PURBA BHARATI GAS PRIVATE LIMITED

(A Joint Venture of Assam Gas Company Limited (AGCL), GAIL Gas Limited & Oil India Limited (OIL))
Guwahati, Assam (India)

TENDER DOCUMENT FOR CONSTRUCTION OF CNG STATION (GREEN FIELD AND AT DAUGHTER BOOSTER STATIONS/ RETAIL OUTLETS/ DEALER'S STATIONS) AT CACHAR, HAILAKANDI & KARIMGANJ GA AND KAMRUP & KAMRUP METROPOLITAN GA (2 YEARS ANNUAL RATE CONTRACT (ARC))

OPEN DOMESTIC COMPETITIVE BIDDING

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MEC/S/05/11/01

SPECIFICATION

FOR

CIVIL ENGINEERING WORKS

MECON LIMITED

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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

relevant clauses of IS: 4031 (Part-I to Part-15) 1988 to 1991 & IS: 4032-1985.

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.

Reinforcement - For each consignment within 4 days of delivery in accordance with I.S. 1786-1985, I.S. 1599-1985 and I.S. 1608-1972.

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.

Nominal Size (Dia) (mm)	Mass Per Metre Run (Kg)
6	0.222
8	0.395
10	0.617
12	0.888
16	1.580
18	2.000
20	2.470
22	2.980
25	3.850

28	4.830
32	6.310

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

Test certificates from manufacturer shall be submitted for each consignment. Any additional test which the Engineer may require shall be done according to IS : 1786-1985, 1566-1982, 280-1978, 2062-1992, 1161-1979, 2614-1969, 3063-1972, 1239 (Part 1 and 2)-1990 and 1992 and 1367-1980.

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

Non-metallic conduits for electrical use shall conform to IS : 9537 (Part 3) -1983 for rigid pipes and to IS : 6946 -1973 for flexible pipes. Fittings shall conform to IS : 3419-1989.

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 Kgf 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

: 6908 -1991 "Asbestos Cement Pipes and Fittings for Sewerage and Drainage ". Building pipes gutters and fittings shall conform to IS : 1626 -(Part 1 to 3)-1980 to 1991 "Asbestos Cement Building pipes and pipe fittings".

Pressure pipes shall satisfy Hydraulic test and transverse crushing test as per IS : 5913-1989.

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 wheathering 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 atleast 5cm back from the face, and side joints for atleast 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 upto 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 be 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, alkalies, 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 occuring 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 veener 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 enamelled/ 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 4.8mm
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. Shallac 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.

12.11.2 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 spreadng 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 water proofing 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 water proofing 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 [width] : : Not less than 7.1 Kg/cm

v) Elongation at Break : 130%

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.

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.

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.

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.

Nominal size	Weight per piece in Kg. excluding ears Overall length		
	1500 mm	1800 mm	2000 mm
50	9.56	11.41	12.65
75	13.83	16.52	18.37
100	18.14	21.67	24.15
150	26.70	31.92	35.66

Specials and Fittings shall include bends, offsets, branches of various types, junctions etc., as required for the work which shall be provided according to drawings and directions of the Engineer. 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 the 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.

e) 15 mm PVC connection pipe with brass couplings and 15 mm brass stop cock.

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.

The C.I. manhole covers and frames shall conform to IS : 1726-1991.

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 1mm for low level cisterns. For high density polyethlyne 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.

The flush pipe shall be securely connected to the cistern outlet and made airtight by means of a coupling net. Float valve shall conform to IS : 1703-1977 or IS : 12234-1988. Polyethylene float valve shall conform to IS : 9762-1981.

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.

18.18 Plastic Seats & Covers for Water Closets

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:-

Pipe Dia (Nominal Bore)	Dimension of Pipe		Thick -- ness	Dimension of ordinary socket		Wt. of Pipe plain end
	Max. (outside dia)	Min.		Outside dia (approx.)	Min. length	
mm	mm	mm	mm	mm	mm	Kg/m
15	21.8	21.0	2.65	26.90	34	1.21
20	27.3	26.5	2.65	33.70	36	1.57
25	34.2	33.5	3.25	42.00	43	2.42
32	42.9	42.0	3.25	51.00	48	3.11
40	48.8	47.9	3.25	57.00	48	3.59
50	60.8	59.7	3.65	70.00	56	5.07
65	76.6	75.3	3.65	88.00	65	6.49
80	89.5	88.0	4.05	101.60	71	8.43

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

These shall be of approved manufacture and quality and shall conform to IS : 458 1988, IS : 1592 1989, IS : 9627 1988 & IS : 784 1978 respectively.

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:

No. of size (mm)	Bib taps (kg)	Stop tap (kg)
10	0.30	0.35
15	0.40	0.40
20	0.75	0.75
25	1.25	1.30
32	-	1.80

40	**-**	**2.25**
50	**-**	**3.85**

The taps shall be tested under internal hydraulic pressure of at least 20 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 pies 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 objection able 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 :

Grading Number	Size Range	Layer Thickness
1	90 mm to 40 mm	More than 90 mm
2.	63 mm to 40 mm	90 mm to 75 mm
3.	50 mm to 20 mm	75 mm to 50 mm

21.4 Screenings

Screenings used for filling voids in coarse aggregates for water bound macadam shall generally be of the same material as the coarse

aggregate. Non-plastic materials such as Kankar nodules, moorum or gravel (other than river bore rounded aggregates) may be used, provided that the liquid limit and plasticity index are below 20 and 6 respectively. The fraction passing 75 microns sieve shall not exceed 10%. Size and grading of screenings shall be as specified in Table-3 of IRC-19 - 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 grae 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.

Sl No	Items/Name of Products	Makes / Brands / Manufacturers
1.	Reinforcement Steel	TATA,SAIL,RINL,IISCO,RATHI
2.	Cement	Ambuja,ACC,JK,Grasim,Ultratech,Birla,L&T,Cement Corporation of India,Maihar
3.	Structural Steel	TATA,SAIL,RINL,IISCO,ESSAR, ISPAT
4.	Pre- engineered building (PEB) firms	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 Lioyd Corporation Ltd.
5.	Structural Steel Tubes ISI Marked	TATA, JINDAL , SURYA , SWASTIK
6.	(a) Zincalume colour coated steel sheet(COIL) (b) Profile of Sheet(as per tender specification)	(a)Tata Blue scope, Dongbu Steel ,Union Steel, JSW STEEL Ltd. 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 Lioyd Corporation Ltd
7.	Polycarbonate Sheet	Sabic Innovative Plastic , Everest
8.	Mineral wool for thermal insulation of ceilings (Under deck insulation)	Rock wool (india) Ltd. Minwool Rock Fibres Ltd., Lloyd Insulation,
9.	Rolling shutters(ISI marked)	Swastic, Hercules, Shubdwar, M/s Bharat Rolling Shutters Industries Agra, Bengal Rolling Shutter Rama Rolling Shutter Works, Gandhi Entrance Automations Private Limited
10.	Wind driven air Ventilators	Apurva Enterprises (Mumbai), SVS Wind Driven Turbo Ventilator(Ahmadnagar),Real Green Engineers Pvt.Ltd. Bangalore;Sun Green Ventilation system Pvt.Ltd. Mylapore-Chennai,Citadel

		Mumbai, Multi colour, Anchit Ispat Pvt Ltd. (Faridabad),
11.	Synthetic Enamel Paint (1st quality only)	ICI Paint (Dulux), Asian Paint (Apcolite), Berger Paints (Luxol). Goodlass Nerolac Paints (Nerolac), Jenson & Nicholson Paints Ltd (Borolac), Shalimar, Garware & Goodlass
12.	G.I SHEET	ESSAR,JSW,,SAIL
13.	Sheeting Screw	Corroshield, Buildex,
14.	Chemical for Antitermite treatment	DE- NOCIL Bombay, Pest Control of India, Trishul
15.	Factory made Panelled Door shutter	M/s Goel Brothers Raipur New Industrial Area Raipur (CG) M/s Hindustan Housing factory Ltd- New Delhi M/s Delhi Construction Eqpt Sadar Bazar Delhi M/s Joinery manufacturing Co Calcutta M/s Goyal Industries Faridabad M/s Surbhi Metal (India) Ltd Jodhpur M/s Jain wood Industries Sonipat/Rohini Delhi (HO) M/s Poineer Timber Products, Chandigarh
16.	Flush doors IS-2191, 2202	M/s Mysore Wood Products M/s Laxmi Doors, Faizabad Road, Chinhat, Lucknow M/s Merino flush doors M/s Poineer Timber Products, Chandigarh, M/S Goyal Industries Faridabad M/s National M/s Century Plyboards (i) Limited.
17.	Fly proof doors (Made out of solid block marine grade)	M/S Laxmi Doors, Faizabad Road, Chinhat, Lucknow, Northern doors Kanpur
18.	Natural Fibre Thermo Composite door/window shutter & frames, roofing sheets etc	Durosam
19.	PVC Panel Door (Solid Core)	Rajshri Plastiwood Limited, Sintex, Hindopan, Marino
20.	Pressed steel door frames/ cupboard and window frames (manufacturers)	M/s SAIL, M/s TATA
21.	Pressed steel door	M/s Loyal safe works Mayapuri, N/Delhi

	frames/ cupboard and window frames (fabricators)	M/s Multiwyn Industrial Corpn Calcutta M/s Metal Window Corpn N/Delhi M/s Chhabra Steel Udyog, 260 Sadar Bazar, Meerut Cantt M/s Delite safe works, Rani Jhansi Road, N/Delhi M/s Ishwar Industries, 175/A Bombay Bazar, Meerut Cantt M/s Chandni Industries, J-142, Patel Nagar 1st, Ghaziabad.
22.	Steel Windows, Ventilators(as per IS-1038 of 1983) & frames pressed steel door/window	M/S Multiwyn Industrial Corpn Calcutta M/S Metal Window Corp N/ Delhi Govind Enterprises, Delhi M/S Chhabra Steel Udyog 260, Sadar Bazar, Meerut Cantt, Agent steel MFG Pvt Ltd, Ahmedabad, Godrej, M/S Chandni Industries, J-142, Patel Nagar 1st, Ghaziabad
23.	AI Section for AI Door/ Window/ Partitions	Hindalco, Indal, Ajit India, Jindal
24.	Aluminuml Door/ Window/ Glazing Fabricated and Anodized	M/s Ahlcon 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
25.	Aluminium door and windows Fittings	M/s Elite Enterprises C/6 Shalimar Hardware 133, Jarg Mahal, Dhobitalao Mumbai 400002. M/s Mohan Metal Industries 178/2-A, Bhole Nath Nagar, Shahadara, Delhi 110032. Mepro, Argent New Delhi, Classic, New Delhi. Jindal, Argent New Delhi, Golden Industries Pvt. Ltd. ECIE
26.	Automatic Glass Door	Ditec (Gandhi)
27.	Aluminium Grill	Alu Grill, Arihant Aluminium Corporation, Decogrille
28.	Door Closer	Everite, Golden, Gandhi
29.	Floor Spring	Prabhat,Everite
30.	Builders Hardware	M/s Golden Industries Pvt. Ltd., Everite, Solo, Hardwyn
31.	Plywood for general purpose (IS-303)	National Plywood Inds Pvt Ltd, S Fancy lane, 8th floor Calcutta-700001, Merino Plywood, Archid Ply, Kitply,Swastik,Universal

32.	Pre laminated Particle board	Kitply, Bhutan board, Ecoboard, Novapan, Archid ply, Merinova, Merino
33.	Laminated Sheets	Formica, Merino Lam, Greenlam, National
34.	Modular Partitions	Godrej, Blowplast
35.	False Ceiling (Mineral Fibre Board)	Armstrong, , Daiken, Luxalon, Llyods, Gypboard,Trac,Aerolite
36.	False Ceiling (POP/ Gypsum Board)	Gypboard, Anchor ceiling tiles, LA
37.	Aluminium False Ceiling	Lloyds,Armstrong,Luxlon,Trac
38.	Flooring Tiles (Mosaic / Terrazzo / PCC) (1st quality only)	M/S Mehtab Tiles, NITCO, Royal Tiles, Gem Tiles, Hindustan Tiles, M/S National Tiles & Industries, Ultra Tiles
39.	Glazed Ceramic Tiles, Non-Skid (Floor/Wall), (1st quality only)	Kajaria, Somany, NITCO. Murudeshwar Ceramic Ltd (Navin Diamond tile), Johnson (Marbonite), Marbito, Somany, Orient, Asian
40.	Vitrified/ Designer Vitrified Tiles (1st quality only)	Asian, Marbonite (Johnson), Kerrogres (Kajaria), NITCO, Orient
41.	PVC Tiles/Flooring (IS 3461) (1st quality only)	Marblex Tiles, Krishna Tiles, Polyfin, Armstrong, Wonder floor.
42.	False Flooring	Godrej or equivalent
43.	Glass Mosaic Tiles (1st quality only)	Paladio, Coral, Accura, Bisazza, Italia, Mridul.
44.	Designer Paver Tiles/ Interlocking tiles ISI marked/ Grass-jointed Tiles (1st quality only)	Pavit, Ultra, Hindustan, Eurocon, Vyara, National Tiles, Gem, Unistone, Konkrete, Unitile
45.	Glass reinforced Paver block	Unistone or equivalent
46.	Wall care Putty for Base preparation (1st quality only)	Birla Wall care putty, Berger, Jenson & Nicholson, JK White
47.	White Cement (1st quality only)	Birla, JK
48.	Cement based Paints (1st quality only)	Super Snowcem, Duracem, Super Acrocem.
49.	Dry Distemper / Oil bound Distemper	Goodlass Nerolac Paint, Shalimar Paint, Jenson & Nicholson, Asian Paint, Berger. ICI Dulux

	(1st quality only)	
50.	Acrylic Washable Distemper (1st quality only)	Asian, Berger, ICI Dulux, Jenson & Nicholson, Nerolac,Shalimar,Garware & Goodlass
51.	Plastic Emulsion Paint (1st quality only)	Asian, Berger, ICI, Nerolac, Jenson & Nicholson, Shalimar,Garware & Goodlass
52.	Exterior Acrylic Emulsion (1st quality only)	ICI (Weathercoat), Excel (Nerolac), Apex (Asian), Berger, Jenson & Nicholson, Shalimar,Garware & Goodlass
53.	Polymer based Paint	STP,CICO
54.	Textured Paint / Wall Tile (1st quality only)	Unitile, Heritage, Spectrum, Iokos, Acropaints, Asian
55.	Flexible board for Expansion joint	STP or equivalent
56.	Grout	Shrinkomp,Fosroc,Fairmate
57.	Integral water proofing compound	STP, Pidilite, Fosroc, CICO, Sika.
58.	Concrete Admixture	Pidilite, Fosroc, CICO, Sika.
59.	Water proofing for cementitions surface IS-2645	Acrocrete & Acrocote, CICO, Fosroc, STP
60.	Bituminous Product	M/s Faridabad Spinning & 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
61.	Hardeners	Ironite, Ferrok, Hardonate
62.	Construction Chemicals	Choksey, CICO, Forsroc, Sika
63.	Non Metalic Surface Hardners	CICO, Fosroc, STP, Sika
64.	Corrugated, Semi Corrugated & AC Sheets (IS-459-1970,IS-2098)	M/s Everest Bldg Products Ltd Jata Sankar Bosa Marg Muland (west) Bombay 400080, M/s Ramco AC Sheets “SWASTIK”, M/s Eternit Everest Ltd, UP Asbestos Ltd
65.	GI Sheet ISI Marked	Multicolor, TATA, Bluescope, JSW, Colour Plus, Interarch, Lloyds, Jindal, Everest
66.	Sheet Glass /Structural Glazing	Hindustan Pilkington Glass Works, Saint Gobain, Modi Float, Triveni Float Glass, ASI, Fresca, Emirates.

67.	Multiell / Multiwall Polycorbonate Panel	M/s Coxwell Domes Engineering , Delhi, M/s Lexan , M/s Gallina India Pvt. Ltd. M/s Vijaynath Interiors & exteriors products
68.	Stainless Steel Cladding	Jindal
69.	Punch Tape Concertina Coil	Global Technocrat, S.G.Engineers Delhi
70.	Punch Tape In Plastic Spool	Global Technocrat, S.G.Engineers Delhi
71.	Stainless Steel Railing	Jindal
72.	FRP/ HDPE Garbage Bins	Sintex, Swift, Nutech, Sheetal
73.	Thermoplastic Road Marking Paint	Shalimark (STP)
74.	Bollard	STP
75.	Cateye	TATA, STP
76.	Readymade Speed Breaker	STP
77.	Fountain	Ripples, Green Evolutions, Agritech Services, Premier
78.	Multi-Vent	Multicolor
79.	Sanitary ware	Neycer Kermag (standard), Hindustan Sanitary Ware (Ist quality), Parryware (superfine), Cera (Ist quality), Classica (Ist / standard)
80.	WC seat cover ISI Marked	Parryware, Neycer Kermag (standard), Hindustan Sanitary Ware (Ist quality), Cera (Ist quality), Classica (Ist / standard)
81.	PVC Flushing Cistern IS: 774-1984 (ISI Certified)	Parryware, Hindustan Sanitary Wares, Cera.
82.	Faucets & Taps, Stop Valves & Pillar Taps, Surgical basin mixer, Shower rose etc.	Gem, Parko, Parryware, HSW, Jaquar,Orient
83.	Kitchen Stainless Steel Sink	Diamond, Nirali, Neel Kanth, Jayna
84.	Looking Mirror	Saint Gobain, Modi Float, Triveni Float Glass, Crown, Atul,Ashai
85.	Ready made Bathroom Cabinets	Commander Gratings (I) Pvt Ltd, Gratolite Cabinet, A-4 Sector Viii Noida-202701, Alpina, Cera.

86.	Float Valve	Leader, Bombay Metal & Alloy Co, Bombay superflow.
87.	SGSW Pipes (IS-651) ISI Marked	Perfect Agra, Devraj Ind Gaziabad, Buran, RK, Prince, ,Supreme pipe and Fittings.
88.	CI (Centrifugally Cast) Pipes for sewage disposal ISI marked	NICCO, SRIF, A-1 Singhal Casting Co Agra, Jindal Saw, Kesoram, NECO
89.	PVC rain water/sewage pipes (IS-4985)	Reliance, Finolex, Supreme, Kisan, Prince,Hindustan Plastic & machine corporation,Polypack industries (P) Ltd.
90.	HDPE Water storage tanks (Rotational Moulded)	Sintex, Swift, Nutech, Sheetal
91.	Cast Iron Pipes and Fittings	Hindustan Engineering Products Company Calcutta, S..L.C., Standard approved manufacturers of any other brand of fittings having ISI marking,RIF,BIS
92.	RCC Pipes	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
93.	Brass Fittings	Leader Engineering Works, Jalandhar; L & K Mathura; Luster Sanitary, Jalandhar; Annapurna Metal Works, Calcutta; Neta Metal Works, Jalandhar; Honey Industrial Corporation, Bombay.
94.	C.P. Fittings	Ego Metal Works, Ballabhgarh; Jaquar Industries, Delhi; Soma Plumbing Fixtures Limited, Calcutta; Gem Sanitary Appliances Pvt. Ltd.,Delhi; Essco Sanitations, Delhi; Bilmet, Bombay.
95.	Stone Ware (Salt-Glazed) Pipes	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.
96.	Asbestos Cement Pipes and Fittings	Ganga Asbestos Limited, U.P.; Hyderabad Asbestos Cement Products Limited; J.K. Super Pipe Industries, Nanded; Konark Cement and Asbestos Limited, Orissa; Maharashtra Asbestos Limited, Bombay; Poddar Industrial Corporation, Patna; Sarbamangala Mfg. Company, Calcutta
97.	HDPE pipes and fittings	ORI-PLAST,HASTI

23.0 MATERIALS NOT SPECIFIED

Any materials not fully specified in these specification and which may be offered for use in the works shall be subject to approval of Engineer, without which it shall not be used anywhere in the construction works.

SPECIFICATION FOR CIVIL WORKS

PART – II WORKMANSHIP

C O N T E N T S

14.3 Ash Carpet

14.4 Boulder Soling

14.5 Kerbs

14.6 Water Bound Macadam Surfacing

14.7 Preparation of Base and Shoulders

14.8 Spreading Coarse Aggregates

14.9 Rolling

14.10 Application of Screenings

14.11 Sprinkling and Grouting

14.12 Application of Binding Material

14.13 Setting and Drying

14.14 Surface Evenness

14.15 Bituminous Pavements

14.16 Berms

14.17 Kerbs

14.18 Bridges and Culverts

14.19 Boulder Pitching

14.20 Scarifying & Dismantling

14.21 Diversions

15.0 WATERPROOFING TO ROOFS & BASEMENTS & WATER PROOFING PAINTS

15.1 Scope

15.2 Material

15.3 General Workmanship

15.4 Painting with Hot Bitumen

15.5 Painting with Bitumen Emulsion

15.6 Waterproofing of Roof

15.7 Waterproofing for Basement

15.8 Surface Application

15.9 Guarantee

15.10 Waterproofing course with fibre glass R.P. tissue.

15.11 Waterproofing course with PVC sheets/membrane

15.12 Waterproofing with Non-shrink polymeric waterproof grouting compound.

16.0 MISCELLANEOUS

16.1 False Ceiling

16.2 Wall Panelling & Wooden Partition

16.3 Expansion and Isolation Joints

16.4 Barbed Wire Fencing

16.5 Concertina Coil Fencing

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

the Engineer, the Contractor shall maintain these throughout the period of construction without causing any disturbance to them.

1.6 Setting out

The Contractor shall set out all the works to be executed by him, in line with the standard base lines, levels, position and bench marks and truly as per drawings within the accepted tolerance limits at no extra cost to Owner. The Contractor shall be solely responsible for the setting out of all the works, to be executed by him and the approval of such setting out by the Engineer shall in no way absolve the Contractor his responsibility for carrying the work to the true lines, levels and positions as per drawings.

1.7 Dewatering

The Contractor shall 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 burried 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 lime stone, sand stone, 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, burried 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 upto 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

lines. 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 upto a level of 150 mm above the top of pipes before backfilling with other fill materials. All clods and lumps shall be broken before placement. Care shall be taken not to disturb, break or damage the pipes during backfilling and compaction process.

2.15 Backfilling of foundations

Backfilling of foundations shall be done using suitable soils from excavations. Soil shall be free from organic matter and other materials which would affect the stability of the fill and shall be free from boulders, brick bats wood pieces and other injurious materials, lumps and clods. Before commencement of backfilling of foundations. all shoring and formwork, bits of timber, cement bags and all other rubbish shall be removed. Hydro-insulation, Bitumen painting or application of anti-corrosive protective and anti-termite treatments shall have been completed. Backfilling operation shall not commence without approval of Engineer. Backfilling shall be carried out in well compacted layers of 150 mm thickness. Each layers shall have near optimum moisture content. Layers will extend to the entire width of excavation and shall be sprinkled with water during compaction process. Ramming shall be done to achieve firm compaction. Backfill shall be trimmed and finished to lines and levels indicated in the drawings and/or as directed by the Engineer. 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 doo rs, 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 :

Grade off Concrete	Characteristic Strength i.e. Compressive Strength of 15 cm cubes at 25 days (N/mm^2)	Nominal Maximum Aggregate Size (mm)
M-5A	5	63
M-5B	5	40
M-7.5A	7.5	63
M-7.5B	7.5	40
M-10A	10	63
M-10B	10	40
M-10C	10	20
M-10D	10	12

Grade off Concrete	Characteristic Strength i.e. Compressive Strength of 15 cm cubes at 25 days (N/mm^2)	Nominal Maximum Aggregate Size (mm)
M-15A	15	63
M-15B	15	40
M-15C	15	20
M-15D	15	12
M-20A	20	63
M-20B	20	40
M-20C	20	20
M-20D	20	12
M-25C	25	20
M-25D	25	12
M-30C	30	20
M-30D	30	12
M-35C	35	20
M-35D	35	12
M-40C	40	20
M-40D	40	12

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 :

a)	For concreting in very narrow space or in very small thickness	12 mm
b)	For all reinforced concrete work except in massive foundations	20 mm
c)	For all ordinary plain concrete & massive reinforced foundations	40 mm & 63 mm

4.4 Mix Design

4.4.1 General

At the commencement of the contract the Contractor shall make preliminary tests to determine the proportions by weight of cement, fine aggregates, coarse aggregates and water necessary to produce required grades of concrete. The mix proportions shall be selected to ensure that workability of the fresh concrete is suitable for the conditions of handling and placing and when concrete hardens, it shall have the required strength, durability and surface finish. The Contractor shall get approval of Engineer to such proportions before he starts concreting. However, such approval shall not relieve the Contractor of his responsibility to produce concrete having compressive strengths as laid down in the foregoing Table.

No departure from the approved proportions will be permitted during the works unless and until the Engineer gives written 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 I S 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 if becomes completely consistent and homogeneously surrounds all the reinforcement and completely fills the formwork.

4.6.2 The workability of fresh concrete at the place of batching/mixing shall be measured by compacting factor test and at the place of disposition by means of slump test. During the 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

Degree of Workability	Slump in mm with Standard - Cone		Use for which concrete is suitable as per IS : 1199
	Minimum	Maximum	
Very low	0.0	25.0	Large mass concrete structure with heavy compaction equipment, roads and the like.
Low	25.0	50.0	Uncongested wide and shallow R.C.C structures
Medium	25.0	75.0	Deep but wide R.C.C structures with congestion of reinforcement and inserts
High	75.0	125.0	Very narrow and deep R.C.C structures with congestion due to reinforcement and inserts

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 through out the period of construction. For this purpose, the Contractor shall submit to the Engineer sufficient data indicating the weight/volume relationship of aggregates for different types of concrete and after such approval, periodic checks on the weight/volume relationship of the aggregates shall be made by the Contractor to the satisfaction of the Engineer. Where aggregates are moist and volume batching is adopted, allowance shall be 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	Surface water carried by Aggregates	
	% by weight	Lit / m^3
Very wet sand	7.5	120
Moderately wet sand	5.0	80
Moist sand	2.5	40
Moist gravel & stone chips**	1.25 - 2.5	20-40

** - Coarser the aggregate, less the water it will carry.

4.12.4 Admixtures

Any solid admixture, to be added, shall be measured by weight, but liquid or semi-liquid admixture may be measured by weight or volume.

4.12.5 Accuracy of batching

The accuracy of batching shall be within the following tolerance:

Cement within plus or minus	2%	by weight.
Aggregate within plus or minus	5%	by weight.
Water within plus or minus	0.5%	by weight.

4.13 Mixing & Transportation of concrete

4.13.1 Mixing of Concrete

4.13.1.1 Machine mixing

Concrete shall always be mixed in mechanical mixer. Water shall not, normally, be charged into the drum of the mixer until all other ingredients are already in the drum and mixed for 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 (eg. 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)

(i)	Walls projecting from base slab	:	300 mm from top of base slab
(ii)	Walls supporting the suspended slab	:	75 mm from the lowest soffit of the slab

Note :

In the case of water retaining structures and structures under the influence of ground water, approved water bars of suitable size shall be provided to make the joint completely water-tight.

(c) In beams

Beams shall be cast, as a rule, without a joint. But if provision of a joint is unavoidable, the joint 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 exceeds 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 carryout 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 upto 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 upto 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 upto 20 mm diameter shall have a minimum bead length of 12 times the diameter of bar or 200 mm whichever is more arranged on one or both sides. The throat thickness of weld beads shall be 5 mm or 0.75 times the nominal size of weld (which is the radius of bar) whichever is more. In case of unsymmetrical lap weld with weld bead on one side only, the maximum length of each weld bead shall be 6 times the diameter of bar or 100 mm (whichever is more), separated by an equal length in between weld beads. Splice bars used in symmetrical weld joint shall have same diameter as the parent bars. Lap joint with single splice bars shall have weld beads on both sides.

Lap welding of bars above 20 mm shall be done using splice plate or splice angle. Thickness of splice plate shall not be less than 0,65 times the diameter of bar and width shall not be less than twice the diameter of bar. The size of splice angle shall be such that its area of cross section is 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.

4.21.5 Cleaning

All steel for reinforcement shall be free from loose scales, rust coatings, oil, grease, paint or other harmful matters immediately before placing the concrete. To ensure this, reinforcements with rust coatings shall be cleaned thoroughly before bending/placement of the same.

4.21.6 Placing in position

All reinforcements shall be accurately fixed and maintained in positions as shown on the drawings and by adequate means like mild steel chairs and/or concrete spacer blocks 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 inter-changeable. 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 -

1969 "Code of Practice for use of metal arc welding for General Construction in Mild Steel". Mild steel electrodes conforming to IS: 814-1991 "Specification for covered electrodes for metal arc welding of mild steel shall be used.

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 masonary 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 upto 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 masonary.

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 upto 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 te 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 leftout 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.

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 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 : Tterrazzo

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 sub-grade. 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

(c) Alignment of joints, dividing strip etc.

(d) Colour, texture

(e) Surface finish

(f) Thickness of joints including the workmanship in joints.

(g) Details at edges, junctions etc.

(h) Performance

(i) Precautions specified for durability.

(j) 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 smoothened 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 brig ht 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 w ide 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 d ia 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 ap proved 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 a 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

11.3.1 General

Wherever scaffolding is required/necessary, it shall be erected on double support tied together by horizontal pieces, over which the scaffolding planks shall be fixed. No part of it shall rest on or touch the surface which is being washed/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 be sand paper to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry. The cement primer shall preferably be applied by brushing and not by spraying. Horizontal strokes shall be given first and vertical strokes shall be applied immediately, afterwards. This entire operation will constitute one coat. The surface shall be finished as smooth as possible, leaving no brush marks.

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 under coat 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 SUPPPLY 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

accordance with IS:2065-1983 "Code of Practice for Water Supply in Buildings" & IS:2064-1993 "Code of practice for selection, installation and maintenance of sanitary appliances".

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 a external surface of tanks. The paint shall be so selected as not to impart any taste or odour of water and be of lead free composition.

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 topand 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 Patttern 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;

ii) By means of a mirror at one end of the line and lamp at the other. If the pipe line is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.

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 net work 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 lev el of the center line of the pipe.**

ZONE-"B" **From the level of the center line o f 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
for nominal bore	350 to 400mm	4 degrees
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

Nominal **of pipe mm**	**Lead / Joint kg**
80	1.8
100	2.2
125	2.6
150	3.4
200	5.0
250	6.1
300	7.2
350	8.4
400	9.5
450	14.0
500	15.0
600	19.0
700	22.0
750	25.0
800	31.5
900	35.0
1000	41.0
1100	46.0
1200	50.0
1500	66.5

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

Nominal Internal dia in mm	Lead wool weight in kg	Spun yarn weight in kg
80	1.30	0.17
100	1.70	0.23
150	2.41	0.34
175	2.89	0.37
200	3.37	0.57
225	3.63	0.64
250	4.11	0.74
300	4.82	0.82
350	6.04	1.17
375	6.52	1.25
400	7.00	1.33
450	9.64	1.84
500	10.86	1.99

Nominal Internal dia in mm	Lead wool weight in kg	Spun yarn weight in kg
600	12.79	2.83
750	15.68	3.52
825	17.12	3.88
900	18.80	4.25
1200	28.44	6.01

Note : Higher tolerance may be permitted under special circumstances depending upon site condition for quality of lead wool and spun yarn.

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 longi-tudinal 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.

Sl. No.	Consolidated thickness of premix carpet	Stone chips (cum)	Sand (cum)	Tack coat (kg)	Binder Carpet (kg/cum)	Seal coat (kg/cum)
	Using Paving bitumen80/100 or 30/40 grade					
1.	Priming tack coat					

Sl.	Consolidated	Stone chips	Sand	Binder
a)	on a water bound macadam surface		75	
b)	on an existing black top surface		65	
2.	Carpe t			
	2 cm	2.4 (10 mm nominal size)		64
	2.5 cm	3.0 (10 mm nominal size)		64
	4.0 cm	4.8 (12 mm nominal size)		64
3.	Seal Coat			
a)	Dry area (Premixed sand seal coat)		0.6	68
b)	Wet area (Liquid seal coat with chips		0.9	98

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 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

Sl. No.	Thickness of consolidated bitumen concrete surfacing	Tack coat (kg)	Hot Bitumen (cut back)/ Paving Bitumen 80 / 100 grade	
			Bitumen concrete	
			Stone aggregate (kg / cum)	Sand (kg / cum)
1.	4 cm, 5 cm, 6 cm & 7.5 cm	75	560	128

Aggregate

Sl.	Thickness of compacted bitumen concrete surfacing		Stone aggregate (cum / 100 sqm)	Coarse sand (cum / 100 Sq.m)
1.	4 cm	3.8	(12mm nominal size)	1.90
2.	5cm	4.8	(20mm nominal size)	2.40
3.	6cm	5.8	(60% 40mm nominal size) (40% 25mm nominal size)	2.90
4.	7.5 cm	7.3	(60% 50mm nominal size) (40% 40mm nominal size)	3.65

The nominal size of Coarse Aggregate herein shall mean as defined below:

Sl. No.	Nominal size of coarse aggregate	Designation of IS sieve through which the aggregate shall wholly pass	Designation of IS sieve through which the aggregate shall be retained
i)	40 mm	50 mm	25 mm
ii)	25 mm	40 mm	20 mm

iii)	20 mm	25 mm	12.5 mm
iv)	12 mm	20 mm	10 mm
v)	10 mm	12.5 mm	6.3 mm
vi)	6 mm	10 mm	2.36 mm

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 grove 6.5 cm. wide and 7.5 cm deep, the chase being filled with cement mortar (1:4).

Where waterproofing is done to the roof of an underground structure, such as a tunnel, it shall be done in a similar way. The structural concrete shall be rendered smooth, hot bitumen and bitumen felts applied in the same way as for the floor and walls, and over this shall be laid a protective layer of cement concrete 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.

General

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 water proofing 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

High range water reducing admixture and integral cement waterproofer for concrete. Super plasticiser shall conform to ASTM C-194 Type F, IS: 9103-1979 & IS:2645-1975.

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, y, 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 frame work 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 runner 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 15 th 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

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.

Sl.No.	Description of Item		Cement Requirement
MASONRY WORK			
1.	Random rubble masonry with	CM 1:4	1.255 quintals per cum
2.	Random rubble masonry with	CM 1:6	0.825 quintal per cum
3.	Coursed rubble masonry in	CM 1:6	0.75 quintal per cum
4.	Brick work in	CM 1:4	0.950 quintal per cum of BW
5.	Brick work in	CM 1:6	0.625 quintal per cum of BW
6.	Half brick work in	CM 1:3	1.43 quintals per 10 sqm of area
7.	Half brick work in	CM 1:4	1.06 quintals per 10 sqm of area
8.	75mm thick brick in	CM 1:4	0.65 quintal per 10 sqm of area
9.	75mm thick brick in	CM 1:3	0.81 quintal per 10 sqm of area

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
7.	Concrete grade	(i)	M -15B	mix design to be prepared by contractor & approved by the Engineer
		(ii)	M -15C	
		(iii)	M -15D	

8.	Concrete grade	(i) (ii) (iii)	M -20B M -20C M -20D	plus wastage and all incidentals as decided.
9.	Concrete grade	(i) (ii) (iii)	M -25B M -25C M -25D	
10.	Concrete grade	(i) (ii)	M -30C M -30D	
11.	Applying cement slurry on RCC slab for receiving cement concrete flooring.			2.75 kg/sqm

FINISHING

1.	6mm thick C.P. 1:4	0.280 quintal per	10 sqm area
2.	10mm thick C.P. 1:5	0.370 quintal per	10 sqm area
3.	10mm thick C.P. 1:4	0.430 quintal per	10 sqm area
4.	10mm thick C.P. 1:6	0.300 quintal per	10 sqm area
5.	12mm thick C.P. 1:3	0.734 quintal per	10 sqm area
6.	12mm thick C.P. 1:4	0.547 quintal per	10 sqm area
7.	12mm thick C.P. 1:6	0.360 quintal per	10 sqm area
8.	15mm thick C.P. 1:4	0.655 quintal per	10 sqm area
9.	15mm thick C.P. 1:6	0.440 quintal per	10 sqm area
10.	20mm thick C.P. 1:4	0.850 quintal per	10 sqm area
11.	20mm thick C.P. 1:6	0.560 quintal per	10 sqm area
12.	12mm thick bearing plaster in CM 1:4 with neat cement finish	0.590 quintal per	10 sqm area

13.	Neat cement punning	0.200 quintal per	10 sqm area
14.	Flush or ruled or cut or weather pointing on brick work with CM 1:3	0.155 quintal per	10 sqm area
15	Flush or ruled or cut out or weather pointing on brick work with CM 1:2	0.200 quintal per	10 sqm area
16.	Raised and cut pointing on brick work with cement mortar 1:3	0.235 quintal per	10 sqm area
17.	Flush or ruled pointing on brick flooring with cement mortar 1:4	0.075 quintal per	10 sqm area
18.	Flush or ruled pointing on brick flooring with cement mortar 1:6	0.050 quintal per	10 sqm area

FLOORING

1.	Brick on edge flooring in cement mortar 1:4	1.100 quintal per	10 sqm area
2.	Brick on edge flooring in cement mortar 1:6	0.800 quintal per	10 sqm area
3.	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.	1.020 quintal per	10 sqm area
4.	40mm thick (IPS) cement concrete flooring 1:2:4 with 20mm and down stone chips finished with a floating coat of neat cement.	1.500 quintal per	10 sqm area
5.	25mm thick (IPS) flooring with base coat 19mm thick 1:2:4 using stone		

	chips 10mm nominal size and 6mm topping coat 1:1 (1 cement : 1 stone chips 3mm size) with a floating coat of neat cement.	1.370 quintal per	10 sqm area
6.	40mm thick (IPS) flooring with base coat 30mm thick 1:2:4 using stone chips 10mm nominal size and10mm 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 and10mm 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	1.583 quintal per	10 sqm area
	b) Light shade pigment or without any (grey cement) pigment with white cement	1.010 quintal per (grey cement) 0.580 quintal per (white cement)	10 sqm area 10 sqm area
	c) Medium shade pigment with 50% grey cement and 50% white cement	1.295 quintal per (grey cement) 0.290 quintal per (white cement)	10 sqm area 10 sqm area
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	1.705 quintal per	10 sqm area
	b) Light shade pigment or without any (grey cement) pigment with white cement	0.895 quintal per (grey cement) 0.810 quintal per (white cement)	10 sqm area 10 sqm area
	c) Medium shade pigment with 50% grey cement and 50% white cement	1.300 quintal per (grey cement)	10 sqm area

		0.405 quintal per (white cement)	10 sqm area
d)	White cement without any pigment	0.895 quintal per (grey cement)	10 sqm area
		0.810 quintal per (white cement)	10 sqm area
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		
a)	Dark or light shade pigment with grey cement	1.490 quintal per	10 sqm area
b)	Light shade pigment or without any pigment with white cement.	1.090 quintal per (grey cement)	10 sqm area
		0.400 quintal per (white cement)	10 sqm area
c)	Medium shade pigment with 50% grey cement and 50% white cement	1.290 quintal per (grey cement)	10 sqm area
		0.200 quintal per (white cement)	10 sqm area
(B)	21mm thick, with under layer 15mm thick cement plaster 1:3		
a)	Dark or light shade pigment with grey cement	1.640 quintal per	10 sqm area
b)	Light shade pigment or without any pigment with white cement.	1.230 quintal per (grey cement)	10 sqm area
		0.400 quintal per	10 sqm area

		(white cement)	
c)	Medium shade pigment with 50% grey cement and 50% white cement	1.430 quintal per (grey cement) 0.200 quintal per (white cement)	10 sqm area 10 sqm area
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 (grey cement) 0.44 quintal per (white cement)	10 sqm area 10 sqm area
c)	Medium shade using 50% grey cement and 50% white cement	0.66 quintal per (grey cement) 0.22 quintal per (white cement)	10 sqm area 10 sqm area
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 (grey cement) 0.22 quintal per (white cement)	10 sqm area 10 sqm area
c)	Medium shade using 50% grey cement	1.285 quintal per	10 sqm area

	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 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 10 sqm area
b)	30 mm thick	1.290 quintal per (grey cement) 0.075 quintal per (white cement)	10 sqm area 10 sqm area
c)	40 mm thick	1.310 quintal per (grey cement) 0.075 quintal per (white cement)	10 sqm area 10 sqm area
17.	Marble tiles 18 to 24 mm thick in risers	1.16 quintal per	10 sqm area

	of steps, skirting, dado, walls and pillars laid on 12mm thick cement mortar 1:3 (1 cement : 3 sand) and jointed with white cement slurry	(grey cement) 0.075 quintal per (white cement)	10 sqm area
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 (grey cement) 0.170 quintal per (white cement)	10 sqm of area 10 sqm of area

	dust)		
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 (grey cement) 0.170 quintal per (white cement)	10 sqm of area 10 sqm of area
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

7.	DPC 25mm thick (1:2:4)	0.81 quintal per	10 sqm of area
8.	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.	0.86 quintal per	10 sqm of area
9.	Providing and fixing 25mm dia GI pipe outlet in CM 1:3 including cutting and making good the walls.	0.05 quintal per	10 RM
10.	Providing and fixing 40mm dia GI pipe outlet in CM 1:3 including cutting and making good the walls.	0.075 quintal per	10 RM
11.	Providing chases 75mm wide 50mm deep in walls for conduit pipe and filling the same with CC 1:3:6	0.075 quintal per	10 RM
12.	Fixing steel windows with 1:2:4 concrete blocks	0.40 quintal per	10 sqm of area
13.	Cement-sand mortar :		
a)	1:1(1cement :1sand)	10.2 quintals per	cum
b)	1:2(1cement : 2sand)	6.8 quintals per	cum
c)	1:3(1cement : 3sand)	5.1 quintals per	cum
d)	1:4(1cement : 4sand)	3.8 quintals per	cum
e)	1:5(1cement : 5sand)	3.1 quintals per	cum
f)	1:6(1cement : 6sand)	2.5 quintals per	cum

DRAINAGE/SANITARY & WATER SUPPLY INSTALLATIONS

1.	100mm dia AC rain water pipe l/c fittings with CM 1:2	0.725 quintal per	100 RM of pipe
2.	150mm dia AC rain water pipe l/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	l each
6.	Fixing urinal cistern including pipes	0.025 quintal	each
7.	Fixing & finishing floor trap	0.015 quintal	each
8.	Fixing HCI 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.

Description		**Permissible tolerance**
Building bricks, in length width and height	:	As per IS 1077 - 1992
Laterite stone, in length, width & height	:	Plus or minus 5 mm
Natural building stone		
a) For stones required in ashlar masonry :		
Length & Breadth	:	Plus or minus 5mm
Height	:	Plus or minus 3mm
b) For stones required other than in ashlar masonry :		
Length & Breadth	:	Plus 5mm, minus 10mm
Height	:	Plus 5mm, minus 5mm

Description		Permissible tolerance
Concrete and reinforced concrete pipes :		
Length	:	Plus or minus 1% of standard length
Internal diameter, upto 300 mm	:	Plus 3 mm Minus 1.5 mm
Cast iron spigot & socket pipes and fittings :		
Length of fittings	:	Plus or minus 10mm
Length of pipe	:	Plus or minus 20mm
Thickness	:	minus 1 mm
Internal dia of socket	:	Plus or minus 3 mm
Depth of socket	:	Plus or minus 10mm
External dia, upto 75 mm	:	Plus or minus 3mm
100 mm	:	Plus or minus 3.5mm
150 mm	:	Plus or minus 4mm
Stoneware pipes, in length		
upto 75 cm	:	Plus or minus 10mm
Upto 90 cm	:	Plus or minus 15mm
In thickness of barrel and socket not exceeding 450mm	:	Plus or minus 2mm

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%

ii) for quantity of less than 150m of one size : + 10% , - 8%

iii) for quantity of 150m and over of one size : + 4% , - 4%

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 100 mm

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

Axes of anchor bolts in plan	:	Plus or minus 5mm
Axis of foundation in either direction	:	Plus or minus 10mm
Deviation in vertical line along height	:	Plus or minus 10mm
Sizes of pits in plan	:	Plus or minus 20 mm
Sizes of steps in plan	:	minus 20mm
Levels of steps, benches and pits	:	minus 20mm
Axes of inserts in plan	:	Plus or minus 10 mm
Basic dimensions in plan	:	Plus or minus 10mm
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 10mm
Top level	:	Plus 20 mm
Threaded length	:	Plus 30 mm

		For Walls	For Pillars
Masonry			
Width	:	Plus or minus 10 mm	Plus or minus 10 mm
Shift in axes	:	Plus or minus 10 mm	--- ---
Deviation in row from horizontal line for every 10m length	:	Plus or minus 15 mm	--- ---
Flatness of surface when checked with a 2 m long straight edge	:	Plus or minus 10 mm	Plus or minus 5 mm
Deviation in lines separating storeys Deviation of surface from vertical and and at angles and corners	:	Plus or minus 15 mm	Plus or minus 15 mm
for 1 storey	:	Plus or minus 10 mm	Plus or minus 10 mm
for whole building	:	Plus or minus 30 mm	Plus or minus 30 mm

Dimensions of openings for doors, windows etc	:	Plus 15 mm Minus 0 mm
Flooring, skirting, dado and plastering	:	
Insitu concrete floor	:	4 mm
Concrete tile and mosaic, 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

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 in equalities 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.

ii) Openings upto 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 upto 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.

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.

(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 form work 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. utp 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 upto two places of decimal and area calculated in sq.m. upto 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 upto 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.

SPECIFICATION FOR CIVIL WORKS

PART – VI SAFETY REQUIREMENTS FOR CONSTRUCTION WORKS

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) 1987 to 1991	Scaffolds and Ladders.
6922 - 1973	Structures Subject to Underground Blasts.
4756 - 1978	Tunneling Work.
5499 - 1969	Underground Air-raid Shelters in Natural Soil.

4138 - 1977 Working in Compressed Air.

7293 - 1974 Working with Construction Machinery

8989 - 1978 Erection of Concrete Framed Structures.

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 atleast 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 atleast 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 atleast 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 upto 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 atleast 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 'DONT'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 Not withstanding 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

ANNEXURE - A

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 456	:	Code of practice for plain and reinforced concrete.
IS 712	:	Specification for building limes.
IS 3182	:	Specification for broken brick (burnt clay) fine aggregate for use in lime mortar.
IS 269	:	Specification for 33 grade ordinary Portland Cement.
IS 455	:	Code of practice for Portland Slag Cement.
IS 1489	:	Specification for Portland Pozzolana Cement.
IS 8041	:	Specification for rapid hardening Portland Cement.
IS 8112	:	Specification for 43 grade ordinary Portland Cement.

