing or moist curing may be used interchangeably on a time-ratio basis of 5 and 1/3 hour of moist curing to 1 hour of accelerated curing. In any case, the total curing period shall be equivalent to 96 hours of moist cure. The lining shall be kept continuously moist until completion of the minimum specified curing period. Curing shall start not later than 30 minutes of application of lining.

Moist curing shall be used when the minimum temperature exceeds $5^0$ C continuously during the required minimum curing period.
Field joints
Material and mortar proportion for application of lining at field joints shall be 1 part of cement and 1 part of sand by weight. The cement and sand shall be dry mixed and moistened with sufficient water to permit placing and troweling without crumbling.

Inside joints of mortar lined pipe shall be filled with cement mortar and finished of smooth flush with the inside surface of the pipe by troweling or by equivalent means. Before placing the cement mortar against the surfaces of the lining, the surfaces shall be carefully cleaned, have all soap removed, and then be wetted to ensure a good bond between the lining and the joint cement mortar.

Defective lining
All defects in cement mortar lining including, but are not limited to, sand pockets, voids, over sanded areas, blisters, and cracking as a result of impacts, shall be cut out, and replaced by hand or pneumatic placement.

Repairs of defective lining
Small defective areas shall be repaired by manual removal of the defective lining and reapplication of mortar lining by hand. Defective areas encompassing the full diameter of the pipe shall be replaced by machine application wherever possible.

Lining cracks
Temperature and shrinkage cracks in the mortar lining less than 1.5 mm in width need not be repaired. Cracks wider than 1.5 mm need not be repaired if it can be demonstrated to the satisfaction of the Engineer that the cracks will heal autogenously under continuous soaking in water. The autogenously healing process may be demonstrated by any procedure that keeps the lining of the pipe continuously wet or moist.

Sampling and testing
Sampling and testing frequency
Compression test cylinders or centrifugal test cylinders shall be prepared for testing. A set of at least two standard test cylinders, 150mm in diameter and 300 mm in length, shall be made each day from the cement mortar lining for each shift. Samples may be prepared by omitting sufficient water from the production mix to obtain a 25 to 75 mm slump. Test cylinders from this mix shall be made in conformance with ASTM C31.

Centrifugal spun test cylinders may be substituted for cement mortar test cylinders, at the option of the manufacturer. The test cylinders shall be spun about their longitudinal axis in 150 mm diameter by 300 mm long steel moulds at a speed that will simulate the compaction of mortar in the lining to
Curing of samples and testing
All cement mortar test cylinders shall be cured with the pipe at the same temperature and for the same length of time, and shall be tested in accordance with ASTM C39 in an approved testing laboratory unless the manufacturer has approved testing facilities at the work site.

Strength requirements
Cement mortar test cylinders shall attain a minimum compressive strength of 31 MPa in 28 days or at the time of dispatch to work site, if less than 28 days. The pipe lined with cement mortar lining that does not meet these strength requirements may be rejected.

The average of any 10 successive strength tests of cylinders representing each cement mortar mix shall be equal to or greater than the specified strength, and not more than 20% of the strength tests shall have values less than the specified strength. No cylinder test result shall be less than 80% of the specified strength.

The contractor shall submit the test certificate from the manufacturer for the daily tests of the test cylinders, without which, the payment for lining will not be allowed.

Performance criteria for surface finish
The Hazen Williams c factor s (Cnw) shall be criteria for determining the acceptability of surface finish of cement mortar lining. For acceptable performance, guaranteed Cnw shall not be less than 140. The sections for carrying out C-Value tests shall not be length less than 1 km. each.

If, in any section of the cleaned and mortar lines pipe, the coefficient ‘C’ as determined for the loss of head test fails to meet the guaranteed figure, the unit prices for cleaning and lining will be reduced as follows.

If the ‘C’ value is deficient by more than 10 units below the guaranteed ‘C’ value, the work shall be considered unsatisfactory and shall be rejected. The contractor will have to remove the mortar lining carried out and redo the same to the ‘C’ value to the desired value at his own cost.

produce a spun cylinder wall thickness of approximately 40 mm. The net cross sectional area of hollow cylinder shall be used to determine its compressive strength. Damaged cylinders shall not be used.