IS 12269	:	Specification for 53 grade ordinary Portland Cement.
IS 8043	:	Specification for Hydrophobic Portland Cement
IS 12330	:	Specification for Sulphate resisting Portland Cement.
IS 6452	:	Specification for high alumina cement for structural use.
IS 8042	:	Specification for White Portland Cement.
IS 3535	:	Methods of sampling Hydraulic Cement.
IS 4031 (Part 1 to 15)	:	Methods of test for Hydraulic Cement.
IS 4032	:	Method of Chemical Analysis of Hydraulic Cement.
IS 2645	:	Specification for Integral Cement Waterproofing Compounds.
IS 1599	:	Method of Bend Test.
IS 1608	:	Method of Tensile Testing of Steel Products.
IS 6925	:	Method of test for determination of Water Soluble Chlorides in concrete admixtures.
IS 432	:	Specification for mild steel and medium

tensile steel bars and hard drawn steel wire for concrete reinforcement.

IS 1786	:	Specification for high strength deformed steel bars and wires for concrete reinforcement.
IS 1566	:	Specification for hard drawn steel wire fabric for concrete reinforcement.
IS 280	:	Mild steel wire for general engineering purposes.
IS 2062	:	Structural steel (Standard Quality).
IS 1161	:	Steel Tubes for Structural purposes.
IS 5624	:	Foundation bolts.
IS 1363 - (Part 1 to 3)	:	Hexagon Head bolts, screws, nuts.
IS 2016	:	Plain washers.
IS 3063	:	Single coil rectangular section spring washers.
IS 1239 (Part 1&2)	:	Mild Steel Tubes and other wrought steel pipe fittings.
IS 1367	:	Technical supply conditions for threaded steel fasteners.
IS 1030	:	Carbon steel castings.

IS 3480	:	Flexible steel conduit for electrical wiring.
IS 2667	:	Fittings for rigid steel conduits for electrical wiring.
IS 9537 (Part 3)	:	Conduit for electrical installations - Rigid Plain conduits of insulating materiel.
IS 6946	:	Flexible non-metallic conduits for electrical installations.
IS 3419	:	Fittings for rigid non-metallic conduits.
IS 5913	:	Methods of tests for Asbestos Cement Products.
IS 2098	:	Specification for asbestos cement building boards.
IS 2096	:	Specification for asbestos cement flat sheets.
IS 9537 (Part 2)	:	Conduit for electrical installations - Rigid steel conduits.
IS 2614	:	Method for sampling of fasteners.
IS 1592	:	Specification for asbestos cement pressure pipes.
IS 9627	:	Specification for asbestos cement pressure pipe (Light duty).

IS 6908	:	Specification for asbestos cement pipes and fittings for sewerage and drainage.
IS 1626 (Part 1 to 3)	:	Specification for asbestos cement building pipes & pipe fittings and roofing fittings
IS 459	:	Specification for unreinforced corrugated and semi corrugated asbestos cement sheets
IS 1077	:	Specification for common burnt clay building bricks.
IS 3495 (Part 1 to 4)	:	Method of Test for burnt clay building bricks.
IS 3620	:	Specification for laterite stone block for masonry.
IS 1121	:	Method of test for determination of strength properties of natural building stone.
IS 1124	:	Method of test for determination of water absorption Sp. Gr. etc. of building stones
IS 1125	:	Method of test for determination of weathering of natural building stones.
IS 1126	:	Method of test for determination of dura-bility of building stone.
IS 1127	:	Recommendation for dimensions and

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 6041	:	Code of practice for construction of Auto claved Cellular concrete block masonry.
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

tiles.

IS 777	:	Specification for glazed earthen ware wall tiles.
IS 1129	:	Recommendation for dressing of natural building stone.
IS 1130	:	Specification for Marble (blocks, slabs and tiles).
IS 809	:	Specification for rubber flooring materials for general purposes.
IS 3462	:	Specification for unbacked flexible PVC flooring.
IS 3461	:	Specification for PVC asbestos floor tiles
IS 2818	:	Indian Hessians.
IS 653	:	Linoleum sheets and tiles.
IS 5389	:	Code of practice for laying hard wood parquet and wood block flooring.
IS 210	:	Grey Iron Castings.
IS 2114	:	Code of practice for laying in-situ terrazzo finish.
IS 1198	:	Code of practice for laying of linoleum flooring.

IS 1003 (Part-2)	:	Specification for timber panelled & glazed shutters, windows and ventilator shutters.
IS 1141	:	Code of practice for seasoning of timber.
IS 1003 (Part-1)	:	Specification for timber panelled & glazed shutters - Door shutters.
IS 287	:	Recommendation for maximum permissible moisture content of timber used for different purposes.
IS 2202 (Part-1)	:	Specification for wooden flush door shutters (Solid core type).
IS 2191 (Part-1&2)	:	Specification for wooden flush door shutters (cellular and hollow core type).
IS 3087	:	Specification for wood particle boards (Medium density) for general purposes.
IS 3478	:	Specification for high density wood particle boards.
IS 3097	:	Specification for veneered particle boards
IS 303	:	Specification for plywood for general purposes.
IS 1328	:	Specification for veneered decorative plywood.
IS 205	:	Specification for non-ferrous metal butt

hinges.

IS 1341	:	Specification for steel butt hinges.
IS 362	:	Specification for parliament hinges.
IS 453	:	Specification for double acting spring hinges.
IS 3818	:	Specification for continuous (Piano) hinges.
IS 206	:	Specification for Tee and Strap hinges.
IS 281	:	Specification for mild steel sliding door bolts for use with padlocks.
IS 1019	:	Specification for rim latches.
IS 2681	:	Specification for non-ferrous metal sliding door bolts for use with padlocks.
IS 204 (Part 1&2)	:	Specification for tower bolts - Ferrous and Non-ferrous metals.
IS 208	:	Specification for door handles.
IS 2209	:	Specification for mortice locks (vertical type).
IS 6607	:	Specification for rebated mortice locks (vertical type).
IS 1823	:	Specification for floor door stoppers.

IS 1837	:	Specification for fan light pivots.
IS 207	:	Gate and shutter hooks and eyes.
IS 6343	:	Specification of door closers (peneumatically regulated) for light door weighing upto 40 Kg.
IS 8756	:	Specification for ball catches for use in wooden Almirah.
IS 6315	:	Specification for floor springs (hydraulically regulated) for heavy doors.
IS 7197	:	Specification for Double action floor spring (without oil check) for heavy doors
IS 364	:	Specification for fan light catch.
IS 3828	:	Specification for ventilator chains.
IS 363	:	Specification for hasp and staples.
IS 9899	:	Specification for hat, coat and wardrobe hooks.
IS 729	:	Specification for drawer locks, cup-board locks and box locks.
IS 3564	:	Specification for door closers (Hydraulically regulated).
IS 4351	:	Specification for steel door frames.

IS 419	:	Putty for use on window frames.
IS 5187	:	Specification for flush bolts.
IS 3847	:	Specification for mortice night latches.
IS 4621	:	Specification for indicating bolts.
IS 1038	:	Specification for steel doors, windows and ventilators.
IS 1977	:	Structural steel (ordinary quality).
IS 1361	:	Specification for steel windows for industrial buildings.
IS 7452	:	Hot rolled steel sections for doors, windows and ventilators.
IS 1948	:	Specification for aluminium doors, windows and ventilators.
IS 1148	:	Specification for hot rolled rivet bars for structural purposes.
IS 1949	:	Specification for aluminium windows for industrial buildings.
IS 204 (Part 1)	:	Specification for tower bolts-non-ferrous metal.
IS 733	:	Wrought aluminium and aluminium alloy bars, rods and sections (for general

engineering purposes).

IS 6248	:	Specification for metal rolling shutters and rolling grills.
IS 1081	:	Code of practice for fixing and glazing of metal doors, windows and ventilators.
IS 2339	:	Specification for Aluminium Paint for general purpose in dual containers.
IS 2835	:	Flat Transparent sheet glass.
IS 5437	:	Wired and figured glass.
IS 101 (Part 1 to 8)	:	Method of sampling and test for paints, varnishes and related products.
IS 2074	:	Ready mixed paint, air drying, red oxide zink chrome, priming.
IS 5410	:	Cement paint, colour as required.
IS 427	:	Distemper, dry, colour as required.
IS 428	:	Distemper, oil emulsion, colour as required.
IS 348	:	French polish.
IS 5411 (Part 1&2)	:	Plastic emulsion paint.
IS 702	:	Industrial Bitumen.
IS 73	:	Paving Bitumen.

IS 217	:	Cut Back Bitumen.
IS 454	:	Specification for Digboi type cutback bitumen.
IS 5467	:	Specification for shellac Wax.
IS 3384	:	Specification for Bitumen primer for use in water proofing and damp proofing.
IS 290	:	Specification for Coal Tar Black Paint.
IS 341	:	Specification for Black Japan, Type A, B & C.
IS 1322	:	Specification for bitumen felts for water proofing and damp proofing.
IS 218	:	Specification for creosote oil for use as wood preservative.
IS 3037	:	Specification for Bitumen mastic for use in water proofing of roofs.
IS 1580	:	Specification for Bituminous compound for water proofing and caulking purposes.
IS 8542	:	Specification for polish for wooden furniture paste.
IS 9862	:	Ready mixed paint, brushing etc.
IS 782	:	Specification for caulking lead.

IS 405 (Part 1&2)	:	Lead sheet and strips.
IS 5134	:	Bitumen impregnated paper.
IS 2849	:	Specification for non load bearing gypsum partition blocks.
IS 8591	:	Specification for floor polish paste.
IS 2095	:	Specification for gypsum plaster boards.
IS 77	:	Specification for linseed oil, boiled for paints.
IS 533	:	Gum Spirit of turpentine (oil of Turpentine).
IS 1504	:	Bees Wax.
IS 3536	:	Ready mixed paint, brushing, wood primer pink.
IS 8273	:	Specification for gypsum plaster for use in the manufacture of fibrous plaster board.
IS 5871	:	Specification for bitumen mastic for tanking and damp proofing.
IS 651	:	Specification for salt glazed stoneware pipe and fittings.
IS 1729	:	Sand cast iron spigot and socket soil pipe.
IS 771 (Part 1 to 7)	:	Specification for glazed fire clay appliances.

IS 1230	:	Cast iron rain water pipes and fittings.
IS 774	:	Flushing cisterns for water closets and urinals.
IS 2548 (Part 1&2)	:	Specification for plastic seats and cover for water closet.
IS 1726	:	Specification for cast iron manhole cover and frames.
IS 1239 (Part 1&2)	:	Mild steel Tubes and fittings.
IS 4984	:	Specification for high density polyethylene pipes for potable water supplies: Sewerage and industrial effluents.
IS 2556 (Part 1 to 15)	:	Specification for vitreous sanitary appliances (vitreous china).
IS 7328	:	High density polyethylene materials.
IS 4985	:	Specification for unplasticised PVC pipes for potable water supplies.
IS 3076	:	Specification for low density polyethylene pipe for potable water supplies.
IS 9762	:	Specification for polyethylene floats for ball valve.

IS 3395	:	Code of practice for fire safety of industrial buildings.
IS 7834 (Part 1 to 8)	:	Specification for injection moulded PVC fittings with solvent cement joint for water supplies.
IS 8008 (Part 1 to 7)	:	Specification for injection moulded HDPE fittings for potable water supplies.
IS 8360 (Part 1 to 3)	:	Specification for fabricated high density polyethylene fittings for potable water.
IS 784	:	Specification for prestressed concrete pipe.
IS 1703	:	Specification for copper alloy float valves (horizontal plunger type) for water supply fittings.
IS 12234	:	Specification for plastic equilibrium float valve for cold water services.
IS 778	:	Specification for copper alloy gate, globe and check valves for water works purposes.
IS 1536	:	Centrifugally cast (spun) iron pressure pipes.
IS 1537	:	Vertically cast iron pressure pipes for water, gas and sewage.
IS 1538 (Part 1 to 23)	:	Sand cast iron spigot and socket soil, waste

and ventilating pipes, fittings and accessories.

IS 3589	:	Electrically welded steel pipes for water, gas and sewage.
IS 781	:	Specification for cast copper alloy screw down bib taps and stop valves for water services.
IS 1239 (Part 1&2)	:	Mild steel tubes and fittings.
IS 779	:	Specification for water meters.
IS 1795	:	Specification for pillar taps for water supply purposes.
IS 1363 (Part 1 to 3)	:	Dimensions for screw thread run-outs and undercuts.
IS 2016	:	Plain washers.
IS 638	:	Sheet rubber jointing and rubber insertion jointing.
IS 4127	:	Code of practice for laying of glazed stoneware pipes.
IS 458	:	Specification for precast concrete pipes.
IRC 19	:	Standard specification and code of practice for water Bound macadam.

IRC 29	:	Tentative specification for 4 cm Asphaltic concrete surface course.
IRC 15	:	Standard specification and code of practice for construction of concrete roads.
IS 6313	:	Code of practice for antitermite measures in building.
IS 1054	:	Dieldrin emulsifiable concentrates.
IS 1308	:	Aldrin dusting powders.
IS 6439	:	Hepta chlor emulsifiable concentrates.
IS 2632	:	Crotonaldehyde.
IS 1791	:	Specification for batch type concrete mixers.
IS 10262	:	Recommended guidelines for concrete mix design.
IS 7861 (Part 1)	:	Code of practice for extreme weather concreting - Recommended practice for hot weather concreting.
IS 1199	:	Methods of sampling and analysis for concrete.
IS 516	:	Method of test for strength of concrete.
IS 7861 (Part 2)	:	Code of practice for extreme weather

concreting. Recommended practice for cold weather concreting.

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 3370 (Part 1&2) : Code of practice for concrete structures for the storage of liquids.

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

lime.

IS 2212	:	Code of practice for brick work.
IS 1597 (Part 1&2)	:	Code of practice for construction of stone masonry.
IS 4101 (Part 1 to 3)	:	Code of practice for external facing and veneer.
IS 737	:	Wrought aluminium and aluminium alloys, sheet and strips (for general engineering purposes).
IS 2572	:	Code of practice for construction of hollow connect block masonry.
IS 1661	:	Code of practice for application of cement finishes.
IS 5766	:	Code of practice for laying of burnt clay brick flooring.
IS 5491	:	Code of practice for laying of in-situ granolithic concrete flooring topping.
IS 3316	:	Specification for structural granite.
IS 1196	:	Code of practice for laying bitumen mastic flooring.
IS 1195	:	Specification for bitumen mastic for flooring.

IS 3462	:	Specification for unbacked flexible PVC flooring.
IS 1198	:	Code of practice for laying fixing and maintenance of linoleum floor.
IS 848	:	Specification for synthetic resin adhesive for plywood.
IS 4457	:	Specification for ceramic unglazed vitreous acid resisting tiles.
IS 851	:	Specification for synthetic resin adhesive for construction work (non structural) for wood.
IS 2202 (Part 1&2)	:	Specification for wooden flush door shutters.
IS 102	:	Ready mixed paint.
IS 1081	:	Code of practice for fixing and glazing of metal doors.
IS 6248	:	Specification for metal rolling shutters and rolling grills.
IS 1868	:	Anodic coatings on aluminium and its alloys.
IS 2065	:	Code of practice for water supply in buildings.

IS 2064	:	Code of practice for selection, installation and maintenance of sanitary appliances.
IS 7634 (Part 1 to 3)	:	Code of practice for plastic pipes.
IS 1742	:	Code of practice for building drainage.
IS 5330	:	Criteria for design of anchor blocks for penstocks with expansion joints.
IS 3114	:	Code of practice for laying of cast iron pipes.
IS 783	:	Code of practice for laying of concrete pipes.
IRC-SP11	:	Hand book of quality control for construction of roads and run-ways.
IRC-63	:	Tentative guidelines for use of low grade aggregates and soil aggregate mixtures in road pavement construction.
IRC-60	:	Tentative guidelines for use of Lime Fly Ash Concrete as pavement base or sub-base.
IRC-74	:	Tentative guidelines for use of Lean Cement Concrete and lean concrete Fly Ash Concrete as pavement base or sub-base.
IS 6509	:	Code of practice for installation of joints in

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.
IRC-15	:	Standard specifications and code of practice for construction of concrete road.
IS 3036	:	Code of practice for laying lime concrete for a water proofed roof finish.
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 4365	:	Code of practice for application of bitumen mastic for waterproofing of roofs.
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.

IS 278	:	Specification for Galvanized barbed wire for fencing.
IS 2721	:	Specification for Galvanized steel chain link fabric.
IS 280	:	Specification for Mild steel wire.
IS 4826		Specification for hot dipped galvanized coating on round steel wires.
IS 1200 (Part 1 to 28)	:	Method of measurement of building and Civil Engineering Works.
IS 4081	:	Safety code for blasting.
IS 5916	:	Specification for cast iron gratings for drainage purposes.
IS 4130	:	Safety Code for demolition of building.
IS 3764	:	Safety code for excavation work.
IS 5121	:	Safety code for piling.
IS 4014 (Part 2)	:	Code of practice for steel tubular scaffolding.
IS 3696 (Part 1&2)	:	Safety code of scaffolds and ladders.
IS 6922	:	Criteria for safety and design of structures subject to underground blast.

IS 5499	:	Code of practice for construction of underground raid shelter.
IS 4138	:	Safety code for working in compressed air.
IS 7293	:	Safety code for working with construction machinery.
IS 8989	:	Safety code for erection of concrete framed structures.
IS 4756	:	Safety code for Tunneling work.
IS 7205	:	Safety code for erection of structural steel works.

SPECIFICATION
FOR
BORED CAST-IN-SITU CONCRETE PILES

SPECIFICATION NO. MEC/S/05/11/02

(CIVIL ENGINEERING SECTION)

MECON LIMITED
DELHI - 110 092

TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU CONCRETE PILE

01 General

This specification covers the piling work required for the construction. The contractor shall be deemed to have visited & carefully examined the site & surrounding, to have satisfied him about the nature of existing terrain, existing underground services, general site condition etc. and all other matters affecting the work. Claims and objections due to ignorance of site condition shall not be considered after submission of tender.

Soil characteristic at site along the pipe line route and at work stations varies at different locations. End bearing / skin friction piles may be provided as per soil report and site requirement if any. Soil characteristic shall be verified at individual locations by detailed soil investigation, if required.

The Termination criteria & Vertical Compressive Capacity of 30 T for piles shall be maintained as per soil characteristic along the route. No change / modification shall be entertained at any stage. However length of pile at a particular location will depend on level of top of rock stratum/stiff soil at that location. For any particular location, if the contractor feels any insufficiency of data pertaining to the soil, they shall conduct geotechnical investigation, as per requirement, at no extra time & cost to Owner.

The capacity of piles shall be confirmed by the executing agency by Load Test on Initial Trial Piles & Routine Load test on working piles as per clause No. 9, IS: 14593: 1998 - Indian Standard code on "Design & Construction of Bored Cast-in-situ Piles Founded on Rocks - Guidelines" or as per IS :2911 (Part IV) for stiff soil condition.

02.01 Codes

Any Standards / Codes mentioned in this specification means the latest revision of it including its all amendments, if any.

IS:2911 (Part 1/Section 2)-1979 : 'Code of practice for design & construction of Bored Cast-in- Situ concrete piles', IS : 2911 (part 4) -1985 'Load Test on Piles & IS : 14593 : 1998 : 'Design And Construction of Bored Cast-in-situ Piles founded on Rocks – Guidelines' shall be referred to in conjunction with this specification during the entire design, construction & Load Testing work. These codes form the integral part of this specification.

If for any material or workmanship, appropriate Indian Standards or Codes are not available or have not been adequately specified in the Technical Specification, such materials & workmanship shall conform to other suitable Standard & Codes as may be approved by client.

In case of any conflict between the requirement of this specification & those of the referred codes / standards, the former shall govern.

Any special requirements as shown or noted on the project drawings shall govern over this specification.

02.02 Design

The piles shall be bored cast-in-situ cylindrical type RCC piles terminated within underlying original rock layer (below virgin soil) with a rock- socket length not less than 3D (where D is the diameter of the pile) or in stiff soil as per for length of fixity as per IS :2911 (Part I/SEC 2), to achieve the design capacity. Minimum center to center spacing between adjacent piles shall be 2.5 D.

The contractor shall submit the structural design and drawing of pile for approval of Owner/EIC.

02.03 Permanent Liner

For Piles of 400 mm diameter, no permanent liner is required. Only temporary casing shall be used.

02.04 Materials

All the materials proposed to be used, shall be free from any objectionable substances, shall conform the following stipulation & shall be approved by client. Any testing required proving the suitability of such materials shall be carried out by the contractor at his own cost & in presence of client representative. Any material rejected by client shall be immediately removed from the site.

02.04.01

Reinforcement steel shall conform to High yield strength deformed bars of grade Fe 415/Fe-500D as per IS:1786- For marine / coastal / corrosive surroundings, corrosion resistant bars shall be used as directed by EIC. Test certificate for reinforcement steel shall be obtained from recognised agency, before using. If the steel is purchased by the contractor, client may desire to check the testing of the same and the contractor shall arrange it in an approved laboratory at his own cost.

Reinforcement shall be provided for full depth of pile as furnished in the approved drawing.

02.04.02

Reinforced Cement Concrete for Piles shall be of Grade M-25 with minimum Cement content of 400 Kg/m^3 and using 20 mm & down graded stone aggregates. The slump of concrete shall range between 150 mm to 180 mm. The water-cement ratio shall not exceed 0.5. To achieve the specified slump using specified water cement ratio without compromising with strength, suitable plasticiser, if required, may be used at no extra cost, subject to approval of client. If

concentration of Sulphate (measured as SO_3) exceeds 0.5% in soil or 1200 ppm in ground water, sulphate resisting cement shall be used.

02.04.03

The cement shall be Ordinary Portland Cement conforming to IS: 269-1989 or Portland Pozzolona Cement conforming to IS: 1498-1991. Each batch of cement supply shall be accompanied by valid manufacturer's certificate.

02.04.04

The physical properties, mechanical properties & gradation of coarse & fine aggregate shall follow IS: 383-1970. Testing of aggregate properties (if desired by CLIENT) shall follow relevant parts of IS: 2386:1963.

02.04.05

Water used for concrete shall be clean & free from injurious amount of harmful substances in such amounts that may impair the strength & durability of pile concrete. Generally potable water shall be considered satisfactory. In case of any doubt felt by CLIENT about the quality of water, contractor has to prove that the concrete prepared with proposed water shall not have a compressive strength lower than 95% of the strength of similar concrete prepared with distilled water.

02.04.06

Preliminary mix design shall be done in accordance with IS: 10262-1982 & SP: 23 subject to approval of the customer. Cube tests, slump test & other relevant tests for preliminary mix design and Routine cube test, slump test for regular concreting shall be carried out at site / approved laboratory at contractor's own cost. Concrete cube tests shall be done as per IS: 516-1959. The calibration certificate (not older than one year) of the testing machine shall be available at site. If client feels any doubt about the calibration, the contractor has to check the same at an approved laboratory at his own cost. All such tests shall be conducted in presence of client. At least one set (3 cubes for 7 days & 3 for 28 days strength) of cube shall be tested for every 10 piles or at any deterioration in concrete quality if felt by Owner/EIC, whichever occurs earlier. Slump tests (apparatus conforming to IS:7320-1974) shall be carried out at least once for each pile or more frequently, if desired by Owner/EIC.

02.05 E uipment & A essories

The equipment & accessories should be compatible with the type of deposit, method of installation, type of founding strata & required penetration in the founding strata.
The capacity of rig shall be adequate so as to bore upto required depth. Rig shall be equipped with suitable Chisel &/or Bailer capable to penetrate through any Local Obstruction / Hard strata.

In case, pile is required to be socketted in any type of rock strata, the equipment shall be capable to do so upto required socket length at required depth.

No excuses, whatsoever, in relation to the inability of equipment shall be entertained during execution of work.

Contractor must furnish a detailed list of equipment & accessories (in sufficient quantities to complete the job within scheduled time frame & as per specification) to be deployed by him for this job indicating quantity, type, capacity/dimension & model/make of each along with his offer & reconfirm the same in writing immediately after mobilisation to site.

02.06 Constru tion

02.06.01

Piles shall be installed as accurately as possible as per drawing. Permissible positional deviation shall be as per clause 7.1. 2 , IS: 2911 (part 1/sec 2) –1979.

02.06.02

Boring in soft material liable to cavitation, boring tools shall not be operated at a level below the toe of the casing. The Care shall be taken to ensure that the volume of water added to the bore shall be no more than the minimum necessary for the operation of the boring tools. The casing shall be driven down through the soft material to penetrate a hard stratum not subjected to cavitation and shall be sealed in this material as far as possible. Thereafter the boring shall be continued by means of boring tools until the approved bearing layer is reached.

At the last stage of boring or in intermediate hard layers chisel or chopper may be used. The rate for piling work should be inclusive of any chiseling, chopping of hard strata, clearing of bottom of pile bore hole etc. complete as per specifications. The piles shall be installed with due consideration for safety of adjacent structures by a method which leaves their strength unimpaired and which develops and retains the required bearing resistance.

02.06.03

In green-field areas of the site, piling is to be started right from virgin soil deposit, pile boring may be done either by Bailer / Chisel method or by rotary boring with mud circulation process. In rotary boring method, stabilisation of the side of borehole can be done by the use of bentonite slurry. Either, Direct Mud Circulation (DMC) or Reverse Mud Circulation (RMC) process shall be adopted depending on soil condition & pile dimension. In such cases, the bentonite slurry must be used at least from the level of sub-soil water, & the hole should then be always kept almost full with the fluid. The specific gravity of bentonite slurry shall be in the range of 1.05 to 1.10. This shall be checked regularly at an interval of 10 piles or at any change in its specified quality if felt by the purchaser, whichever occurs earlier. Pressure of slurry pump shall be sufficient enough to clear out all cuttings efficiently from the hole.

02.06.04

Reinforcement as required shall be made into stiff cages sufficiently welded to withstand handling without any damage or distortion. Reinforcement shall be placed immediately after cleaning and inspection of the bottom of bore holes. The reinforcement should be supported away from the sides of the shaft by means of suitable space block to ensure concentric alignment in the shaft. Steps shall be taken to ensure correct positioning during concreting of reinforcement in the piles without any distortion. The clear cover to main reinforcement shall not be less than 50 mm.

02.06.05

Immediately before placing of reinforcement and concreting, the bored hole shall be cleaned of all the loose material, debris and all the water shall be removed. The pile tip zone shall be thoroughly cleaned by flushing the bore with fresh Bentonite slurry to completely replace the old Bentonite slurry used during the previous operations. This shall be carried out for 45 minutes in two stages. Cleaning for initial 30 minutes shall be done before lowering of reinforcement cage & final 15 minutes after lowering the reinforcement cage.

02.06.06

Concrete shall be so placed as to fill the entire volume of the tube or bore without the formation of voids caused by the faulty consolidation or entrapped air. Proper care shall be taken to ensure that the fluid alluvial soil does not penetrate between batches of the concrete.

In case of bore holes stabilised by Bentonite slurry, concrete shall be placed by means of tremie pipe which will be suitably closed at bottom at the start of concreting. The tremie pipe must extend upto the bottom of the borehole at the start and may be withdrawn in sections as the level of concrete rises in the borehole; but its discharge end shall at all times be embedded in the concrete to a minimum depth of 500 mm. Placing of concrete should be continuous and the pile holes will be maintained full with the bentonite slurry where used throughout the concreting operation. Slurry displaced from the borehole by the concrete shall be channeled away or pumped into suitable receptacles for re-use or disposal to waste.

In case of cased holes, after the required founding level is encountered, the bottom shall be sealed with concrete and the reinforcement cage shall be lowered. If the borehole is dry, concrete shall be deposited in such a manner so as to avoid any segregation of concrete followed by gradual withdrawal of casings. If water is present in the borehole, it shall be bailed out by bailer. If it is difficult to dewater by the bailer, concrete shall be placed under water by means of a placer. After the head of water has been neutralised by the head of the concrete, excess water shall be bailed out and concrete shall then be deposited by direct pouring from the top, as is done, if the borehole is dry.

02.06.07

Concreting of Pile shall continue until the Pile is fully formed upto a level of not less than 750 mm above cut-off level of piles. Extraction of casing wherever used, shall be done in such a way so that no necking or shearing of concrete in the shaft takes place. Pile length above cut-off level

shall not be paid & shall be trimmed of free of cost. Trimming of Pile top shall not be permitted before 7 days of concreting in case of mechanical chipping & not before 3 days concreting in case of manual chipping.

02.06.08

The concreted length of piles shall be measured from the toe of pile to cutoff level of pile.

02.06.09

Temporary stoppage of work may be permitted only during boring stage. Thereafter right from boring or chiseling of final portion of pile length through subsequent activities of flushing, lowering of reinforcement cage, lowering of tremie, pre-concrete flushing & upto concreting of full pile length, no halt whatsoever in the execution of work shall be permitted.

02.06.10

Boring of any pile shall not be carried out within a clear distance of three times of the pile diameter from the adjacent pile which has been freshly concreted within past 24 hours.

02.06.11

The contractor shall take all necessary actions to prevent side collapse (if any) of pile bore at his own cost.

02.06.12

Concreting of Pile shall continue until the Pile is fully formed upto a level of not less than 750 mm above cut off level of piles. Extraction of casing wherever used shall be done in such a way that no necking or shearing of the concrete in the shaft takes place. Pile length above cut off level shall not be measured for payment and shall be trimmed off free of cost. Trimming of pile top shall not be permitted before 7 days of concreting.

02.06.13

The Contractor shall be responsible for the prompt removal from the site of all spoil due to the boring to places as indicated by Owner/EIC. The cost of such disposal shall be deemed to have been included in the rate of piling.

02.07 Founding Strata

All the piles shall be founded on approved bearing strata or upto specified depth as per design requirement & as mentioned in the drawing.

In general, criteria for approval of founding strata shall be agreed between Owner/EIC & contractor based on visual identification of recognisable samples recovered from pile borehole & specified SPT criteria.

In case, pile is socketted in rock strata, a minimum socketted length of Thrice the pile diameter (3D) shall be provided. The founding rock strata shall be identified by recognisable rock piece sample obtained by boring tool from pile bore &/or wash of rock powder in return water, SPT N > 100 at termination level and as decided by Owner/EIC. In stiff soil pile shall be imbedded for length of fixity as per IS :2911 (Part I/SEC 2), to achieve the design capacity.

Termination criteria may be standardised / modified at site by Owner/EIC depending on actual sub-surface material encountered and rate of penetration through such strata with the available equipment & accessories.

2.08 Pile Load Test

02.08.01

Immediately on mobilisation to site the contractor shall arrange to construct Initial Test Piles with a view to establish suitability, installation criteria, safe load bearing capacity & guidelines for acceptance of routine tests. Initial tests shall separately be conducted for Vertical Compressive & Lateral load in non-working piles as shown in the project drawing. Maximum load to be applied for such tests shall be 2.5 times of the corresponding safe design loads.

These Initial Test piles shall be constructed using same equipment & technique as for working piles.

While executing the pile bore for Test Piles a continuous record of bore log shall be maintained and Standard Penetration Test as per IS:2131-1981 at an depth interval of 1.5 m including one compulsory test at termination level, shall be conducted at no extra cost.

02.08.02

Generally 1% of total number of working piles shall be tested for Routine Test. However exact number & location of the same shall be indicated by Owner/EIC at site. Maximum load in such tests may be limited to 1.5 times of the corresponding safe design load.

02.08.03

For all types (Initial / Routine & Vertical Compressive / Lateral) of load test the testing arrangement, procedure shall follow relevant criteria set out in IS: 2911(part 4) -1985 along with the following stipulations:

i) All the tests shall be carried out in presence of Owner/EIC.

ii) Load test shall be carried out after 28 days from the date of casting.

iii) Test load shall be applied at cut-off level. If the test level is below the ground water table, suitable arrangement for dewatering shall be made by the contractor without any extra cost so as to conduct the test at dry condition.

iv) Loading shall be applied by reaction method consisting of a hydraulic jack placed centrally against a suitable loaded platform / anchorage system. Reaction system shall be well designed & capable of taking 1.25 times of the maximum load to be applied. It is the responsibility of the contractor to ensure the required capacity of the reaction system.

v) Test load shall be applied to pile in a static manner. Stage loading shall be applied in equal increments of 20% of estimated safe design load. Unloading may be done in higher decrements with at least 5 stages. For Cyclic Load test, each stage of loading shall correspond to unloading upto zero loads. At each stage of loading & unloading, deflection of pile top shall be recorded accurate to 0.02 mm at an interval of 1, 2, 4, 8, 15, 30, 60 & 120 minutes upto a time when the deflection rate reduces to 0.1mm in 30 minutes or 0.2 mm in one hour or till two hours whichever occurs earlier.

vi) Increments of loads shall be continued upto Maximum Load (2.5 times of safe design load for Initial Test & 1.5 times of safe design load for Routine Test) or failure (soil-pile yielding or structural failure) whichever occurs earlier.

vii) Where failure does not occur, the final test load shall be maintained for 24 hours and deflection records shall be taken at every 6 hours interval, including initial 2 hours detailed records, as mentioned earlier.

viii) Assessment of Safe Load for different types of load test of pile socketted in rock, shall follow clause No. 9 of IS: 14593: 1998.

ix) The contractor shall ensure that all the instrument / apparatus used by him shall be properly calibrated. The calibration certificates (not older than one year) of all the dial gauges & pressure gauges proposed to be used for load test shall be available at site. If Owner/EIC desires to check any calibration, the contractor has to arrange the same in an approved laboratory at his own cost.

x) The Contractor shall maintain & submit Owner/EIC immediately after completion of any load test, the following records / reports:

a) Tabular & Graphical representation of Load vs. Settlement during loading and unloading.

b) Tabular & Graphical representation of the Time vs. Settlement for each load.

c) Graphical analysis of initial cyclic load test results (if any) to separate skin friction & end - bearing. as per Annexure A, IS 2911 (part 4).

d) Remarks concerning any unusual occurrence (if any) during boring, installation or testing of piles.

02.08.04

In case of failure of piles to achieve the specified safe design load in load test, the contractor shall install extra piles at his own cost as per design requirement & as instructed by Owner/EIC.

02.09 Standard of A eptan e

The piles shall be accepted as satisfactory only when the work has been executed in accordance with this specification, IS Codes, and the Standards stated hereinafter and instructions given by Owner/EIC at site from time to time:

a) The total volume of concrete shall not be less than actual shaft volume. The calculated volume for this purpose shall be the cross sectional area in side the bore multiplied by the length of the shaft. The concrete shall show the specified strength as indicated by the cube test results. The payment shall be made for theoretical volume of concrete in case of excess pour.

b) The toe of pile shall be at approved bearing level in each case.

c) Safe Load carrying capacity of pile as obtained from Load test shall not be less than corresponding Safe Design Load as mentioned.

d) Tolerances specified in clause No. 02.05.01 shall be satisfied.

If an individual pile fails to meet the requirements specified in any of above clause/s, such pile shall be deemed to be defective.

When any pile is found defective, one or more pile shall be installed as a replacement of defective pile as necessary without any extra cost to Owner. Defective piles shall be left in place or pulled out as directed by Owner/EIC. Contractor shall not be paid any additional amount on this account. No payment shall be made for test piles found defective / unsatisfactory.

02.10 Re ord

The contractor shall maintain a record for each pile indicating the following data and shall be signed jointly with Owner/EIC.

a) The date and time of commencement and completion of each stage of piling operation.

b) The particulars of the equipment and method of boring and concreting.

c) The location and type of pile, Pile number, with a reference to approved drawings.

d) The diameter of the pile and verticality.

e) Bored depth, concreted depth, empty boring and nature of stratum at founding Level.

f) The volume of concrete poured, quantity of cement, w/c ratio used and slump of poured concrete.

g) Details of reinforcement provided.

h) The sequence of installation of pile groups.

i) During boring operation, a separate record for rate of advancement of borehole in terms of effective time vs. boring depth shall be maintained for each pile. The effective time implies the time required exclusively for boring operation barring the time for other activities such as temporary stoppage, cleaning of hole, in-situ tests, if taken etc.

j) During chiseling through weathered rock strata, exact record for depth of penetration against time & number of blows for each 10 cm of chiseling shall be maintained. Weight & average height of fall of chisel shall also be recorded.

UALIT ASSURANCE & UALIT CONTROL

SITE QUALITY PLAN

CIVIL ENGINEERING DIVISION

MECON LIMITED

13th FLOOR, SCOPE MINAR, NORTH TOWER
LA MI NAGAR, DISTRICT CENTRE,
DELHI-110 092

Doc. No. Mec/05/11/S P R0

Issued in - Jan' 2011

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
A: MATERIALS									
1.0	**COARSE AGGREGATE**								
1.1	Specific Gravity, Density, Voids	Once in 12 weeks or change of source whichever is earlier	Labora tory Test	Weigh balance, Oven, Jar	IS:2386 Part III, IS:456, IS:383			Package Contractor	These test will be carried out while establishing design mix.
1.2	Sieve Analysis	For Industrial Projects: One sample per 200 M^3 (or part thereof) or change of source whichever is earlier. For Building Projects: One sample per 45M^3 (or part thereof)	Field Labora tory Test	Sieve set & weigh balance	IS:383	As per requirement of design mix within the limits specified in relevant IS Codes.	L-04	-do-	Mandatory Site Test
1.3	Petrography examination including visual inspection	To be done once per source	Visual/ Checki ng	-	IS:2386 Part IV, IS:383 (for acceptanc e limits)		-	-do-	Test will be carried out while establishing mix design

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
1.4	Deleterious Chemicals	To be done once per source	Lab Test	Balance Sieve & Container	IS:2386 Part III, IS:383 (for acceptanc e limits)			-do-	Test will be carried out while establishing mix design
1.5	Soundness	To be done once per source	-do-	Sieve Scales & Drying Oven	IS:2386 Part V, IS:383 (for acceptanc e limits)			-do-	Test will be carried out while establishing mix design
1.6	Acid & Alkali Reactivity	To be done once per source	Lab Test	Weigh balance	IS:2386 Part VII, IS:383			-do-	Test will be carried out while establishing mix design
1.7	Flakiness	To be done once per source	-do-	-	IS:2386 Part-I, IS:2386 Part VII, IS : 383			-do-	-do-

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
1.8	Bulk Density	One Sample per 200 m3 or part thereof		Oven, Jar & Weigh balance	IS:2386			-do-	-do-
2.0	**FINE AGGREGATE**								
2.1	Bulkage Moisture	One sample per 20M^3 (or part thereof)	Routin e Measu rement	Oven, Jar and weigh balance	IS : 2386 Part-III, IS : 383			-do-	Mandatory Site Test. Volume of sand and weight of water shall be adjusted as bulkage & moisture contents.
2.2	Sieve Analysis	For Industrial Projects. One sample per 200 m3(or part thereof) or change of source whichever is earlier. For Building Project. One sample per 40 M^3 (or part thereof)	Routin e	Sieve Set, Weigh balance	IS : 2386 Part-I, IS : 383	As per requirement of design mix within the limits specified in relevant IS Codes	L 03	-do-	Mandatory Site Test.
2.3	Particle Size and Shape	To be done once per source and to be repeated if source is changed	Routin e	-do-	IS : 2386 Part-I, IS : 383	Particle size shall be maximum 4.75		-do-	To be carried out during mix design.

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
						mm. Grading shall be within the limits of grading zone III for concrete work and for mortar and grout within the limits of grading zone III & IV.			
2.4	Deleterious Chemicals	-do-	-do-	Balance, sieve & Container	IS : 2386 Part-III, IS : 383			-do-	To be carried out during mix design.
2.5	Soundness	-do-	-do-	Sieve, Scales & Drying Oven	IS : 2386 Part-V, IS : 383 (for acceptanc e limit)		-	-do-	To be carried out during mix design.

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
2.6	Acid and Alkali Reactivity	To be done once per source and to be repeated if source is changed	-do-	Weigh Balance	IS : 2386 Part-VII, IS : 383		-	-do-	To be carried out during mix design.
2.7	Mortar Making Properties	-do-		Compressio n testing machine, 7.06 cm cube moulds	IS : 2386 Part-VI, IS : 383		-	-do-	To be carried out during mix design.
2.8	Petrographic Examination including visual inspection	-do-	Visual/ Physic al	-	IS : 2386 Part-VI, IS : 383 (for acceptanc e limit)		-		
2.9	Specific Gravity, Density, Voids	Once in 12 weeks, change of source whichever is earlier	Measu rement	Weigh Balance	IS : 2386 Part-III				These tests will be carried out while establishing design mix.
2.10	Check Silt and Clay Content	Every $20M^3$ (or part thereof)	Measu rement	Jar & Oven	IS : 2386 Part-II, IS : 383	Deleterious material not to exceed 5	-		Mandatory Site Test

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
3.0	**LIME**								
3.1	Chemical and Physical Properties	Every 10 MT (or part thereof)	Labora tory Test		IS: 6932 (Part I to X)			-do-	Optional Test if required.
4.0	**CEMENT**								
4.1	Fineness	For each consignment of 100T (or part thereof).	Labora tory Test		IS : 4031, IS : 269, IS : 1489, IS : 455			Manufactur er/ Package Contractor	Manufacturer's certificate to be furnished.
4.2	Normal consistency	-do-	Labora tory Test	Vicat needle	IS : 4031, IS : 269, IS : 1489, IS : 456			Manufactur er/ Package Contractor	-do-

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
4.3	Initial and Final setting	-do-	Labora tory Test	Vicat needle	IS : 4031, IS : 269, IS : 1489, IS : 457	Depending on the type of cement and as per relevant IS		Manufactur er/ Package Contractor	-do-
4.4	Soundness, Specific Gravity	-do-	Labora tory Test		IS : 4031, IS : 269, IS : 1489, IS : 458			Manufactur er/ Package Contractor	-do-
4.5	Compressive Strength	Every fortnight for each consignment.	Measu rement	Compressio n Testing Machine	IS : 4031, IS : 269, IS : 1489, IS : 459	Depending on the type of cement and as per relevant IS		Package Contractor	Mandatory Site Test
5.0	**CONCRETE**								
5.1	Workability, Slump test and compaction factor test	Once a day for each batching/ mixing plant	Measu rement		IS : 456, IS : 1199, Client's specificati on	Degree of workability adopted depending on the type of structure and type of		Package Contractor	Mandatory Site Test

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
						compaction equipment.			
5.2	Crushing Strength	One set of 6 cubes of 150 cm. Size per 35 Cum. of concrete or part thereof for each grade of concrete per 8 hours of work or portion thereof.	Measu rement	Compressio n Test Machine	IS : 516, IS : 1199, IS : 416 and Client's specificati on	Shall be as per IS: 456		Package Contractor	Three specimens shall be tested at 7 days and remaining at 28 days. Mandatory Site Test.
5.3	Water Cement Ratio	At random at the time of batching	Measu rement	Visual observation	As per approved design mix			Package Contractor	
5.4	Check cement content	-do-	Measu rement / by weigh batche r		IS : 3025, IS : 456 and approved design mix.			Package Contractor	
6.0	**WATER**								

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
6.1	Tests for ascertaining limits of solid	Once for each source of supply	-do-	Lab Test	IS : 3026 and Soil investigation record.			Package Contractor	During mix design stage
6.2	Test of pH value	-do-	-do-	PH meter	IS : 456	PH value shall be less than 6.	Site log book		-do-
7.0	**BRICK**								
7.1	Compressive Strength	For designation 100, Every 50,000 or part thereof. For designation up to 75, Every 100,000 or part thereof.	Compr essive strengt h	Compressio n Testing Machine	IS: 1077	As per brick designation.			Mandatory Site Test
7.2	Shape, Size, Colour	-do-	Visual & measu rement for size.		IS: 3495				Mandatory Site Test

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
7.3	Water absorption and efflorescence	One test for each source of manufacturer and every lot of 200,000.	Routin e		IS: 3495	Water absorption: a) after 24 hours not less than 20 by weight b) after 6 hours not less than 10 by weight. c) moderate degree of efflorescence			Mandatory Site Test
8.0	**REINFORCEMENT STEEL**								
8.1	Tensile Strength	Every 20T or every consignment purchased by Package Contractor	Measu rement	Universal Testing Machine	IS: 1599			Manufactur er/ Package Contractor	Manufacturer test certificate must be submitted
8.2	Bend Strength	-do-	-do-		-do-			-do-	-do-

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
8.3	Surface cracks, Rusts etc.	Random	Visual	Visual					
9.0	**TIMBER**								
9.1	Moisture Content	Every 1M^3 or part thereof	Measu rement	Moisture meter				Package Contractor	Mandatory Test
10.0	**FLUSH DOOR SHUTTER**								
10.1	End Immersion	N Total No of Shutters 1 Shutter for N 65 2 Shutters for 65 N 180 3 Shutters for 180 N 300 4 Shutters for 300 N 500 5 Shutters for N 501	Destru ctive Test	At approved test house	IS: 2202			Package Contractor	Mandatory Test
10.2	Knife Test								
10.3	Adhesion Test								
11.0	**ALUMINIUM DOORS/ WINDOW FITTINGS**								
11.1	Thickness of Anodic Coating	Cost of fittings of every Rs.20,000/- or part thereof	Measu rement	At approved test house	IS: 5523			Package Contractor	Mandatory Test

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
12.0	**MARBLE**								
12.1	Moisture absorption	For value of every Rs.10,000/- or part thereof	Measu rement		IS: 1124			Package Contractor	Mandatory Test
12.2	Mhose Scale hardness								Optional Test
13.0	**TERRA O TILES**								
13.1	Transverse Strength	Every 2000 tiles or part thereof	Site Measu rement		IS: 1237			Package Contractor	MandatoryTest
13.2	Water absorption	-do-	Site Measu rement		-do-			-do-	-do-
13.3	Abrasion Test	-do-	Labora tory Test		-do-			-do-	-do-
14.0	**WHITE GLA ED TILES**								
14.1	Water absorption	Every 3000 tiles or part thereof	Measu rement		IS: 777			Package Contractor	Mandatory Test
14.2	Crazing Test	-do-	-do-	-do-	-do-	-do-	-do-	-do-	-do-

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
14.2	Impact Test	-do-	-do-	-do-	-do-	-do-	-do-	-do-	Optional Test
15.0	**MORTICE LOCK**								
15.1	Testing of springs	Every 100 locks or part thereof	Measu rement	Approved Test House				Package Contractor	Mandatory Test
16.0	**BITUMEN**								
					IS: 73				
17.0	**STORAGE OF MATERIALS**								

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
17.1	Cement	100	Visual		IS: 4082	Covered storage. ❖ Clear gap of min. 15cm from the floor. ❖ Space of min. 45cm around the exterior wall. ❖ Stacking not more than 15 bags high arranged alternately lengthwise and crosswise.			

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
						❖ Width of the stack shall not be more than 3 meters			
17.2	Reinforcement	100	Visual		IS: 4082	Open storage. ❖ Bars of different classification , sizes and length will be stacked separately.			

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
17.3	Brick	100	Visual		IS: 4082	Open storage. ❖ Bricks shall be stacked on dry firm ground. ❖ Stacks shall be 50 bricks long and 10 bricks high. ❖ Bricks shall be placed on edge. ❖ Width of each stack shall be two bricks.			

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
17.4	Aggregates	100	Visual		IS: 4082	❖ Shall be stored at site on a dry ground/ platform of planks/ old corrugated iron sheets/ floor of bricks/ thin layer of lean concrete. ❖ Stacks of fine aggregate and coarse aggregate shall kept in separate stockpiles.			

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
17.5	Other Bought Out Items	100	Visual		IS: 4082	Covered storage. Materials shall be stored as per manufacturer s specification.			
18.0	**PILING**								
18.1	**PLANT & MACHINERY**								

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
	❖ Concrete mixer ❖ Vibrators of adequate capacity ❖ Power driven rigs of adequate capacity ❖ Weigh Batchers ❖ Lighting ❖ Mobile Cranes		Visual/ Physical						
19.0	**CONSTRUCTION OF PILE**								
19.1	SPT values during boring operation	100							

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
19.2	Tolerances in position	100	Measu rement	Measuring Tape	IS: 2911 (Part I/ Sec2)	Piles 600mm: 75mm or D/4 whichever is less. Piles 600mm: 75mm or D/10 whichever is more. For single pile: 600mm: 50mm or D/4 whichever is less. 600mm: 100mm.		Piling Contractor	
19.3	Control of alignment	100	Measu rement	Measuring Tape	IS: 2911 (Part I/ Sec2)	Vertical pile: 1.5 deviation maximum. Raker pile: 4			

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
19.4	Chipping of pile top	100				Manual chipping after 3 days of casting. Pneumatic tools after 7 days of casting.			
20.0	**BENTONITE SUSPENSION:**								
20.1	Liquid limit		Measu rement			300 400		Piling Contractor	
20.2	Sand content of Bentonite powder		-do-			Not more than 7		-do-	
20.3	Density of freshly prepared Bentonite suspension		-do-	Hydrometer	IS:9556	Between 1.034 and 1.10gm/ ml.		-do-	Shall be recorded for initial 10 piles and subsequently at every 10^{th} pile.
20.4	Marsh viscosity		-do-	Marsh cone		Between 30 and 60 sec		-do-	

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
20.5	*P*H value of Bentonite suspension		-do-	*P*H indicator paper strip		Between 9 and 11.5		-do-	
20.6	Density after mixing with deleterious material		-do-	Hydrometer		Maximum. 1.25gm/ ml.		-do-	Shall be recorded for initial 10 piles and subsequently at every 10^{th} pile.
21.0	**PILE TESTING**								

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
21.1	Vertical Load Test (for both test & job piles)	Test pile. No of pile to be tested shall be minimum one.	Testin g	Dial Gauge (Sensitivity of dial gauge : 0.01 mm)	IS:2911, Part-IV	Safe load shall be minimum of the following: (a)2/3rd of final load against total displacement of 12 mm. (b) 50 of final load against total displacement of 10 of pile diameter.		Piling contractor	

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
		Working pile. No of piles to be tested shall be minimum 1/2 of total no of piles.	-do-	-do-	-do-	Maximum settlement shall not exceed 12 mm against test load 150 of working load.		-do-	
21.2	Lateral load test	Optional	Testin g	-do-	IS:2911, Part-IV	Safe load shall be minimum of the following: (a) 50 of the final load against total displacement of 12 mm. (b) Final load against total displacement of 5 mm		-do-	

ANNE URE 1 MATERIAL TESTS FOR SITES

SL. No	Component/ Operation and Des ription of test	Sampling plan with basis	Type of he	Instru-ment	Refer-en e do u-ment	A eptan e Norm	Format of Re ord	Testing agen y	Remar s
21.3	Pull out Test	Optional	Testin g	-do-	IS:2911, Part-IV	Safe load shall be least of the following: (a) 2/3rd of total load against displacement of 12mm. (b) Half of the load at which load displacement curve breaks		-do-	Initial test shall be carried out up to twice the estimated safe load. Routine test shall be carried out to 150 of the estimated safe load or 12mm total displacement.

ANNEXURE – 2 TESTING EQIPMENT FOR SITES

SL NO	BROAD CLASS	NOMENCLATURE DESCRIPTION	UTILITY	TEST PROCEDURE	REFERENCE DOCUMENT	TO BE AVAILABLE AT SITE
1.0	**ROUTINE TEST LAB. EQUIPMENT**	1.1 Vicat Apparatus	Cement consistency & Penetration	Penetration of Std. Needle	IS : 5513	Yes
		1.2 Lechatelier's test Apparatus	Cement shrinkage	Size variation after curing of sample	IS : 5514	Yes
		1.3 Mould (Cement) (70.7x70.7x70.7 mm)	Cement cubes	Cubes made of 1:3 cement : Sand	IS : 10086	Yes
		1.4 Cement Mortar Mould Vibrator	Cube compaction	Vibration for fixed duration	IS : 10078	Yes
		1.5 Concrete Cube mould (150x150x150) mm	Concrete Cubes	-	IS : 10086	Yes
		1.6 Compressive strength Testing machine	Concrete Cube Test	Crushing strength of cube	IS : 2505	Yes
		1.7 Concrete slump cone	Workability Check	Drop in cone height of concrete	IS : 7320	Yes
		1.8 Coarse aggregate sieves	Sieve analysis	Sieving	IS : 383	Yes
		1.9 (a) Soil Core cutter	To test compaction of soil	Core cut out of soil and density measured	IS : 2720	Yes
		(b) Proctor Compaction				
		1.10 Fine aggregate sieves	Sieve analysis	Sieving	IS : 383	Yes
		1.11 Sieve shaker	Mechanical sieving	-	-	Yes
		1.12 Aggregate impact Test Machine	Impact value of aggregate	-	IS : 9377	Yes
2.0	**DIMENSIONAL & ALLIED MEASURING EQUIPMENT**	2.1 Theodolite & levelling staff	Levelling and centre line marking and verticality measurement	Measurement and recording	-	Yes
		2.2 Measuring Tape	Dimension	-	-	Yes

ANNEXURE – 2 TESTING EQIPMENT FOR SITES

SL NO	BROAD CLASS	NOMENCLATURE DESCRIPTION	UTILITY	TEST PROCEDURE	REFERENCE DOCUMENT	TO BE AVAILABLE AT SITE
		2.3 Laser Beam apparatus	Verticality of structures	Centre line alignment	-	Yes
3.0	**PROCESS CONTROL ACCESSORIES**	3.1 Oven	Material Drying for moisture control	Material to be kept for specific duration	-	Yes
		3.2 Physical balance	Weighing	-	-	Yes
		3.3 Air entrainment meter	To determine % of air in fresh concrete mix	Samples of fresh concrete to be taken and tested in the equipment	IS : 1199	Yes
4.0	**SPECIAL TEST EQUIPMENT**	NDT 4.1 Rebound hammer	Strength test of concrete	Rebound of the ball is proportional to the strength of concrete	-	Yes
		4.2 Ultrasonic test for concrete	Test for porosity for concrete	Speed of the ray transmitted through the concrete indicates the extend of porosity	-	Yes
		4.3 Profometer/Micro covermeter	Location & diameter of reinforcement	Variation in density used to detect steel location	-	Yes
		D.T. 4.4 Portable electrically operated concrete core cutter	Strength of In-situ concrete	Core cut out of concrete tested for strength	-	Yes

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
1	Earth work	(a) Classification of Soil, for payments, if required. (b) Line & level. (c) Disposal lead. (d) Levelling at Disposal ard. (e) Initial & Final level in Level Book. (f) Rolling/Tamping/Compaction of Fills, as per IS : 2720 (g) Arrangement for de-watering. (h) Shoring & Strutting. (i) Safety (side slopes, ramps, working space around foundation, dumping at safe distance beyond top edge). (j) Excess excavation depth properly filled for foundation works. (k) Foundation bed level, bearing capacity conformance.	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
2	Piling Work	a) Diameter of Pile. b) Depth Driver. c) Sequence of driving in a pile group. d) Set for last 10 blows or as specified. e) Type and size of hammer and its stroke, in case of double acting hammer, No. of blows per minute & stroke. f) Type and condition of packing on the pile head and or dolly in the hammer. g) Driving resistance record through variable strata in case of driven cast-in-situ pile. h) Bore log in case of Bored pile. i) Density of slurry in case of Bentonite slurry pile. j) Date & time of driving. k) Date of concreting & time gap between end of driving & concreting.	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
		l) Standing ground water level. m) Ground level at the commencement. n) Length of Pile. o) Length of Permanent casing. p) Set at intervals during last 3 Metres. q) Concrete Mix. r) Details of Reinforcement. s) Volume of Concrete supplied to pile against theoretical volume. t) Water tightness of pile before concreting. u) Eccentricity v) Deviation for Verticality. w) Condition of pile head at cut-off. x) Routine load test results. y) Initial load test results. z) Integrity test results of each pile.	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
3	Concreting Works	(a) Check quality and size of coarse aggregate with special reference to undersize/oversize materials, disintegrated/self materials, earth and other foreign materials beyond limit, organic impurities. (b) Fineness modulus of sand, silt content, bulkage, foreign materials in sand. (c) Check formwork. (d) Line, level of concrete. (e) Honeycombed surface in concrete. (f) Strength of Concrete. (g) Check Mix Boxes. (h) Mixing of concrete by hand/machine. (i) Use of Vibrator. (j) Slump of concrete.	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
4	Formwork	a) Line, level and dimensions as per drawing. b) Cross bracing of supporting framework. c) Diagonal bracings. d) Ground support rigidity to avoid settlement. e) Plumbness of shores. f) Wedge tightening of shores. g) Thickness of shutter to withstand pressure of wet concrete. h) Leakproofness of shutter (IS : 457) i) Demoulding agent/Oiling of shutter. j) Facility for removal of formwork in proper sequence. k) Avoid premature removal.	

ANNE URE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Des ription of Site A tivity	Wor manship Che s to be underta en	Remar s
5	Reinforced Concrete Works	a) Sieve analysis of coarse aggregate to check oversize, undersize, improperly graded aggregate. b) Check presence of disintegrated/soft or foreign materials in aggregates. c) uality of sand, Silt content, Bulkage test. d) uality of Cement and age of Cement (1st in 1st OUT system) e) uality of water for mixing and curing. f) Slump test. g) Cube Tests. h) Cover Block thickness and integrity (cover not reduced more than 2mm or increased by more than 10mm). i) Whether reinforcement exposed on removal of forms. j) Tensile testing of steel reinforcement, as required. k) Gauge of binding wire and its use at all joints. l) Reinforcement placement as per drawing and top reinforcement to be supported by chairs etc.	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
		m) Spacing of laps and staggering and length of lap. n) Mix design record/requirements. o) Rigidity and evenness of centring & shuttering. p) Finish requirement of surface. q) Throating and moulding requirements as per drawings. r) Line and level requirements as per drawing. s) Expansion joint contraction, joint provisions. t) Fixing of inserts, conduits, bolts to proper alignment. u) Hacking of green concrete for future plastering. v) Adequate curing. w) Corrosion protection requirements of reinforcement. x) Drainage provisions on roof surface (slope & spout) y) Gangway placement for concreting to be independent of reinforcement. z) Rigidity of reinforcement cage to avoid distortion during concreting	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
		aa) Compaction requirements of concrete by needle vibrators/Form vibrator etc. bb) Provisions at construction joint Waterbar Nozzles etc. cc) Provision of dowel bars 12mm ø 300 long (400mm either side) at 250 C/C on construction joint surface.	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
6	Brickwork	(a) Quality of bricks for strength, dimensional accuracy, efflorescence water absorption and evenness of backing. (b) Sand quality for fineness modulus and Silt content. (c) Cement quality. (d) Mixing of Mortar to structural space. (e) Thickness of joint not exceeding 10mm. (f) Raking of joints in green stage by raking tool (15mm deep) (g) Filling of vertical joints properly. (h) Soaking of bricks. (i) Line and level of brickwork. (j) Plumbness. (k) Brick corners are provided with proper brick closer not by brick bat. (l) Top coarse in plinth, windowsill, below RC slab and parapets are with brick on edge.	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
		(m) Type of scaffolding. (n) Filling of scaffolding potholes. (o) Brick coarses are in level. (p) Proper bonding of main wall with cross wall (No toothing joints) (q) Brickwork taken-up in layers not exceeding 1 Metre. (r) Proper provision of reinforcement in brick-wall. (s) Lateral bonding of brick-wall to steel/concrete columns. (t) Filling-up voids between brick wall and door/windows shutter. (u) Adequate curing of brickwork.	

ANNE URE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Des ription of Site A tivity	Wor manship Che s to be underta en	Remar s
7	Stone Masonary Work	(a) uality of stone. (b) Strength of Mortar. (c) Mix of Mortar. (d) uality of Sand Silt content & fineness modulus. (e) Whether joints fully filled with Mortar. (f) Whether required number of bond stones provided (Marking of bond stone during construction needed for easy identification). (g) Extent of spalls in hearting. (h) Line, Level, Thickness. (i) Joint thickness (whether excessive thick)	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
8	Flooring Work		
8.1	Cement Concrete Floor	(a) Aggregates, Sand refer PCC Works. (b) Strength. (c) Thickness. (d) Hardener type and mix. (e) Panel size. (f) Curing arrangement. (g) Polishing requirement.	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
8.2	Cast in situ Mosaic Floor	a) Aggregates, Sand refer PCC Works. b) Strength. c) Thickness. d) Hardener type and mix. e) Panel size. f) Curing arrangement. g) Polishing requirement.	

ANNE URE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Des ription of Site A tivity	Wor manship Che s to be underta en	Remar s
8.3	Terrazzo Tile Floor	(a) uality of Lime. (b) Strength test of tile. (c) Abrasion test of tile. (d) Thickness of Joint & Colour matching. (e) Polishing by 80, 120, 320 Grade Carborandum. (f) Any hollow sound when tapped. (g) Curing arrangement.	
8.4	Glazed Tile Floor	(a) Size of Tile (b) Thickness of Tile (± 0.5 mm) (c) No glazed surface at edges. (d) Free from crazing.	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
9	Woodwork	a) Specified timber is used. b) Grade of Wood. c) Free from cracks, dead knots etc. as per grade specification. d) Seasoning done or not. e) Moisture content by moisture meter. f) Lines, level and smoothness of finish & planning. g) Glue utilised in joints or not and whether bamboo pin (min. 10mm dia.) used in joint. h) Tolerance of finished size. i) Use of preservative against masonry surface. j) Size of Holdfasts as per Specification. k) Thickness and dimension of shutter in door panels. l) Thickness of glass panels and quality of glass. m) Whether Putty provided between glass-pane and sash bar & glass pane and beading (No rattling sound when tapped).	

ANNE URE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Des ription of Site A tivity	Wor manship Che s to be underta en	Remar s
		n) Whether healing in flush door is of specified type solid core, hollow, particle board etc. o) uality of Ply and Glue in flush door (Not Urea formaldehyde). p) Destruction test of flush door (End emersion, Knife test etc.) q) Fitting quality and number as per Specification. r) Surfacing of steel fittings as per specification (bright, black Japan, black enamelled, oxidised) and plate thickness. s) Anodising thickness of aluminium fittings. t) Type of brass fittings (Extruded/Cast) with plate thickness. u) Check whether top & bottom surface of shutter properly painted or note. v) Painting of shutter to be done after checking of Knots etc. w) Provision of Chits and Sand blocks. x) uality of Mesh in meshed shutter (No. of mesh/Sq.inch.) and folding of mesh at the edges before fixing.	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
10	Steel Doors / Windows / gRILLS	a) Size of frame and corner welding of frames (Flush butt welded as per specification) b) Proper fixing of Hinge. c) Primer Coating. d) Provision of Tie Rod at bottom of Door frame for proper size maintenance during fixing. e) Line, Level & Plumb. f) uality of friction hinges. g) uantity of Putty (≅185 Gm. Per Meter length) and painting of Putty within 2 weeks. h) Number of glazing Clips (4 to 6). i) Provision of metal beadings as per specification. j) Material of striking plate in windows (brass or not as per specification) k) Welding of grill before fixing glazing without deformation of frame. l) Length of screws for fixing grills to windows frames.	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
11	Painting Work	(a) Name of Manufacturer, Specification, Batch Number, Colour, Date of Manufacture, ISI Marking on Paint Container. (b) Cracks, voids, pores on masonry surface properly filled. (c) Nail-holes, cracks on wood surface properly filled. (d) Steel surface preparation, sand blasting, derusting etc. as per Specification. (e) Soundness and adherence of Old Paint. (f) Paint quality (No. adulteration by thinner) and quality of Primer. (g) Application of each coat of Paint for uniformity, paint drop, dabs, brush-marks, waves and variation of colour. (h) Difficult to reach areas like edges, corners, nuts, bolts etc. are properly painted. (i) Spilled Paints on floors & walls properly cleaned. (j) Painting of fan hooks and exposed surfaces of inserts as per Specification.	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
12	Roofing Works	(a) Slope of roof. (b) uality of Lime, Waterproofing materials etc. as per Specification. (c) Size & quality of brick ballast. (d) Weight & quality of bitumen felt. (e) Over-lapping of bitumen felts. (f) Test by ponding with water. (g) Formation of ridges & valleys. (h) Drip course provision. (i) Embedding of felt at vertical wall. (j) Hollering at the vertical turning point below felt. (k) Grouting of rainwater pipe. (l) Proper termination of Tarfelt near RWP.	

ANNE URE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Des ription of Site A tivity	Wor manship Che s to be underta en	Remar s
13	Water Supply & Sanitary works	(a) uality of G.I. Pipe with original colour paint for class of pipe and IS Mark on surface of pipe. (b) Joining of pipe with white lead and jute yarn on threads. (c) Pipes are approachable for future maintenance. (d) Provision of union at each Stop Cock. (e) Supporting pipes with clamps suitably embedded & jammed in wall (f) uality/Weight of water-tap, Stop Cocks, Ball Valves and Water Supply fittings as per Specification and ISI Mark. (g) Provision of Vent. Pipe above Overhead Tank to avoid Airlock. (h) Leading over-flow pipe from Tank upto roof drain spout. (i) Mosquitoproof cemplings at over flow pipe of Tank & Cisterns. (j) uantity of lead provided at Spigot & Socket joints of pipes. (k) Internal surface of HCI Pipes to have painting with Dr. Angus Smith Solution. (l) Hydraulic testing of Water Supply system.	

ANNEXURE 3 WORKMANSHIP CHECKS FOR DIFFERENT SITE ACTIVITIES

SL. No	Description of Site Activity	Workmanship Checks to be undertaken	Remarks
		(m) Proper quality HCI Pipes used (Dimension, Weight, Finish, ISI Marks etc.) in Sewage System (C.I. Rain-water pipes) are not used in Sewage System. (n) Flushing test of flushing Cistern. (o) Hume Pipe Class, makes, dimension and test certificate. (p) Stone ware pipe make, dimension, finish, glazing and conforming to Class AA/Class A as per Specification. (q) uality of Line and level of system. (r) Floor tap water-seal to be minimum as per Specification. (s) Manhole covers, road gully groutings weight, sizes, make & finish. (t) Commercial quality ceramic fittings are not used. (u) Brand name, quality, dimension, colour, ISI marking for sanitary fixtures as per Specification. (v) Static head water test for HCI Pipe in section (4.5 Metres) (w) Test Performance for Water closets (six pieces of toilet papers 150 x 115mm flushed completely 3 times out of 4 trials) Water supply network tested to a pressure of 10 Kg/Cm^2 before taking over the system.	

ANNE URE 4 FORMATS FOR SITE RECORDS

FORMAT NO L - 01

DETERMINING THE GRADING OF SAND (FINE AGGREGATE)

Date of Testing:
Weight of samples: **gms.** **Type of aggregate:**

SL.NO	RETAINED ON IS SEIVE NO	WT. RETAINED	PERCETAGE WT. RETAINED	CUMULATIVE % WT. RETAINED	PERCENTAGE PASSING	REMARKS (GRADING ZONE)
1	10 mm					
2	4.74 mm					
3	2.36 mm					
4	1.18 mm					
5	600 microns					
6	300 microns					
7	150 microns					
8	75 microns					

REFERENCE GRADING ZONES OF FINE AGGREGATE (IS 383)

IS SEIVE DESIGNATION	PERCENTAGE PASSING FOR GRADING ZONE I	GRADING ZONE II	GRADING ZONE III	GRADING ZONE IV
10 mm	100	100	100	100
4.75 mm	90 – 100	90 – 100	90 – 100	95 – 100
2.36 mm	60 – 95	75 – 100	85 – 100	95 – 100
1.18 mm	30 – 70	55 – 90	75 – 100	90 – 100
600 micron	15 – 34	35 – 59	60 – 79	80 – 100
300 micron	5 – 20	8 – 30	12 – 40	15 – 50
150 micron	0 – 10	0 – 10	0 – 10	0 – 15

ANNE URE 4 FORMATS FOR SITE RECORDS

FORMAT NO L – 02

SIEVE ANALYSIS

METHODS OF DETERMINING THE GRADING OF COARSE AGGREGATE

Date of Testing:
Weight of samples: **gms.** **Type of aggregate:**

SL.NO	RETAINED ON IS SEIVE NO	WT. RETAINED	PERCETAGE WT. RETAINED	CUMULATIVE % WT. RETAINED	PERCENTAGE PASSING	REMARKS (GRADING ZONE)
1	40 mm					
2	**20 mm**					
3	16 mm					
4	12.5 mm					
5	10 mm					
6	4.75 mm					
7	2.36 mm					

GRADING ZONES OF COARSE AGGREGATE (IS 383)

IS SEIVE DESIGNATION	PERCENTAGE PASSING FOR GRADED AGGREGATE OF NOMINAL SIZE			
	40 mm	**20 mm**	**16 mm**	**12.5 mm**
40 mm	95 – 100	100	-	-
20 mm	30 – 70	95 – 100	100	100
16 mm	-	-	90 – 100	-
12.5 mm	-	-	-	90 – 100
10 mm	10 – 35	25 – 55	30 – 70	40 – 85
4.75 mm	0 – 5	0 – 10	0 – 10	0 – 10
2.36 mm	-	-	-	-

ANNE URE 4 FORMATS FOR SITE RECORDS

FORMAT NO L - 03

DATE :

COMPRESSIVE STRENGTH OF CEMENT CONCRETE

AGENCY :
LOCATIONS :
CUBE SIZE :
DATE OF CAST :
TYPE OF CEMENT :
GRADE OF CONCRETE :
WATER/ CEMENT RATIO :
ADDITION OF PLASTICISER :
WEIGHT OF CUBE :

CUBE TEST				7 DAYS STRENGTH		28 DAYS STRENGTH	
SL. NO	**MARK**	**DATE**	**SLUMP**	**FAILURE LOAD (KN)**	**STRENGTH (Kg/Cm^2)**	**FAILURE LOAD (KN)**	**STRENGTH (Kg/Cm^2)**
1							
2							
3							
4							
5							
6							

PERIOD	SPECIFICATION	ACTUAL (AVERAGE)
7 DAYS	**Kg/Cm^2**	**Kg/Cm^2**
28 DAYS	**Kg/Cm^2**	**Kg/Cm^2**

ANNE URE 4 FORMATS FOR SITE RECORDS

FORMAT NO L – 04

DATA SHEET			
SITE:		REF DRG NO:	
PILE DATA:			
Pile No:	Diameter of pile (mm):	Inclination:	
Drilling depth (m):	Plain drilling (m):	Concreted length (m):	
Pile: Cased: ☐	Partly cased: ☐	Un cased: ☐	
REINFORCEMENT:			
CONCRETE:			
Concrete strength/ grade:	Cement:	Quantity (kg/cbm):	
Aggregate:	Water/ cement ratio:	Additives (% of cement):	
Retarder:	Setting time (hour)		
Slump: Theoretical (cm): From	To	Actual (cm):	
Cubes: Yes ☐	No ☐		
CONCRETING:			
Concrete volume (Cbm):	Theoretical:	Actual:	
Method of concreting:			
Tremie: ☐	Pump: ☐	Other: ☐	

CONSTRUCTION TIME:			
Construction:		Date:	Time:
Drilling	Start:		
	End:		
Concreting	Start:		
	End:		
SIGNATURES:			
Representative of piling contractor:			
Representative of MECON:			

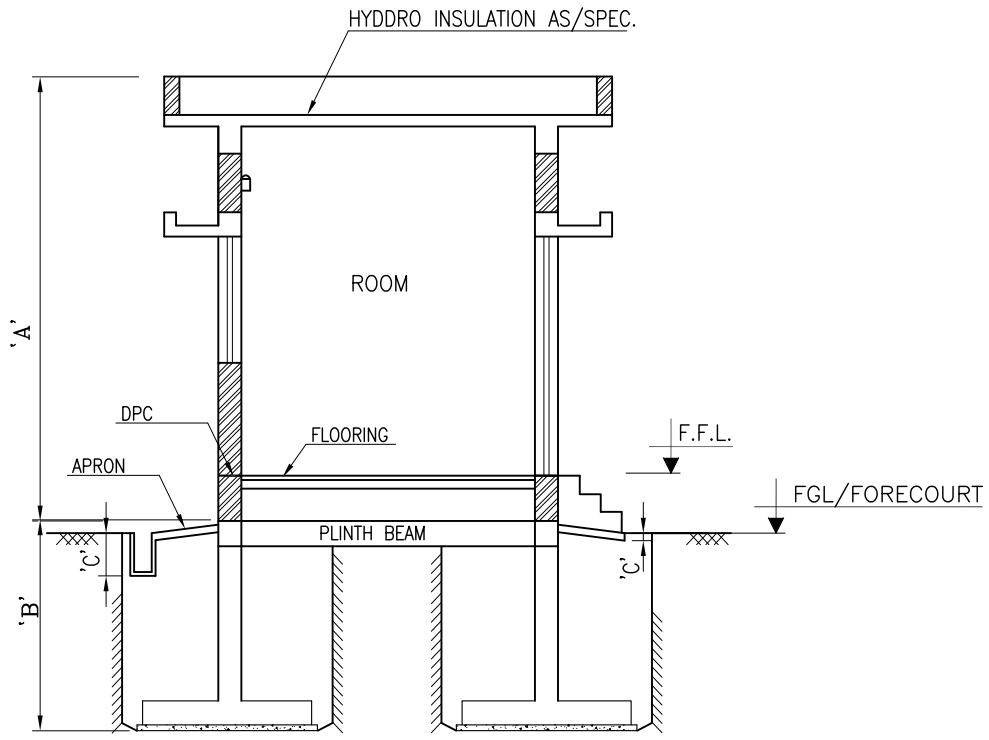
ANNE URE 4 FORMATS FOR SITE RECORDS

DATE:

TENDER DRAWINGS - CIVIL

LIST OF STANDARD DRAWINGS (CIVIL)

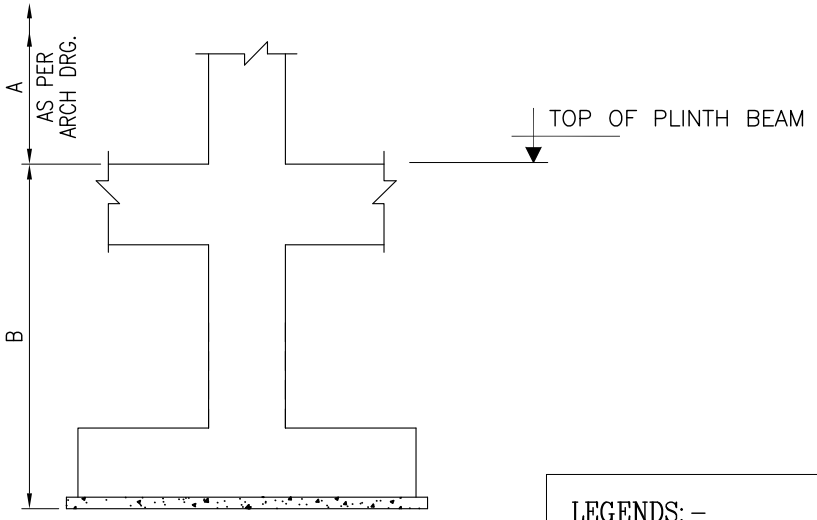
Sl No.	Des ription	Do ument No./ Drawing No.	Rev. No.
01	SCOPE FOR BUILDING WORKS	MEC/05/11/STD/CNG/001	Rev 0
02	TYPICAL DETAILS OF FORECOURT	MEC/05/11/STD/CNG/002	Rev 0
03	TYPICAL DETAILS OF ROAD & PAVER BLOCK FLOORING	MEC/05/11/STD/CNG/003	Rev 0
04	TYPICAL DETAILS OF SS TUBE TRENCH	MEC/05/11/STD/CNG/004	Rev 0
05	DETAILS OF DISPENSER ISLAND (REINFORCEMENT & SHUTTERING)	MEC/05/11/STD/CNG/005	Rev 0
06	DETAILS OF BOUNDARY WALL	MEC/05/11/STD/CNG/006	Rev 0
07	SHUTTERING & REINFORCEMENT DETAILS OF SOAK PIT & SEPTIC TANK	MEC/05/11/STD/CNG/008	Rev 0
08	DETAIL OF BOUNDARY WALL WITH PRECAST WALL PANEL	MEC/05/11/STD/022	Rev 0



FOUNDATION FOR BUILDINGS

NOTES:–

1. 'A' – PAYABLE UNDER BOQ ITEM "BUILDING WORKS."
2. 'B' – PAYABLE UNDER BOQ ITEM "RCC WORKS–SUB STRUCTURE"
3. 'C' – APRON & PERIPHERAL DRAIN ALONG WITH PLASTERING PAYABLE UNDER BOQ ITEMS "PCC WORKS" & "BRICK WORKS" RESPECTIVELY.
4. 'A' – TO COVER ALL WORKS OF BUILDING, CONCRETE WORKS , ARCHITECTURAL INCLUDING RELATED CIVIL WORKS FOR INTERNAL & EXTERNAL ELECTRICAL WORKS, ANTI–TERMITE PROTECTION AND ALL FINISHING WORKS ABOVE FGL etc.
5. 'B' – TO COVER EARTH WORK & CONCRETE WORK/SOIL STABILISATION WORK FOR FOUNDATION & PLINTH BEAM.
6. CENTER LINE MEASURMENT FOR BUILDING SHALL BE CONSIDERED FOR PAYMENT PURPOSE.
7. FLOORING ALONG WITH FLOOR FINISH IS INCLUDED UNDER 'A' i.e. BOQ ITEM "BUILDING WORKS".
8. PLINTH BEAM PROVIDED EITHER ABOVE FGL OR/AT BELOW FGL IS INCLUDED UNDER 'B' i.e. BOQ ITEM "RCC WORKS–SUB STRUCTURE".
9. ROOF SLAB PROJECTION & CHAJJA PROJECTION ARE INCLUDED IN ITEM 'A'.



FOUNDATION FOR BUILDING WORKS

A – TO BE PAID UNDER ITEM "BUILDINGS WORKS" IN SOR

B – TO BE MEASURED AND PAID UNDER ITEM "REINFORCEMENT CONCRETE" IN SOR

LEGENDS: –

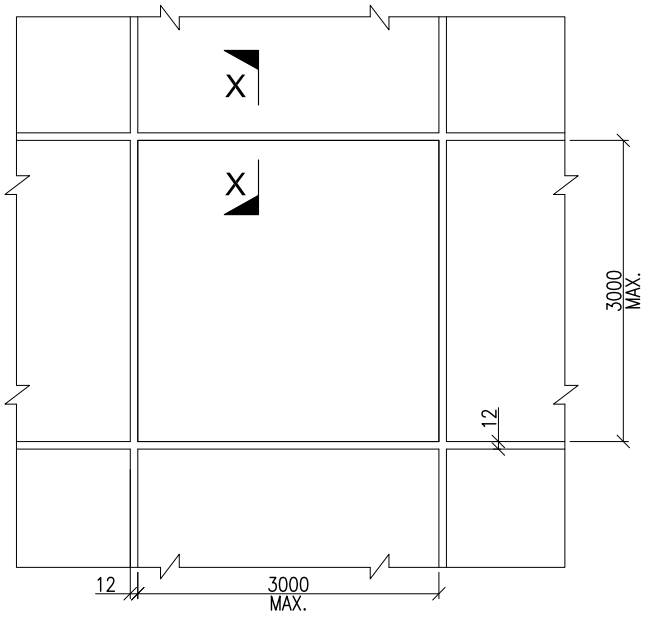
FFL – FINISHED FLOOR LEVEL

FGL – FINISHED GROUND LEVEL

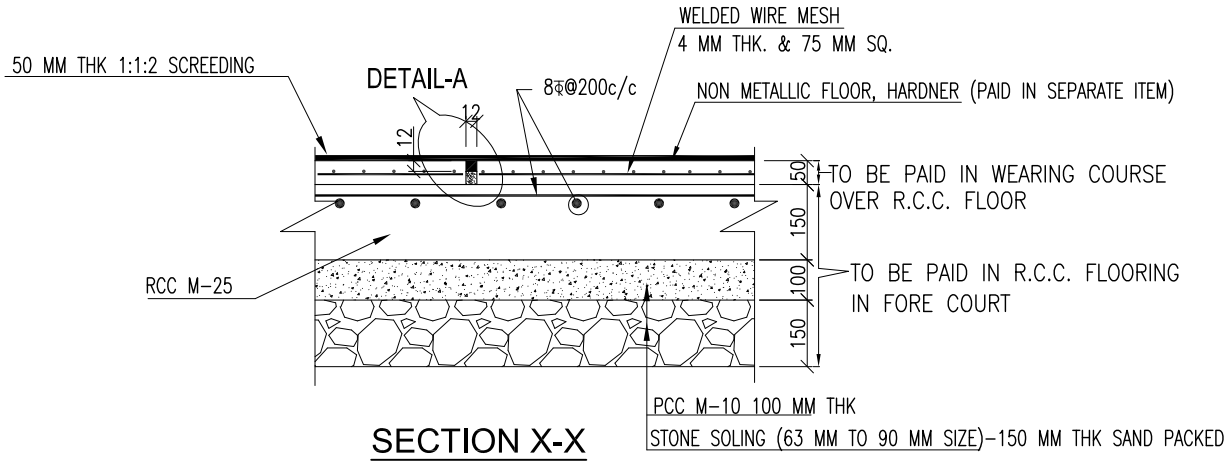
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
			REVISIONS				

SECTION	CIVIL (DELHI)			CIVIL STANDARD FOR CNG STATIONS	मेकॉन लिमिटेड
	NAME	SIG.	DATE		
DSGN.	RA				MECON LIMITED
DRWN	MINJ				
CHKD. & VERIFIED	MKC			SCOPE FOR BUILDING WORKS	SCALE : NTS
APPROVED	H.C.				SKT.NO. MEC/05/11/STD/CNG/001

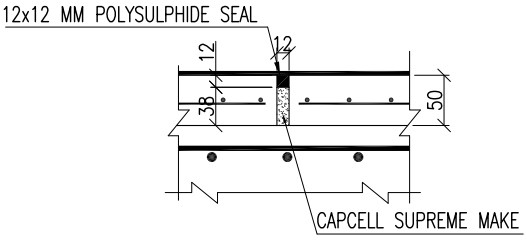
REV 0



SECTIONAL PLAN OF RCC FLOOR IN FORECOURT



SECTION X-X



DETAIL-A

FOR TENDER PURPOSE ONLY

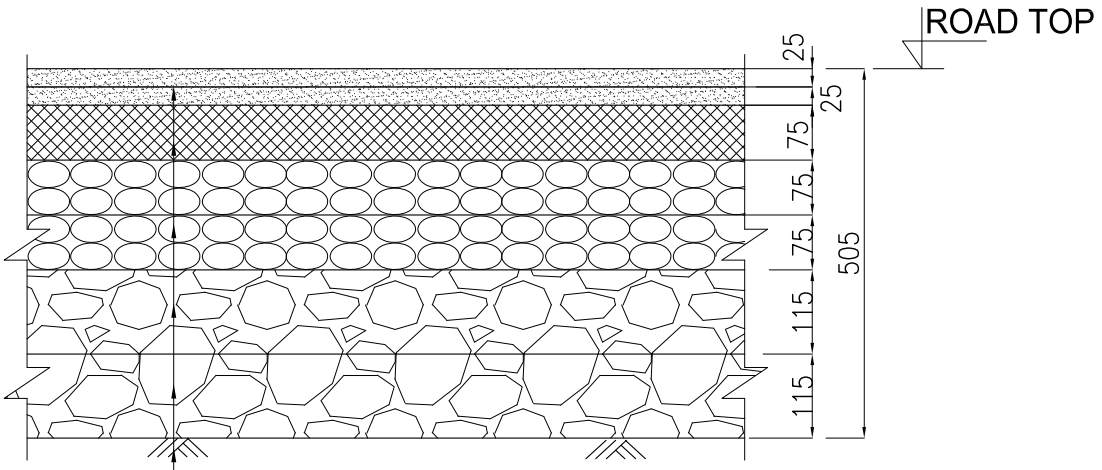
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
			REVISIONS				

SECTION	CIVIL			CIVIL STANDARD FOR TERMINALS	मेकॉन लिमिटेड
	NAME	SIG.	DATE		
DSGN.	RINSHU		16.02.13		
DRWN	MINJ		16.02.13	TYPICAL DETAILS OF FORECOURT	MECON LIMITED
CHKD. & VERIFIED	MKC		16.02.13		
APPROVED	HC				

SCALE : NTS

SKETCH NO.: MEC/05/11/STD/CNG/002

REV 0



25 THK. PREMIX CARPET

25 THK. PREMIX CARPET

75 THK. BITUMEN MACADAM WITH TACK COAT

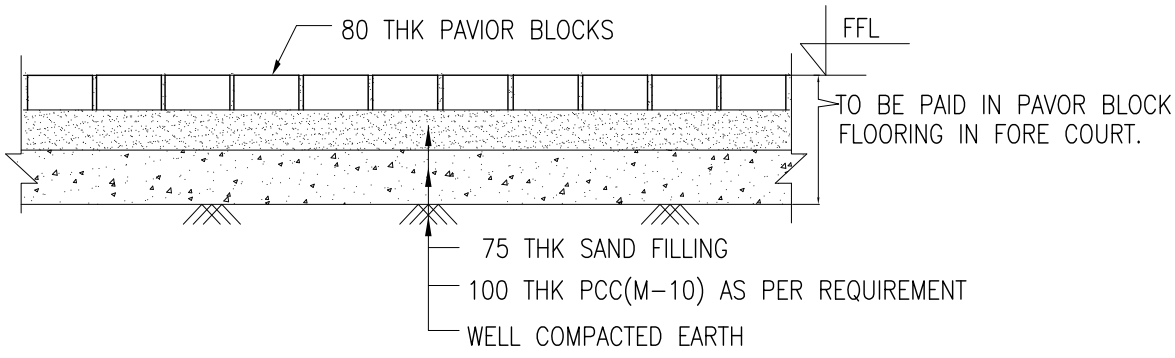
75 THK. BASE COURSE WBM
(53–22.5MM STONE)

75THK. BASE COURSE WBM
(63–45MM STONE)

2 LAYER OF 115 THK. W.B.M
(90–45MM STONES)

WELL CONSOLIDATED SUB–GRADE

DETAIL OF BITUMINOUS ROAD



TYPICAL CROSS SECTION OF PAVIOR BLOCK FLOORING

FOR TENDER PURPOSE ONLY

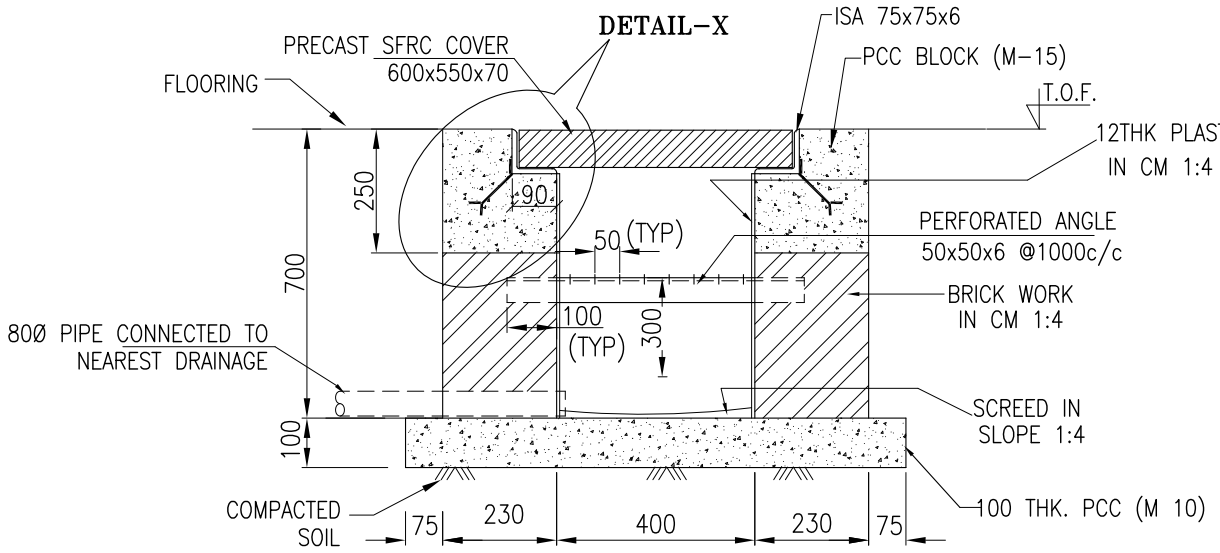
REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD		
REVISIONS						REFERENCES	DRG. NO.

SECTION	CIVIL			CIVIL STANDARD FOR TERMINALS	मेकॉन लिमिटेड
	NAME	SIG.	DATE		
DSGN.	RINSHU		16.02.13		
DRWN	MINJ		16.02.13	TYPICAL DETAILS OF ROAD AND PAVER BLOCK FLOORING	MECON LIMITED
CHKD. & VERIFIED	MKC		16.02.13		
APPROVED	HC				

SCALE : NTS

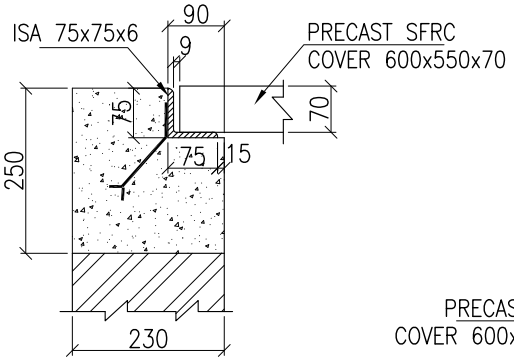
SKETCH NO.: MEC/05/11/STD/CNG/003

REV 0

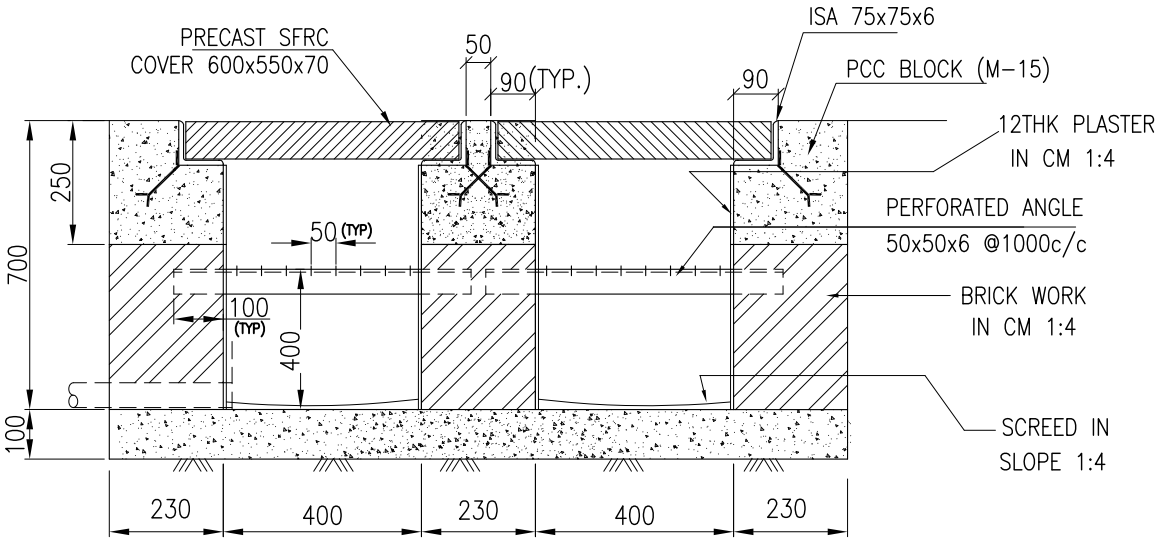


TYPICAL DETAIL OF SINGLE SS TUBE TRENCH

TO BE PAID IN ITEM "SINGLE SS TUBE TRENCH IN FORECOURT"



DETAIL–X



TYPICAL DETAIL OF DOUBLE SS TUBE TRENCH

(TO BE PAID IN ITEM "DOUBLE SS TUBE TRENCH IN FORECOURT")

FOR TENDER PURPOSE ONLY

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS				REFERENCES	DRG. NO.

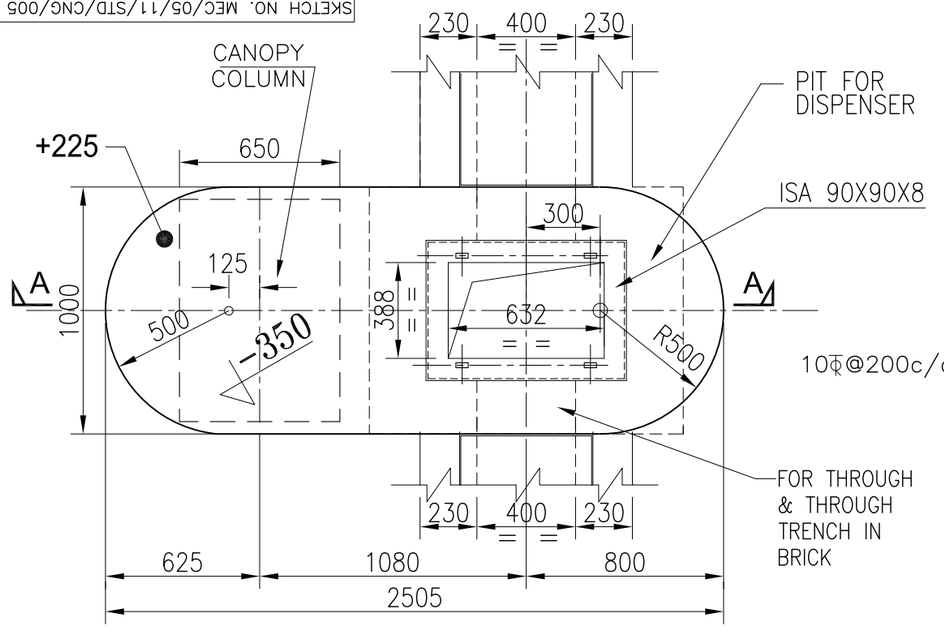
SECTION	CIVIL			CIVIL STANDARD FOR TERMINALS	मेकॉन लिमिटेड
	NAME	SIG.	DATE		
DSGN.	RINSHU		16.02.13		
DRWN	MINJ			TYPICAL DETAILS OF SS TUBE TRENCH	MECON LIMITED
CHKD. & VERIFIED	MKC		16.02.13		
APPROVED	HC				

SCALE : NTS

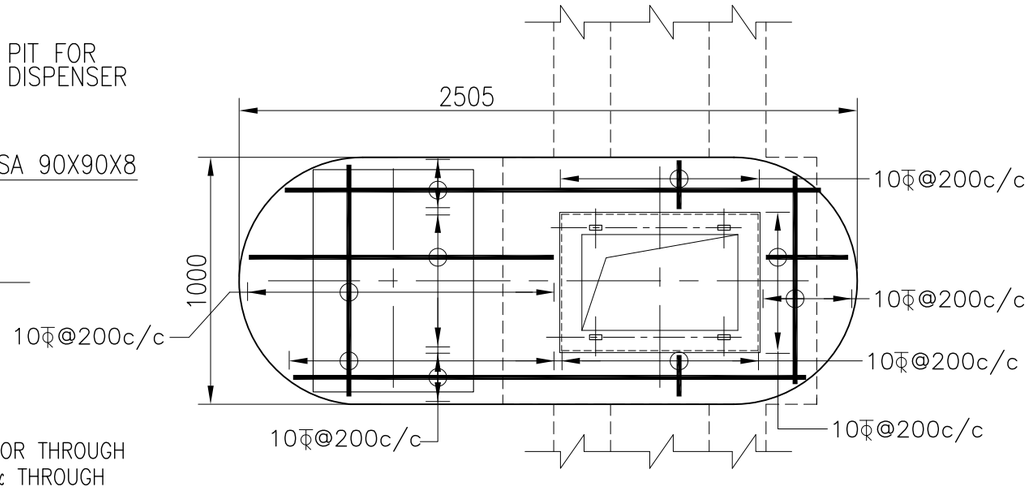
SKETCH NO.: MEC/05/11/STD/CNG/004

REV 0

SKETCH NO. MEC/05/11/STD/CNG/005

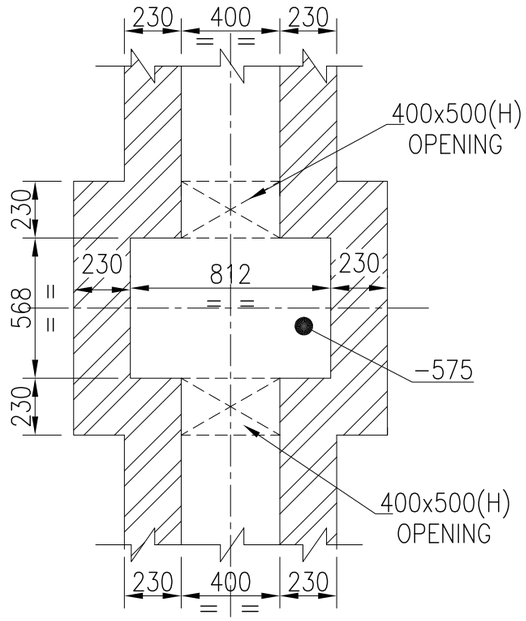


PLAN OF DISPENSER ISLAND

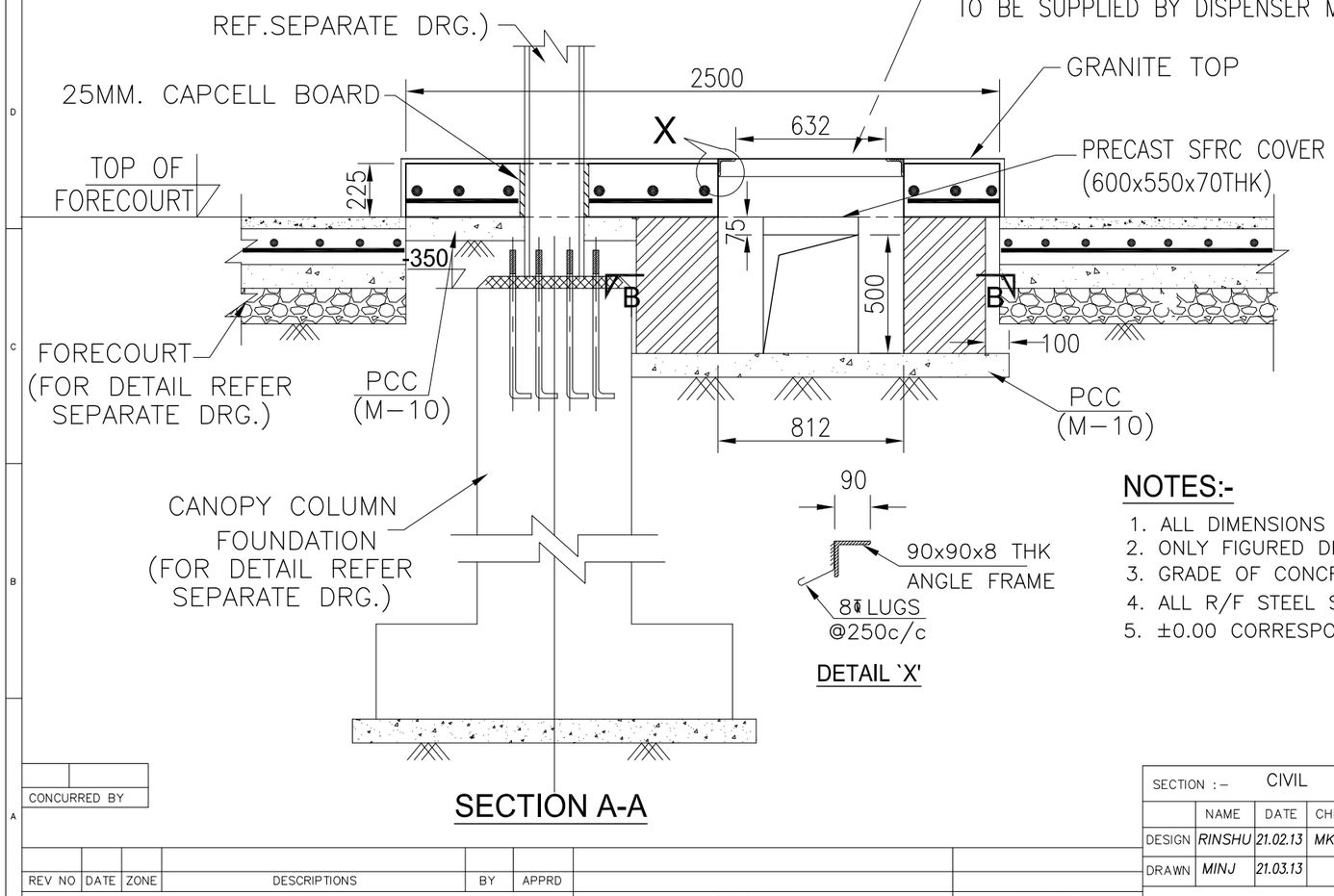


REINF. DETAIL OF DISPENSER ISLAND BASE SLAB

(REINFORCEMENT TO BE SUITABLY CUT & ADJUSTED AROUND OPENING AND COLUMN LOCATION)

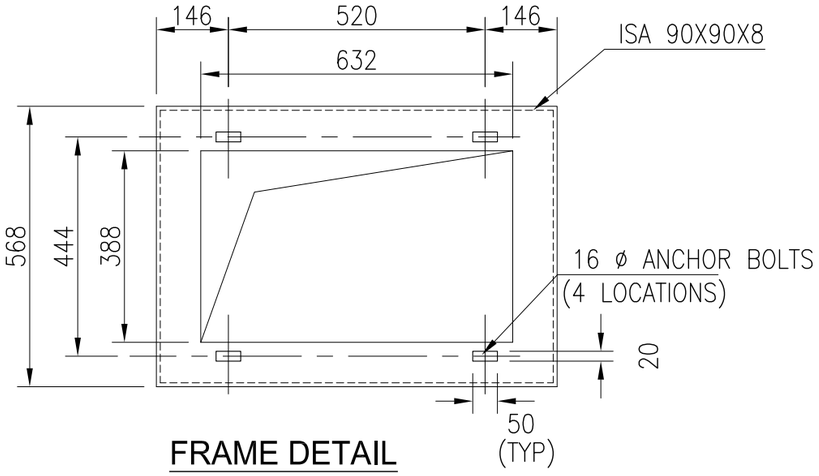


SECTION B-B



DETAIL `X'

SECTION A-A



FRAME DETAIL

NOTES:-

1. ALL DIMENSIONS ARE IN mm.
2. ONLY FIGURED DIMENSIONS ARE TO BE FOLLOWED.
3. GRADE OF CONCRETE FOR RCC SHALL BE M-25 & FOR PCC M-10.
4. ALL R/F STEEL SHALL BE HYSD (Fe 415) CONFORMING TO IS: 1786.
5. ±0.00 CORRESPONDS TO TOP OF FORECOURT LEVEL.

FOR TENDER PURPOSE ONLY

CONCURRED BY	

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
REVISIONS							

SECTION :- CIVIL	NAME	DATE	CHKD	DATE
DESIGN	RINSHU	21.02.13	MKC	21.02.13
DRAWN	MINJ	21.03.13		
APPROVED	H. CHANDNANI			

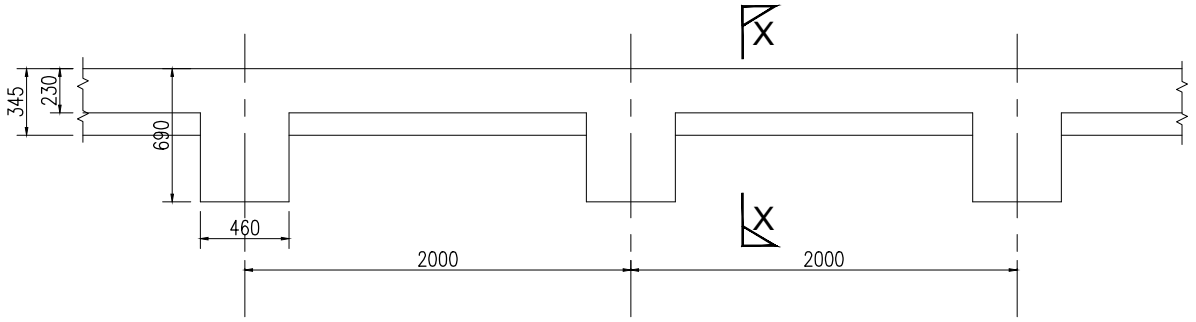
CIVIL STANDARD FOR TERMINALS

DETAILS OF DISPENSER ISLAND (REINFORCEMENT & SHUTTERING)

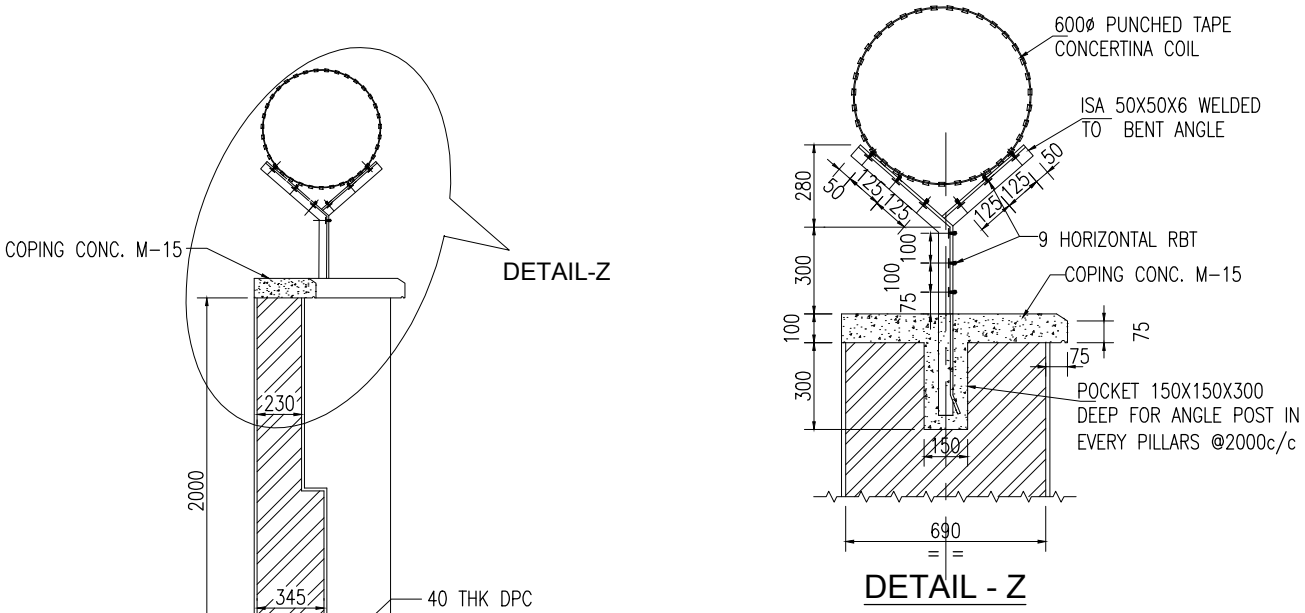
मेकॉन लिमिटेड

MECON LIMITED

SCALE :- 1:50	SHEET	REV
SKETCH NO. MEC/05/11/STD/CNG/005	1	0



PLAN



DETAIL - Z

SECTION X-X

NOTES:-

1. ALL DIMESIONS ARE IN mm.
2. EXPANSION JOINT SHALL BE PROVIDED EVERY 20M SPAN UPTO FULL DEPTH OF WALL.

FOR TENDER PURPOSE ONLY

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
			REVISIONS				

SECTION	CIVIL		
	NAME	SIG.	DATE
DSGN.	RA		
DRWN	MINJ		
CHKD. & VERIFIED	MKC		
APPROVED	H.C.		

CIVIL STANDARD FOR TERMINALS

DETAILS OF BOUNDARY WALL

मेकॉन लिमिटेड

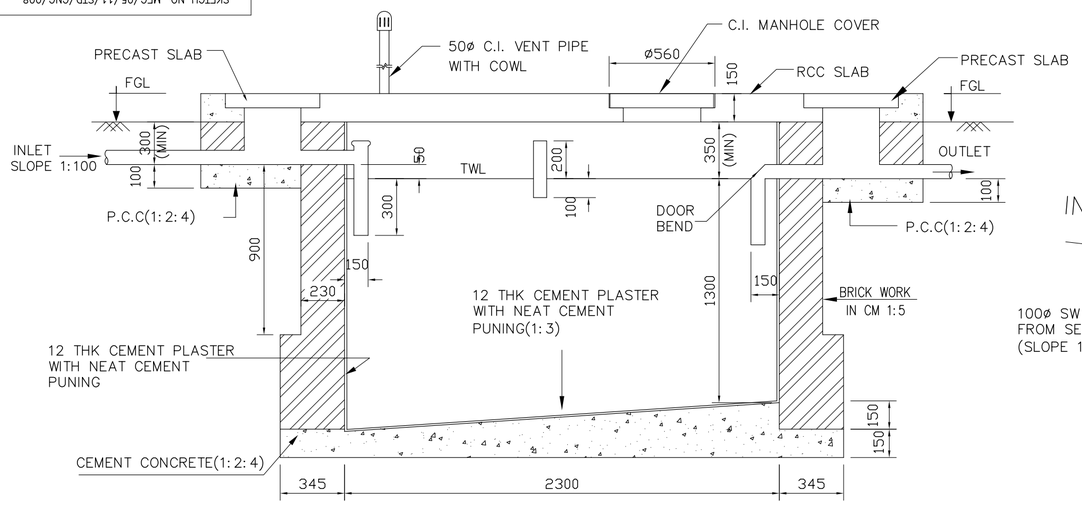
MECON LIMITED

SCALE : NTS

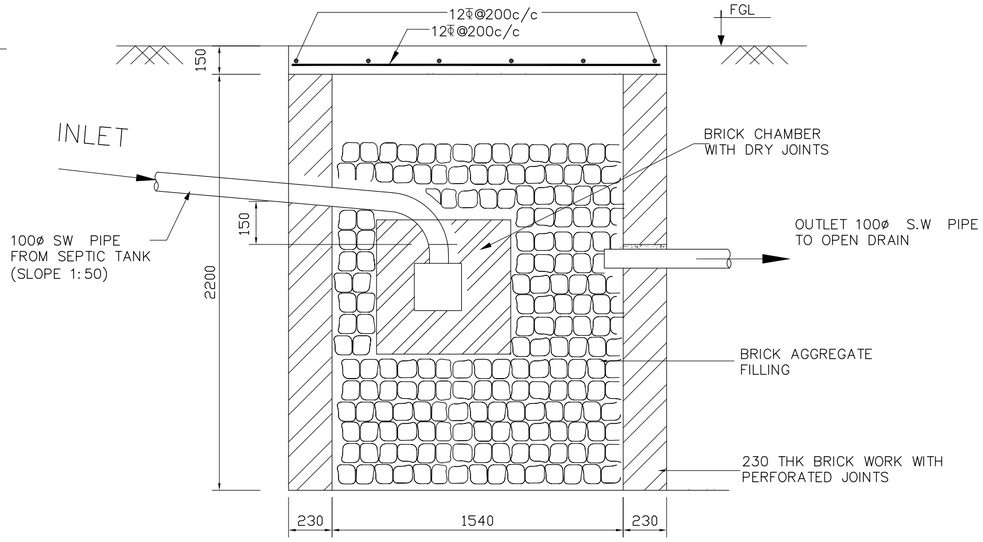
SKETCH NO. MEC/05/11/STD/CNG/006

REV 0

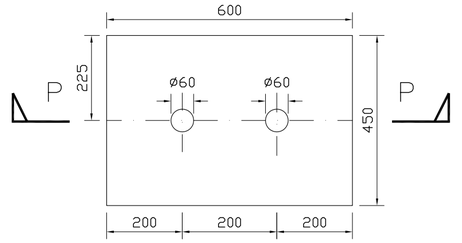
SKETCH NO. MEC/05/11/STD/CNG/008



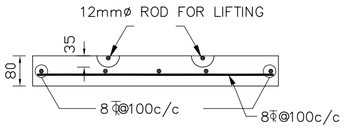
SECTION 1-1



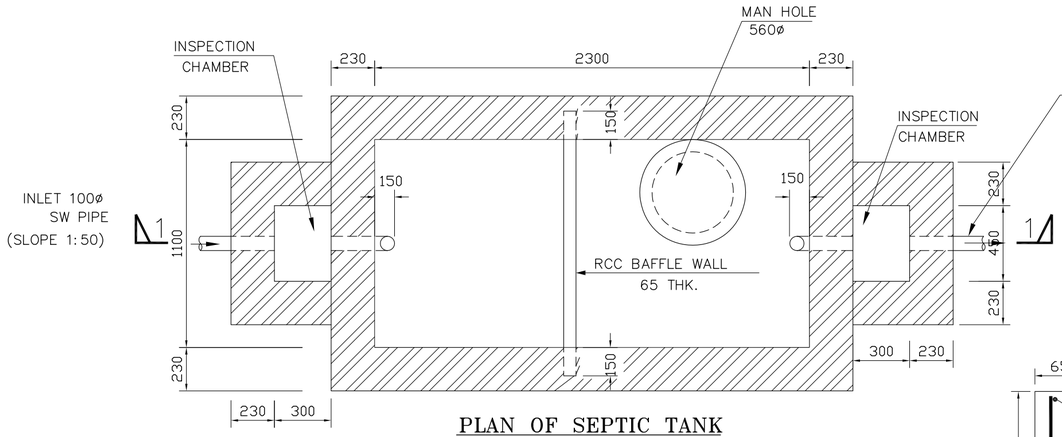
SECTION S-S



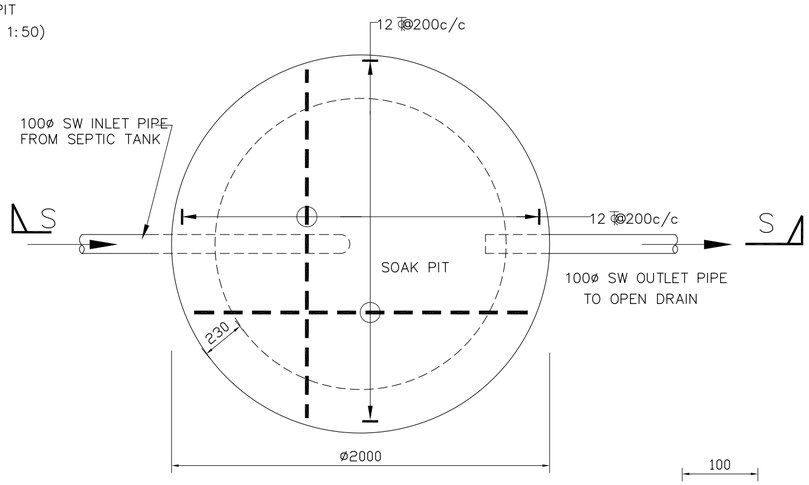
PLAN OF PRECAST SLABS
(2-NOS)



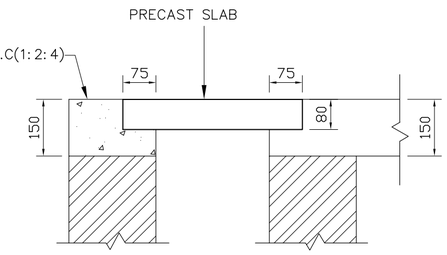
SECTION P-P



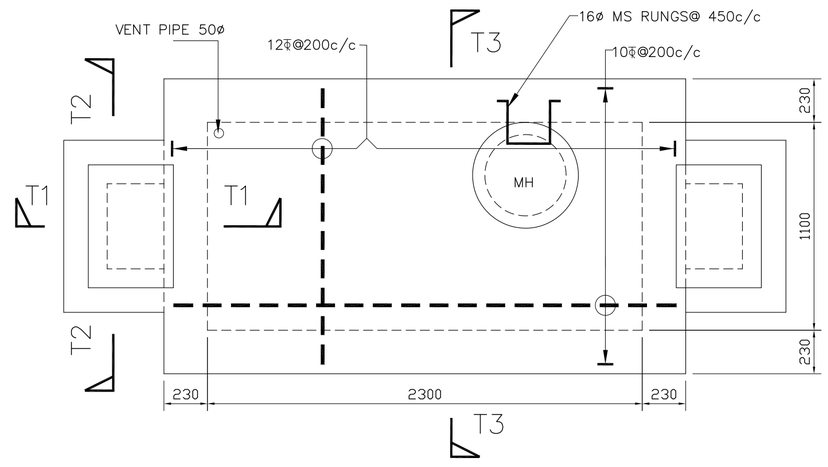
PLAN OF SEPTIC TANK



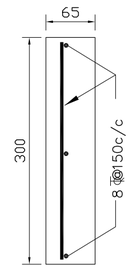
TOP PLAN OF SOAK PIT



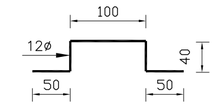
SECTION T1-T1



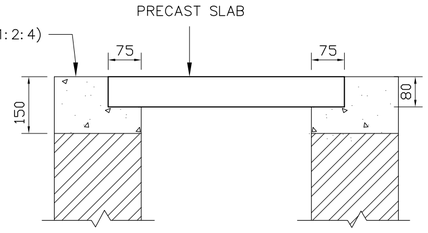
TOP PLAN OF SEPTIC TANK
(R.C.C. SLAB) (CLEAR COVER 50 mm)



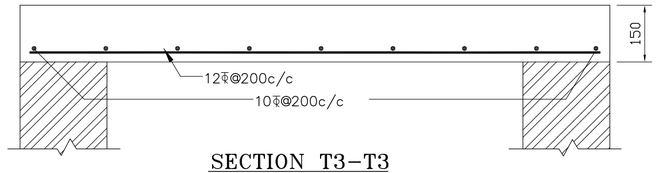
SECTION
OF BAFFLE WALL



DETAILS OF
LIFTING ROD
(2X2 NOS)



SECTION T2-T2



SECTION T3-T3

FOR TENDER PURPOSE ONLY

NOTES :-
1. ALL DIMENSIONS ARE IN MM.
2. GRADE OF CONCRETE FOR RCC WORKS SHALL BE M-25.
3. ±0.00 LVL. CORESPONDS TO FGL/FORECOURT LEVEL.
4. BRICK WORK SHALL BE IN CM 1:5.
5. SLUDGE REMOVAL FREQUENCY FOR SEPTIC TANK SHALL BE ONCE IN TWO YEARS.
6. THE VENT PIPE SHALL BE WELL FIXED AND SUPPORTED.
7. NO STAGNATION OF WATER IS ALLOWED AROUND THE SOAK PIT.
8. BACK FILLING AROUND SEPTIC TANK SHALL BE DONE SIMULTANEOUSLY WITH FILLING OF WATER INSIDE THE TANK TO THE WATER LEVEL.
9. LOCATION OF SOAK PIT TO BE DECIDED AS PER SITE CONDITION.

REV	SEC	CONCURRED BY
△		
△		
△		
△		
△		
△		

REV. NO.	DATE	ZONE	DESCRIPTION / REVISION	BY	VERIFIED

REFERENCES | DRG. NO.

मेकॉन लिमिटेड
MECON LIMITED

SECTION	CIVIL
LOCATION	DELHI
DESIGNED	RINSHU
DRAWN	MINJ
CHECKED AND VERIFIED	M.K. CHATURVEDI
APPROVED SIG	(H. CHANDNANI)
DATE	21.02.2013

CIVIL STANDARD FOR TERMINALS

SHUTTERING & REINFORCEMENT DETAIL OF SOAK PIT & SEPTIC TANK

SCALE : NTS | SHEET 1 OF 1 | REV 0

SKETCH NO. MEC/05/11/STD/CNG/008

PART II

STRUCTURAL WORKS

TECHNICAL SPECIFICATION FOR FABRICATION, ERECTION AND PAINTING OF STEEL STRUCTURES, GATES AND MISCELLANEOUS WORK

SPECIFICATION NO.: MEC/S/05/12/01 (Rev-0)

C O N T E N T S

LIST OF ANNEXURES

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

1.0 GENERAL

1.1 This specification shall apply to general steelwork, for CNG & CGD distribution works. The structures shall include canopies, loading unloading platforms, hoarding, crossovers, ladders, Fencing and Fencing Gates, staircases, pipe supports, skid supports, sheds, stockades/trestles, Boundary wall MS Gate etc.

SECTION-1: FABRICATION OF STEEL STRUCTURES

2.0 SCOPE OF WORK

2.1 The scope of work under fabrication includes, but not limited to, the following:

a) Preparation and supply of material indents, bolt lists, bought out items list, etc.

b) Procurement and collection of all material from stockyards/stores, including loading, transportation, unloading and stacking and storing on skids or supports.

c) Procurement and collection of all consumables like bolts, nuts, washers, electrodes, paints, shims, packs, etc., including allowance for spares and wastage.

d) Preparation and submission of modification/rectification sketches, As-Built drawings, erection drawings, bill of materials, and shipping documents for approval of CLIENT.

e) Cold straightening of section and plates, whenever they are bent and kinked.

f) Fabrication of all steel structural components covered under tender drawings, design drawings and generally described under the scope of the project.

g) Making arrangements for and conducting tests such as chemical analysis, physical and mechanical tests on raw materials where specified/as directed by CLIENT.

h) Control Assembly of steel structural components at shop, wherever required.

i) Preparation of steel structural surfaces for painting as provided in the specifications/drawings.

j) Application for one primer coat of painting at shop, as specified in the design drawing/specifications.

k) Loading, transportation from fabrication workshop to site of erection and unloading of all steel structural components/units/assemblies.

l) Preparation of ‘As-built’ drawings.

3.0 MATERIALS

3.1 Structural Steel

3.1.1 Structural steel and other related materials for construction shall conform to Annexure-D.

3.1.2 Due to non-availability of specified materials, suitable substitutions may be provided with the consent of CLIENT. Such substitution shall be incorporated in the "As-built" drawings.

3.1.3 All the items are to be cut as per requirements of the drawing. If joints are to be provided in any item in order to meet requirements of size and shape, cutting plan showing locations of joints shall be prepared for consideration of purchaser. Joints provided shall be incorporated in "As-built" drawings.

3.1.4 Rolling and cutting tolerances shall be as per IS:1852-2017.

3.1.5 Only tested materials shall be used unless use of untested materials for certain secondary structural members is permitted by CLIENT. If test certificate for the material is not available from the main producer, the following tests shall be carried out at the discretion of CLIENT:

a) Chemical Composition
b) Mechanical Properties
c) Weldability test

3.2 Bolts and Nuts

3.2.1 Black hexagonal bolts, nuts and lock nuts shall conform to IS:1363-2002.

3.3 Electrodes

3.3.1 Electrodes shall conform to IS:814-2019.

4.0 STORING OF MATERIALS

4.1 Materials shall be stored and stacked properly ensuring that place is properly drained and is free from dirt. It shall be ensured that no damage is caused due to improper stacking.

5.0 MATERIAL PREPARATION

5.1 Cut edges shall be finished smooth by grinding or machining wherever necessary. Sufficient allowance (3mm to 5mm) should be kept in the items incase machining is necessary.

5.2 Cutting may be affected by gas cutting, shearing, cropping or sawing.

5.3 Straightening and bending shall be done in cold condition as far as practicable.

5.4 If required, straightening and bending may be done by application of heat between 900ºC and 1100ºC. Cooling down of the heated item shall be done slowly.

6.0 DRILLING AND PUNCHING OF HOLES

6.1 Drilling and punching of holes for bolts shall be in accordance with IS:800-2007, unless otherwise specified by CLIENT.

6.2 Drifting of holes for bolts during assembly shall not cause enlargement of holes beyond permissible limit or damage the metal.

6.3 Holes for bolted connection should match well to permit easy entry of bolts. Gross mismatch of holes shall be avoided.

6.4 Permissible deviation in holes for mild steel bolts of normal accuracy and high strength bolts are given in the Annexure-A.

7.0 ASSEMBLY FOR FABRICATION

7.1 Fabrication of all structural steelwork shall be in accordance with IS:800-2007 and in conformity with various clauses of this Specification, unless otherwise specified in the drawings.

7.2 Fabrication of structures shall preferably be taken up as per the sequence of erection.

7.3 All erection units shall bear reference drawing no. at a prominent location on the structures for easy identification at site.

7.4 Fabricated structures shall conform to tolerance as specified in this Specification and in IS:7215-2016. In case of contradiction, tolerance specified in this Specification shall prevail.

7.5 All the components of structures shall be free from twist, bend, damage, etc.

7.6 Splice joints shall generally be of full strength butt weld and wherever possible, shall be located at zones of minimum or substantially lesser stress.

7.7 Splice joints of flange and web should preferably be staggered.

7.8 Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads of nuts and bolts satisfactory bearing.

7.9 The threaded portion of each bolt shall project through the nut at least by one thread.

7.10 Tolerance of assembled components of structures are given in Annexure-B.

7.11 Permissible deviations from designed (true) geometrical form of the despatch elements shall be in accordance with IS:7215-2016.

8.0 WELDING

8.1 The Contractor shall work out welding procedure for CLIENT's approval, considering the following factors:

i) Specification and thickness of steel.
ii) Specification of electrode or/and base wire.
iii) Welding process (manual arc welding, submerged arc welding).
iv) Type of structures to be welded (thickness of components meeting at a joint).
v) Sequence of welding.
vi) Weather condition.
vii) Inspection procedure to be followed
viii) Design requirements of the joints.

8.2 All metal arc welding shall be carried out as per IS:9595-1996.

8.3 Electrode shall conform to Clause no. 3.3 of this Specification.

8.4 Electrodes shall be stored in a dry place. Electrodes whose coatings are damaged due to absorption of moisture or due any other reason shall not be used.

8.5 Recommendations of electrode manufacturer are to be strictly followed.

8.6 Welding surface shall be smooth, uniform, free from fins, tears notches or any other defect which may adversely affect welding.

8.7 For multi-run weld deposit, the next run should be done only after thorough removal of slag and proper cleaning of surface.

8.8 Fillet weld shall have the correct profile with smooth transition into parent metal. Dressing of welds, if specified, shall be done by such method which does not cause grooving and other surface defects on the weld or on the parent metal.

8.9 Fillet welds shall not be stopped at corners but shall be returned round them.

8.10 Welding shall not be done under such weather conditions which might adversely affect the efficiency of the welding.

8.11 Ends of structural members and portions of gussets receiving welding at site shall be left unpainted.

8.12 Permissible deviation in assembly of weld joints shall be in accordance with Annexure-C.

9.0 INSPECTION & TESTING

9.1 CLIENT/Inspector shall have free access at all times to those parts of Contractor's or his Sub-contractor's works which are concerned with the fabrication of steel works and shall be afforded all reasonable facilities at all stages of preparation, fabrication and trial assemblies for satisfying himself that the fabrication is being undertaken in accordance with the provisions of relevant specification.

9.2 All gauges and templates, tools, apparatus, labour and assistance for checking shall be supplied by the contractor free of charge. CLIENT/Inspector may, at his discretion, check the test results obtained at the Contractor's works, by independent test at the Government Test House or elsewhere, and should the material so tested be found to be unsatisfactory, the cost of such test shall be borne by the Contractor.

9.3 Contractor shall make all necessary arrangements for stage inspection by CLIENT/Inspector during the fabrication at shop and incorporate all on-the-spot instructions/ changes conveyed in writing to the Contractor.

9.4 Material improperly detailed or wrongly fabricated shall be reported to CLIENT/Inspector and shall be made good as directed. Minor misfits which can be remedied by moderate use of drift pins, and moderate amount of reaming and slight chipping may be corrected in that manner, if

in the opinion CLIENT/Inspector, the strength or appearance of the structure will not be adversely affected. In the event CLIENT/Inspector directs otherwise, the items will be rejected and a completely new piece shall be fabricated. The cost of correcting errors shall be to the account of the Contractor.

9.5 i) CLIENT/Inspector shall have the power:

a) To certify, before any structure is submitted for inspection, that the same is not in accordance with the contract, owing to the adoption of any unsatisfactory method of fabrication.

b) To reject any structure as not being in accordance with Specification and drawings.

c) To insist that no structure or parts of the structure once rejected is resubmitted for inspection/test, except in cases where CLIENT/ Inspector considers the defects as rectifiable.

ii) If, on rejection of structure by CLIENT/Inspector, the Contractor fails to make satisfactory progress within the stipulated period, CLIENT/Inspector shall be at liberty to cancel the contract and fabricate or authorize the fabrication of the structures at any other place he chooses, at the risk and cost of the Contractor, without prejudice to any action being taken in addition to terms of General Conditions of Contract.

iii) CLIENT/Inspector's decision regarding rejection shall be final and binding on the Contractor.

iv) The Specifications prescribe various tests at specified intervals for ascertaining the quality of the work done. If the tests prove unsatisfactory, CLIENT/Inspector shall have liberty to order the Contractor to re-do the work, done in that period and/or to order such alterations and strengthening that may be necessary at the cost of the Contractor and the contractor shall be bound to carry out such orders failing which the rectification/redoing will be done by CLIENT through other agencies and the cost recovered from the Contractor.

v) Notwithstanding any inspection at the workshop, CLIENT/Inspector shall have the liberty to reject, without being liable for compensation any fabricated members or materials brought to site that do not conform to specifications/drawings.

vi) All rejected materials shall be removed from the site of fabrication by the Contractor at his own cost and within the time stipulated by CLIENT/Inspector.

10.0 CONTROL IN WELDING

10.1 The extent of quality control in respect of welds for structural elements shall be as follows and shall be conducted by the contractor at his own cost:

a) Visual Examination - All welds shall be 100% visually inspected to check the following:

i) Presence of undercuts
ii) Visually identifiable surface cracks in both welds and base metals
iii) Unfilled craters
iv) Improper weld profile and size
v) Excessive reinforcement in weld
vi) Surface porosity

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

b) Dye Penetration Test (DPT) - This shall be carried out for all important fillet welds and groove welds to check the following :

i) Surface cracks
ii) Surface porosity

Dye Penetration Test shall be carried out in accordance with American National Standard ASTM E165.

11.0 ACCEPTABLE LIMITS OF DEFECTS IN WELD

11.1 The limits of acceptability of defects detected during visual inspection and Dye Penetration Test shall be in accordance with clause 8.15.1 American National Standard ANSI/AWS D1.1-96.

12.0 RECTIFICATION OF DEFECTS IN WELDS

12.1 In case of detection of defects in welds , the rectification of the same shall be done as follows :

i) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld.

ii) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.

iii) Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc. exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld, and shall be re-welded. Defective weld shall be removed by chipping hammer, gouging torch or grinding wheel. Care shall be taken not to damage the adjacent material.

13.0 DESPATCH INSTRUCTIONS

Each despatchable structure shall bear mark no. along with reference drawing number at two prominent locations.

13.1 "As-built" drawings shall be prepared after fabrication is completed to indicate additions/alterations made during the process of fabrication. (Refer clause 3.1.2 & 3.1.3.)

13.2 Center lines of column flanges and both sides of web shall be punched, preferably at top and bottom to facilitate alignment after erection.

14.0 COMPLETION DOCUMENTS

14.1 On completion of work, the Contractor shall submit to CLIENT the following documents:

a)The technical documents according to which the work was carried out.
b)Copies of the "As built" drawings showing thereon all additions and alterations made during fabrication.
c)Manufacturer's test certificates
d)Certificates/documents on control checking
e)Test of welds

14.2 Inspection Certificates shall be issued to the contractor for the structures found acceptable in all respects by CLIENT/Inspector.

SECTION-2: ERECTION OF STEEL STRUCTURES

15.0 SCOPE OF WORK

In addition to provision of erection and transport equipment, the scope of work includes supply of tools and tackles, consumables, materials, labour and supervision and shall cover the following:

a) Storing and stacking of all fabricated structural components/units/ assemblies at site storage yards till the time of erection.

b) Transportation of structures from storage yard to site of erection, including multiple handling, if required.

c) All minor rectification/modifications such as:

i) Removal of bends, kinks, twists etc. for parts damaged during transportation and handling.

ii) Reaming of holes which do not register or which are damaged, for use of next higher size bolt.

iii) Plug welding and re-drilling of holes which do not register and which cannot be reamed for use of next higher size bolt.

iv) Drilling of holes which are either not drilled at all or are drilled in incorrect position during fabrication.

d) Fabrication of minor missing items as directed by CLIENT.

e) Verification of the position of embedded anchor bolts and inserts w.r.t. line find levels, installed by others based on Geodetic Scheme/Bench mark/ Reference co -ordinates taken by the Contractor.

f) Rectifying at site damaged portions of shop primer by cleaning and application touch-up paint.

g) Erection of structures including making connections by bolts/welding as per drawing.

h) Alignment of all structures true to line levels plumb and dimensions within specified limits of tolerance.

i) Application at site after erection, required number of coats of primer and finishing paint as per specification and drawing.

j) Rectification of structures as per instructions of the Engineer-Incharge.

16.0 STORING AND HANDLING

16.1 Storage of structures shall be preferably be done in such a manner that erection sequence is not affected.

16.2 While storing, care shall be taken so that structures do not come in direct contact with the earth surface and accumulated water.

16.3 Stacking of the structures shall be done in such a way that, erection marks are visible easily and handling does not become difficult. Wherever required, wooden sleepers/grillage may be used.

16.4 Handling and storage of materials shall be as per IS:7969-2017, to ensure safety.

17.0 ERECTION

17.1 General

17.1.1 Erection shall be carried out in accordance with IS:800-2007 and other relevant standards referred to therein.

17.1.2 For safe and accurate erection of structural steelwork, staging, temporary support, false work, etc. shall be erected as required.

17.1.3 The fabricated materials received at erection site shall be verified with respect of marking on the key plan/marking plan or shipping list.

17.1.4 Any material found damaged or defective shall be stacked separately and the damaged or defective portions shall be painted in distinct colour for identification and the same shall be brought to the notice of CLIENT.

17.2 Erection Drawings

17.2.1 The approved erection drawings and any approved arrangement drg, specification or instruction accompanying them shall be followed in erecting structures.

17.3 Erection of Structures

17.3.1 Erection work shall be taken up after receipt of clearance from CLIENT.

17.3.2 For safety requirements during erection, provisions in IS:7205-2016, IS:7969-2017 and other relevant Indian standards shall be followed.

17.3.3 Erection shall be carried out with the help of maximum mechanization possible.

17.3.4 Prior to commencement of erection, all the erection equipment, tools, tackles, ropes, etc. shall be tested for their load carrying capacity. Such tests may be repeated at intermediate stages also if considered necessary and frequent visual inspection shall be done of all vulnerable areas and components to detect damages or distress in the erection equipment, if any.

17.3.5 Following shall be taken care of during erection, whenever necessary:

17.3.5.1 Erected members shall be held securely in place by bolts to take care of dead load, wind load and erection load.

17.3.5.2 All connections shall achieve free expansion and contraction of structures wherever provided.

17.3.5.3 No final bolting or welding of joints shall be done until the structure has been properly aligned.

17.3.5.4 Instrumental checking of correctness of initial setting out of structures and adjustment of alignment shall be carried out in sequence and at different stages as required. The final levelling and alignment shall be carried out immediately after completion of each section.

17.3.5.3 The Contractor shall design, manufacture, erect and provide falsework, staging temporary support etc. required for safe and accurate erection of structural steelwork and shall be fully responsible for the adequacy of the same.

17.3.5.4 The Contractor shall also provide facilities such as adequate temporary access ladders, gangways, tools & tackles, instruments, etc. to CLIENT/Inspector for his inspection at any stage during erection.

17.4 Field Connections

17.4.1 Assembly by permanent bolts.

17.4.1.1 The numbers of washers on permanent bolts shall not be more than two (and not less than one) for the nuts and one for the bolt head.

17.4.1.2 Wooden rams or mallet shall be used in forcing members into position in order to protect the metal from injury or shock.

17.4.1.3 Where bolting is specified on the drawing, the bolts shall be tightened to the maximum limit. The threaded portion of the each bolt shall be project through the nut by at least one thread. Tapered washers shall be provided for all heads and nuts to achieve uniform bearing on sloping surface.

17.4.1.4 To prevent loosening of nuts, spring washers or lock nuts shall be provided as specified in the design/shop drawings.

17.4.1.5 All machine fitted bolts shall be perfectly tight and the ends shall be checked to prevent nuts from becoming loose. No unfilled holes shall be left in any part of the structures.

17.4.2 Assembly by welding.

17.4.2.1 All field assembly by welding shall be executed in accordance with the requirements for shop fabrication. Where the steel has been delivered painted, the paint shall be removed before field welding for a distance of at least 50mm on either side of the joints to be welded.

17.4.2.2 All other requirements in welding shall be in accordance with clauses specified under Section-1 of this Specification

18.0 ACCEPTANCE STANDARD OF WELDING

18.1 Acceptance standard of welding shall be as specified in Section-1 of this Specification.

19.0 BEDDING AND GROUTING

19.1 Base plates shall be set to elevations shown on the drawings, supported aligned and levelled using steel wedges and shims or by other approved methods. Plates shall be levelled properly, positioned and the anchor bolts tightened.

20.0 PAINTING AFTER ERECTION

20.1 The painting shall be as per painting specification (Section-4) of this Specification) and instruction given on drawings.

20.2 Site painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surface to be painted.

21.0 ERECTION TOLERANCE

Maximum permissible tolerance in erected steel structures shall be as given in Annexure-C.

22.0 ACCEPTANCE OF WORK

22.1 Acceptance of erected steel structures shall be either after completion of erection of all the structures or in blocks.

22.2 Preliminary Acceptance will be done in the following cases:

i) Any steelwork or part thereof embedded in concrete.

ii) Steel structures which are to be covered in the process of carrying out further work.

23.0 DOCUMENTATION

23.1 The following documents shall be prepared at the time of acceptance of erected structures:

i) Documents showing actual deviations made during execution of erection work and approval of competent authority.

ii) Documents showing acceptance of embedded structures.

iii) Certificate/documents on control checking and test of materials (if any) and weld.

iv) Data and result of geodetic measurements obtained while checking the erection of the structures.

23.2 Copies of “As-Built” drawing showing thereon all additions and alternations which took place between approval of drawing and erection of structures.

SECTION 3- FABRICATION AND ERECTION OF MISCELLANEOUS STRUCTURES

24.00 Roof and Side Cladding with Zincalume high tensile sheets. .

24.01 The scope of work shall cover:

a. Preparation of drawings showing layout and size of sheets used, details of connections and flashing, Bill of Materials, etc.

b. Procurement and supply sheets of all sizes, flashing and fittings like corner pieces, apron pieces, ridges, cutting and bending of sheets, wherever required, drilling of holes all as per Specification and Drawings.

c. Procurement and supply of all fixtures and accessories such as self drilling, self tapping fasteners (galvanised with EPDM seals), washers, sealants, neoprene fillers etc.

d. Procurement and supply of Rockwool insulation along with its fixing accessories such as cleats for fixing wire mesh, aluminium foil, metal/wire mesh etc(wherever applicable).

e. Loading, transportation, unloading and delivery of sheeting with/without insulation material from place of procurement to erection site.

e. Provision of all tools and tackles, equipment, labour supervision and services required for the satisfactory completion of the work specified herein and on the drawings.

f. Erection in position of sheets and insulation where specified, for roofing, walling, louvers, erection of all flashing, fittings like ridges, valleys, gutters, corners, apron, etc. at all locations all work as per Drawings and Specifications.

24.02 Fixing of sheets

24.02.01 All fixing of the roof and side sheeting to purlins/insulations shall be by means of self drilling, self tapping screws.

24.02.02 Self Tapping screws shall be provided at all crest/valley at purlin locations for roof sheeting and at all valleys of the corrugations for side sheets.

24.02.03 All sheets shall be stitched together by self drilling/self tapping screws at spacing not more than 500mm.

24.03 Laps

24.03.01 All roofing shall be provided with two corrugations side lap and 200mm end lap.

24.03.02 All side/gable end sheets shall be provided with single corrugation side lap and 100mm end lap.

24.03.03 Overhang of sheets on the roof and side cladding shall not exceed 300mm.

24.04 Erection

24.04.01 Erection is to be carried out with the lay of the side laps such that under the prevailing wind, rain is not driven into the lap. The sheets shall be laid so that side lap in any two consecutive rows is staggered.

24.04.02 Broken or otherwise damaged sheeting shall not be erected.

24.04.03 Cutting, framing and trimming of all openings required shall be carried out at site.

25.0 CHAIN LINK FENCING

The scope of work shall cover:

a) Procurement and supply mesh, line wire, stretcher bar, barbed wire (if shown in the drawings) and other accessories for chain link fencing and gate all as per specifications and drawings.

b) Loading, transportation, unloading and delivery of material for fencing and gate from place of procurement to erection site.

c) Provision of all tools, tackles, equipment, labour, supervision and services required for the satisfactory completion of the work specified herein and on the drawings.

d) Erection in position of the fencing and gate at all locations, all work as per specification and drawings.

25.1 Erection

25.1.1 The height of chain link fencing shall be 3.0/2.5m top of vertical post. Punch Tap Concertina coil is to be provided over chain link fencing.

25.1.2 Straining posts shall be provided at all ends and corners of fences, at changes in direction or acute variations in levels and at intervals not exceeding 66m on straight lengths of the fence. Intermediate posts shall be spaced at regular intervals not exceeding 1.5m.

25.1.3 Struts shall be fitted to all straining posts behind the chain link fabric in the direction of the fence.

25.1.4 There shall be four evenly spaced rows of line wire. The top wire shall be doubled, making five line wires in all. The bottom wire shall be close to the ground. Each line wire shall be strained lightly by means of eyebolt strainer at each straining point. The eyebolt strainer shall consist of bolt with welded eye. The bolt shall be sufficiently threaded and fitted with a nut and washer. Each line wire shall be secured to each of the intermediate posts by a wire stirrup passing through holes in the posts and secured to the line wire by three complete turns on each side of the post. Two-way eyebolt strainers shall have suitable ring nuts fitted after wires have been strained on one side.

25.1.5 The mesh shall be strained between each pair of straining posts and shall be secured to each straining post by means of a stretcher bar. One of the top line wires shall be threaded through the appropriate adjacent rows of mesh, care being taken that no meshes in the rows are by-passed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The mesh shall be attached to top and bottom line wires by wire ties spaced 150mm apart and to other line wires by wire ties spaced 450mm apart. Bottom row of the mesh shall be threaded to the foundation concrete using staples spaced 500mm apart and set in concrete to a depth of 150mm. The top of concrete shall be 50mm above G.L. and 50mm below the fencing.

25.2 Chain link fencing Gate

25.2.1 A gate of suitable width shall be provided in the direction of the chain link fabric. The mesh and barbed wire used for the fabrication of gate shall be identical in all respects to that of chain link fencing. The gate may be single leaf or double leaf depending on the width of the gate.

25.2.2 The gate frame shall be a pipe frame with stiffeners at mid-height and mid-width.

The mesh shall be welded to the gate frame/stiffeners.

25.2.3 Each leaf of the gate shall be supported on a pivot in the foundation for the straining post and shall be laterally held at two points, one near the top of the straining post and second near the middle of the straining post. The free end of each leaf shall be provided with a tower bolt at the base of the frame. An aldrop shall be provided at the mid-height of the frame.

SECTION-4: PAINTING OF STEEL STRUCTURES

26.0 SURFACE PREPARATION FOR PAINTING

26.1 General

The steel surface which is to be prepared shall be cleaned of dirt and grease and the heavier layers of rust shall be removed by grinding prior to actual surface preparation to a specified grade.

Surface preparation to be followed prior to painting shall be based on the requirement of a particular painting system as per Clause 28.0.

26.2 Mechanical Cleaning

Manual/ power tool cleaning shall be done as per grade St-2 or St-3, of Swedish Standard Institution SIS 055900.

i) Grade St-2: Thorough scraping and wire- brushing, machine brushing, grinding etc. This grade of preparation shall remove loose mill scale, rust and foreign matter. Finally the surface is to be cleaned with a vacuum cleaner or with clean compressed air or with clean brush. After preparation, the surface should have a faint metallic sheen. The appearance shall correspond to the prints designated St-2.

ii) Grade St-3: very thorough scraping and wire brushing, machine brushing, grinding etc. The surface preparation is same as for grade St-2 but to be done much more thoroughly. After preparing the surface, it should have a pronounced metallic sheen and correspond to the prints designated St-3.

26.3 If no grade of surface preparation is specified, Grade St-2 shall be followed.

27.0 PAINTS AND PAINTING

27.1 For use of specific painting system as mentioned in the Specification, the paint manufacturer's specification shall prevail.

27.2 General compatibility between primer and finishing paints shall be established through the paint manufacturer supplying the paints.

27.3 Before buying the paint in bulk, it is recommended to obtain sample of paint and establish "Control Area of Painting". On control area surface preparation and painting shall be carried out in the presence of manufacturer of paint.

27.4 In order to ensure that the supplied paint meets the stipulation in design drawing/specification, if required, samples of paint shall be tested in laboratories to establish quality of paint with respect to viscosity, adhesion/bond of paint in steel surfaces, adhesion/simulated salt spray test, chemical analysis (percentage of solids by weight), normal wear resistance as encountered during handling & erection, resistance against exposure to acid fumes, etc.

27.5 Whole quantity of paint for a particular system of paint shall be obtained from the same manufacturer.

27.6 Thinners, wherever used, shall be as per recommendation of the paint manufacturer.

27.7 Areas which become inaccessible after assembly of structures shall be painted before assembly, after cleaning the surfaces as specified.

27.8 Wherever shop primer painting is scratched, abraded or damaged, the surfaces shall be thoroughly cleaned using emery paper and power driven wire brush wherever warranted, and touched up with corresponding primer. Touching up paint shall be matched and blended to eliminate conspicuous marks.

27.9 If more than 50% of the painted surface of an item requires repair, the entire item shall be mechanically cleaned and new primer coats shall be applied followed by finishing coats as per painting specification.

All field-welded areas on shop painted item shall be mechanically cleaned (including the weld area proper, adjacent areas contaminated by weld spatter or fumes and areas where existing primer. intermediate / finishing paint is burnt). Subsequently, new primer and finishing coats of paint shall be applied as per painting specification.

27.10 Application of paint shall be by spraying or brushing as per IS:487-1985 and in uniform layers of 50% overlapping strokes. Painting shall not be done when the temperature is less than 5°C or relative humidity more than 85%, unless manufacturer's recommendations permit. Also painting shall not be done in frosty or foggy weather. During application, paint agitation must be provided wherever such agitation is recommended by the manufacturer.

27.11 Paint shall be applied at manufacturer's recommended rates. The number of coats shall be such that the minimum dry film thickness (DFT) specified is achieved. The dry film thickness

of painted surfaces shall be checked with elcometer or measuring gauges to ensure application of specified DFT.

27.12 All structures shall receive appropriate number of primer and finishing coats in order to achieve overall DFT as per design drawings/specifications. First coat of primer paint shall be applied not later than 2-3 hours after preparation of surface, unless specified otherwise.

27.13 The finishing paint as specified shall be of approved colour and quality. The under coat shall have different tint to distinguish the same from the finishing coat.

27.14 Edges, corners, crevices, depressions, joints and welds shall receive special attention to ensure that they receive painting coats of the required thickness.

27.15 Parts of surfaces embedded in concrete shall be thoroughly cleaned of grease, rust, mill scale etc. and shall be given a protective coat of Portland cement slurry immediately after fabrication. No paint shall be applied on this part.

27.16 Zinc-rich primer paints, which have been exposed several months before finishing coat is applied, shall be washed down thoroughly to remove soluble zinc salt deposits. In similar circumstances, the surfaces of paint based on epoxy resin should be abraded or lightly blast cleaned to ensure adhesion of next coat.

27.17 Surfaces which cannot be painted but require protection shall be given a coat of rust inhibitive grease according to IS:958-1975 or equivalent international standard.

28.0 PAINTING SYSTEM

The recommended painting system for general service requirement of steel structures covering surface preparation, application of primer coats, intermediate coats (if necessary) and final coats to develop the required minimum dry film thickness on steel surface is indicated as below

a. Surface preparation: St 2 according to Swedish Standard SIS055900.

b. Primer paint: Two coats of zinc phosphate in phenolic alkyd medium (DFT 35µ/coat).

c. Finishing paint: Two coats of synthetic enamel (DFT 25µ/coat) conforming to IS: 2932-2018.

29.0 MEASUREMENTS

29.1 Structural Steel

Structural steelwork will be measured by the metric tonne and as per IS:1200(Part-8)-2017 and IS:1200(Part-9)-2017 subject to provisions outlined below:

a) The calculation of quantities shall be based on unit weights for structural sections as given in IS Handbooks. In the case of mild steel plates, the calculated weights shall be based on 78.5 kg/m^2/centimeter thick plate. The payments will be made on the basis of weights of members as per drawings. However, any changes on the above weights during fabrication erection, payment shall be based on sketches approved by CLIENT.

b) In the event the IS does not specify any mode of measurement for a particular item of work, the same shall be measured as per any other relevant international standard or as directed by CLIENT.

c) The weight of all plates and sections shall be calculated from the approved drawing using the minimum overall square or rectangular dimensions and theoretical weight, no deduction being made for skew cuts, holes etc. In the case of plates, other than gussets, the actual dimensions shown on approved drawings will apply unless approved otherwise by the purchaser based on cutting diagram of mother plates.

d) The weight of all welding runs, bolt, stanchion base packing, cuttings to waste and rolling margins, and coatings of paint, will be excluded from the measured weight and shall be deemed to have been allowed for in the rates for structural steelworks quoted by the Contractor.

e) Temporary works and all other materials not included in the permanent works shall be excluded from any measurement for payment.

f) Chain link fencing shall be measured in running meter basis, as specified and shown on the drawings.

29.2 Sheets

29.2.1 Sheets for roofing and side cladding shall be measured by lump sum or the square meter of net laid area, as specified and shown on the drawings or scope of work.

29.2.2 No allowance shall be made for wastage, cutouts, overlaps, etc., in the measurement.

29.2.3 The unit rate shall include all fasteners, flashing and fitting such as ridges corners, aprons and other accessories.

29.2.4 No deduction will be made for openings for area less than a single sheet. Also no extra payment will be made for making openings.

30.0 ACCEPTANCE OF WORKS

30.1 After completing the erection of a unit or portion thereof, the Contractor shall give a notice in writing stating that the job is complete in all respects and ready for preliminary acceptance. The job shall be jointly inspected visually by representatives of Contractor and CLIENT. All observed defects and omissions as per drawing and specification shall be noted down.

30.2 The Contractor shall make good all these defects, deficiencies and omissions and shall inform in advance CLIENT/Inspector for inspection. The Engineer-Incharge shall satisfy himself that all the defects, deficiencies and omissions noted down during preliminary acceptance have been rectified.

Annexure-A

Permissible deviations in pitch and gauge of holes for bolts of normal accuracy

Sl. No.	Description	Hole Diameter (mm.)	Permissible deviations in spacing (mm.)	Permissible deviations in each group of holes	
				Carbon steel	Low alloy steel
a.	Deviation in hole diameter.	Upto 17	+1.0	No limits	
		Above 17	+1.5		
b.	Ovality (Difference between the biggest and the smallest diameters).	Upto 17	+1.0	No limits	
		Above 17	+1.5		
c.	Curves exceeding 1mm. and cracks on the hole edges.	-	-	Not permissible	
d.	Non-coincidence of holes in separate details of the assembled unit:				
	Upto 1mm.	-	-	Upto 50%	Upto 50%
	Above 1mm. upto 1.5mm.	-	-	Upto 10%	Upto 10%
e.	Slope of axis.	-	Upto 30% the thickness of unit.	No limits	No limits

Annexure-B

Tolerance of Assembled Components of Structures

Sl. No.	Description of components in structures	Deviation (±) mm. for elements of structures						
		Upto 1m.	1m. to 5m.	5m. to 10m.	10m. to 15m.	15m. to 20m.	20m. to 25m.	Over 25m.
1.								
i.	Deviations from the dimensions assembled.							
	Length and width of the details cut:							
a.	Manual gas cutting as per marking	3.0	3.5	4.0	4.5	5.0	-	-
b.	With shears or with saw as per marking.	2.0	2.5	3.0	3.5	4.0	-	-
c.	With shears or with a saw with a stop.	1.5	2.0	2.5	3.0	3.5	-	-
d.	Machine gas cutting.	2.0	2.5	3.0	3.5	4.0	-	-
ii.	Length and width of planed processed on edge planing machine.	1.0	1.5	2.0	2.5	3.0	-	-
2.								
i.	Distance between centers of the end holes:							
a.	Drilled according to marking.	2.0	2.5	3.0	3.5	4.0	-	-
b.	Drilled according to a gauge with bushing.	1.0	1.5	2.0	2.5	3.0	-	-
ii.	Distance between centers of adjacent holes:							
a.	Drilled according to marking or a gauge..	1.5	-	-	-	-	-	-
b.	Drilled according to a gauge with bushing.	0.5	-	-	-	-	-	-

Annexure-C

Tolerances in Erected Steel Structures

Sl. No.	Description	Tolerance
1.	Deviation of structure at foundation top level w.r.t. true axis	
a.	in longitudinal direction.	± 5mm.
b.	In lateral direction.	± 5mm.
2.	Deviation in the level of bearing surface of structures at foundation top w.r.t. true level.	± 5mm.
3.	Out of plumb of structure from true vertical axis and measured from structure top.	$\pm$ $H/_{1000}$ or ±25mm. Whichever is less.
Note:	'H' above is the structure height in mm.	

Notes:

1. The tolerances do not apply to steel structures where deviations from true positions are intimately linked or directly influenced by technological processes. In such cases, tolerances on erected steel structures shall be as per recommendations of process technologists/equipment suppliers.
2. The observed or calculated values of deviations of steel structures from their true positions shall be rounded off in accordance with IS:2-1960 for comparison with permissible tolerances specified in this table. The number of significant places retained in the rounded off value shall be the same as that specified in this table.

Annexure-D

Material of construction (as applicable)

1.0 Unless otherwise specified in the drawing, all rolled sections and plates shall conform to IS: 2062-2011.

2.0 Steel sheets shall conform to IS:1079-2009.

3.0 Steel tubes for structural purposes shall conform to IS: 1161-2014 (Grade YST-310).

4.0 Gutters and down comers shall be of copper bearing steel conforming to IS: 2062-2011.

5.0 Crane rails shall conform to IS: 3443-1980.

6.0 Roof Covering/ Sheeting: Canopy roof sheeting shall be of 0.6mm Zincalume/ galvalume colour coated sheets and shall have trapezoidal profile with 28-32 mm deep crest and 186-250 c/c profile width with minimum two ribs at centre for stiffening. The sheet shall be of minimum fy = 345 MPa and shall be coated with hot dip metallic Zinc aluminum alloy @ 150 gsm coating mass total on both sides.

7.0 Providing, cutting, fabrication and installation of canopy false ceiling with TRAC 150 F (of Interarch or equivalent as per Approved makes) coil coated (Pre-painted) steel false ceiling system comprising of 150 mm wide x 17 mm deep roll formed out of 0.50 mm thick polyester coated galvanized steel panels, fixed on steel runner of 34.5 mm width x 48 mm deep manufactured out of 0.60 mm thick precoated galvanized steel with rigid suspension of 20x20x0.5 mm fixed with steel brackets/clips etc. The suspension system should be meant of exterior use. The carrier shall be suspended at 1mtr c/c supported from purlin and suspension angle at 500 mm c/c. panel shall be factory cut to provide minimum joints. The longitudinal joints shall have additional special G.I. Splice in between two panels. The carrier joint shall have a carrier splice maintaining a module of 150 mm. The ceiling shall be clipped on to the suspended carriers after they are aligned and leveled. Cutting for fixing of light fittings shall be done as per the cutout required to fit the fixture. The work shall be carried out under a specialized and experienced supervisor.

8.0 All black hexagonal bolts, nuts and lock nuts shall conform to IS: 1363-2002 and IS: 1364-2002 (for precision and semi-precision hexagonal bolts). Washers shall conform to IS: 1148-1982.

8.0 Covered electrodes for arc welding shall conform to IS: 814-2016. Coding of electrodes shall be as follows:

a. ER 421 'C' x for mild steel of Grade A and Grade B as per IS: 2062-2011.
b. EB 542 'C' x H3X for:

mild steel of Grade B as per IS: 2062-2011 for dynamically loaded structures (arising out of crane, vibratory screen, equipment, etc.),
SAIL-MA micro alloyed steel 350 HYA/HYB and
when combined thickness (CT) for steel conforming to IS:2062-2011 exceeds 40mm.
where 'C' is the value of current as recommended by the electrode manufacturer.

9.0 Material for chain link fencing shall conform to IS:2721-2003. Mesh for chain link fencing shall be of 3.15mm hot dip galvanized steel mesh wire, the diameter being measured over zinc coating. The diameter of mesh wire shall not vary from the specified diameter by more than 0.05mm. The material for mesh wire and line wire of chain link fencing shall conform to IS:280-2015. Stretcher bar for erection of mesh shall consist of mild steel flats 25mmx4.75mm. The stirrup wire for securing the line wires to the intermediate post shall be of 2.5mm mild steel wire. Hairpin staples for fastening the bottom line wire to the foundation concrete shall be of 6mm mild steel wire with ends of staples bent outwards for adequate anchorage. The cleats for eyebolts shall be of mild steel plate 10mm thick.

10.0 Material for barbed wire shall conform to IS:278-2015. Line wire for the barbed wire shall be made from two strands of galvanized steel wire of nominal dia 2.5mm twisted together. Barbs shall be made of point wire of galvanized steel of nominal dia 2.5mm in such a way that four points of the barbs are set and located or locked as far as possible at right angles to each other. Droppers for barbed wire shall be of mild steel flat 25mmx4.75mm with 38mmx4.85mm half round staples for fastening the barbed wire.

PART III

ARCHITECTURAL WORKS

SCOPE OF WORK

FOR

ARCHITECTURAL WORKS

I) SCOPE OF WORK

1. The scope of work shall be broadly, but not limited to, the following:

   Architectural works envisaged in **this t**ender involve plastering, painting, flooring works, doors/windows, false ceiling, sanitary & plumbing works, and associated works as per specifications, BOQ, drawings and instructions of engineer in charge required for the completion of building works.

   The scope of work also includes all signage works like monolith, canopy fascia, canopy column cladding, building fascia, spreaders, dispenser stickers, safety signs, direction signs, etc. all complete as per BOQ, specification and drawings.

2. Architectural works shall be carried out for the scope of work listed as above. Bidder shall understand the scope of work by visiting the work site in advance and required to complete all the works as per specifications, SOR, drawings and as directed by Engineer-in-charge.

3. Documents and Submittals:

3.1 The drawings included in the Bidding Document provide a general idea about the work to be performed under the scope of this contract. These are preliminary drawings for bidding purposes only and are by no means the final drawings or show the full range of the work under the scope. Work has to be executed according to latest drawings prepared/approved by the Consultant.

3.2 All specimens and approved samples shall be retained with the Consultant for reference unless handed over to Contractor for safe custody. The Contractor shall make arrangements for proper storage of the same.

3.3 Submission of all original test certificates & records of testing, all warranties, performance guarantees in favour of client.

II) DRAWINGS

The work shall be executed in accordance with the specification and the drawings issued for construction. Drawings will be issued in stages in close coordination with the availability of data and sequence of construction. Only latest revisions of the drawings shall be followed. All old revisions shall be clearly marked 'SUPERCEEDED' and kept separately or destroyed as directed by Consultant.

III) SITE RECORDS

All works shall be recorded in appropriate Performa to be firmed up by the contractor in consultation with the Consultant. Where ever required reference to drawings and clauses of specification shall be recorded in the correspondence.

Records of cement and steel receipts, issue, and consumption shall be scrutinized from time to time by consultants and Owner. Statement of cement and steel receipts, statement of theoretical consumption and reconciliation accompany every bill. Records of spot levels jointly recorded before the start of the work shall form the basis of all measurements.

IV) APPROVAL AND TESTS

A high standard of quality is required for all materials and workmanship in construction work. They shall be 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 timely supply.

All materials shall be subjected to inspection and testing. The Contractor shall submit samples for testing as may be required by the Consultant. Sampling and testing shall be carried out in accordance with relevant IS Standards.

Wherever IS codes are referred, they shall be latest edition/ publication as on date irrespective of the date of finalization of the work.

V) REJECTION OF MATERIALS

Any material brought to site which, in the opinion of the Consultant is damaged, contaminated, deteriorated or does not comply with the requirement of this specification shall be rejected.

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 IS codes as applicable, then that material shall be rejected.

The Contractor at his own cost shall remove from site any and all such rejected material within the time specified by the Consultant.

VI) PREAMBLE TO SCHEDULE OF ITEMS

1.0 GENERAL

This preamble to the schedule of items is an integral part of the schedule and shall have as much force as though this is incorporated into the description of the items themselves.

Contractor's rate for any items of work in the schedule of items shall, unless otherwise stated, be held to include the cost of all materials, including wastages, conveyance and delivery, unloading,

storing, fabrication, hoisting, all labour for finishing to required shape and size, tools and plants, power, fuel, consumables, all taxes royalties, other revenue expenses, temporary facilities like roads, drains etc., providing temporary storage facilities for cement, steel and other materials and their subsequent dismantling, scaffolding and other temporary works, setting out, fitting and fixing in position, site drainage, dewatering, offering samples for approval, cost of all tests, rectification of all defects, replacement of defective materials and work, interruptions to work required to accommodate the work of other agencies working on the site, continuation of work beyond working hour, in the night and holidays also if situation warrants so, site clearance on completion, maintenance work during the period of maintenance, bye-work necessary to complete any particular item of work as per specification and direction of the E-I/C, overheads, profit and other incidental charges.

2.0 PLASTERING AND FINISHING

The rate of the respective item shall be for the complete finished work and shall also include, but not limited to, the following bye-works/activities all complete at all level and locations and as per specification and as directed by the E-I/C.

2.1 Preparation of surface to receive plaster/finish etc. cleaning of masonry/concrete surface of all dust, loose mortar dropping, traces of algae efflorescence and other foreign matter and roughening by wire brushing or hacking as may be required and raking out of joints where required.
2.2 Provision for scaffolding wherever required and removing the same.
2.3 Extra provision necessary to provide plastering /finishing in layers, when required.
2.4 All extra provisions necessary for plastering/surface finish in arises, bonds, bends, closing chases, rounded angles, drip courses, string courses, around openings/holes, and around dissimilar materials like metallic/timber/asbestos.
2.5 Nominal sprinkling of the cement slurry on the surface for proper grip and satisfactory finishing of the plaster work, if required.
2.6 Providing richer mortar 1:3 in a width of 75 mm on either sides of arises of all doors and windows.
2.7 All provisions necessary to achieve levels and true profiles.
2.8 Curing by appropriate means.
2.9 Removal of unused materials, dirts and debris and cleaning of area thoroughly, after completion of the work in particular area, if required.

3.0 PAINTING

The rate of the respective items shall be for the complete finished work and shall also include, but not limited to, the following bye-works/activities at all levels and locations and complete in all respects as per specification and as directed by the E-I/C.

3.1 Preparing the base surface including necessary rectification and treatment.
3.2 Provision of surface ladders, scaffolding etc., wherever necessary.

3.3 Provision of prime coat wherever applicable.
3.4 Curing by appropriate means wherever applicable.
3.5 Cleaning the splashes and drippings on floors, equipments, pipelines, etc.
3.6 Additional work to rectify the improper workmanship especially if final finish is not satisfactory.
3.7 Protection of painted surface during application and till final handing over.
3.8 Provision of brushes, abrasive papers, indigo (neel) and gum.

4.0 FLOORING, PAVING AND FACING

The rate shall include, but not limited to the following:

4.1 Preparation of the base/sub grade before laying the flooring.
4.2 Provision of the under course (where applicable) including the required surface preparation.
4.3 Provision of dividing strips wherever required.
4.4 Provision of necessary covers, chambers, edging, roundings, and the like in the junction of floors with dado/skirting/other vertical surfaces, around the pipes/openings/ends and other types of like cases.
4.5 Provision of small channels, grooves and the like.
4.6 Curing by appropriate means.
4.7 Provision of backing in case of linoleum/rubber/PVC/or similar flooring.
4.8 Working in isolated areas.
4.9 Provision of grinding and polishing when specified.
4.10 Necessary rectification to damages.
4.11 Protecting the floor till final handing over and maintaining the same within the maintenance period.
4.12 Additional thickness, the thickness mentioned shall be finished and minimum.
4.13 Applying cement slurry on the sub-base/structural slab before flooring to have a proper grip.
4.14 Provision of necessary panels to prevent construction cracks.
4.15 Finishing the surface ribbed or chequered or laid to falls if so desired.
4.16 Flooring in discontinuous strips or areas to suit the needs.
4.17 Providing necessary slopes as desired and rectification wherever any flooring is antislope.
4.18 Providing nosing at plinths, sills and steps etc. of so desired.

5.0 WOOD WORKS

The rate shall include, but not limited to, the following:

5.1 Frames and Scantlings

5.1.1 Making necessary holes/openings in masonry/concrete for fixing and jamming the same with appropriate materials.
5.1.2 Provision of bituminous coatings or other anticorrosive paint coatings on the surface in contact with concrete/masonry.

5.1.3 Provision of rawl plugs, screws, nails, pins, adhesives and the like, necessary for joinery and fixing.
5.1.4 Provision of temporary wooden bracings and their removal.
5.1.5 Provision of rebates, roundings and other type of curvings as per drawing.

5.2 **Shutters**

5.2.1 Provision of necessary wooden cleats, wooden blocks, with necessary screws, nails, adhesives, etc.
5.2.2 Provision for mouldings, rebates, roundings and other types of curvings as per drawings.
5.2.3 Provision of all necessary nails, screws, washers, holts, nuts, putties, adhesives, etc.

5.3 **General**

5.3.1 Provision of finishing as desired and directed by the E-I/C.
5.3.2 Rectification of damages and/or replacement of defective/rejected works.
5.3.3 Provision of protection till final handing over and maintaining the same within the maintenance period.

6.0 METAL DOORS, WINDOWS, VENTILATORS, ROLLING SHUTTERS

The rate shall include, but not limited to, the following:

6.1 Making necessary holes/openings in masonry/concrete for fixing and jamming the same with approved materials.
6.2 Shop fitting, assembly and shop coat of primer.
6.3 Doors, windows, gates, rolling shutters, glazed doors and windows and other items which are measured in Sq.m shall include all the necessary frames, angles, plates, sheets, holdfasts or lugs, locking arrangements, handles, bolting devices on both sides, hinges, pivots, guide rails and guide channels (wherever applicable), roller (wherever applicable), hood (wherever applicable), rubber linings, gaskets and the similar other fixtures necessary for fixing and locking arrangements (locks shall be separately paid unless otherwise mentioned in particular schedule of items).
6.4 Glazed doors/windows shall also include the glazing/glass panes glazing beads, glazing clips, putty, gasket and the like.
6.5 Rectification of damages and/or replacement of defective/rejected works.
6.6 Provision of protective measures till final handing over and protection/maintenance of the same within the maintenance period. Protection of glass panes/glazing after final hand over shall be the responsibility of the E-I/C.
6.7 Keeping the entire steel work free from corrosion and scrapping off and cleaning the rust, if any.

VII) GENERAL ARCHITECTURAL CONSIDERATIONS

This part deals with the general norms/standards requirements of materials for use in construction work with regard to quality, testing, approval and storage, before they are used on work.

1. 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.

2. Space Requirements

- Buildings shall accommodate spaces to meet the functional requirements as well as security/safety, maintenance, statutory (stairs/fire exits etc.), utilities & services (toilets/AC/Electrics/LAN/health etc.)/ environmental requirements and incorporated in design & detail engineering drawings/documents.
- Space requirements as indicated are not exhaustive and subjected to finalization by client during detail engineering stage with modifications required to meet the building requirements.

3. Design Requirements

- Entry to be provided at proper location.
- Toilet & Overhead water tank to be provided as per NBC guidelines.
- 600/ 450 mm projection to be provided over each window & ventilator.
- False ceiling to be considered in toilets for concealing pipes in case of G+1 buildings.
- Skirting shall be of same finish as that of floors. Panel dividers shall be provided in IPS/Heavy Duty flooring.
- All Air-Conditioned areas shall have false ceiling.
- Painting on Internal walls shall be done over wall putty.
- All steel frames, Shutters, Grills etc shall be painted with two or more coats of approved quality Synthetic Enamel Paint of Approved shade over a coat of Approved quality red oxide Zinc Chromate Primer.
- False flooring shall be provided in IT/ Server Rooms as per requirement.
- Samples, colour, finish and make of all materials should be approved by client.

4. Natural Ventilation

The area of windows will be a minimum 17% of the floor area to ensure adequate natural lighting and ventilation.

5. FLOORING

5.1 Vitrified / Ceramic Tile Flooring

Polished / glazed Vitrified floor tiles of approved make/ shade/ design/range of size 600mm X 600mm shall be provided in SCADA & Control Room, Telecom Room, Office spaces and corridors.
Heavy Duty Vitrified floor tiles of approved make/ shade/ design/range of size 300mm X 300mm and 12mm thickness shall be provided in Electrical Room and Fire Fighting Room.
Ceramic glazed/matte finish wall tile of size 600mm x 300mm of approved make shall be provided in toilet dado and matt finish/ anti-skid ceramic tiles of size 300mm x 300mm for toilet flooring.

5.2 Kota Stone Flooring

Kota stone slab flooring of 25mm thickness shall be provided in guard rooms, utility areas, stores, staircases, window sills, etc.

5.3 Acid-resistant Tile Flooring

Acid resistant tiles shall be provided in floor and dado upto lintel level of battery rooms of size 300mm x 300mm.
Acid Resistant Tiles are used in flooring and lining to prevent corrosion of surface by acids and other chemicals as well as to resist abrasion on floors. These tiles are made up of materials like clay, feldspar, quartz, and talc and vitrified at high temperatures in ceramic kilns and kept unglazed to prevent slipperiness when laid on floor. Chemical resistant mortars as per IS 4832 are used for laying these tiles. Laying and finishing procedure similar to the other glazed ceramic tiles.

5.4 False Flooring

Telecom Room and Control Room may have false flooring as per requirement.

Providing and fixing noncombustible 600mm high false flooring / cavity floor of modular 600 x 600 size and min thickness of 35mm approximate with pre moulded (USF 1000 grade) in filled access floor tile made from steel and cementitious infill material (M/S Unitile or equivalent), with edge beading and faced with 2 mm thick antistatic high pressure laminates. The Panels shall confirm to Class O & Class 1 Fire Ratings tested as per BS 476 and ASTM E84. The panel shall be designed for minimum concentrated load of 450 kgs, ultimate concentrated load of 1050 Kgs, Rolling load of 225 kgs.
The other components such as stringers, pedestals, supports, check nuts, etc shall be designed suitable in-line with the design parameter of the false floor panel.
The panels shall be placed on GI snap lock grid system stringers channels supported over MS galvanized pedestal supports at 600mm c/c approximate both ways.

Jack heads shall be die formed, out of min 4mm thick galvanized M.S. plate out of 90 mm X 90 mm, electroplated, with die cut notches to hold stringers 'snap on' and threaded holes, in addition, to hold the rigid grid type stringers. The jack heads shall have stud for housing into the pedestal. The pedestal head shall consist of an anti-vibrational conductive cap

Stringers shall be M.S. rigid grid type minimum 30 mm X 20 mm X 1.2 mm thick tubes and shall rest on the jack heads notches and shall be fixed by means of screws. The stringers shall be spray painted with conductive paint or galvanized to prevent rust & corrosion.

The pedestal supports shall be rigidly fixed on to the floor with glue and mechanical fasteners and shall be made of 150 x 150 mmx 8mm thick base plate with CRC pipe of size 32mm dia X 3mm and minimum 19 mm thick MS stools with a coupling and check nut for level adjustment. The sub structure assembly shall be suitably anchored to the floor.

The work includes necessary opening for cables and panel mounting and cutting of tiles to required size and strengthening of pedestals with 300 x 300 mm RCC pedestal at location of panels. The floor panels and stringers shall be completely removable and shall remain in position without screwing. The shade of the flooring material shall be as specified in the drawing or as directed by Engineer.

6. Finishing

6.1 Plastering on masonry structures shall be of thickness 15 mm on either faces, 12mm on internal faces & 6mm on concrete faces. The cement mortar shall not be leaner than 1:4.

6.2 Inside surfaces of walls /Ceiling will be provided with 1.5 mm thick plaster of paris / Wall putty of approved brand over the plastered surfaces.

6.3 All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush then same shall be finished off with roller.

6.4 All paints shall be of approved make including chemical resistant paint.

6.5 All internal walls shall be finished with **Premium Acrylic Smooth Interior Paint**

Minimum 2 finishing coats of paint shall be applied over a coat of primer. Providing and Applying of painting on internal plastered surfaces with two coats of acrylic emulsion - Eco friendly paint with low Volatile Organic Compounds (not exceeding 50 g/L) of approved shade & make, over one coat of approved cement primer consisting of volatile organic compounds less than 50g/L, including preparing the surfaces by applying Wall Care Putty (Fine finish) or approved equivalent make 1.5 mm thick, surface preparation, cleaning and all bye works, filling hair cracks with putty approved filler wherever 'required, scaffolding & cleaning, cost of all materials, labour etc. at all heights and lifts, all as per drawing, specifications and as directed by Engineer In-charge etc. complete.

6.6 All external walls shall be finished with **Premium Acrylic Smooth Exterior Paint**

The paint should be applied in minimum 2 coats (Eco friendly paint with low Volatile Organic Compounds not exceeding 50 g/L) @1.67 litre/10 sqm over and including priming coat of exterior primer applied @ 2.20 kg/10 sqm, on new plastered surfaces inclusive of all required tools, material, scaffolding and other painting accessories etc. The paint shall be applied as per the manufacturer's specifications and instructions and to the entire satisfaction of engineer-in-charge. The paint shall have excellent water resistant property.

6.7 For painting on concrete, masonry and plastered surface IS: 2395 shall be followed.

6.8 Surfaces of handrails, balustrades, steel / wooden door frames, rolling shutters, etc. shall be

finished with synthetic enamel paint (eco-friendly paint with low Volatile Organic Compounds) over a coat of primer of approved shade & make.

For painting on steel work and ferrous metals, BS: 5493 and IS: 1477 shall be followed. The type of surface preparation, thickness and type of primer, intermediate and finishing paint shall be according to the painting system adopted.

6.9 For painting on wood work IS: 2338 shall be followed.

6.10 Bitumen primer used in acid/alkali resistant treatment shall conform to IS: 158.

7.0 DOORS AND WINDOWS

7.1 Aluminium Doors, Windows and Ventilators

Glazed anodized Aluminium door with Aluminium frame of approved sections at specified areas. 8-12 mm thick toughened glass with Etching shall be considered with top & bottom Aluminium frame. Doors of the building shall be anodized aluminium environmentally compatible products containing minimum of 15 to 25 % of recycled content of approved coating (colour to be approved by Designer) fully / partially glazed (float glass panes with thickness as per opening with/without SHGC 0.25 to 3 and required U Value as per design. Doors shall have 8.0mm minimum thick float glass(with or without etching design) panels or prelaminated board panels with decorative lamination on both sides of approved make fixed with C.P. brass / stainless steel screws hydraulic door closer/ etc. complete as per directions of E-I/C ; frames as per approved manufacturer's detail. The item shall include heavy duty double action hydraulic floor springs with stainless steel cover plate of approved make with IS: 6315 mark, pivoting and all other arrangements including cost of cutting floors, S.S cover Plates with brass pivots etc., complete and other necessary accessories required for the works to facilitate smooth operation of the door shutter at all leads and lifts, all as directed by the Engineer- in- charge.

All windows/ ventilators shall be aluminium glazed (min. 5mm thick glass with/without SHGC & U Value as per design) with anodized aluminium hardware & aluminium grill as per requirement. The windows/ ventilators shall be partially/ fully openable or sliding windows as per requirement. All openings for door with aluminium louvers, windows & ventilators shall have high grade wire mesh/mosquito net. The fixtures like handles, stoppers, stays, etc. shall be of approved make. All aluminium sections/sheets including louvers shall be of standard make. Aluminium alloy used in the manufacture of extruded sections shall correspond to IS Designation H E 9 WP of IS 733. Hollow aluminium alloy sections used shall conform to IS Designation HV9 WP of IS 1285. The sections shall be polished and anodized with approved colour. The average thickness of anodic coating shall not be less than 20 microns as per IS: 1868-1982. All work shall be fitted and shop assembled to a first job, and ready for erection. EDPM performed profiles shall be used for inserting into extruded pockets of sections. Glazing beads shall also be of EDPM performed profiles to hold the glass in frame under pressure. Non-metallic setting blocks shall be used to centralize the glass in frame. All work shall be adequately braced and reinforced as necessary for strength and rigidity. Stainless steel ball bearings, housed in nylon type nylon rollers, shall be used. All mechanical connections shall be sealed with silicon sealant. Around all windows, approved quality sealants shall be run down to make sure of total weather/water sealing.

Casement windows / ventilators, single or composite units with 6.0mm thick float/frosted glass,

frame size of 44mm x 46mm x 1.1mm, weight 0.522 kg/m min. amd middle frame (horizontal & vertical) 59mm x 38mm x 1.4mm, weight 0.729 kg/m min(approx.), as per approved manufacturer's detail. Openable portion, section size 44mm x 46mm x 1.4 mm, weight 0.575 kg/m min. as per approved drawing and as per approved manufacturer's specification.

Composite sliding windows with fixed and openable portion, fixed to frame size min. 101.6mm X 44.45mm x 2.01mm, weight 1.605 kg/m (approx.) and 63.5mm x 38.1mm x 1.5mm, weight 0.861 kg/m min. as per requirement. Sliding shutters fixed to frame size 92mm X 31.75mm x 1.5mm min. & weight 1.060 kg/m min and 61.85mm x 31.75mm x 1.5mm, wt. 0.784 kg/m min as per requirement. Shutter side, bottom and interlock shall be 40mm x 18mm x 1.55mm wt. 0547kg/m min., as per approved drawing and as per approved manufacturer's detail.

7.2 PVC Doors

All toilets to have PVC doors of premium quality with solid PVC foam profile door frame.

PVC door frame shall be factory made (single rebate) made out of single piece extruded solid PVC foam profile with homogenous fine cellular structure having smooth outer integral skin having 62 mm width & 32 mm thickness, frame will be mitred & jointed with self-driven self-tapping screws of size 38 mm x 4 mm & PVC solvent cement, including fixing the frame to wall with suitable dia & length anchor fastener as per manufacturer's specification and direction of Engineer-in-charge.

The door shutter shall be factory made 30 mm thick non decorative finish made of solid PVC foam profile. The styles & rails shall be of size 75 mm x 30 mm having wall thickness 5 mm. The styles, top & bottom rails shall have one side wall thickness of 15 mm integrally extruded on the hinge side of the profile for better screw holding power. The styles and rails shall be reinforced with M.S. tubes of size 33 mm x 17 mm x 1 mm, painted with primer, all four corners of reinforcement to be welded or sealed. Solid PVC extruded bidding (push fit type) will be set inside the styles and the rails with a cavity, to receive single piece extruded 5 mm PVC sheet as panel. The styles and rails will be mitred cut and joint with the help of PVC solvent cement & self-driven self-tapping screws. Single piece extruded solid PVC lock rail of size 100 mm x 30 mm with wall thickness 5 mm & 15 mm integrally extruded in the middle of the lock rail & fixed with styles with the help of PVC solvent cement & self-driven self-tapping screws of size 100 mm x 8 mm complete as per manufacturer's specifications and direction of Engineer-in-charge.

7.3 Rolling Shutter

M.S. Rolling Shutter as required to be provided as per IS code and finished with synthetic enamel paint.

8. FALSE CEILING

All specified spaces shall have false ceiling of eco friendly light weight calcium silicate tiles and gypsum board false ceiling.

8.1 Calcium Silicate False Ceiling

Material

Frame:

The frame work shall consist of G.I. Pre-coated Silhouette Profile ' T ' Sections for Main runners / Cross runners of size & thickness specified in the item with galvanization of 120 gsm (minimum),and perimeter w-profile of 0.40mm (minimum thickness) having flanges of size 7mm + 7mm+19mm made from precoated polyester baked Coil length of 3.0/3.60M.fixed to the wall with the help of rawl plugs at 450mm centre to centre with 35x8mm long dry wall wooden screws with virgin plastic rawl plugs@ 450mm interval. The frame work shall be executed in a manner so as to form a grid of 600mm x 600mm as specified in the item. The frame work shall be suspended from ceiling by L shape adjuster hangers made of G.I. sheet of size 85x25x25x2mm having die cut slit for sliding into main T section, also having precut hole so as the 6mm fully threaded MS rod can be inserted and pierces into M 6 dash fasteners of 6 mm dia 40mm long, fixed to the slab/beam and then tightened with check nuts, subsequently the bottom of 6 mm rod will be tightened with check nuts, for adjusting the line & level, in true horizontal plane.

Ceiling Tiles:

Ceiling Tiles shall be of 15 mm thick Integral densified microlook edged, semi perforated / fully perforated or with design/ texture as mentioned in item, eco friendly light weight calcium silicate false ceiling tiles and made from hydrated calcium silicate, reinforcing fibres, natural fillers free from formaldehyde and other harmful materials, & shall not contain any toxic ingredients and shall have 52% recycled material, including 23% fly ash.

The tile shall be of size 595 x 595mm having Integral densified reinforced edges of 15 mm thickness all around with a collar of width 24 mm and 10mm thickness at the centre. The tiles shall have overall density of 350 kg/m3 in the body and 450kg/m3 at the edges. The tiles shall be primer coated on both sides and the fair surface shall be having factory finish in two coats of white dispersion type solvent free paint.

The calcium silicate tiles should be eco-friendly light weight, characterized with 100% relative humidity resistance, non-combustibility as per BS 476 Part IV, thermal conductivity of < 0.043 w/m°kc as per ECBC Code-2007, light reflectance> 85°/0,and Noise Reduction Coefficient (NRC) of 0.50 for Spintone / Cosmos /Fine Fissured and NRC of 0.15 for Hexa/Quadra , and NRC of 0.65 to 0.75 for Globe fully perforated tiles, as per IS-8225-1987. Sound attenuation STA- 32 dB. The tiles should weigh approx 5.0--5.5 kg/m2.

Suspension Material

G.I. Fully threaded galvanized rod of 6 mm dia. having hot dip coating of zinc 80g/ Sqm, and tensile strength of 344-413 MPa. The rod should be used in conjunction with L- adjuster, bent at 90°, and check nuts, so as to ensure that there is no disengagement, both at the bottom of rod and at the top portion which is tightened to M- 6 metal dash fastener, suitably drilled into the slab/beam.

Fixing of frame work and tiles

The main runner of size 42mmx15mmx0.40mm thickness 3.00m/3.60m length having a

black/white reveal in silhouette profile spaced at 1200 mm centres, shall be securely suspended with G.I. Fully threaded rod of 6 mm dia. with L- type adjusters of 85x25x25x2mm made from G.I Sheet. The rod is to be be suspended from the soffit of slab/ beam at 1200 mm centre to centre with the aid of M6 dash fasteners, suitably drilled into the slab. The last hanger at the end of each main runner should not be greater than 600mm from the adjacent wall. Then flush fitting cross tees, also having a black/white reveal in silhouette profile of size 42mmx15mmx0.40mmthickness & 1.20m length are to be inserted in the main tees at 600mm centres at right angles to the main tees to form a grid of 600mm x 1200mm modules, Shorter cross tees of 42mmx15mmx0.40mm thickness & 600mm length are then to be centrally inserted in the longer cross tees in direction parallel to the main tee so as to form a grid of module 600mm x 600mm. The frame system shall rest on periphery walls/ partition on the w-profile of section 0.40 mm thick gauge having flanges of 7mm+7mm+19mm made from G.I coil length 3.0m/3.60m,.The entire grid system shall be designed to bear a distributed load of minimum 15kg/Sqm having galvanisation of 120 gsm (minimum). All tees shall be rotary stitched double-webbed and powder coated in white shade. The ceiling tiles shall be placed directly over the G.I 'T ' Section frame and not to be cemented nor glued to the surface of any other materials.

Precautions

a) All wet trades such as plastering, conduiting, and painting etc be completed prior to start of false ceiling works.
b) Air Conditioning duct work is to be completed, preferably even before the suspension of the grid sections.
c) Electrical chasing or drawing lines & cables, etc. are to be in place before start of false ceiling works.
d) No unauthorized weight is put on false ceiling. Lighting fixtures, diffuser are to be suspended independently with proper chains/ wire & dash fasteners as directed by Engineer in Charge.
e) The area should be completely dry, prior to ceiling installation work.

Measurements

Length & breadth of the finished ceiling shall be measured correct to a centimetre. The area shall be calculated in square meter correct to two decimal places. No deduction shall be made for making openings for electrical, air conditioning, fire fighting fixtures, nor shall extra payment be made either for extra materials or labour involved in making such openings.

8.2 Gypsum Board False Ceiling

Providing and fixing 12.5 mm thick moisture resistant gypsum board suspended false ceiling with M/F Suspended Ceiling Regular System (Single Layer GS-MFSC-4.1) which includes providing and fixing G.I. Perimeter channels of size 0.55 thick having one flange of 20 mm and another flange of 30 mm and a web of 27 mm along with perimeter of ceiling, screwed fixed to brickwall/partition with the help of nylon sleeves and screws, at 610 mm centres. Then supending G.I. intermediate channels of size 45 mm, 0.9 mm thick with two flanges of 15 mm each from the

soffit at 1200 mm centres with ceiling angle of width 25mmx 10mm x 0.55mm thick fixed to soffit with G.I. cleat and steel expansion fasteners.
Finally the board are to be jointed and finished so as to have a flush look which includes filling and finishing the tapered and square edges of the board with jointing compound, paper tape of best quality and two coats of primer suitable for Gypsum board (as per recommended practices of Gypsum board or equivalent).The rate shall be inclusive for making necessary opening for light fittings, grills 14 and cutouts etc. with the frame of perimeter channels of size 20mmx27mmx30mmx0.55mm thick supported suitably and painting the exposed surface of Gypsum board two coats with plastic emulsion paint of approved brand and shade including making necessary service door complete in all respect as per manufacturer's specification as directed by E-IC.

9. ROOF AND ROOF DRAINAGE

9.1 Roof drainage system will be provided for quick and efficient draining of rainwater from roof to avoid seepage and damage to roof. The roof gradient for the roof will not be less than 1 in 100. Roof System will be designed to handle design requirements for the specific site and will be in accordance to stipulations of IS:1742 and IS:2527. Roof drains will conduct water to storm drains through uPVC down take pipes. UPVC Rain water conform to IS : 13592 Type A including jointing with seal ring conforming to IS : 5382 leaving 10 mm gap for thermal expansion Single socketed pipes.

9.2 All exposed RCC roofs shall have waterproofing treatment of acrylic base flexible liquid applied Waterproof cum Insulation Membrane. The surface shall then be finished with crazy ceramic tiles.

Method of Application

Surface Preparation

Prior to application of Waterproof cum Insulation Membrane, all surfaces must be prepared properly to avoid failure. The surface shall be cleaned to remove all dust, foreign materials/loose particles or any deposits of contaminants, which could affect the bond between the original substrate and the membrane system. This can be done by scarifying, grinding, water blasting, sand blasting, acid washing or any other approved method. Rectify depression / honey-comb (if any) in the surface, use mortar (1part mortar, 2part cement, 4 part medium washed sand) and leave it for at least 24 hours before application of Waterproof cum Insulation Membrane.

Treatment of Cracks

If there is any crack up to 2 mm, clean those cracks with vacuum cleaner, to open cracks, pour waterproof acrylic primer followed by a coat of acrylic along the crack line and leave it to dry for overnight.

Application of Primer

Though the membrane adheres strongly with most of building materials like cement concrete, mortar, bricks, woods, metal etc, use of acrylic primer provide better performance of final coating

system. Stir well the Primer and apply it with soft nylon brush or roller over the dry surface. Generally, one coat is sufficient. If the surface is too porous apply two coats of primer. Time gap between two coats should be 2-3 hours.

Application of Membrane

After the application primer coat allow it to reach touch dry for 2-3 hours. Stir the material to a homogeneous smooth consistency and apply it horizontally with soft nylon brush, roller or squeeze to thickness of 125-150 microns in single coat. Allow it to dry for approx. 4-5 hours. When the applied coat becomes sufficiently dry (no foot print observed) apply second coat vertically. Two coats are sufficient for general application (150-200 microns DFT) but for severe conditions, three or more coats are required to achieve desired results.

Precautions

- Reinforcement rods and other sharp materials should not be dragged over the membrane, as this can puncture the same. The material shall always be used without dilution.
- Do not apply coating thickness more than 200 microns in one go. For higher coating thickness apply multiple coats.
- There should not be any rain during and after application of final coating for at least 6-8 hours.
- 24 Hours pond test shall be carried out after 72 hour of final coating application

10. MISCELLANEOUS WORKS

10.1 All staircases and corridors shall have m.s. railings. Handrail shall be of 66x33x3.6 M.S. hollow section. Balusters shall be 16x16 M.S. square bar and mid rail shall be 25x6 M.S. square bar.

10.2 Polished granite/ kota stone of 250mm wide of approved shades shall be provided for window sills, coping, etc.

10.3 Drip mould of size 20mm x 8mm shall be provided over cement plastering of chajjas, roof projections etc.

10.4 Grooves of uniform size 10x10mm shall be formed in plastered surface as per approved pattern.

10.5 The work tops in pantry / basin counters in toilets will be of granite.

10.6 Urinal partitions shall be of granite.

10.7 Providing and fixing 24 gauge Chicken Wire mesh in junction of block work & RCC works at corner/wall surface as per direction of Engineer-In-Charge.

10.8 Apron 0.90M wide of PCC M-10 grade and PCC peripheral Storm water drains around building (as per requirements).

10.9 One or more 1000 liters overhead tank “Sintex” or equivalent with necessary GI incoming and outgoing pipes and fittings along with 0.5 HP pump for pumping water shall be provided for supplying water in toilets / other areas.

10.10 Providing and installation plastic garbage bins(FRP/HDPE) of min 120l capacity of approved model of Sintex/Swift/Nutech/Sheetal or approved equ.make, design & spec as per standard/norms complete with all fitting,fixtures,lids,wheels etc.

11. SANITARY INSTALLATIONS

Standard type white/coloured glazed vitreous china sanitary fittings will be provided in toilets and kitchens of approved model and make. Standard chromium plated brass plumbing fittings and fixtures from approved manufacture will be provided in toilets and kitchens. Stainless steel sink shall be provided in kitchens/ pantries.

12. LANDSCAPING

Areas considered for plantation shall be organized planting in vacant areas in around monolith and other areas as mentioned.

13. SIGNAGE WORKS

All signage works like monolith, canopy fascia, canopy column cladding, building fascia, spreaders, dispenser stickers, safety signs, direction signs, etc. shall be as per BOQ, specification and drawings, all complete, including supply, fabrication, erection, assembly, commissioning the signage works (with client's name & logo) including electrical cabling and lighting etc.

PART-IV

MECHANICALWORKS

CONTENTS

MECHANICAL WORKS

SECTION A-1.

SUPPLY OF SS TUBES, SS FITTINGS, SS VALVES THERMOPLASTIC HOSES FOR CNG REFILLING STATIONS

CONTENTS

1.0 Scope of supply of SS Tubes, SS Valves SS Fittings

1.0 Scope of supply of SS Tubes, SS Valves, SS Fittings & Thermoplastics Houses

The contractor has to supply SS Tubes, SS Valves & SS Fittings strictly as per technical specification no. MEC/TS/05/62/035, MEC/TS/05/62/047 & MEC/TS/05/62/048 attached.

The SS Tubes, valves and fittings are be laid, tested and commissioned as detailed in SECTION– B. The balance items are to be reconciled and submitted to Owner stores in good condition. The uncountable material beyond the permissible limits as specified in clause no. 6.0 of Section- B would not be paid.

The contractor is required to purchase SS Tubes, SS fittings & SS Valves as per the quantities given in Schedule of Rates (SOR) from the approved vendor list enclosed. The contractor shall take prior approval before placement of order and get the QAP approved by MECON / OWNER. The inspection of materials and / or scrutiny of documents would be carried out by OWNER/ENGINEER-IN-CHARGE / Third Party Inspection Agency.

PURBA BHARTI GAS PVT. LTD.	**CONSTRUCTION OF CNG STATIONS (CGS, MOTHER STATION, ON-LINE STATION DBS AT CACHAR, HAILAKANDI KARIMGAN GA AND KAMRUP KAMRUP METROPOLITAN GA FOR M/S PBGPL**	MECON LIMITED

1.0 TECHNICALSPECIFICATION

FOR

SS TUBES FOR
CNG REFILLING STATIONS

(TS NO.: MEC/TS/05/25/035)

MECON LIMITED

(A Govt.of India Undertaking)

PURBA BHARTI GAS PVT. LTD.	**CONSTRUCTION OF CNG STATIONS (CGS, MOTHER STATION, ON-LINE STATION DBS AT CACHAR, HAILAKANDI KARIMGAN GA AND KAMRUP KAMRUP METROPOLITAN GA FOR M/S PBGPL**	MECON LIMITED

15th Floor, SCOPE Minar, North Tower
Laxmi Nagar District Centre,
DELHI -110092

Contents of TS No. MEC/TS/05/25/035

PURBA BHARTI GAS PVT. LTD.	CONSTRUCTION OF CNG STATIONS (CGS, MOTHER STATION, ON-LINE STATION DBS AT CACHAR, HAILAKANDI KARIMGAN GA AND KAMRUP KAMRUP METROPOLITAN GA FOR M/S PBGPL	MECON LIMITED

PREPARED BY:	CHECKED BY:	APPROVED BY:
GURDEEP SINGH	V.K. AGRAWAL	A.K. JOHRI

1.0 SCOPE OF WORK

1.1 The scope of the tenderer will include manufacture/supply, inspection/ testing/marking/ packaging/ handling and dispatch of SS Tubes, as indicated in the Bill of uantities meeting all the requirements as per ASTM A269.

1.2 All codes and standards for manufacture, testing, inspection etc. shall be of latest edition.

1.3 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.

2.0 CODES & STANDARD

Items	Applicable Codes and Standards
Tubes	ASTM A269, ANSI B31.3

3.0 PRECEDENCE

In case of any conflict between this job specification and other document, the following order of precedence shall apply:-

3.1 Job Specification

3.2 International Standards/Codes Applicable

4.0 DEVIATION

Deviations if any required by Tenderer shall be separately furnished against each clause giving reasoning for each deviation. Tenderer to note that except the deviations furnished by them, Tenderer's offer shall be deemed to be in total conformity with the enquiry specifications.

5.0 SAFETY

5.1 All tubes shall be designed as per applicable code & standards.

5.2 All part/ component shall meet the requirement for the specified area's classification.

5.3 Area classification shall be Class-I, Division-I Group-D as per NEC or one-I Group IIA/ IIB as per IS/ IEC Specification or equivalent specifications.

6.0 **SPECIFICATION**

All the items shall be suitable for compressed natural gas service and meet following specifications.

6.1 Tube material shall be stainless steel as per ASTM A269 (Grade TP 316).

6.2 Tubing material shall have minimum molybdenum content 2.5 , carbon content of max. 0.030 .

6.3 Tube shall be bright annealed.

6.4 Tube shall be seamless.

6.5 Tube hardness shall be less than Rb 80. Tubes shall be NACE MR 0175 certified for hardness. Hardness test shall be carried out on each tube.

6.6 Each tube shall be hydro-tested as per requirement of ASTM A450 clause 22.3, at a hydro-test pressure of 350 kg/cm2 (g).However, it shall be ensured that the test pressure does not result in stresses exceeding the yield strength at test pressure.

6.7 All S.S. tubes shall be online 100 eddy current Tested as per ASTM A450.

6.8 Tolerance on outer diameter shall be 0.005 .

6.9 Tube shall be of 5 to 6 meter in length.

6.10 Minimum thickness shall be as per following table.

Tube OD	Minimum Wall Thickness	Maximum Allowable Working Pressure psig
1	0.120	4700
	0.095	4700
	0.083	4700
3/8	0.065	4800
	0.035	4800

Note: Bidder to reconfirm maximum allowable working pressure for each tube size.

6.11 Following documents/ certificates to be submitted.

i) Chemical composition for heat
ii) Chemical composition for products iii) Tensile test
iv) Hardness test
v) Flaring test
vi) Leak test
vii) Visual inspection and dimensional check

6.12 Tubing should be clearly marked with the specifications given in the inspection certificate with heat code, lot code, outer diameter and wall thickness with inspection certificate no.

6.13 Tubes should be supplied with both ends plugged.

7.0 **DOCUMENTATION**

7.1 All documents shall be furnished in English language only.

7.2 At the time of bidding, bidder shall submit following documents.

7.3 Reference list of previous supply for similar item, giving following details.

7.4 Name of the customer.

7.5 Specification of the item i.e., size and pressure & temperature rating.

7.6 Service

7.7 uantity

7.8 ear of supply

7.9 Copy of ISO: 9000 certification for supplier/ manufacturer.

7.10 Manufacturer uality Control Plan.

7.11 Clause-wise deviations to the specification.

7.12 Following test certificates shall be furnished along-with shipment.

7.13 Test certificate of visual, chemical, mechanical testing (incl. tensile, hardness, flaring and leak test).

7.14 Manufacturers standard shop inspection & test report for all items.

7.15 The test report for specified tests.

7.16 Third party inspection report as applicable to meet the requirements of specified codes & standards as applicable.

8.0 PACKING & SHIPMENT

8.1 All the items shall be suitably wrapped and packaged to with stand rough handling during ocean shipment and inland journey. Tubes should be supplied with both end plugged.

8.2 The item shall be properly tagged and package separately to facilitate easy identification.

8.3 Items shall be wrapped and packaged in such-a-way that they can be preserved in original as new condition.

9.0 GUARANTEE

9.1 Manufacturer shall guarantee that the design, materials, manufacturing and testing of tubes conform to the requirement of this specification. Manufacturer shall replace all tubes free of costs which fail during field pressure testing or do not perform satisfactorily due to inadequate engineering, substandard material and poor workmanship.

9.2 The manufacturer shall guarantee against any defect, failure or malfunctioning occurring during 12 months from the date of commissioning or 24 months from the date of supply whichever is earlier.

PURBA BHARTI GAS PVT. LTD.	**CONSTRUCTION OF CNG STATIONS (CGS, MOTHER STATION, ON-LINE STATION DBS AT CACHAR, HAILAKANDI KARIMGAN GA AND KAMRUP KAMRUP METROPOLITAN GA FOR M/S PBGPL**	MECON LIMITED

2.0 TECHNICAL SPECIFICATION

FOR

SS FERRULE FITTINGS FOR CNG REFILLING STATIONS

(TS NO.: MEC/TS/05/25/047A)

MECON LIMITED

(AGovt.ofIndiaUndertaking)

15th Floor,SCOPEMinar,NorthTower

LaxmiNagarDistrictCentre,

DELHI 110092

Contents of TS No. MEC/TS/05/25/047A

PREPARED BY:	CHECKED BY:	APPROVED BY:
GURDEEP SINGH	V.K. AGRAWAL	A.K. JOHRI

1.0 SCOPE OF WORK

The scope of this specification covers the requirement of design, manufacture/ inspection/ testing at works/ marking/ packaging/ and supply of high-pressure SS Ferrule Fittings.

2.0 CODES STANDARD

The latest editions of the following standards are referred to in this specification.

Items	Applicable Codes and Standards
Bar Stock	ASME SA-479-316 or DIN 4401 or BS:970-316-S31
Forging	ASME SA-182-316 or DIN 4401 or BS:970-316-S31
Thread	NPT ANSI B 1.20.1

3.0 PRECEDENCE

In case of any conflict between this job specification and other document, the following order of precedence shall apply:

3.1 Job Specification.

3.2 International Standards/ Codes Applicable.

4.0 DEVIATION

Deviations if any required by Tenderer shall be separately furnished against each clause giving reasoning for each deviation. Tenderer to note that except the

deviations furnished by them, Tenderer's offer shall be deemed to be in total conformity with the enquiry specifications.

5.0 SPECIFICATION

All the items shall be suitable for compressed Natural Gas service and meet following specifications.

5.1 Materials

5.1.1 Fittings shall be manufactured from the following materials:-

i) Bar stock shall be as per BS: 970-316-S31, DIN 4401 or ASME 479-316 but with carbon content less than 0.05 to provide increased resistance to corrosion.

ii) Forgings shall be as per BS: 970-316-S31, DIN 4401 or ASME SA-182-316.

5.1.2 The fittings end connections shall be compatible to tube of hardness Rb80.

5.1.3 All component parts of the fittings shall be of the same material.

5.1.4 The ferrule material shall be able to withstand an atmosphere of Natural Gas, oil and moisture without rusting.

5.2 **Design & Manufa ture**

5.2.1 All fittings shall be designed in conformance with the requirements of ASME B31.3 and applicable standards. Area classification applicable for all items shall be Class-1, Division-1, Group-Das per NEC or one-1 Group- IIA/IIB as per IS/ IEC specification or equivalent specification. All fittings shall be designed so that all parts/ components meet the requirements for the specified area classification.

5.2.2 The SS fittings shall be of flareless design and four piece construction, consisting of front and rear ferrules, nut and body suitable for use on SS tubes conforming to ASTM A269 TP316.

5.2.3 Fittings shall be rated for at least the design pressure as stipulated in the material requisition. The design of fittings shall ensure that they shall be capable of holding full tube burst pressure after only one and a quarter turn pull up of the nut.

5.2.4 The threaded ends of fittings shall be NPT as per ANSI B1.20.1.

5.2.5 The fittings shall hold the tube with collecting action producing a firm grip on the tube without substantially reducing the tube wall thickness.

5.2.6 Fittings shall not torque the tubing during original or subsequent make-up of the connection and should use geometry for inspection before and after makeup the fittings shall not require disassembly for inspection before or after makeup.

5.2.7 All tube fittings shall be gauge-able for sufficient pull up after one and a quarter turn. All tube fittings shall have a gauge-able shoulder and there will be no radius at the point where the shoulder meets the neck of the fitting body.

5.2.8 The gap inspection gauge shall be easily insert-able at finger tight position of nut. The gap inspection gauge shall not be insert-able between the nut and shoulder of the fitting after completing only one and a quarter turn pull up of the nut.

5.2.9 The tube seat counter bore in the body shall be faced flat 90 to the axis of the tubing to minimize tube expansion and subsequent galling.

5.2.10 The sealing and gripping power of the fitting shall be controlled such that the action between ferrules will overcome commercial variations in tubing wall thickness, hardness, diameter and installer skill.

5.2.11 The seal contact are as of the fittings body shall have a machined finish of 32 Ra or better.

5.2.12 The fittings body shall have no machined stop or shoulder to preclude additional tightening in subsequent make-up.

5.2.13 Front Ferrule

i) The front ferrule shall effect a long, smooth repeatable seal by contact with body and a grip hold on the tube surface.

ii) The front ferrule shall always remain in a sprung condition to compensate for thermal stresses and to accomplish repeated make

and break.

5.2.14 Rear Ferrule

i) The rear ferrule shall collect the tubing surface, improving the performance of the tubing in systems of high impulse or vibration.

ii) The rear ferrule shall have a machine recess on the inside diameter and shall have complete surface hardening so as to substantially reduce the required pull up torque. Both the requirements i.e. complete surface hardness and machined recess shall be met for all rear ferrules.

5.2.15 Nuts shall have silver plated threads to act as a lubricating agent to avoid galling and to reduce tightening torque.

5.3 Inspe tion and Testing

5.3.1 The manufacturer shall submit typical type test reports for the following test carrier out on random samples of two ferrule fittings:-

i) Hydraulic burst pressure test.

ii) Helium leak test under 0.0002 PSIA negative pressure, leaks into assembly greater than 4.0 x 10^{-9}atm-cc/sec being unacceptable.

iii) Gas pressure test for 25 remarks at 5000 Psig. No leakage should be detectable even after 25 remarks.

iv) Impulse& vibration testing by rotary beam method for 5,00,000 impulse cycles and 20million vibration cycles with no detectable leakage at full working pressure throughout till the end of the test.

5.4 Test Reports and Certifi ates

5.4.1 The manufacturer shall supply material compliance certificates conforming that the raw material for fittings conforms to the requirements of ASME Section-II and ASME Section-III sub section NB, NC and ND.

5.4.2 The manufacturer shall furnish test procedure and typical test reports of all tests conducted on fittings as per the requirements of clause 5.3.

6.0 MARKING, PACKING & SHIPMENT

6.1 Heat code traceability number shall be stamped or etched on both body and nut of each fitting.

6.2 Replaceme4ntnuts and ferrules shall be packaged in a manner so as to allow safe and simple replacement.

6.3 All the items shall be suitably wrapped and packaged to with stand rough handling during ocean shipment and inland journey.

6.4 Item shall be properly tagged and packaged separately to facilitate easy identification.

6.5 Items shall be wrapped and packaged in such-a-way that they can be preserved in original as new condition.

7.0 DOCUMENTATION

7.1 All documents shall be furnished in English language only.

7.2 At the time of bidding, bidder shall submit following documents:

i) Reference list of previous supply for similar item, giving following details:

a) Name of the customer.
b) Specification of the item i.e., size and pressure & temperature rating.
c) Service
d) uantity
e) ear of supply

ii) Test procedure and typical certificates to be submitted as per clause 5.3 and 5.4 of this specification.

iii) Manufacturer uality Control Plan and sampling plan.

iv) Copy of ISO:9000 certification for supplier/ manufacturer.

7.3 Following test certificates shall be furnished along-with shipment.

i) Test certificate of chemical, mechanical testing.
ii) Manufacturers standard shop inspection& test report.
iii) The procedure and certificates to be submitted as per the requirements of clause 5.4 of this specification.

8.0 GUARANTEE

8.1 Manufacturer shall guarantee that the design, materials, manufacturing and testing of fittings comply with the requirement of this specification and applicable codes and standards. Manufacturer shall replace all fittings which should result defective or fail during field pressure testing or fail to perform satisfactorily due to inadequate engineering, substandard material and workmanship.

8.2 The manufacturer shall guarantee against any defect, failure or malfunctioning occurring during 12 months from the date of commissioning or 24 months from the date of supply whichever is earlier.

3.0 TECHNICAL SPECIFICATION

FOR

SS BALL VALVES FOR

CNG REFILLING STATIONS

(TS NO. MEC/TS/05/25/048)

MECON LIMITED

(AGovt.ofIndiaUndertaking)

15th Floor,SCOPEMinar,NorthTowerLaxmiNagarDistrictCentre,

DELHI 110092

Contents of TS No. MEC/TS/05/25/048

PREPARED BY	CHECKED BY	APPROVED BY
GURDEEP SINGH	V.K. AGRAWAL	A.K. OHRI

1.0 SCOPE OF WORK

1.1 The scope of this specification include design, manufacture/ supply, inspection/testing/ marking/packaging/handling and despatch of SS Ball Valves as per relevant codes.

1.2 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.

2.0 CODES & STANDARD

Items	Applicable Codes and Standards
Valves	MSS-SP-99

3.0 PRECEDENCE

3.1 In case of any conflict between this job specification and other document, the following order of precedence shall apply:

3.1.1 Job Specification.

3.1.2 International Standards/ Codes Applicable.

4.0 DEVIATION

Deviations if any required by Vendor shall be separately furnished against each clause giving reasoning for each deviation. Vendor to note that except the deviations furnished by them, Vendor's offer shall be deemed to be in total conformity with the enquiry specifications.

5.0 MATERIALS

5.1 The valve body shall be made out of material conforming to ASTM A479

Type316.

5.2 Material of construction of ball shall conform to ASTM A276 Type 316.

5.3 Material of construction of seat springs shall be Alloy X-750.

6.0 DESIGN & MANUFACTURE

6.1 All ball valves shall be designed in conformance with the requirements of ASMEB31.3, MSS-SP-99and other applicable code and standards. Area Classification applicable for all items shall be Class-1, Division-1, Group-D as per NEC or one-1Group-IIA/ IIB as per IS/ IEC specification or equivalent specification. All fittings shall be designed so that all parts/ components meet the requirements for the specified area classification.

6.2 Valves shall be rated for a maximum working pressure of 5000 psig and shall be capable of operation between a temperature range of (-40) to 250 F.

6.3 Valves shall have spring loaded PEEK seats allowing seal-ability over the full pressure range at any port and low operating torque over the full range of pressures and temperatures.

6.4 Elastomeric seals, which require no packing adjustment, shall be used.

6.5 Valves stem shall be of bottom loaded and blow out proof design.

6.6 Ball shall be blow out proof and trunnion mounted.

6.7 Valves shall have positive wrench/ handle stops, Phenolic black wrench/ handle shall be provided. Wrench/ handle shall indicate the direction to flow. In the case of three way valves the stem shall also provide the visual indication of flow direction if the handle is removed.

7.0 INSPECTION AND TESTING

7.1 The valve manufacturer shall submit typical type test reports for the following test carrier out on similar valves:-

i) Hydrostatic seat leak test shall be carried out with de-ionized water. There shall be no detectable set leakage at 1.1 times the rated pressure of the valve.

ii) Gas pressure test for seat and shell shall be carried out with nitrogen at 1000 psig. There shall be no detectable external leakage. Maximum allowable seat leakage shall be 0.1 atm-cc/min.

8.0 **OTHER REQUIREMENTS**

8.1 Manufacturer should confirm that valves are approved by Rail Road Commission of Texas, LP Gas Division under regulation for compressed natural gas or ANSI/ AGA NGV 3.1 1995, CAN/ C GA-12.3-M95 Fuel Systems Components for Natural Gas Powered Vehicles by Canadian Standard Association .

8.2 Spares and Accessories

i) If required, manufacturer shall furnish a list of recommended spares and accessories for valves required during start up and commissioning.

ii) If required, manufacturer shall furnish a list of recommended spares and accessories required for two years of manual operation and maintenance of valves.

iii) Manufacturer shall quote for spares and accessories as per the material requisition.

9.0 **TEST REPORTS & CERTIFICATES**

9.1 The manufacturer shall supply material compliance certificates.

9.2 The valve manufacturer shall provide test procedure and valve inspection and test report for type tests carried out on similar valves as per the requirements of clause 7.0.

10.0 **MARKING, PACKING & SHIPMENT**

10.1 Heat code shall be marked on valve body to facilitate tractability.

10.2 All the items shall be suitably wrapped and packaged to with stand rough handling during ocean shipment and inland journey.

10.3 Each item shall be properly tagged and packaged separately to facilitate easy identification.

10.4 All items shall be wrapped and packaged in such-a-way that they can be preserved in original as new condition.

11.0 **DOCUMENTATION**

11.1 All documents shall be furnished in English language only.

11.2 At the time of bidding, bidder shall submit following documents:

i) Reference list of previous supply for similar item, giving following details:

a) Name of the customer.
b) Specification of the item i.e., size and pressure & temperature rating.
c) Service
d) uantity
e) ear of supply

ii) Test procedure and typical certificates to be submitted as per clause 5.3 and 5.4 of this specification.

iii) Copy of ISO: 9000 certification for supplier/ manufacturer.

iv) Manufacturer uality Control Plan and sampling plan.

v) Technical descriptive catalogue of manufacturer.

vi) General arrangement/ assembly drawing of valve showing all features.

vii) Sectional drawing showing major parts with reference number and material specification.

11.3 Prior to shipment, manufacturer shall submit following test certificates and documents.

i) Test certificate of chemical, mechanical testing.
ii) Manufacturers standard shop inspection test.
iii) Manufacturers standard shop inspection and test reports.
iv) The procedure and certificates to be submitted as per the requirements of clause 8.0 of this specification.
v) Manual for installation, erection, maintenance and operating instructions including a list of recommended spares for valves.

12.0 **GUARANTEE**

12.1 Manufacturer shall guarantee that the design, materials, manufacturing and testing of fittings comply with the requirement of this specification and applicable codes and standards. Manufacturer shall replace all fittings which should result defective or fail during field pressure testing or fail to perform satisfactorily due to inadequate engineering, substandard material and workmanship.

12.2 The manufacturer shall guarantee against any defect, failure or malfunctioning occurring during 12 months from the date of commissioning or 24 months from the date of supply whichever is earlier.

PURBA BHARTI GAS PVT. LTD.	**CONSTRUCTION OF CNG STATIONS (CGS, MOTHER STATION, ON-LINE STATION DBS AT CACHAR, HAILAKANDI KARIMGAN GA AND KAMRUP KAMRUP METROPOLITAN GA FOR M/S PBGPL**	MECON LIMITED

4.0 TECHNICAL SPECIFICATION
FOR
THEMOPLASTIC HOSES

(TS NO. MEC/TS/05/62/SO49)

MECON LIMITED

(A Govt. of India Undertaking)

15th Floor, SCOPE Minar, North Tower

LaxmiNagar District Centre,

DELHI 110092

CONTENT

1.0 SCOPEOFWORK

1.1 The scope of this specification includes design, engineering, manufacturing, inspection/ testing, marking, packaging, handling and supply / dispatch of Conductive Core Thermoplastic Flexible Hoses as per relevant codes.

1.2 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.

2.0 CODES STANDARD

Sr.No.	Description
1	3/8”IDHOSE HoseLength:1.5meterwithBreakawaycoupling HoseendtoendConnections:3/8”ODTubeadaptorwithnut &ferrule.
1A	Breakawaycouplingfor3/8”IDHOSE Material-SS316 RatedPressure– 5000PSI@70Deg.FMin. Flowrate–2000SCFM Temperature–0Deg.Fto400Deg.F

Hose should conform to NFPA 52, AGA1-93 and ANSI / CSA NGV 4.2-2014 /CSA12.52-2014
andendconnectionshallconformtoASTMA276;ASTMA479,ASMESA479.

3.0 PRECEDENCE

Incaseofanyconflictbetweenthisjobspecificationandotherdocument,moststringent shallapply.

4.0 DEVIATION

Deviations,ifany,requiredbyVendorshallbeseparatelyfurnishedagainsteachclause givingreasoning foreachdeviation.Vendortonotthatexceptthedeviations furnished by them, Vendor's offer shall be deemed to be in total conformity with the enquiry specifications.

5.0 SPECIFICATIONS

a) Thecorematerialshallbenon-metallic,flexibleincompleteconformitywiththe relevantstandardasmentionedabove.

b) ElectricalconductivityshallcomplywithAGA1-93

c) End connectionsshall be316stainless steelmaterialsconformingtorelevantdesign standardasspecifiedabove.

6.0 DESIGN MANUFACTURE

I. Hosesshallbedesignedinconformancewith therequirements52,AGA1-93andANSI / CSANGV4.2-2014/CSA12.52-2014 andotherapplicablecodesandstandards.Area classificationapplicableforallitemsshallbeClass-1,Division-1,Group-DasperNEC orZone-1Group-HA/HBasperIS/IECspecificationorequivalentspecification. All fittingsshallbe designedso thatallparts/components meettherequirements forthe specifiedareaclassification.

II. End connectionsshall bedesigned inconformancewith therequirementofASTM A276;ASTMA479,ASMESA479.

III. Thewholeassemblyshallberatedforaworkingpressureof5000psiandshallbe ratedfortemperaturerangeof(-40)°to250°F.

7.0 INSPECTION AND TESTING

The manufacturer shall submit typical type test reports for the following test carried out:

I. Hydrostatic test shall be carried out with de-ionized water. There shall be no detectable leakage at 1.5 times the rated pressure.
II. Electrical conductivity test shall be carried out.
III. Mechanical properties as a result of the test conducted and
IV. Chemical analysis report

7.1 TEST REPORTS CERTIFICATES

I. The manufacturer shall supply material compliance certificates.
II. Chemical Analysis report
III. Mechanical properties test report
IV. Hydrostatic test report
V. Electrical conductivity test report
VI. Warranty certificate

8.0 MARKING, PACKING SHIPMENT

8.1 Heat code shall be marked to facilitate tractability.
8.2 All theitems shallbe suitably wrapped and packagedto withstand rough handling during ocean shipment and inland journey.
8.3 Each item shall be properly tagged and package separately to facilitate easy identification.
8.4 All items shall be wrapped and packaged in such-a-way that they can be preserved in original as new condition.
8.5 Packing note shall carry easily identifiable name or code of the physical item

9.0 DOCUMENTATION

9.1 All documents shall be furnished in English language only.
9.2 At the time of bidding, bidder shall submit following documents:

I. Reference list of previous supply for similar item, giving following details:
   a) Name of the customer.
   b) Specification of the item i.e., size and pressure & temperature rating.
   c) Service
   d) Quantity
   e) Year of supply

II. Test procedure and typical certificates to be submitted as per clause 5.3, 5.4 and 5.5 of this specification.

III. Copy of regulatory compliance document/certification for similar product supplied earlier.

IV. Manufacturer Quality Control Plan and sampling plan.

V. Technical descriptive catalogue of manufacturer.

VI. General arrangement/ assembly drawing showing all features.

VII. Sectional drawing showing major parts with reference number and material specification.

1.1 Prior to shipment, manufacturer shall submit one set of all the documents and test certificates as specified above. And one set of the same documents and certificates along with the material in addition to the following documents:

i. Manual for installation, erection, maintenance and operating instructions including a list of recommended spares.

SECTION- A-2 SS TUBE LAYING AND TESTING

CONTENTS

1.0 SCOPE OF WORK AND TECHNICAL SPECIFICATION

1.1 LAYING OF SS TUBE

Laying, testing and commissioning of SS tubes and fittings complete with all supports. The MS Angle and U-clamps (galvanized) / other fixing arrangement shall be procured and installed by the contractor. Payment shall be at the rate for the work set out in the agreed Schedule of Rates.

Contractor shall engage OWNER/MECON approved sub-contractor for this speciali ed work. The list of parties are enclosed in Annexure-I.

1.2 SCOPE OF WORKS FOR LAYING, TESTING COMMISSIONING OF SSTUBING

Generally, the following shall constitute the Contractor's scope of work but not limited to as given herein:

1.2.1 SS tubes shall be clamped to the MS Angle at every 1000 mm using U-clamps (galvanized) OR P-clamps of SWAGELOK make / any other approved make / SS–308 clamps with EPDM cushion. **The practice of flattening tubes forclamping purposes shall not be permitted.**

1.2.2 MS Angle and U-clamps (galvanized) shall be procured from approved manufacturers and through a QAP including stage inspection and pre-dispatch inspection of the materials by OWNER. / MECON. (To be isolated by rubber gaskets).

1.2.3 Tubes shall be bend using tube benders only and any hot bending will be totally rejected. Tubes shall be cut using pipe cutting device. **Hot cutting is notallowed.**

1.2.4 Carrying out pneumatic testing and purging with nitrogen as per approved procedures; providing all tools, tackles, instruments, manpower and other related accessories for carrying out the testing of tubes.

1.2.5 Start-up and commissioning assistance.

1.2.6 Handing over the completed works to OWNER for their operation/ use purposes.

1.2.7 Any other work not specifically mentioned herein but required for the 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 OWNER.

2.0 INSTALLATION PROCEDURE

2.1 TUBE END PREPARATION

2.1.1 Cut the ends square with a hacksaw and a suitable guide. Tube cutters are satisfactory for most tube materials but tend to work harden stainless steel. As such proper care shall be exercised while cutting the SS tubes to avoid the hardening.

2.1.2 Burrs must be removed inside and outside for proper entry into fitting to prevent contamination and/ or restricted flow. 'Swagelok' / 'Parker' deburring tool shall be used.

2.1.3 Remove all fittings, chips, and grit before attachment of fittings.

2.2 ASSEMBLY

2.2.1 Tube line fabrication must be accurate so that the tube end easily enters the fitting in proper alignment. Do not force an improperly fitted tube line into the fittings.

2.2.2 Ensure that the tube end is bottomed against the shoulder in the fitting body. This is necessary to prevent movement of the tube while the nut forces the ferrule to grip the tube and to seal through any imperfections that may exist on the outside tube surface.

2.2.3 Never permit the fitting body to rotate during tube end make-up, use two wrenches. Assemble port connectors to components first and hold with a wrench while making up the tube joint. All types of union bodies must be held while each of the tube ends is made up.

2.2.4 Never attempt to make up by torque.

2.2.5 Always turn the nut the prescribed amount regardless of torque required. Fitting end plugs required only 1- ¼ turn from finger tight make up in all sizes.

3.0 REMAKE OF FITTINGS

A disassembled joint can be remade, simply by retightening the nut to the position of the original make up. For maximum number of remakes, mark the fitting and nut before disassembly. Before retightening, make sure the assembly has been inserted into the fitting until the ferrule(s) seats in the fitting. Retighten the nut by hand. Rotate the nut with a wrench to the original position as indicated by the previous marks lining up. (A noticeable increase in mechanical resistance will be felt indicating the ferrule is being re-sprung into sealing position.) Then snug the nut 1/12 turn (1/2 hex flat) past the original position.

4.0 REFERENCE SPECIFICATION, CODES AND STANDARDS

The Contractor shall carry out the work in accordance with this specification, MECON's Engineering Standards, ASME B 31.8 - Gas Transmission and Distribution Piping Systems, Oil Industry 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.

5.0 SCOPE OF SUPPLY

5.1 SUPPLIED BY THE CONTRACTOR AT HIS OWN COST AS PART OF THISSPECIFICATION

The procurement and supply of MS Angle with U- clamps at the appropriate time of all the materials and consumables except for the materials specifically enlisted under Owner's scope of supply, shall be entirely the Contractor's responsibility and its rates of execution shall be inclusive for all these items, as follows but not limited to these:

i) Bolts and nuts for supports, U-bolts with nuts, P-clamps for tubes, anchor bolts of various sizes for fixing to concrete structure.
ii) Bitumen paints primer and solvents.
iii) All material for minor civil works like grouting etc.,
iv) Minor structural steel for fabrication of tube/ tray supports like MS plates, GI plates, flats, pipe etc.,
v) Pumps, compressor, Corrosion Inhibitor for water used for hydrostatic testing, including water for testing, inert gas for purging.
vi) All items not expressly mentioned in the Contract but which are necessary for the satisfactory completion and performance of the Work under this Contract.

Note: Samples of all the consumables items / test certificates required to be approved by EIC.

6.0 SCRAP AND EXCESS MATERIAL

Every month the Contractor shall submit an account for all the materials issued to him by the owner in the standard Performa prescribed for this purpose by the Engineer-in-charge. On completion of the work, the Contractor shall submit material appropriation statements for all the materials issued by the Owner in the standard Performa. The following scrap allowances are permissible.

ITEM	UNACCOUNTABLE	SCRAP
Tube	1 %	1% (Less than 0.3 m)
Valves	0 %	0%
Ferrule Fittings	0 %	0 %

All excess materials and scrap shall be returned after duly accounting for, to theOWNER stores. Where materials are to be weighed before return, the Contractor shall be responsible for making necessary arrangements for weighing etc. The contractor shall not use scrap sections obtained during the course of construction for fabrication of temporary supports or other items without prior written permission of Engineer-in-Charge.

If the Contractor fails to return the surplus material aforesaid, the Owner will charge the Contractor for such unreturned material at penal rates, which will be deducted from whatever

amount is due to the Contractor. In case any material issued by the Owner deteriorates during storage by the Contractor, new material will be issued to him if available at penal rates, but delaying procuring such materials will be at the Contractor's account only. ***Any damaged valve andferrule fittings should not be used and shall be returned to OWNER stores.***

SECTION B ERECTION OF MECHANICAL EQUIPMENT

CONTENTS

LOADING, UNLOADING, TRANSPORTATION ERECTIONOF MECHANICALEQUIPMENT

1.0 SCOPE OF WORK

1.1 Generally the following shall constitute the Contractor's scope of work but not limited to as given herein:

i) Receiving of material from stores.
ii) Loading of material/ equipment on a trailer / truck from stores. Safe transportation to various sites.
iii) Unloading, placement and alignment on foundation -on ground or aboveground + 4.5 m at roof top (cascade only).
iv) Transit Insurance of equipment from stores to site.
v) All equipment transported shall be securely boarded and transported without causing any damage to equipment. Any damage caused duringloading, transportation & unloading shall be recoverable from the contractor
vi) All the equipment shall be leaktested after erection as per instruction of engineer in charge and standard practice.

All excess, unutilized or defective materials and scrap shall be returned after duly accounting for, to the OWNER. stores. Where materials are to be weighed before return,

2.0 Equipment weight & sizes

Sl. No.	E uipment	Si e	Weight/ Unit Approx.
1.	Cascade 4500/3000 L (water litre capacity)	5.3 M X 1.75M X 1.6M (H) approx	6.0 T

the Contractor shall be responsible for making necessary arrangements for weighing etc. The contractor shall not use scrapped or defective materials obtained during the course of construction for fabrication of temporary supports or other items without prior written permission of Engineer-in-Charge.

If the Contractor fails to return the surplus material aforesaid, the Owner will charge the Contractor for such un-returned material at penal rates, which will be deducted from whatever amount is due to the Contractor. In case any material issued by the Owner deteriorates during storage by the Contractor, new material will be issued to him if available at penal rates, but delay in procuring such materials will be at the Contractor's account only.

Contractor to arrange all equipment & tools such as cranes, winch, lifting hook etc and skilled & semiskilled manpower and consumables for erection of all the electro-mechanical equipment.

SECTION C SUPPLY, ERECTION COMMISSIONING OF MISCELLANEOUS ITEMS

CONTENTS

SUPPLY, ERECTION COMMISSIONING OF MISCELLANEOUS ITEMS

1.0 **Air Compressor (Pump)**Contractor will supply, erect at prepared location, testand commission an Air Compressor-cum-Pump with Accessories such as dispensing stand, hose, nozzle, valves, connectors etc complete with Automatic Intelligent Tyre Inflating M/C [AITIM].
Air compressor – cum- pump shall supply compressed air for all types of vehicles that visitthe station for refueling of CNG or other purposes.

Details of air compressor

Type Drive	-V belt drive
Electrical Supply	- 415V/3ph/50Hz
Discharge pressure	- 12 kg/cm2
Motor	- As per manufacturer
Make	- As per ISI Mark/standard manufacturer like Ingersoll Rand/Elgi.
Display	- Digital in both system [MKS & CGS]
Alarm	- Digital & Sound
Control	- To stop filling of air on alarm/set point.
Housing	- Steel/ Fiber glass – coated/painted in approved colors withOWNER. Logo.
Dispensing Hose	- Non –conductive.
AITIM	- PrecisionTesting Machines Pvt. Ltd, New Delhi/Instrument Research Association Pvt. Ltd, Bangaloreor any other approved make.

Note- 1.Supply shall be made against a QAP, stage & pre-dispatch inspection.

2. One-year spares shall be supplied along with those for accessories.

2.0 **Water Cooler -**Contractor will supply, erect at prepared location, test and commission a Water Cooler with Accessories such as dispensing fountain, filter, deodorizer, electronic purifier, drain tray, drain tube, drain valve, strainer, stand etc.
Water Cooler shall supply cold/ hot drinking water for drinking purposes.

Details of Water Cooler:

Compressor	-	Hermetic type
Capacity	-	40 litres/hr
Refrigerant type	-	R-22.
Electrical Supply	-	230V/Single phase/50Hz

Motor	-	Suction gas cooled/as per manufacturer
Condenser Fan	-	Propeller type
Make	-	As per ISI Mark/standard manufacturerlike USHA/ VOLTAS/ SHRIRAM
Control	-	To start/stop dispensing of water-12.7 mm BSP connection
Housing	-	SS/ Fiber glass – coated/painted in approved colors.
Dispensing	-	SS fountain &tap.

Note-

1. Supply shall be made against a QAP, stage & pre-dispatch inspection.
2. One-year spares and refrigerant shall be supplied along with those for accessories.

3.0 **Fire Fighting E uipment** Contractor will supply and erect at designated locations thefirefighting equipment. The details of the firefighting equipment are given below.

1. Supply and installation of **4.5 kg** capacity **CO2 type fire extinguishers** with steel cylinder with discharge valve and conforming to **IS 15683.** Extinguisher shall be painted with red enamel paint and hardware/ bracket required for fixing to wall.

2. Supply and installation of **9 kg** capacity dry chemical powder **(DCP)** type **fireextinguisher** with extinguishers cabinet suitable for inverted operation andfabricated from MS sheet internally protected with anticorrosive treatment and hydraulically tested. Extinguishers shall be externally painted with red enamel paint. Manufacturing code **IS 15683.**

3. Supply and installation of **75 kg** capacity trolley mounted dry chemical powder **(DCP)** type **fire extinguisher** suitable for inverted operation fabricated from MS sheet internally protected with anticorrosive treatment and hydraulically tested extinguishers externally painted with red enamel. Manufacturing code **IS 16018.**

4. Providing & installation of galvanized mild steel **fire buckets** of **9 liters**. capacity made as per **IS 2546** including supplying & fixing of **MS angle iron stand** to accommodate **4 nos.** of fire buckets and first fill with sand/water all complete as per direction of Engineer In charge (One set consisting of 4 buckets with stand).

Note: The equipment are to be purchased from the vendor list enclosed.

ANNEXURE I

LIST OF SUPPLIERS OF MA OR BOUGHT-OUT ITEMS

A. FIRE FIGHTING EQUIPMENT

Fire Extinguishers

1. Nitin Fire Protection Pvt. Ltd., Mumbai
2. Safex Fire Services, Bombay
3. Fire Safety Services, New Delhi
4. HD Fire Protect Co., Thane
5. Zenith Fire Services, Bombay
6. Steelage Industries, New Delhi
7. Atlas Firetech Pvt. Ltd., Delhi

Note: **Contractor shall select vendor/ agency from above list and clearly indicatename(s) as selected from the list, in his bid.**

B. LIST OF PARTIES FOR LAYING OF SS TUBING

1. M/s Aadhar Projects, New Delhi – (Contact No. 8809724365)
2. M/s Khurana Engineering Works, New Delhi – (Contact No. 9810046779)
3. M/s Eco Technologies, New Delhi – (Contact No. 9313901100)
4. M/s Mass Gas Air Systems Pvt. Ltd., Delhi – (Contact No. 9810214452)
5. M/s Vaishnow National Corporation, MayurVihar, Delhi – (Contact No. 9311214431)
6. M/s Pervious Exim India Pvt. Ltd., New Delhi- – (Contact No. 8368018797)
   E-Mail: ivecogasxinc@gmail.com

List of parties to be provided by bidder for approval from Client / MECON

C. VENDOR LIST FOR SS FITTINGS, VALVES THERMOPLASTIC HOSES

1. **M/s Parker Hannifin India Pvt. Ltd.,**
   Plot EL-26, MIDC, TTC, Industrial Area,
   Mahape, Navi Mumbai – 400 701 Tel. No. :
   022-55907081/ 82 Fax No. : 022-55901080
   E-mail: parker@vsnl.com / aoke@parker.com

   Thru Delhi Representative:
   M/s Parker Hannifin India Pvt. Ltd., C-105, Mahindra Apartments, VikasPuri, New Delhi
   Tel. No.: 011-32591978; Fax No.: 011-25526858,25152718

   Thru Representative:

M/s Super Technical (India) Pvt. Ltd.
501, Samarpan Complex, New Link Road, Chakala,
Andheri (E), Mumbai- 400099
Ph: 022- 2832 3760/ 61, Fax: 2832 3759,
E-mail: sales@supertechnical.in

2. **M/s Swagelok, Singapore**

Thru Delhi Representative:

M/s Delhi Fluid System Components Pvt. Ltd.,

F-7B, Okhla Industrial Area Phase-I, New Delhi - 110 020
Tel. No.: 011-51614144-47 Fax No: 011-51614148

Thru Bangalore Representative:

M/s Bangalore Fluid System Components Pvt. Ltd.,

#1, Doddanakkundi Industrial area, Mahadevapura Post, Bangalore- 560048
Tel No., 080-42669100
Mob- 91 9686700138
E-mail: bangalore@swagelok.com

3. **M/s Circor Instruments Ltd. U.K.**

Thru Indian representative

M/s Oiltech Consultancy Services,
11, VeenaBeena, Guru Nanak Road, Bandra (W),
Mumbai – 400 050 (India)
Tel. No. : 022-56936500, 56964146 (D) Fax No. : 022-26514429/26405644
E-mail:ashisn@oiltechconsultancy.com;oiltech@vsnl.com

4. **M/s Flow Line Instrumentation Pvt. Ltd.**

Vazhakala Complex, Next to # 460
4th Phase, Peenya Industrial Area
Bangalore 560 058
Telephone +91 (0) 80-4117-1802
Fax +91 (0) 80-4117-1801
E-mailsales@flowline.co.in

5. **M/s Bangalore Fluid Systems Components (P) Ltd.,**

(M/s Swagelok)
C-011 D, Super Mart – 1

Commercial Complex,
DLF City, Phase – IV
Gurgoan - 122002
Ph No.: 0124 – 4045631/2/3
Fax No.: 0124 – 404563
E-mail:swagelokdel@gmail.com

6. **M/s SSP .U.S.A**

Thru Indian representative
M/s Oiltech Consultancy Services,
11, VeenaBeena, Guru Nanak Road, Bandra (w), Mumbai- 400 050(India)
Tel.No.:022-56936500, 56964146(D), Fax No.:022-26514429/ 26405644
E-mail:ashisn@oiltechconsultancy.com ; oiltech@vsnl.com

7. **M/s D-lokCorp., South Korea SS fittings and Valves**

Thru Indian representative
Metco Marketing (India) Pvt. Ltd.
104, Niraj Industrial Estate, Off Mahakali Caves Road,
Andheri (East), Mumbai-400093, India
Tel: + 91 22 4073 8484, Fax: + 91 226693 8485
E-mail:dipen@metcoindia@gmail.com
Homepage: www.metcoindia.com

Techsol Engineers

No. 94, 4th Floor, 2nd Cross, MLA Layout, R. T. Nagar, Bangalore, Karnataka- 560032
Tel: + 91 8861200084 87, Fax: + 91 80 23535285
E-mail:contact@techsolengineers.com

8. **M/s Hylok, South Korea for SS fittings and Valves**
Thru Indian representative
M/s SSSP Technologies (Hy-Lok)
130, Sahid Dinesh Gupta Road, (29, Sahid Dinesh Gupta Road), Behala, Jadu Colony,
Kolkata- 700 034, India
Mob- 91 98306 88788
E-mail:spban1958@gmail.com,
phalgunibanerjee943@yahoo.in

D. VENDOR LIST FOR SS TUBE

1. **M/s Sandvik Steel Asia Pvt. Ltd.**
Steel Division, Mumbai-Pune Road, Dapodi, Pune-4110212, India
Tel. No. : 020-27104562, 27104568 Fax No.: 020-27145022, 27145339
E-mail:genny.dcruze@sandvik.com; siddarth.mittal@sandvik.com

2. **M/s Ratnamani Metals Tubes Ltd.**
17/18, Rajmugat society, Naranpura Char Rasta, Ankur Road, Naranpura, Ahemdabad-380013
Tel. No.: 079-7415501-4

Fax No.: 079-7480999
E-mail: ratnamani@ratnamani.com

3. **M/s Mitsubishi Corporation**
(New Name M/s Metal One Corporation)
Vijya Building,2nd floor,17, Barakhamba Road New Delhi-110001
Tel. No. : 011-23327317, 23322211 Fax No.: 011-23738680
E-mail: gagan.arora@mitsubishicorp

4. **M/s FAE S.A**
Centro AtomicoEzeiza,
Pdo.de Ezeiza (1804) Prov. De Buenos Aires, Argentina
Tel. No. : (54-11)4480-9155/9028 Fax No.: (54-11)4480-0604
E-mail: fae@conuar.com.ar

Thru India Representative
Shubh Consulting (Oil & Gas Division) C-65, Greater Kailash Part-I
New Delhi – 110 048 (India)
Tel. No. : 011-26425817/26431499, Fax No.: 011-26230361, 25729329
E-mail: shubhcons@hotmail.com

5. **M/s Sumitomo Corporation India Pvt. Ltd.,**
4th Floor, DLF Centre, Sansad Marg,
New Delhi, Fax No. : 011-23737111

6. **M/s Parker HannifinIndia Pvt. Ltd.**
Plot EL-26, MIDC, TTC,Industrial Area, Mahape,Navi Mumbai – 400 701
Tel. No.: 022-55907081/ 82Fax No. : 022-55901080
E-mail:parker@vsnl.com /aoke@parker.com

Thru Delhi
M/s ParkerHannifin India Pvt. Ltd., C-105, MahindraApartments, VikasPuri, New Delhi
Tel. No.: 011-32591978 FaxNo.: 011-25526858,25152718

7. **M/s Tubacex India,**
402-A, Platina-G block, Bandra-kurla complex, Bandra (E).
Mumbai-400 051, Ph No. 022-40015 300, 022-40015 350
E-mail: sales@tubacexindia.com

Note-1

For procuring bought out items from vendors other than those listed above, the same may be acceptable subject to prior approval of Consultant/owner to the following: -

a) The vendor/ supplier of bought out item(s) is a regular and reputed manufacturer/ supplier of said item(s) for intended services and the sizes being offered is in their regular manufacturing/ supply range. Further, the bidder has to certify that the item(s) has/have been regularly used by them in all the packages for the last two years and they are working satisfactorily.

b) The vendor/ supplier should not be in the Holiday list of Client / Any other PSU.

Note-2

For any other item(s) for which the vendor list is not provided, bidders can supply those item(s) from reputed vendors/ suppliers who have earlier supplied same item(s) for the intended services in earlier projects and the item(s) offered is in their regular manufacturing/ supply range.

The bidder is not required to enclose documentary evidences (PO copies, Inspection Certificate etc.) along with their offer, however in case of successful bidder; these documents shall be required to be submitted by them

Rev. : 0
Edition : 1

SPECIFICATION

FOR

MAINLINE CONSTRUCTION (ONSHORE)

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

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

1.0 SCOPE

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

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

- Clearing, grubbing and grading of Right-of-way
- Construction of all temporary facilities required in connection with the WOR S
- 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 aux iliary 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 COMPAN 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 se rvices and labour, inclusive of supervision thereof, all materi als, excluding the materials indicated as COMPAN Supplied materials in the CONT RACT, equipment, appliances or othe r 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 fo r the stability and safety of all operations and methods involved in the WOR .

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

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

2.0 REFERENCE CODES, STANDARDS AND SPECIFICATIONS

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

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

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

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

- the words Shall and Must are mandatory.

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

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

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

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

CONTRACTOR shall not commence work on such crossings before having obtained approval from the authorities and land owners concerned to the satisfaction of COMPANY. The crossings shall be installed to meet at all times the requirements and conditions of the permit issued by the authorities concerned. In the absence of any specific requirements by authorities, CONTRACTOR shall comply with COMPANY'S instructions.

The right of ingress and egress to the ROW shall be limited to points where such ROW intersects public roads, Arrangements for other access required by the CONTRACTOR shall be made by him at his own cost and responsibility, and for such access, the conditions of this specifications shall also apply.

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

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

3.1.1 General

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

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

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

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

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

3.1.1.5 To prevent electrical voltage in a no n-buried section of the pipeline from rising to dangerous levels, the length of the pipeline section which has b een welded together before burial must not exceed the length at which the max. admissible voltage may be induced. This length may be calculated using an approved calculation method.

3.1.1.6 Before a p ipeline section is lo wered into the trench the structure s earth electrodes indicated in the drawings or determined with calculatio n method must have been installed and connected both to the pipeline section already buried and t o the section which is about to be buried. The electrical connections which serv e the purpose of preventing dangerous voltages must have a min. area of $35mm^{2.}$

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

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

3.1.1.8 Personnel doing work inside the area o f influence o f the high voltage system must wear electrically insulating foot-wear (e.g. rubber kneeboots) and we ar 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 t han 50m fro m the centre of the high voltage system, the regulations below must be complied with in addition to th e 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 hoist ing equipments from approaching high voltage lines to within any of the following distances.

This distance depends on the voltage carried. For individual c onnections the distance must be :

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

The measures taken may be as follows :

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

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

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

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

The driver must not leave his vehicle unitl be has managed to leave the dangerous area, or a lternatively, 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 p ossible, while t he 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 ot her arrangements with the land owner and/ or tenant for using extra land. Variation in this width caused by local condit ions or installation of a ssociated pipeline facilities or existing pipelines will be identified in th e field or instructed to the CONTRACTOR by COMPAN .

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 COMPAN s opinion, it is considered essential to ensure safety and non-interference, especially in areas like grasing lands, villages etc.

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

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

4.4 **Row Clearing and Grading**

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

4.4.2 All grubbed stumps, timber, bush undergrowth and root cut or removed from the Right-of-way shall be disposed of in a manner and method satisfactory to COMPAN , land-owner and/ or tenant, and Government Authorities having jurisdication and as soon as practical after the initial removal. In no case, it shall be left to interfere with the grading and laying operations. Whenever stumps are grubbed and a hole is left in the ground, CONTRACTOR shall back-fill the hole and compact it to prevent water from gathering in it and creating a big hole.

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

4.4.4 CONTRACTOR shall grade sharp points or low points, without prejudice to section 6.0 of this specification, to allow the pipe to be bent and laid within the limits set forth in these specifications and drawings as regards the minimum elastic curvature permitted, and shall drill, blast or excavate any rock or other material which cannot be graded off with ordinary grading equipment in order to make an adequate working space along the pipeline.

4.4.5 No temporary or permanent deposit of any kind of material resulting from clearing and grading shall be permitted in the approach to roads, railways, streams, ditches, drainage ditches and any other position which may hinder the passage and/or the natural water drainage.

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

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

4.4.8 In the case of Right-of-Way clearing and grading on hillside or in steep slope areas, proper barriers or other structures shall be provided to prevent the removed materials from rolling downhill. The Right-of-Way crossfall shall not exceed 10 .

4.4.9 Wherever the pipeline Right-of-Way runs across plantations, alongside farmyards, built up areas, groups of trees, horticultural spreads, gardens, grass-fields, ditches, roads, paths, railways or any other area with restrictions of some kind, CONTRACTOR shall grade only the minimum area required for digging and constructing the pipeline. In the said places, CONTRACTOR shall carry out the works in such a way that damage done from the pipeline construction is kept to a minimum.

4.5 **Provision of Detours**

CONTRACTOR shall do all necessary grading and bridging at road, water and other crossings and at other locations where needed, to permit the passage of its men and equipment. It is understood that the CONTRACTOR has recognised such restricctive features of the Right-of-Way and shall provide the necessary detoors and execute the works without any extra cost to COMPAN . 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 COMPAN a copy of such approval.

4.6 **Steep and Rocky Terrain**

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

In rough or steep terrain, CONTRACT OR may have to grade access roads and temporary bypass roads for its own use. Wh ere 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 COMPAN , 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, we dging or by other recognised means of quarrying solid rocks.

Where use o f explosives is req uired in co nnection with Right-of-Way grading and trenching, CONTRACTOR shall comply fully with requirements of the use of explosives as provided under clause 6.3 of this Specification.

4.7 **Off Right-of-Way Damages**

CONTRACTOR shall confine all its operations within limit s of the Right-of-Way. Any damage to proper ty outside ROW sh all be restored or se ttled to the CONTRACTOR s account.

CONTRACTOR shall promptly settle all o ff Right-of-Way damage claims. Should CONTRACTOR fail to do so, COMPAN shall give written notice to CONTRACTOR that if CONTRACTOR does not settle such claims within seven days after such notice, COMPAN shall have the authority to se ttle claims from the account of the CONTRACTOR.

5.0 HANDLING, HAULING, STRINGING AND STORING OF MATERIALS.

5.1 **General**

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

CONTRACTOR shall reimb urse the COMPAN for the cost of replacement of all COMPAN supplied materials damaged during the period in which such materials are in the custody of the CONTRACT OR. It shall be CONTRACTOR s responsibility to unpack any packing for the materials supplied by COMPAN .

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 COMPAN .

CONTRACTOR shall receiv e and take over against requisition, line pipe from the COMPAN s designated place(s) of delivery as de fined in the CONTRACT. CONTRACTOR shall perform visual inspection of the bare pipes and c oating of the corrosion coated pipes, as t he case may be, in the presence of COMPAN and all damages shall be recorded. In the case of corrosion coated pipes CONTRACTOR at his option may c arry out holiday de tection at a prescribed set voltage and record such holidays, in t he presence of COMPAN , 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 lay ing the pipeline shall be carried out by the CONTRACTOR at no extra cost to COMPAN . The CONTRACTOR shall be ent itled 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 damage s after taking over the delivery of the materials shall be to the CONTRACTOR S cost. In case of delay in handing ov er of COMPAN supplied material, CONTRACTOR shall be fully responsible for stopping and rearranging mean s of transportation at no extra cost to the COMPAN .

5.2 **Handling and Hauling of Line Pipe**

5.2.1 **Bare Pipe**

CONTRACTOR shall unload, load, stockpile an d transport the bare pipes using suitable means and in a manner t o avoid denting, flattening, or othe r damage to pipes. Pipe shall not be allowed to drop or strike objects which will da mage the pipe but shall be lifted or lowered from one leve l to another by suitable eq uipment. Lifting hooks when used, shall be equipped with a plate curved to fit the curvature of the pipe. In loading pipe on truc ks each length shall be lowered to position without dropping and e ach succeeding length shall rest on special supports on the tr uck and shall be separated from the adjacent pipes. After loading, suitable chains and padding shall be used to tie the load securely to each bols ter. Pipes, when stock piled, shall be placed on suitable skids to keep them clear o f the ground and flood water. The CONTRACTOR shall provide all necessary timber or other materials required for th e stock-piling. While stacking, the number of allowable layers of bare pipes shall be calculated as per API RP5L1 and shall be agreed with COMPAN . The stacks must be properly secured against sliding and shall consist of pipes of the same d iameter and wall thickness. Adjacent stacks of pipes hav ing 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 COMPAN), particularly those which are dented, buckled, or othe rwise permanently deformed, must be stacked separately and may be transported to th e sites only when these defects have been repaired or eliminated.

5.2.2 **Corrosion Coated Pipes**

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

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

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

During handling, suitable handling equipmen t with prope r length of booms shall be used. Fork lifts may be used provided that the arms o f the fork lift are co vered by suitable pads pre ferably rubber. Before lifting operations it is esse ntial to ensure that the pipe surface is free from foreign mat erial 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 sh all be stacked completely clear from the ground so that the bottom row of pipe s remain free from any surface water. The pipes shall st acked at a slope so that driving rain does not collect inside the pipe.

The coated pipes at all times shall be st acked by placing them on ridges of sand free from stones and covered with a plast ic film or on woode n supports provide d with suitable cover. This cover can, for ex ample, consist of dry, germ free st raw with a plastic film, otherwise foam rubber may be used. The supports shall be spaced in such a manner so as t o avoid permanent bending of the pipes, particularly in case of small diameter pipes with low wa ll thickness. The pipes sha ll 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 la yers 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 me ans of spac ers suitably spaced for t his 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 pipe s shall be positioned in such a manner so as not to touch the adjacent pipes.

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

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

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

All stachions of lorries/rail wagons used for transportation shall be covered by non-abrasive material like rubber belts or equivalent. Care sha ll be exerclsed to prope rly cover the top of the stanchions and convex portions such as reinfo rcement o f the truck/rail wagon only, rivets etc. to prevent damage to the coated surface.

5.3 **Stringing of Pipe**

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

The stringing of the pipe on the ROW shall be done in such a manner so as to cause the least interference with the normal use of the land crossed and to avoid damage to and interference with the pipes. The sequence of pipes must be interrupted at suitable intervals, spaced to coincide with passages, roads, railwys , water crossings as well as at other places if requested by landowner / tenants to permit use of land.

In case line pipe supply is by diffe rent manufacturers s, CONTRACTOR shall string all line pipes of one manufacturer before commencing the stringing of line pipes of another manufacturer.

When parallel pipelines ar e being constructed, bumping against and c ontact with the strung sections of pipe shall be avoided, whether the stringing of the pipes for the individual lines is carried separately or simultaneously.

The pipe lengths shall be properly spaced in order to make easier the handling during the welding phase.

It shall be the responsibility of the CONTRACTOR to see that pipe is strung as per the approved drawings for the proper placement of pipe by size, thickness, grade and other specifications. Any additional handling of pipes due to failure to comply with the requirements shall be at the CONTRACTOR's expense.

5.4 Repair of Damaged pipes

After the pipes have been strung along the ROW, they shall be inspected by the CONTRACTOR and by the COMPANY. All defective pipe ends shall have to be repaired as per the directions of the COMPANY or as per the requirements of this specification.

5.5 **Materials other than linepipe**

CONTRACTOR shall receive and take over against requisition all COMPANY supplied materials from COMPANY's designated place(s) of delivery as defined in the CONTRACT. CONTRACTOR shall perform visual inspection and defects, if any noted, shall be recorded separately. The CONTRACTOR shall be entitled to extra compensation for repair and rectification of such defects at the rates set forth in the CONTRACT.

The CONTRACTOR shall perform the necessary loading, unloading, hauling from points designated by the COMPANY and storing, if necessary, of all materials. The CONTRACTOR shall exercise care in handling, storing and distribution of materials in order to avoid damage and deterioration of these materials and prevent their theft or loss.

Materials excluding line pipe shall be stored in sheltered storages. Such materials shall not be strung on the Right-of-Way but shall be transported in covered conveyances for use only at the time of installation.

CONTRACTOR shall ensure that all valves and whenever applicable, other materials are fitted with suitable end covers of the type approved by COMPANY. Materials with worked surfaces such as flanges, pipe fittings, etc. must be stacked and handled so as to avoid contact with the ground or with substances that could damage them.

The manufacturer's instructions regarding temperature and procedure for storing materials which are subject to alteration of the original properties and cnaracteristics did to unsuitable storage must be strictly complied with and, if required, an adequate heat conditioning shall be provided for these materials.

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

Storage of coating materials which are susceptible to deterioration or damages especially due to humidity, exposure to high thermal cconditions or other diverse weather conditions, shall be suitably stored and protected. These materials shall be

kept permanently in store, supported above the ground in a dry place, protected against the weather and transported for use only at the time and in quantities necessary for immediate application. Deteriorated materials shall not be used and replaced with no extra cost to COMPANY.

5.6 **Identification**

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

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

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

Before a pipe length, pipe end, etc. is cut the painted serial number and stamped-in pipe number shall be transferred by CONTRACTOR in the presence of COMPANY to either side of the joint which is to be made by cutting, and the changes shall be recorded in the above mentioned list stating the (new) length. The results shall be such that all pipes, pups, etc. of diameter greater than 2" bear clear marks painted on.

CONTRACTOR shall explicitly instruct his staff that parts which cannot be identified must not be removed, except after permission by COMPANY.

As a general rule parts must be marked as described above before being moved. In no conditions may unmarked parts be incorporated into the WORK.

6.0 TRENCHING

6.1 **Location**

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

6.2 **Excavation**

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

Suitable crossing shall be provided and maintained over the open ROW where necessary, to pemit general public, property owners or his te nants to cross or move stock or equipment from one side of the trench to the other.

Care shall b e exercised to see t hat fresh so il recovered from trenching operation, intended to be used for backfilling over the laid pipe in the trench, is not mix ed 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 COMPAN 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 ne ar the ditch and the Right-of-Way in orde r to guarantee soil stability.

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

6.3 Blasting

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

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

CONTRACTOR shall obtain ne cessary permits for storage and use o f 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 COMPAN , Government authorities, land-owners, property occupants, adjacent work crew, and other concerned parties.

CONTRACTOR shall employ only such wo rkmen who are ex perienced in t he 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 COMPAN 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 COMPAN prior to commencement and performing of trial blasting.

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

6.3.2 All necessary precaution s shall be taken to prevent st ones 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 COMPAN and the peak particle velocities shall not exceed 50 mm/ sec.

COMPAN 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 COMPAN .

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 COMPAN .

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

Notes :

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

6.5 **Cutting and Removal of Paving**

Whenev er it is permitted by Authorities and / or COMPAN to open cut a paved road crossing, or where t he line is ro uted within the road pavement, CONTRACTOR shall remove the paving in accordance with the restrictions and requirements of the authorities having jurisdiction thereof or as d irected by COMPAN . 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 pi peline, backfilling sh all be immediately performed and all the area connected with the works shall be temporarily restored.

Throughout the period of execution of such works, CONTRACTOR shall provide and use warning signs, traffic lights or lanterns, barricades, fencing, watchman, etc. as required by the local authorities having jurisdiction and/ or COMPANY.

For all roads, paths, walkway etc. which are open-cut, CONTRACTOR shall provide temporary diversions properly constructed to allow the passage of normal traffic with the minimum of inconvenience and interruptions.

The paving shall be restored to its original condition after the pipeline is installed.

6.6 Extra Depth and Clearance

At points where the contour of the earth way require extra depth to fit the minimum radius of the bend as specified or to eliminate unnecessary bending of the pipe according to customary good pipeline practice, or where a deep trench is required at the approaches to crossings of roadways, railroads, rivers, streams, drainage ditches, and the like, CONTRACTOR shall excavate such additional depth as may be necessary at no extra cost to the COMPANY.

CONTRACTOR shall excavate to additional depth where the pipeline approaches and crosses other pipelines, sewers, drain pipes, water mains, telephone, conduits, and other underground structures, so that the pipeline may be laid with at least 50 centimeters free clearance from the obstacle or as specified in the drawings, or such greater minimum distances as may be required by authorities having jurisdiction.

Where the pipeline crosses areas, whose easements specifically require greater than normal depths of cover, the trench shall be excavated to extra depth in accordance with the Right-of-way Agreements or as required.

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

6.7 Grades, Bends and Finish of Trench

The trench is to be cut to a grade that will provide a firm, uniform and continuous support for the pipe. Bends shall be made in the pipe at significant changes in grade of the trench. COMPANY reserves the right to set the grade of the trench and locate the bends if so desired, in which case CONTRACTOR shall excavate, at no extra cost, the trench and bend the pipe to such a grade. COMPANY desires to reduce to a minimum the required number of cold field bends to lay the pipe to conform to the general contour of the ground and maintain a normal cover. This can be accomplished by cutting the trench slightly deeper at the crest of ridges and by gradually deepening the trench in aproaches to crossings. Such trenching work shall be done by CONTRACTOR at no extra cost to the COMPANY.

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

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

6.8 **Padding**

In all cases where rock or gravel or hard soil is encountered in the bottom of the trench, COMPAN 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 COMPAN 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 COMPAN 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 COMPAN 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 COMPAN .

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

Details of some underground utilities, as far as acquired by COMPAN , 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 underpinning 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 COMPAN and the concerned Owner/ Authority. If CONTRACTOR fails to repair in reasonable time, COMPAN reserves the right to have the repair executed at the cost of the CONTRACTOR.

6.11 Encroachments and Working near other utilities

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

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

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

6.12 Provisions for negative buoyancy to the pipe

CONTRACTOR shall check if up-floating danger is present in open trench and then shall take appropriate measures to prevent up-floating such as applying soil dams and dewatering of trench or temporary filling of water into the line (in exceptional cases).

In the case of water on the ditch bottom when the pipeline is being laid, the ditch shall be drained to the extent and for the time required to make a visual inspection of the ditch bottom. After this inspec tion, the presence of water will be allowed provided its level does not cause sliding of the ditch side s 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 hori ontal alignment by making elastic bends. CONTRACTOR may provide cold field bends, at its option for change of dire ction and c hange of slope. COMPAN at its option, may authorise fabricated bends for inst allation at points where in COMPAN 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 ac cordance with relevant job standards. The elastic bend shall be cont inuously 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 sha ll not be less than 40 tim es 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 recognised 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 :

$$\text{Wall Thinning} \quad \frac{50}{n \quad 1}$$

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) sh all normally be used for making cold field bends.

7.2.9 Cold bent pipes on site shall have the corrosion coatin g 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 disbonde d from the pipe wall during be nding 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 COMPAN approved procedures.

7.2.10 When pipelines are laid in parallel, the hori ontal 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 COMPAN . In the event the CONTRACT provides for supply of line pipe by COMPAN , the pipes required for replacement will be furnished by COMPAN , 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 ex amined internally and ex ternally to make sure that it is free from v isual 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 c anvas belt disc of proper diameter or by othe r methods approved by the COMPAN . 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 dist ance of 25 mm from e dge of be vel. The bevel shall be thoroughly inspe cted at this stage. Should laminations, spilt ends or manufac turing defects in the pipe observed, the length of the pipe cont aining such de fects shall be remove d from the line in accordance with relevant specification.

Contractor shall align and weld together the oints of pipe so a s to c onstruct 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 Comp any'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 COMPAN 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 circumfere ntial 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 COMPAN 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 recor d, provided with the pipe identification number is to be submitted to the COMPAN .

8.1.5 If due to c utting or re pairs, the pipe identification number is removed, it shall be reprinted immediately by CONTRACTOR in the presence of COMPAN . In the event, the CONTRACT provides for supply of line pipe by COMPAN , 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 damage d pipe ends by hamme ring 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 COMPAN 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 ove rstress it. Proper pipe slings approved by COMPAN shall be used. CONTRACTOR shall submit his method of skidding and skid spac ing for COMPAN s approval. A st rip of soft material shall be placed in be tween skid and pipe to protect the external coating of the pipe. The material shall be approved by the COMPAN .

8.2.2 The maximum skid spacing is not allowe d 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 co ntact with the pipe shall have a width of atleast 150mm. Pipe supports sh all be stable, so that pi pe movement will not cause the supports to move. Skids shall not be re moved under a st ring 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 days 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 COMPAN so as to prevent the entry of dirt, water, or any foreign matter into the pipeline. These covers shall not be removed until the work is to be resumed. The caps/plugs used shall be mechanical type and shall not be attached to pipe by welding or by any other means which may dent, scratch or scar the pipe.

8.4 Temporary Caps

Whenever the welded strings of pipes are left open at intervals to be tied in later after an appreciable time lag, under roads, railroads, rivers, marshy crossings, ets., temporary caps approved by COMPAN 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 offcuts, 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 CONTRACTORs 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 utili ing standard pipe cradles shall be permitted if CONTRACTOR demonstrates that pipe coating is not damage d. 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 hori ontal or vertical), the trench shall be rectified or in exceptional cases a ne w assembly shall be carried out, to be approved by COMPAN , 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 lo calised points where t he 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 th e excavation, without jerking, falling, impact or other similar stresses. In partic ular, care must be taken that the deformation caused during t he 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 COMPAN 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 th e 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, wh en weighting is not provided for the pipe.

9.1.9 CONTRACTOR shall t ake precautions immediately after lowering in t o prevent the movement of the pipe in trench.

9.1.10 In laying parallel pipelines in t he same t rench, 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 sa nd/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 sh all 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 indi cated in t he engineering specification.

9.2.2 The erection of the supports shall b e carried out taking care that the elevation and alignment is in accordance with the drawings.

In the case of metal work supports, pre fabrication and/or assembly shall t ake 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 sei ure, the defect shall be repaired or ro ller 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. Be fore 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 b e carried out in acco rdance with the provisions of clause 9.1.5.

An insulation sheet shall be installed to isolate the pipe from the support or support from the earth.

The sheet shall be hard polyethylene at least 5mm thick.

It shall extend at least to 1cm outside the saddles or clamps.

9.2.5 Moving supports, if any, shall be cent ered on their support and allow for a mov ement 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 th e COMPAN 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 re lated calculations, whenever lifting method cannot be used.
(c) Pulling device and its characteristics
(d) Method of anchoring the pulling device
(e) Characteristics of the pulling rope

(f) Braking device, if any

(g) Pipeline assembly systems.

10.0 BACK-FILLING

10.1 Backfilling shall not be done until the pipe and appurtenances have the proper fit and the pipe is following the ditch profile at the required depth that will provide the required cover and has a bed which is free of extraneous material and which allows the pipe to rest smoothly and evenly. Before any such work is done, it shall be the CONTRACTOR's responsibility to first secure the approval of COMPANY. If any backfilling is done without COMPANY's approval, COMPANY will have the right to require removal of the backfill for examination, and the cost of such uncovering and refilling shall be borne by CONTRACTOR. Backfilling of trench in water courses shall be carried out as per the relevant specifications issued for the purpose.

10.2 Backfilling shall be carried out immediately after the pipeline has been laid in the trench, inspected and approved by the COMPANY, so as to provide a natural anchorage for the pipeline, thus avoiding long exposure of coating to high temperature, damaging actions of adverse weather conditions, sliding down of trench sides and pipe movement in the trench. If immediate back filling is not possible, a covering of atleast 200mm of earth, free of rock and hard lumps shall be placed over and around the pipe and coating.

On no account the top soil from the ROW be used for this purpose. In general, the trench shall be dry during backfilling. Deviations there of must have prior approval of the COMPANY. The backfill material shall contain no extraneous material and/or hard lumps of soil which could damage the pipe / coating or leave voids in the backfilled trench. After the initial backfill has been placed into the trench to a level slightly above the surrounding ground, CONTRACTOR shall compact the backfill material. The surplus material shall be neatly crowned directly over the trench and the adjacent excavated areas on both sides of the trench as per clause 6.2.1, to such a height which will, in COMPANY's opinion, provide adequately for future settlement of the trench backfill during the maintenance period and thereafter. The crown shall be high enough to prevent the formation of a depression in the soil when backfill has settled into its permanent position. Should depression occur after back fill, 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 days 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 COMPAN , 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 COMPAN to survey the center line of the pipe and the level of the pipeline in the backfilled trench. Within 48 hours after backfilling, COMPAN sh all 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 sect ions as staked out by COMPAN and as referenced by CONTRACTOR after backfilling is limited to:

Pipeline dia upto and including 24 : 200mm

P ipeline greater than 24 : 300mm

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

10.12 Stabili ation of backfill shall be carried out by the CONTRACTOR in sandy areas and other such places to obtain consolidated cover as d irected by the COMPAN . CONTRACTOR shall carry out th e stabili ation over the pipe line at no ex tra cost to COMPAN .

The backfill shall be stabili ed preferab ly with 150mm layer of marl, mattresses of gatch other than straw or othe r stable materials. The width of stablisation shall be atleast 5.0 meters on either side of the pipeline, plus one meter for every 10 met ers height of dune (where the line passes through the dune areas).

10.13 Temporary workers shall be installed during backfilling an d 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 backf illed. The sections to be connected shall have at the ends, sections of ove r lapping, uncovered pipe of suffic ient 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 COMPAN .

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 COMPAN .

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

12.0 SPECIAL INSTALLATIONS ON THE PIPELINE.

12.1 General

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

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

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

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

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

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

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

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

The bending tool shall be subject to COMPAN 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 b e centered with equal amounts of thread visible on both sides. Bolts shall be uniformly tightened to produce a leak-proof joint. Bolts that yield during tightening shall be remover and discarded. It is mandatory that a torque wrench is used for bolt tightening.

12.1.4 **Threaded connections.**

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

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

Except for the threaded connections of in struments, which will require periodic testing and maintenance, all threaded connections shall be seal welded. Th e 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 th at the adjoining internal surfaces will be approximately flush. All welding shall be performed in accordance with the specification Specification for welding of pipelines and related facilities .
Tie - ins between fixed points shall be made at maximum ambient temperature.

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12.1.6 **Civil Work**

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

12.1.7 **Painting**

All exposed surfaces like piping, valves, structures, and miscellaneous appurtenances shall be painted in accordance with the specifications issued for this purpose. The corrosion coating on pipe surface will end approximately 0.3 meter above the finish grade and it will be necessary for CONTRACTOR to provide a clea n 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 fit tings and appurtenances shall be coat ed with minimum three coats of approved quality of c oal-tar epoxy or any other equivalent suitable COMPAN approved coating at no extra cost to the COMPAN . For buried pipes either heat shrink tapes conforming to COMPAN s specification or coal tar epox y shall be used. CONTRACTOR shall submit to COMPAN

a report used alongwith all the test certificates. Only after obtaining written approval from the COMPAN , 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 COMPAN . 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 COMPAN .

12.2.3 A suitable concrete foundation as directed by COMPAN 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 Sectionaliing valves shall be installed on sections of the pipeline in the horiontal 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 sectionali ing valve and any other inline assemblies shall be prefabricated and tested hydrostatically ex-situ as per applicable sp ecification. All su ch assemblies shall be installed at the locations shown in the drawings only aft er successful completion of the hydrostatic test and dewatering. Thereafter the ends of the assembly shall be closed off. CONTRACTOR sha ll carry out necessary ex cavation, cutting, bevelling and welding of the tie-ins required for the installation of such assembly. The tie-in joints shall be radiographically ex amined over 100 length an d also 100 ultrasonically examined prior to backfilling. All works sha ll be ex ecuted in accordance with the relevant specifications issued for the purpose.

12.3 **Installation of Scraper Launchers and Receivers**

12.3.1 Scraper stations shall be fabricat ed and installed as pe r the approved drawings and whenever applicable as p er the requirements of clause 12.2 of this specification. It is CONTRACTOR s responsibility to have the units completely a ssembled, tested and made fully functional including all instruments & related piping.

12.3.2 The civil and structural works for the scraper stations sh all be carried out as per the relevant specifications, in accordance with the drawings and as directed by the COMPAN . The work as a minimum shall includ e 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 accurat e and field welds shall not be performed under stress of pipe ends.

12.3.4 The painting for the scra per stations shall be carried out as per Specificat ions for Painting . The underground sections shall be coated as specified for the pipeline upto atleast 300mm above grade.

12.3.5 The hydrostatic testing of the scraper stations shall be ex ecuted 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 obt ain approval from t he COMPAN 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 th e welded joints shall be protected by external coating as per relevant specifications issued for the purpose.

12.4.4 The in-line inserting sha ll be made on the buried pipeline care shall be taken to operate at an ex ternal temperature as clo se as p ossible 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 cont inuously 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. T he 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 ms

Between backfilling and final clean-up : 05 ms

The above limitations do not apply to poin t spreads such as cont inuous rock blasting, river crossing, etc.

Any deviations from the above shall re quire prior approval of COMPAN . COMPAN reserves the right to stop the work, in case t he 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 a nd all sites used for the construction of pipelines, water crossing and other structures in acco rdance with COMPAN s instructions, and deliver them to the satisfaction of COMPAN .

14.2 **Surplus Materials**

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

All surplus and defective materials supplied by COMPAN shall be collected by CONTRACTOR and delivered to designated stockpile areas.

All Pipe-ends shorter than 1.0m shall be returned to COMPAN being scrap, all pipes longer than 8.0m shall be reconditioned (b evels, coating, provided with pipe letter,

number and length) and be returned to COMPANs designated stockpile areas together with all undamaged, unused COMPAN supplied materials. All pieces between 1.0 and 8.0m shall be charged to the CONTRACTOR by COMPAN. 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 Owners plot after authorisation by COMPAN.

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

14.3.5 All loose stones and rock exposed by the construction operations and scattered over the ROW or adjacent grounds shall be removed by CONTRACTOR and be transported to a location considered suitable by the authorities having jurisdiction, for satisfactory disposal. For stones, gravel or other hard material which may be buried in the trench the provisions of the specifications shall apply with the understanding that the use of the land by the land-owner and/or tenant will not be interfered with.

14.4 **Temporary Structures**

All auxiliary structures such as bridges, culverts, sheet piling, posts, signs, etc., which were erected or installed by CONTRACTOR as temporary measure, shall be removed. However, it may be necessary to remove the fence of ROW during the maintenance period.

14.5 **Repair of Damage**

Damages to roads, bridges, private property shall be repaired by CONTRACTOR. All fences and other structures which are damaged during construction shall be restored to original condition.

Slopes, water course sides or banks which have been partially or totally demolished during the execution of the works shall be properly consolidated and restored without waiting for their natural consolidation and settling.

All boundary stones which have been moved or removed during the work must be reset in their original location to the satisfaction of the landowner concerned.

14.6 On completion of clean-up, the ROW shall be restored to such stable and usable condition as may be reasonably consistent with the condition of the ROW prior to laying the pipeline. The COMPANY shall be completely indemnified and held harmless by CONTRACTOR from any and against all claims, demands, losses, expenses etc. that may arise in this behalf or the COMPANY may anyway suffer or sustain, relative to, arising out of, or in connection with same. The COMPANY may require from the CONTRACTOR signed Releases from land owners regarding satisfactory indemnification and restoration of their lands.

14.7 Special precautions shall be taken near slopes prone to erosions and land slides. All necessary steps shall be taken to ensure the rapid growth of grass by providing wicker barriers and by regulating the drainage of surface waters.

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

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

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

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

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

14.13 If, in the opinion of COMPAN , the sod in pasture land has been damaged by vehicles and wheel tracks are visible, the ROW sha ll be tilled with a di sc-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 h as 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 COMPAN . Subsequently, the entire ROW which is part of pasture land, shall be prepared for seeding and fertili ed according to the instructions of COMPAN .

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 c m. In general the ROW has also to be ripped. After this c ultivation process no c losed-in layers must be found in t he ROW. The equipment used and methods adopted shall require the approval of COMPAN . Ripping, has to be done with rippers with a distance of 50 c m between the ripper blades. The type to be used shall be approved by COMPAN .

14.15 A sapling of any plant/tre e uprooted or cut during construction shall be planted along the route as per the direction of the COMPAN and in accordance with the Forest Preservation Act, 1981. T he cost of sapling and its planta tion shall be to CONTRACTOR s account.

14.16 The ROW and the backfilled trench in partic ular 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, COMPAN can order CONT RACTOR to bring these parts to the original level. If the level of the ROW fo r clean-up is o rdered by COMPAN , 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, CO MPAN 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)
- fertili ing
- cover with sand.

If during clean-up operat ions, soil shortages become apparent outside the trench, CONTRACTOR shall supplement said soil shorta ge using suitable materials, approved by COMPAN .

If site and/or climatic conditions should render this necessary, COMPAN shall have the right to order CONTRACTOR to su spend certain parts of the WOR re lated to th e clean-up and postpone it to a later date.

14.17 **Soil Surplus**

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

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 COMPAN has given prior permission for mixed excavation of the sub-soil as well as in cases where COMPAN 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 WOR , this shall only be done after prior permission by land-owner, land-user and COMPAN .

14.18 **Soil Shortages**

If due to unforeseen circumstances during backfilling and compacting there isn t enough soil to fill the trench properly, or to install the crown height as stipulated, CONTRACTOR shall supply the necessary backfill material.

Soil shortages shall be supplemented and applied before the top-soil is replaced.

The soil to be supplied shall be worked up in those locations and into those layers where a soil shortage has been established. The quality of the supplemented soil shall be equal to that of the shortage.

15.0 MAINTENANCE DURING DEFECTS LIABILITY PERIOD

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

COMPAN 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 COMPAN), workmanship or design (other than a de sign made, furnished or specified by COMPAN and for which CONTRACTOR has disclaimed responsibility in writing), or

b) from any ac t or omission of CONTRACTOR done or omitte d during the said period.

If such defect shall appe ar or damage occur, COMPAN shall forthwith inform CONTRACTOR thereof stating in writing the nature of the defect or damage.

If any such defect or damage be not re medied within a re asonable time, COMPAN may proceed to execute the work at CONTRACTOR s risk and expense, provided that he does so in a re asonable 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 dent s, 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 LIABILIT PERIOD and whenever conditions are mo re favorable for this job. The work shall at or as soon as practicable after the expiration of the Defects Liability Period be delivered to COMPAN in the conditions required by the CONTRACT, fair wear and tear excepted, to the satisfaction of COMP AN . 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.

Rev. : 0
Edition : 1

SPECIFICATION

FOR

WELDING OF ONSHORE GAS PIPELINES

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

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

01. SCOPE

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

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

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

02. APPLICABLE CODES, STANDARDS & SPECIFICATIONS

All welding works, equipment for welding, heat treatment, other auxiliary functions and the welding personnel shall meet the requirements of the latest editions of the following codes, standards and specifications as listed below :-

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

03. MATERIAL SPECIFICATIONS

- In general carbon steel is used in this specification. The details of material specifications will be given in a welding Specification Chart attached alongwith other project data sheets.
- The CONTRACTOR will keep a record of test certificates of all the materials for the reference of the welding engineer.

04. WELDING CONSUMABLES

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

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

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

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

Electrode Qualification test records shall be submitted as per **Annexure-I** with respect to the electrodes tested by the CONTRACTOR and submitted for approval of the COMPANY, f or each batch of electrode.

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

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

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

04.01 Shielding Gas

The composition and purity of shielding gas when required by the welding processes other than shielded metal arc welding, when permitted by the COMPANY, shall have prior approval of the COMPANY. Where appropriate, gases or gas mixture of the following quality shall be used.

a) argon complying with BS 4365

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

c) gas mixture that have been proved to be satisfactory as a result of procedure approval tests.

When a gas mixture is used which has specified additions, e.g. 2% O_2, 5% CO_2 the variation of such addition shall not exceed ± 10% of that stated. Moisture content shall correspond to a dew point of - 30°C or lower.

05. EQUIPMENT & ACCESSORIES

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

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

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

06. WELDING PROCESSES

6.1 Welding of various materials under this specification shall be carried out using 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 damged ends shall be cut and re-bevelled to the satisfaction of the COMPANY, with an approved bevelling machine. Manual cutting and weld repairs of bevels is not allowed. Should laminations, split ends or inherent manufacturing defects in the pipe be discovered, the lengths of pipe containing such defects shall be removed from the line to the satisfaction of COMPANY. On pipes which have been cut back, a zone extending 25mm back from the new field bevel, shall be ultrasonically tested to the requirement of the line pipe specification to ensure freedom from laminations. The new bevel shall be subjected to 100% visual and 100% dye penetrant/ MPI tests. A report shall be written for all testing and records kept.

08. ALIGNMENT AND SPACING

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

Seam orientation of welded pipe shall be selected to ensure that at the circumferential welds, the longitudinal welds shall be staggered in the top 90° of the pipeline, or 250mm whichever is the lesser. A longitudinal joint shall pass an appurtenance of a structural element at a minimum distance of 50mm. Should a section of the line containing uncompleted welds fall from the skids, the CONTRACTOR shall immediately inform COMPANY.

Every effort shall be made to reduce misalignment by the use of the clamp and rotation of the pipes to obtain the best fit. For pipe of same nominal wall thickness off-set shall not exceed 1.6mm. The off set may be checked from outside using dial gauges. Any branch connection, sleeve, etc. shall be atleast 150mm from any other weld. The welds for fittings shall be so located that the toe of the 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 oridinary line welding without misalignment or uneveness.

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

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

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

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

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

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

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

j) Peening shall not be used.

10.2 **Joint Completion**

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 atleast 100°C shall be carried out. Subsequent passes up to weld completion shall be protected to avoid rapid cooling, if meteorological conditions so dictate. Cleaning between passes shall be done carefully so as to reduce the possibility of inclusions.

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

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

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

11.0 HEAT TREATMENT

11.1 Preheating

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

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

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

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

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

11.2 Postweld Heat Treatment

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

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

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

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

e) While carrying out local post weld heat treatment, technique of application of heat must ensure uniform temperature attainment at all points of the portion being heat treated. Care shall be taken to ensure that width of heated band over which specified post weld heat treatment temperature is attained is atleat as that specified in the relevant applicable standards/ codes.

The width of the heated band centered on the weld shall at least be equal to the width of weld plus 2" (50mm). The temperature gradient shall be such that the length of the material on each side of the weld, at a temperature exceeding half the heat treatment temperature, is atleast 2.5 rt where is the bore radius and t is the pipe thickness at the weld.

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

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

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

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

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

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

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

12.0 INSPECTION AND TESTING

12.1 General

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

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

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

ii. To supervise the welding procedures qualification.

iii. To supervise the welder's performance qualification.

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

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

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

12.2 Welding Procedure Qualification

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

b) COMPANY's inspector will review, check and approve the welding procedure submitted and shall release the procedure for procedure qualification tests. The procedure qualification test shall be carried out by the CONTRACTOR under field conditions at his own expense. A complete set of test results in format as per **Annexure-III & Annexure-IV** (attached) shall be submitted to the COMPANY's Inspector for approval immediately after completing the procedure qualification test and atleast 2 weeks before the commencement of actual work. Standard tests as specified in the code shall be carried out in all cases. In addition to these, tests, other tests like radiography, macro/ micro examination,

hardness tests, dye penetrant examination, charphy V-notch etc. shall be carried out on specimens. It shall be the responsibility of the CONTRACTOR to carry out all the tests required to the satisfaction of the COMPANY's Inspector. The destructive testing of welded joints shall be as per Clause 14.0.

12.3 **Welder's Qualification**

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

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

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

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

12.4 **Visual Inspection**

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

12.5 **Non Destructive Examination**

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 metalographic examination, hardness surveys and Charpy tests to determine the effects of repair welding on the associated structure.

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

grinding for repairs, care shall be taken to ensure that no grinding marks are made on the pipe surface anywhere.

The repair shall be subjected, as a minimum requirement to the same testing and inspection requirements as the original weld. The re-radiography of repaired weld shall be limited to 6" weld length on either edge of the repaired area. A 100% ultrasonic test shall be done at the repaired area externally. Any repaired area that is wide, irregular or rough shall be rejected and a full cut out shall be done. Single pass repairs shall be subjected to 100%, Dye-Penetrant / MP testing.

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

13.2 Weld Rejected by Accumulation of Defects

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

14. DESTRUCTIVE TESTING OF WELDED JOINT - BUTT WELDS

14.1 Preparation

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

After satisfactory completion of all visual and non-destructive testing the test weld shall be set aside for a period not less than 24hours. No further work on the test weld and no cutting of test specimens from the weld shall be performed until a period of at least 24 hours has expired. Having passed the visual and the nondestructive inspection, the test weld shall be subjected to mechanical test.

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

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

14.2 Tensile Strength

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

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

14.2.1 **Method**

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

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

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

14.3 **Nick-Break Test**

14.3.1 **Preparation**

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

14.4 **Macroscopic Inspection**

14.4.1 **Preparation**

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

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

14.4.2 **Method**

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

14.4.3 **Requirements**

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

14.5 **Hardness Test**

14.5.1 **Preparation**

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

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

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

14.5.2 **Method**

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

14.5.3 **Requirements**

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

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

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

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

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

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

14.6.2 **Test Method**

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

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

14.6.3 **Requirements (Note-1)**

The impact energy shall be as follows :

Sl. No.	Test Specimen in mm	"Average of three Specimens (Note-2) Joules (Min.)	Minimum Single Value (Note-1) Joules
1.	10.0	27.0	22.0
2.	7.5	21.5	17.0
3.	5.0	18.5	15.0
4.	2.5	10.0	8.0

Note :

1) Only one value is permitted to be lower than average value upto the value specified.
2) These values are specified for resistance to brittle fracture only, where additional requirements are specified in project data sheet. (Ex. pipeline materials with arrest properties i.e. a higher upper shelf charpy V-energy for resistance against propagating ductile fractures) the same shall be followed.

14.7 Bend Test Requirements

The Bend test Specimens shall be made and tested as per the requirements of API 1104 Sixteenth Edition May 1983 except that the dimensions of the Jig for guided bend test Fig. 5 para 2.6 API 1104 shall be modified as follows:

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

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

Note : t = thickness of specimen

15. ULTRASONIC INSPECTION

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

15.1 Equipment and Operators

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

The operators shall be fully qualified as per a recognised standard (ASME Sec. V or equivalent) and they shall have as minimum level II as described in para 11.4.3, API 1104; nineteenth edition. The operators shall be able to :

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

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

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

15.2 Specification for Ultrasonic Inspection Procedure Qualification

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

This specification shall state, as an indication only but not limited to the following information :

- type of U.T. equipment used
- type and dimensions of transducers
- frequency range
- details for calibration
- coupling medium
- inspection technique
- record details
- reference to the welding procedure where it is intended to adopt the specification.
- temperature range of the joints to be inspected.

15.3 Qualification of Ultrasonic Inspection Procedure

The ultrasonic inspection procedure shall be approved by the COMPANY. Before inspection begins, the COMPANY may require the qualification test of the ultrasonic inspection procedure. This specification test consists in testing (under normal operating conditions) some CONTRACTOR welds made according to the same production procedure, where there are typical defects the test intends to detect.

This test shall be conducted in the presence of the COMPANY. The Ultrasonic inspection procedure shall be approved by the Company.

15.4 Test Procedure

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

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

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

interfered with the ultrasonic beam.

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

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

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

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

b) continuous operation

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

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

15.5 Ultrasonic Instruments

The Ultrasonic Instruments shall satisfy the following:

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

15.6 **Probes**

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

15.7 **Reference Sample Pieces**

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

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

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**

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

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

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

- **APPROVED AGENCIES**

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 ≥ 20 dB for shear waved probes.

- **COUPLING**

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

- **SEARCH UNITS**

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

- **CALIBRATIONS**

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

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

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

A re-calibration shall be carried out if :

a) The calibration of an inspection function differs more than +/- 3dB from the previous calibration

b) The gate settings need to be adjusted with more than +/- 1.5 mm with the previous calibration – 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 upto the previous calibration will be re-examined.

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

- **PROCEDURE**

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

- Functional description of equipment
- Reference standards and guidelines controlling equipment maintenance
- Instructions for scanning device, Ultrasonic instrument, Ultrasonic electronics, Hard & Software for recording processing, Display presentation and storage of inspection data
- Transducer configuration(s), characteristics types coverage.
- Number of examination zones for each wall thickness to be examined.
- Gate settings
- Equipment settings -Description of calibration blocks including type, size and location of calibration reflectors, a) calibration intervals, b) calibration records - Static and dynamic calibration procedure
- Identification of inspection starting point scanning direction and indication of length inspected
- Method for scanner alignment and maintenance of alignment
- Allowed temperature range
- Couplant coupling and coupling control and channels provided to indicate lack of coupling and method to ensure constant coupling
- Transducer and over all functional checks
- Height and length sizing methodology
- Surface condition and preparation
- Description of inspection work
- Acceptance criteria and instructions for reporting including example of recorder

chart and form to be used.

- A table indicating corresponding channel no., probe, type, location of reflector, probe coupling etc.

- **Setting of Inspection Gates**

Pulse-echo and Tandem Channels

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

Mapping Channels

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

TOFD Channel

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

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

Sensitivity Settings

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

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

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

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

- **TRAINING AND QUALIFICATION**

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

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

- **FIELD EXAMINATIONS AND REPORTING**

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

- **INTERPRETATION OF RESULTS**

General

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

Inspection Result

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

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

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

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

   a) Horizontal interaction

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

   b) Vertical interaction

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

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

- **ACCEPTANCE CRITERIA**

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

17.0 RADIOGRAPHY

17.1 Scope

This covers the radiographic inspection of all types of welded joints of the main pipeline.

The welded joints shall include the following :-

i. Full girth welds on the mainline construction including double jointing of pipe, if adopted.

ii. Welds for installation of block valves, insulating joints and other appurtenances and tie-ins.

iii. Welds at scraper launching and receiving barrels.

iv. Terminal Piping

17.2 **Applicable Standards**

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

i. API 1104, Standard for welding Piplines and Related Facilities.

ii. ANSI B31.8, Code for Gas Transmission and Distribution Piping Systems.

iii. ANSI B31.4, Code for Liquid Petroleum Transportation Piping Systems.

iv. ASTM E94, Recommended practice for Radiographic Testing.

v. ASTM E142, Standard Method for Controlling Quality of Radiographic Testing.

vi. The American Society for Non-destructive Testing. Recommended Practice No. SNT - TC-1A Supplement A.

17.3 **Procedure**

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

17.3.2 The procedure of radiographic examination shall be qualified to the entire satisfaction of COMPANY prior to use. It shall include but not be limited to the following requirements :

i. Lead foil intensifying screens, at the rear of the film shall be used for all exposures.

ii. Type 2 and 3 films as per ASTM E-94 shall be used.

iii. A densitometer shall be used to determine film density. The transmitted film density shall be 2.0 and 3.5 throughout the weld. The unexposed base density of the film shall not exceed 0.30.

iv. Radiographic identification system and documentation for radiographic interpretation reports and their recording system.

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

17.3.4 The procedure of radiographic examination shall produce radiographs of sufficient density, clarity and contrast so that defects in the weld or in the pile adjacent to the weld, and the outline and holes of the penetrameter are clearly discernible.

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

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

17.3.7 Three copies of each acceptable radiographic procedure (as per Annexure-VI) and three copies of radiographic qualification records, shall be supplied to COMPANY. One set of the qualifying radiographs on the job shall be kept by the CONTRACTOR's authorised representative to be used as a standard for the quality of production radiographs during the job. The other two sets shall be retained by COMPANY for its permanent record.

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

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

17.3.10 Each day's production of processed radiographs shall be properly packaged separately, identified by at least the (1) date, (2) radiographic unit, (3) job locations, (4) starting and ending progress survey stations and (5) shall include original and three copies of the daily radiographic record. The package shall be submitted to the COMPANY daily when possible, but in no event later than noon of the following day.

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

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

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

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

17.4 **Radiation Source**

17.4.1 Radiographic examination shall be carried out using x-radiations, Radiographic examination by Gamma rays may be allowed, at the discretion of the COMPANY, in case of inaccessible joints. Radiography by Gamma-Ray for tie-in-joints shall be acceptable provided D4 AGFA film or equivalent is used and the required sensitivity obtained.

17.4.2 Whenever possible, pipeline welds will be inspected by placing the radiation source inside the pipe, on the pipeline axis, with a radiation of 6.28 rad. (360°C).

If it is impossible to place the radiation source inside the pipe, the weld will be inspected with the source on the outside. An overlap of at least 40mm at the ends of each film shall be required to ensure that the first and last location increment numbers are common to successive films and to establish that no part of a weld has been omitted.

17.5 **Level of Quality**

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

17.6 **Penetrameters**

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

less than the values shown in Fig. 6 of this specification.

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

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

17.7 **Film Identification Markers**

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

17.8 **Protection and care of film**

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

17.8.2 The exposed and unexposed film shall be protected from heat, light, dust and moisture. Sufficient shielding shall be supplied to prevent exposure of film to damaging radiation prior to and following the use of the film for radiographic exposure.

17.9 **Re-radiography**

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

17.9.2 All the repaired weld joints shall be re-radiographed at no extra cost to the COMPANY in the same manner as that followed for the original welds. In addition, the repaired weld areas shall be identified with the original identification number plus the letter R to indicate the repair.

17.9.3 When evaluating repair film, radiographers shall compare each section (exposure) of the weld with the original film to assure repair was correctly marked and original defect removed.

17.9.4 The COMPANY will review prior to any repair of welds, all the radiographs of welds which contain, according to the CONTRACTOR's interpretation, unacceptable defects. The final disposition of all unacceptable welds shall be decided by the COMPANY.

17.10 **Qualification of Radiographers**

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

17.10.2 Certification of all the radiographers, qualified as per 16.10.1 above, shall be furnished by the CONTRACTOR to the COMPANY before a radiographer will be permitted to perform production radiography. The certificate record shall include :

i. Background and Experience Record
ii. Training Course Record
iii. Technical Examination Record
iv. Doctor's report on radiographer's Oaecuer 0-1 acquity eye test.
v. Date of qualification

17.10.3 The radiographers shall be required to qualify with each radiographic procedure they use, prior to performing the work assigned to him in accordance with the specification.

17.11 **Preservation of Radiographs**

17.11.1 The radiographs shall be processed to allow storage of films without any discoloration for at least three years. All the radiographs shall be presented in suitable folders for preservation alongwith necessary documentation.

17.11.2 All radiographs shall become property of the COMPANY.

17.12 **Equipment and Accessories**

17.12.1 CONTRACTOR shall make necessary arrangement at his own expense, for providing the radiographic equipment, radiographic film and all the accessories for carrying out the radiographic examination for satisfactory and timely completion of the job.

17.12.2 For carrying out the mainline radiographic examination the CONTRACTOR shall be equipped with suitable mobile/ stationary type dark rooms.

These shall have all the required facilities for film processing. Film viewer used shall be equipped with the film illuminator that has a light source of sufficient intensity and suitably controlled to allow viewing film densities upto 4.0 without damaging the film.

17.13 **Radiation Protection**

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

17.13.2 The protection and monitoring shall comply with local regulations.

17.13.3 In view of visual hazards in the handling of Radioactive source of material, CONTRACTOR shall be solely responsible for complying with all rules and regulations

set forth by Atomic Energy Commission or any other Government agency of India in this regard and COMPANY shall not be responsible and shall be kept indemnified by the CONTRACTOR for default (s) of whatever nature by the CONTRACTOR. Safety equipment as considered adequate by the COMPANY for all necessary personnel shall be made available for use and maintained for immediate and proper use by the CONTRACTOR.

17.14 **Display of Safety Instructions**

17.14.1 The safety provisions shall be brought to the notice of all concerned by display on a notice board at a prominent place at the work spot. The person responsible for the "safety" shall be named by the CONTRACTOR.

17.15 **Enforcement of Safety Regulations**

17.15.1 To ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangement made by CONTRACTOR shall be open to inspection by COMPANY or its representatives.

17.16 **First Aid and Industrial Injuries**

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

17.16.2 CONTRACTOR shall make outside arrangements for ambulance service and for treatment of industrial injuries. Names of those providing these services shall be furnished to COMPANY prior to start of work and their telephone no. shall be posted prominently in CONTRACTOR's field office.

17.16.3 All critical industrial injuries shall be reported promptly to the COMPANY and a copy of CONTRACTOR's report covering each personal injury requiring the attention of physician shall be furnished to the COMPANY.

17.17 **No Exemption**

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

ANNEXURE-I

ELECTRODE QUALIFICATION TEST RECORD

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

Manufacturer's Name :

Brand Name :

Batch Number & Size Tested :

Classification & Code :

Intended for Welding in Position :

In combination with (if any) :

Code of Reference (used for testing) :

Special requirements (if any) :

B. **All Weld Tensile Test**

Base Material used :

Pre-heat temp. :

Postweld Heat Treatment Details :

Visual Examination :

Radiographic Examination Results :

Tensile Test Results :

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

ANNEXURE-I
Sheet 2 of 3

C. **Impact Test Results**

Test Temperature : Notch in :

Type of Specimens (Charpy) : Size of Specimens :

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

D. **Chemical Analysis Result**

Electrode Size used :

Batch No. :

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

E. **Fillet Weld Test Results**

Welding Positions :

Base Materials :

Size of Electrode used :

Visual Inspection Results : 1)
2)
3)

Macro Test results :

ANNEXURE-I
Sheet 3 of 3

Fracture Test Results :

Remarks :

F. **Other Test Results**

1. Transverse Tensile Test :

In combination with :

Base Material used :

Position of Welding :

Preheat Temperature :

Post Weld Heat Treatment :

Radiography :

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

2. **Guided Bend Test**

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

Any other Tests :

Conclusion :

ANNEXURE-II

Sheet 1 of 2

STRESS RELIEF HEAT TREATMENT PROCEDURE SPECIFICATION

Name of the Heat-Treater :

Name of the Project : Specification Reference No.:

1. **General Details**

   Name of the Equipment :

   Name of the Assembly/ Part :

   Assembly/ Part Drawing No. :

   Material :

2. **Furnace Details**

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

   Capacity (Size) :

   Maximum Temp.(°C) :

   Method of Temp. Measurement :

   Atmosphere Control :

3. **Heat Treatment Cycle Details**

   Changing Temp. °C :

   Rate of Heating, °C/ Hr. :

ANNEXURE-II

Soaking Temp. °C :

Soaking Time, Hrs. :

Rate of Cooling, °C/ Hr. :

Mode of Cooling :

4. Other Details, if any.

Notes :

The following documents shall be furnished alongwith the specifications :

i. Material Test Certificates

ii. Assembly/ Part Drawing.

ANNEXURE-III
Sheet 1 of 3

FORMAT FOR WELDING PROCEDURE SPECIFICATION (WPS)

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

JOINTS

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

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

BASE METALS

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

ANNEXURE-III
Sheet 2 of 3

FILLER METALS

F.No. _____ Other _____
A.No. _____ Other _____
Spec. No. (SFA) _____
A WS No. (Class) _____
Size of filler metals _____
_____
(Electrodes, Cold Wire, Hot Wire etc.)

Electrode-Flux (Class) _____
Flux Trade Name _____
Consumable Inset _____
Each base metal/filler metal combination should be recorded individually.

WPS NO. _____ Rev. _____

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

ELECTRICAL CHARACTERISTICS

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

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

Electrode Wire feed speed range _____
_____

ANNEXURE-III

TECHNIQUE

String or Weave Bead _____

Orifice or Gas Cup Size_____

Initial and Interpass Cleaning (Brushing, Grinding, etc.) _____

_____

Method of Back Gouging _____

Oscillation _____

Contact Tube to Work Distance _____

Multiple or Single Pass (per side) _____

Multiple or Single Electrodes _____

Travel Speed (Range) _____

Peening _____

Other _____

_____

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

ANNEXURE-IV
Sheet 1 of 3

FORMAT FOR PROCEDURE QUALIFICATION RECORD (PQR)

RECORD ACTUAL CONDITIONS USED TO WELD TEST COUPON

Company Name _____

Procedure Qualification Record No. _____ Date _____

WPS No. _____

Welding Process (es) _____

Types (Manual, Automatic, Semi-Auto) _____

JOINTS

Groove Design of Test Coupon

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

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

ANNEXURE-IV
Sheet 2 of 3

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

GUIDED BEND TESTS

Type of Figure No.	Result

TOUGHNESS TESTS

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

FILLET WELD TEST

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

Marco – Results _____

OTHER TESTS

Type of Test _____

Deposit Analysis _____

Other _____

_____

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

ANNEXURE-IV
Sheet 3 of 3

Test Conducted by _____ Laboratory Test No. _____

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

Date : _____ Manufacturer : _____

By : _____

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

ANNEXURE-V
Sheet 1 of 2

FORMAT FOR MANUFACTURER'S RECORD FOR WELDER OR WELDING OPERATOR QUALIFICATION TESTS

Welder Name _____ Check No. _____ Stamp. No. _____

Using WPS No. _____ Rev. _____

The above welder is qualified for the following ranges

Variable	Record Actual Values Used in Qualification	Qualification Range
Process	_____	_____
Process Type	_____	_____
Backing (metal, Weld metal, flux, etc)	_____	_____
Material Spec.	_____ to _____	_____ to _____
Thickness		
Groove	_____	_____
Filler	_____	_____
Diameter		
Groove	_____	_____
Filler	_____	_____
Filler Metal		
Spec. No.	_____	_____
Class	_____	_____
F. No.	_____	_____
Position	_____	_____
Weld Progression	_____	_____
Gas Type	_____	_____
Electrical Characteristics		
Current	_____	_____
Polarity	_____	_____

ANNEXURE-V
Sheet 2 of 2

Guided Bend Test Results

Type and Fig. No.	Result

Radiographic Test Results
For alternative qualification of groove welds by radiography

Radiographic Results _____

Fillet Weld Test Results

Fracture Test (Describe the location, nature and size of any crack of tearing of the specimen _____
Length and Per Cent of Defects _____ inches _____%
Macro Test – Fusion _____
Appearance - Fillet Size (ing) _____x_____ Convexity or Concavity _____

Test Conducted by _____ Laboratory - Test No. _____

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

Date _____ Organization _____
By _____

(Details of record tests are illustrative only and may be modified to conformation to the type & number of tests required by the Code).

Note: Any essential variables in addition to those above shall be recorded.

ANNEXURE-VI

Sheet 1 of 1

RADIOGRAPHIC PROCEDURE QUALIFICATION RECORD FOR PIPE WELDING

1. Location
2. Date of Testing
3. Name of the Contractor / Agency
4. Material : Carbon steel / Alloy Steel / Stainless Steel

4.A Technique: DWSI / SWSI / DWDI

5. Diameter & Thickness:
6. Type of Weld Joint:
7. Radiation Source:
8. Intensifying Screens/Lead Screens:
9. Geometric Relationship:
10. Limit of Film Coverage:
11. Film Type and Make:
12. Exposure Time:
13. Processing:
14. Density:
15. Sensitivity:

16.* Type of penetrameter: (Source side)

17.* Type of penetrameter: (Film side)

Signature of Contractor / Agency with Seal

Approval of MECON's Inspector

* Ref. Para regarding recommended practice on placement of penetrameters Article 22, SE 142, ASME Sec. V.

* For "Random Radiography" lines placement of penetrameters as per Article 2, ASME, Sec. V is permitted.

ANNEXURE-VII

Sheet 1 of 1

WELDERS IDENTIFICATION CARD

Name :

Identification :

Date of Testing :

Process :

Diameter and Thickness :

Thickness Range Qualified :

Diameter Range Qualified :

WPS No. :

Welding Position & Progression :

Type of welding consumables used :

Valid Till :

Photograph

Approved by :

Employer's Signature with seal

ANNEXURE-VIII

Sheet 1 of 1

Type of Source and Films to be used for RADIOGRAPHY

NOMINAL WALL THICKNESS (T) IN mm		SHOP WELDED JOINTS		IN-SITU WELDS	
		SOURCE	FILM : CEN Class	SOURCE	FILM : CEN Class
T> 19	All Materials	Gamma Ray	C5	Gamma Ray	C5
8<T<19	Carbon Steel	Gamma Ray	C4	Gamma Ray	C4
	All other materials	Gamma Ray	C3	Gamma Ray	C3
<8	Carbon Steel Other than Inspection Class IV *	Gamma Ray	C3	Gamma Ray	C3/C1
All Thickness	All other materials and Carbon Steel of Inspection Class IV *	X-Ray	C5	X-ray with C5 or Equivalent to be used. Gamma Ray (Se 75 Source only) with C3/C2 Equivalent may be allowed only if in the assessment of the owner's inspector, Joints are inaccessible for X-ray equipment and radiographic sensitivity is achieved.	

Note: Integral to above table

1) Films slower than the above may have to be used, if required radiographic sensitivity is not achieved consistently.

Piping classes where 100 RT is specified. Refer Std. Spec. No. MEC/S/05/21/06.

COMPARISON OF FILMS FROM DIFFERENT MANUFACTURERS

CEN Classification	KODAK	AGFA	FUJI
---	CX	D8	IX150
C5	AA400	D7	IX 100
C4	T200	D5	IX80
C3	MX125	D4	IX50
C2	M100	D3	IX50
C1	DR50	D2	IX25
---	SR**	---	---

* * *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>
<tr><td colspan="5">12”,10”, 8”,6” & 4” THK 6.4 mm</td></tr>
<tr><td rowspan="4">MATERIAL SPECIFICATIONS</td><td>PIPES</td><td colspan="3">API 5L Gr B/X-42/X-52/X-56 PSL 2 LINE PIPE</td></tr>
<tr><td>FITTINGS</td><td colspan="3">-</td></tr>
<tr><td>FLANGES</td><td colspan="3">-</td></tr>
<tr><td>OTHERS</td><td colspan="3">-</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>BASE METAL ‘P’ NO</td><td colspan="4">1</td></tr>
<tr><td rowspan="4">WELDING PROCESS</td><td colspan="4">GROOVE JOINTS</td></tr>
<tr><td colspan="2">BUTT</td><td colspan="2">OTHERTHAN BUTT</td></tr>
<tr><td>ROOT&HOTPASS : SMAW</td><td>FILLER PASS : SMAW</td><td>ROOTPASS :N.A.</td><td>FILLER PASS :N.A.</td></tr>
<tr><td colspan="4">FILLET JOINTS /SOCKETJOINTS :N.A.</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td rowspan="4">WELDINGMATERIAL</td><td colspan="4">GROOVE JOINTS</td></tr>
<tr><td colspan="2">BUTT</td><td colspan="2">OTHERTHAN BUTT</td></tr>
<tr><td>ROOTPASS:E6010
HOT PASS: E7010</td><td>FILLER PASS
E7010</td><td>ROOTPASS :N.A.</td><td>FILLER PASS :N.A.</td></tr>
<tr><td colspan="4">FILLET JOINTS /SOCKETJOINTS :N.A.</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>JOINT PREPARATION</td><td colspan="4">API1104/ ASME SEC.–IX</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>GASES</td><td colspan="2">PURGING:</td><td colspan="2">SHIELDING:</td></tr>
<tr><td>GAS COMPOSITION</td><td colspan="2">PURGING:</td><td colspan="2">SHIELDING:</td></tr>
<tr><td>PREHEATING</td><td colspan="2">PREHEATTEMP: As Applicable</td><td colspan="2">POSTHEATING:</td></tr>
<tr><td colspan="5">CONTINUITYOF WELDINGANDPREHEAT :REFER TOSPECIFICATION</td></tr>
<tr><td rowspan="3">POSTWELDHEAT TREATMENT</td><td colspan="2">HOLDINGTEMP:</td><td colspan="2">HOLDINGTIME:</td></tr>
<tr><td colspan="2">RATEOFHEATING:</td><td colspan="2">MIN. HOLDINGTIME:</td></tr>
<tr><td colspan="2">METHODOFCOOLING:</td><td colspan="2">RATEOFCOOLING:</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td rowspan="3">MECHANICAL PROPERTY REQUIREMENTS</td><td colspan="2">CHARPY‘V’NOTCH VALUE:</td><td>MIN: 20J</td><td>AVERAGE: 27J</td></tr>
<tr><td colspan="2">ATTEMPERATURE:</td><td colspan="2">At0°C</td></tr>
<tr><td colspan="2">HARDNESS :</td><td colspan="2"></td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="2">CODEOFFABRICATION:</td><td colspan="3">API1104/ ASME SEC.–IX</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Technical Notes :
1. All passes will be carried out by SMAW process.
2. D7 Film shall be used for radiography by X-Ray</td></tr>
</table>

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

<table>
<tr><td colspan="2">PIPINGCLASS:</td><td colspan="4">A1A, A3A,B1A,D1A,E1A</td></tr>
<tr><td rowspan="4">MATERIAL SPECIFICATIONS</td><td>PIPES</td><td colspan="4">ASTMA106GR.B, API5LGRBPSL2, API5LX52 PSL2, API5LGR X-65 PSL2, API5LGR X-70 PSL2, IS-1239(BLACK) ASSORTED PIPES</td></tr>
<tr><td>FITTINGS</td><td colspan="4">ASTMA105, ASTMA234GR.WPB, ASTMA234RG.WPB-W, MSS SP-75 GR.WPHY-52, MSS SP-75GR.WPHY-65</td></tr>
<tr><td>FLANGES</td><td colspan="4">ASTMA105, ASTMA694GR.F-52, ASTMA694GR.F-65, ASTMA694GR.F-70, ASTMA516GR.70</td></tr>
<tr><td>OTHERS</td><td colspan="4">-</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>BASEMETAL'P'NO</td><td colspan="5">1</td></tr>
<tr><td rowspan="4">WELDING PROCESS</td><td colspan="3">GROOVE JOINTS SINGLESIDE BEVEL</td><td colspan="2"></td></tr>
<tr><td colspan="2">BUTT</td><td colspan="3">OTHERTHAN BUTT</td></tr>
<tr><td>ROOTPASS :GTAW</td><td>FILLER PASS : GTAW/SMAW</td><td>ROOTPASS :GTAW</td><td colspan="2">FILLER PASS :SMAW</td></tr>
<tr><td colspan="5">FILLET JOINTS /SOCKETJOINTS : SMAW</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td rowspan="4">WELDINGMATERIAL</td><td colspan="5">GROOVE JOINTS</td></tr>
<tr><td colspan="2">BUTT</td><td colspan="3">OTHERTHAN BUTT</td></tr>
<tr><td>ROOTPASS : ER70S-2</td><td>FILLER & CAPPASS ER70S-2/E7018-1</td><td>ROOTPASS : ER70S-2</td><td colspan="2">FILLER PASS : ER70S-2/E7018-1</td></tr>
<tr><td colspan="5">FILLET JOINTS /SOCKETJOINTS :E7018-1</td></tr>
<tr><td colspan="3">BACKING RING : N.A.</td><td colspan="2">CONSUMABLE INSERT : N.A.</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td colspan="2">JOINT PREPARATION</td><td colspan="4">API 1104/ ASME SEC.–IX</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td colspan="2">GASES</td><td colspan="2">PURGING:</td><td colspan="2">SHIELDING: Argon</td></tr>
<tr><td colspan="2">GAS COMPOSITION</td><td colspan="2">PURGING:</td><td colspan="2">SHIELDING:99.995%</td></tr>
<tr><td colspan="2">PREHEATING/ INTER PASS</td><td colspan="2">PREHEATTEMP 10-100Deg
INTERPASS :Max200 Deg</td><td colspan="2">POSTHEATING: NA</td></tr>
<tr><td colspan="6">CONTINUITYOF WELDINGANDPREHEAT :REFER TOSPECIFICATION</td></tr>
<tr><td colspan="2" rowspan="3">POST WELDHEAT TREATMENT</td><td colspan="2">HOLDINGTEMP:</td><td colspan="2">HOLDINGTIME:</td></tr>
<tr><td colspan="2">RATEOFHEATING:</td><td colspan="2">MIN. HOLDINGTIME:</td></tr>
<tr><td colspan="2">METHODOFCOOLING:</td><td colspan="2">RATEOFCOOLING:</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td colspan="2" rowspan="3">MECHANICAL PROPERTY REQUIREMENTS</td><td colspan="2">CHARPY'V'NOTCH VALUE:</td><td>MIN: 20J</td><td>AVERAGE:27J</td></tr>
<tr><td colspan="2">ATTEMPERATURE:</td><td colspan="2">At0°C</td></tr>
<tr><td colspan="2">HARDNESS :</td><td colspan="2"></td></tr>
<tr><td colspan="6"></td></tr>
<tr><td colspan="3">CODEOFFABRICATION:</td><td colspan="3">API 1104/ ASME SEC.–IX</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td colspan="6">TECHNICALNOTES :</td></tr>
</table>

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

Terminal Piping: PIPINGCLASS:		**A4A,B4A,D4A,E4A**			
MATERIAL SPECIFICATIONS	PIPES	ASTMA333GR.6**ASSORTED PIPES**			
	FITTINGS	ASTMA350GR.LF2, ASTMA420GR.WPL6, ASTMA 420GR.WPL6-W			
	FLANGES	ASTMA350GR.LF2			
	OTHERS	-			
BASE METAL 'P'NO		**1**			
WELDINGPROCESS		**GROOVE JOINTS SINGLESIDEBEVEL**			
		BUTT		**OTHER THAN BUTT**	
		ROOTPASS: **GTAW/ SMAW**	FILLER PASS: **GTAW/ SMAW**	ROOTPASS: **GTAW**	FILLERPASS: **SMAW/GTAW**
		FILLETJOINTS / SOCKETJOINTS :**SMAW**			
WELDINGMATERIAL		**GROOVE JOINTS**			
		BUTT		**OTHER THAN BUTT**	
		ROOTPASS : **ER70S-2/ E6010** HOTPASS : **ER70S-2/ E7018-1**	FILLER&CAP PASS **ER70S- 2/ E7018-1**	ROOTPASS : **ER70S-2/ E6010** HOTPASS : **ER70S-2/ E7018-1**	FILLERPASS : **ER70S- 2/ E7018-1**
		FILLETJOINTS / SOCKETJOINTS:**E7018-1**			
		BACKINGRING:N.A.		**CONSUMABLEINSERT:N.A.**	
JOINTPREPARATION		**API1104/ASME SEC.–IX, latest edition**			
GASES	PURGING:		SHIELDING:**Argon**		
GAS COMPOSITION	PURGING:		SHIELDING:**99.995%**		
PREHEATING	PREHEAT/ **INTERPASS**TEMP:**100^{0}C MAX**		POSTHEATING:		
CONTINUITYOFWELDINGANDPREHEAT:REFER TO SPECIFICATION					
POSTWELDHEAT TREATMENT	HOLDINGTEMP:		HOLDINGTIME :		
	RATE OF HEATING:		MIN.HOLDINGTIME :		
	METHODOFCOOLING:		RATEOFCOOLING:		
MECHANICALPROPERTY REQUIREMENTS	CHARPY 'V'NOTCHVALUE :		MIN: **22J**	AVERAGE :**27J**	
	ATTEMPERATURE :		0°C		
	HARDNESS:				
CODEOFFABRICATION:	**API1104/ASME SEC.–IX / B 31.8/ OISD 226,latest edition**				

TECHNICALNOTES :

Rev. : 0
Edition : 1

SPECIFICATION
FOR
HYDROSTATIC TESTING OF ONSHORE PIPELINE

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

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

1.0 SCOPE

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

2.0 REFERENCE CODES, STANDARDS AND SPECIFICATIONS

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

a)	ANSI B 31.8	Gas Transmission and Distribution Piping Systems.
b)	ANSI B 31.4	Liquid Petroleum Transportation Piping Systems.
c)	API RP 1110	Pressure Testing of Liquid Petroleum Pipelines.
d)	ASME Sec. VIII Div-1	Boiler & Pressure Vessel Code.
e)	OISD 226	Natural Gas Transmission Pipelines and City Gas Distribution Networks

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

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

- the words shall and Must are mandatory

- the words Should, May, and Will are non-mandatory, advisory or recommended.

3.0 GENERAL

3.1 Hydrostatic test shall be performed on the entire length of the pipeline. Hydrostatic test shall be performed in accordance with approved Hydrostatic Test Diagrams for each test section. The maximum length of each test section shall not exceed 50 kms.

3.2 For pipeline sections which in COMPANY's opinion, once installed would require an inordinate amount of effort for repair in case of a leak, a provisional pre-test shall be conducted. However, after installation, such pretested sections shall be tested again alongwith the entire pipeline.

3.3 Hydrostatic test shall commence only after mechanical and civil works completion, i.e., all welds have been accepted and the pipeline has been laid and backfilled according to the specifications. Hydrostatic test shall include those sections which have been previously tested, viz. Rail/ road crossing, major water crossings including test on banks and in place after installation, and scraper traps at the terminals. CONTRACTOR shall perform all works required for hydrostatic testing after obtaining prior written approval from the COMPANY.

3.4 The pipeline shall be tested in accordance with the requirements of the latest edition of ANSI B 31.8 or ANSI B 31.4, OISD 226 as applicable, and requirements laid down in this specification.

4.0 HYDROSTATIC TEST PROCEDURE MANUAL

CONTRACTOR shall prepare for COMPANY's approval a hydrostatic test procedure manual. The procedure shall strictly comply with the requirements of this specification and shall be submitted to COMPANY for approval well in advance. The procedure manual shall include all temporary materials & equipment, but not be limited to the following items:

a) For the systems to be tested, a diagram indicating all fittings, vents, valves, temporary connections, relevant elevations and ratings. The diagram shall also indicate injection locations and intake and discharge lines.

b) Estimated amount of test water, water sources, including required concentration of corrosion inhibitors and additives, procedure for inhibitor injection and control of concentration.

c) Filling and flushing procedures, including a complete description of all proposed equipment and instruments (including spares), their location and set-up.

d) The type and sequence of pigs and the pig tracking systems for cleaning and removal of air pockets. Pig inspection procedures, including procedure to be followed in case the calliper pig indicates damage.

e) Procedures for levelling and stabilization after filling and for pressurization and to allow for temperature stabilization.

f) Pressure testing procedure including a complete description of all proposed equipment and instruments (including spares), their location and set-up, and proposed system for observation and recording of data during the pressure test.

g) Procedure for detection and location of leaks.

h) Procedure for dewatering the pipeline section(s) after testing, including a complete description of all proposed equipment and instruments, (including spares), their location and set-up, the type and sequence of pigs and the pig tracking system along with the pig specifications.

i) Forms for recording the test data.

5.0 TEST DURATION AND PRESSURE

5.1 The duration of hydrostatic test shall be a minimum of 24 hours after stabilization and the test pressure shall be as indicated in the approved hydrostatic test diagram.

5.2 Unless specified otherwise in the CONTRACT, the hydrostatic test pressure shall be as follows :

For pipeline handling hydrocarbon in gaseous phase :

a) 1.25 times the design pressure for pipeline located in Class-1 and Class-2 locations as per ASME B 31.8.

b) 1.4 times the design pressure for pipeline located in Class-3 and Class-4 locations as per ASME B 31.8.

6.0 EQUIPMENT AND INSTRUMENTATION

The CONTRACTOR shall furnish all necessary equi pment for performing the work as stated in cleaning, flushing, filling, levelling, stabili ing, testing and dewatering procedures. This shall include the following :

a) Pigs for filling , cleaning and gauging including

- Cleaning pigs with spring loaded steel wire brushes except for internal coated pipes. In this case pigs to be provided with nylon / polyurethane brushes.

- Four cup batching pigs

- Calliper pigs with gauge plate diameter equal to 95 of the heavy wall pipe in the pipe sections. Gauging pig fitted with gauge plate.

The CONTRACTOR shall provide sufficient number of pigs including spares.

b) Fill pumps : The CONTRACTOR shall determine the type and number of fill pumps in order to guarantee the following :

Differential head 20 greater than the maximum required.
Flow rate : 400m^3 / hr. min. 1000m^3 / hr. max.
If a single pump is used, a standby unit must be available.

c) Variable speed positive displacement pumps e quipped 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 wi th a callibration certificate not older than one month.

e) Portable tanks of sufficient si e to provide a continuous supply of water to the pump during pressuri ing.

f) Bourdon pressure gauges of suitable pressure range and accuracy.

g) Dead weight testers with an accuracy of 0.01 bar measuring in increments of 0.05 bar provided with a calibration certificate not older than one month.

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

i) Pressure recording charts.

j) Two temperature recorders for fill water.

k) Thermocouples for measuring the pipe wall temperature.

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

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

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

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

p) The temporary scraper traps shall be installed according to the testing sections fixed in the test procedure manual. Proper piping and valuing arrangements shall be available to allow launching and receiving of each pig independently.

The test heads shall be si ed 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 in creased 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 max imum 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 COMPAN 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 max imum 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, vi . Aerial lengths on piers, suspension bridges, etc., which shall be tested separately.

7.3 The test medium shall be so ft non-aggressive water furnished by the CONTRACTOR. The water to be used shall be filt ered, shall not be contaminated, and fre e from sand or silt. CONTRACTOR shall submit laboratory test reports of water used for testing. The possible use of sea water shall be su bject to its degree of cleanliness, the possibility of obtaining a pre determined salinity neutrali ation and the use of corrosion inhibitors, this at the sole discretion of COMPAN . CONTRACTOR shall provide COMP AN approved corrosion inhibitors, oxyge n scavengers and bac tericides 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 CO NTRACTOR 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 th is purpose temporary headers for air cleaning shall be attached to the pipeline. The number of pig runs is depending upon t he cleaning result s and shall be determined by the COMPAN 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 th e test section. While computing the ID of he aviest wall pipe, pipe manufacturing tolerance shall not be considered. A 10mm thick al uminium 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 re ctify the line and repeat the gauging pig run to the satisfaction and approval of the Company Representative. Any obstruc tion and/ or faults such as dents, buckles, flat spots, etc. analysed and not ed during gauging pig run shall be located and any ne cessary repair work shall be performed to re ctify the same to th e satisfaction of the Company. A w ritten approval shall be obtained from Company regarding successful completion of gauging pig run.

After acceptance of gauging operat ion, air he ader shall be cut and removed. Pre-tested test headers loaded with three numbers of four cup batching pig shall be welded to test Section. Un-inhibited water equal to 10 of the volume of test section shall be introduced in front of the first pig. The first pig shall be launched by introducing about 1.5 km un-inhibited water.

Then the second pig shall be launched by pumping the inhibited water till the second pig is received at the other end. The thermal stablisation and pressurisation can now the started.

7.6 Thermal Stabilization

After a check has been made to confirm if the pressure has attained at least 1 bar (g) on the highest section, thermal stabilization can be started.

Thermal equilibrium between the pipeline and environment shall be checked through the thermocouples installed on the pipeline.

Temperature readings shall be made at 2 hours-intervals. Thermal stabilization shall be considered to have been achieved when a difference not higher than 1°C is attained between the average values of the last two readings. Thermal stabilization completion shall be approved by COMPANY.

7.7 Pressurisation

Pressurisation shall be performed in the presence of COMPANY at moderate and constant rate not exceeding 2 bars/min. One pressure recording gauge shall be installed in parallel with the dead weight tester. Volume required to reach the test pressure shall be recorded periodically throughout the pressurization as follows:

- each 5 bar increments up to 80 of test pressure as recorded by the dead weight tester
- each 2 bar increment between 80 to 90 of test pressure as recorded by the dead weight tester
- each 0.5 bar increment between 90 of test pressure to full test pressure as recorded by the dead weight tester.

The pressurizing shall be cycled according to the following sequence:

a) Pressurize to 50 of test pressure, hold pressure for 1 hour.

b) Drop pressure to static head of test section at test head.

c) Pressurize to 75 of test pressure, hold pressure for 1 hour.

d) Drop pressure to static head of test section at the test head.

e) Pressurize to test pressure.

During the pressurization to each test pressure, two tests shall be carried out for the calculation of air volume in the pipeline under test.

In case, during the hold pressure periods indicated above, a decrease in pressure is observed, the operations shall not be repeated more than twice, after which the line shall not be considered capable of test, until the CONTRACTOR has isolated and eliminated the cause for the lack of water tightness.

7.8 Air Volume Calculation

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

For calculation of air in the pipeline the second pressure lowering shall be used, and the relevant drained water shall be accurately measured (V_1). This amount measured shall be compared to the theoretical amount (V_p) corresponding to the pressure lowering that has been carried out, by using the procedure outlined in clause 12.1 of this specification.

If no air is present in the length under test:

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

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 pressuring 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 pressuring can then continue, to reach the value of test pressure.

7.9 Testing

After the section has been pressured 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 repressuring the line, due to poor workmanship, shall be borne by the CONTRACTOR. In the event of leaks or failures resulting form faulty COMPANY furnished materials, CONTRACTOR shall be reimbursed for furnishing all labour, equipment, materials, except those materials furnished by the COMPANY, and transportation necessary to repair and repressurize the section of the pipeline to the pressure at the time of recognition of leak or line failure. CONTRACTOR shall be entitled for compensation as per the provisions of the CONTRACT. All work of re installing 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. oint 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
- pressuri ation and stabili ation records
- pressure and temperature recording charts with appropriate information inscribed thereon

- temperature data along the pipeline
- dead weight tester logs and recording
- air volume calculations
- pressure change due to temperature change calculations
- environmental data
- depressuri ation logs and records
- dewatering procedure and schematic layout of relevant facilities
- dewatering logs and records
- records and photograph of all leaks.

11.0 MEASUREMENTS

11.1 Water Amount Measurement

The water volume added to the section to be tested shall be measured during the filling stage through a positive displacement meter (a turbine meter may also be used). In the calculation, as per clause 12.1 of this spec ification, use shall be made of the geometrical volume of the section in question.

11.2 Pressure Measurement

Pressure shall be measured wit h 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 sh all 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 me ans of de ad weight tester at the beginning, during and at the end of the hydrostatic test.

A pressure gauge tested with dead weight tester shall be co nnected 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 stabili ation 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 o f a recording thermometer (temperature recorder) throughout the filling stage.

The recording thermometer shall have the following features :

Accuracy 1 of the scale range

Scale - 10° to 40° C

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

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

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

d) Environmental temperature shall be recorded from the beginning of pressuri ation to the end of the test by m eans of a recording thermometer featuring the following characteristics:

Accuracy 1 of the scale range

Scale - 0° to 60° C

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

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

12.0 **CALCULATIONS**

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

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

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

Where:

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

Vt geometrical volume of the section (m^3)

Δ P Pressure rise (bar)

r i nominal inner radius of the pipe (mm)

t nominal pipe thickness(mm)

A isothermal compressibility value for water at the pressuri ation temperature in the P range (bar_{-1}) x 10^6.

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

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:

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

Where,

ΔP pressure change resulting from a temperature change (bar)

ΔT algaebrical difference between water temperature at the beginning of the test and water temperature as measured at the end of the test (°C).

B value of the difference between the thermal expansion of water at the pressure and temperature as measured at the end of the test and that of steel ($°C^{-1}$) x 10^6

(Refer table A)

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

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

t nominal thickness of pipe (mm).

13.0 PRECAUTIONS DURING THE TEST

In addition to all that has been expressly described in the procedures for carrying out the tests, the following additional requirements shall be complied with:

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

13.2 Signs stating PIPE UNDER TEST- EEP OFF with local language transl ation 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 t o prevent access of unauthori ed personnel. No unaut hori ed personnel shall be closer than 40 m to the pipeline or equipment under test.

13.3 Provisional scraper traps sha ll 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 loca tion as to prevent it from being affect ed by a catastrophic failure in the test head.

13.5 Once dewatering is over, the sectionali ing valves and other va lve assemblies tested previously, shall be installed at locations shown in the drawings and in accordance wit h the procedures contained in the relevant specifications. All thermocouple in stalled in the pipeline shall be removed and damaged corrosion coating shall be repaired using COMPAN 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 su fficient quantity of corrosion inhibitors depending upon quality of water and the period of conservation, at a pressure to be agreed upon wit h the COMPAN at a lat er stage. CONTRACTOR sha ll obtain necessary approval from the COMPAN of the procedure and the type and quantity of the inhibitors used before commencement of the works.

TABLE - A

^{0}C Bar	1	2	3 4		5	6 7		8
0.981	-98.62	-79.89	-61.81	-44. 34	-27.47	-11.14	4.66	19.98
10	-95.55	-76.94	-58.99	-41.65	-24.89	-8.67	7.02	22.23
20	-92.15	-73.68	-55.86	-38.64	-22.01	-5.92	9.65	24.74
30	-88.74	-70.40	-52.72	-35.63	-19.14	-3.16	12.29	27.26
40	-85.32	-67.12	-49.58	-32.62	-16.24	-0.41	14.93	29.78
50	-81.90	-63.84	-46.43	-29.60	-13.36	2.36	17.57	32.31
60	-78.47	-60.55	42.27	-26.58	-10.46	5.15	22.89	34.85
70	-75.03	-57.25	-40.10	-23.54	-7.56	7.92	22.89	37.39
80	-71.60	-53.96	-36.94	-20.51	-4.65	10.70	25.55	39.94
90	-68.16	-50.66	-33.77	-17.47	-1.73	13.50	28.23	42.50
100	-64.72	-47.35	-30.60	-14.43	1.18	16.29	30.90	45.05
110	-61.28	-44.05	-27.43	-11.38	4.10	19.08	33.58	47.61
120	-57.84	-40.74	-24.26	-8.34	7.02	21.88	36.26	50.18
130	-54.40	-37.44	-21.08	-5.29	9.95	24.68	38.94	52.75
140	-50.96	-34.13	-17.90	-2.25	12.87	27.49	41.63	55.32
150	-47.53	-30.83	-14.73	0.80	15.79	30.29	44.31	57.89
160	-44.10	-27.53	-11.56	3.85	18.72	33.10	47.00	60.46
170	-40.67	-24.23	-8.40	6.89	21.64	35.90	49.69	63.04
180	-37.24	-20.94	-5.23	9.94	24.56	38.70	52.37	65.62
190	-33.83	-17.65	-2.06	12.98	27.48	41.51	55.06	68.19
200	-30.42	-14.37	1.09	16.01	30.40	44.30	57.75	70.77
210	-27.02	-11.09	4.25	19.04	33.31	47.10	60.43	73.34
220	-23.63	-7.82	7.40	22.06	36.22	49.90	63.12	75.90
230	-20.24	-4.56	10.54	25.08	39.13	52.69	65.80	78.48
240	-16.87	-1.30	13.67	28.10	42.03	55.48	68.48	81.05
250	-13.50	1.94	16.79	31.11	44.92	58.26	71.15	83.61
260	-10.14	5.17	19.90	34.12	47.81	61.04	73.81	86.81
270	-6.80	8.39	23.00	37.11	50.69	63.80	76.48	88.73
280	-3.48	11.60	26.11	40.09	53.56	66.57	79.14	91.29
290	-0.17	14.80	29.19	43.07	56.43	69.33	81.78	93.83
300	3.13	17.98	32.27	46.03	59.29	72.06	84.83	96.38

DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL THERMAL EXPANSION FACTOR (^{0}C $^{-1}$) (10^{-6})

TABLE - A

^{0}C Bar	9	10	11	12	13	14	15
0.981	34.82	4922	63.20	76.78	89.99	102.83	115.34
10	36.97	51.26	65.15	78.64	91.75	104.51	116.93
20	39.36	53.55	67.33	80.71	93.72	106.39	118.71
30	41.76	55.84	69.51	82.79	95.70	108.26	120.49
40	44.18	58.14	71.70	84.87	97.68	110.14	122.28
50	46.60	60.45	73.90	86.96	99.68	112.04	124.07
60	49.02	62.76	76.10	89.07	102.67	113.93	125.88
70	51.44	65.08	78.32	91.17	103.68	115.84	127.69
80	53.88	67.40	80.53	93.29	105.69	117.76	129.50
90	56.32	69.73	82.75	95.41	107.70	119.67	131.32
100	58.77	72.07	84.98	97.53	109.73	121.59	133.15
110	61.21	74.41	87.22	99.66	111.75	123.52	134.98
120	63.67	76.74	89.45	101.79	113.79	125.46	136.82
130	66.12	79.09	91.69	103.93	115.83	127.39	138.67
140	68.58	81.45	93.93	106.07	117.67	129.34	140.51
150	71.05	83.80	96.18	108.21	119.90	131.20	142.37
160	73.51	86.15	18.43	110.36	121.96	133.74	144.22
170	75.97	88.51	100.68	112.51	124.01	135.19	146.08
180	78.44	90.87	102.94	114.66	126.06	137.15	147.94
190	80.91	93.23	105.19	116.82	128.12	139.11	149.81
200	83.37	95.59	107.45	118.97	130.17	141.07	151.68
210	85.84	97.95	109.71	121.13	132.24	143.03	153.55
220	88.30	100.31	111.97	123.29	134.29	144.99	155.42
230	90.67	102.67	114.23	125.45	136.36	146.96	157.30
240	93.22	105.03	116.48	127.60	138.42	148.93	159.18
250	95.69	107.39	118.74	129.76	140.48	150.90	161.05
260	98.14	109.74	121.00	131.92	142.54	152.87	162.93
270	100.60	112.10	123.25	134.08	144.61	154.84	164.81
280	103.05	114.44	125.50	136.24	146.67	156.84	166.69
290	105.50	116.79	127.75	138.39	148.73	158.78	168.57
300	107.94	119.13	130.00	140.54	150.79	160.75	170.45

DIFFERENCE BETWEEN THE THERMAL EXPANSION FACTOR THE STEEL THERMAL EXPANSION FACTOR (^{0}C $^{-1}$) (10^{-6})

TABLE - A

^{0}C Bar	16	17	18 19		20	21 22		23
0.981	127.52	139.41	151.00	162.31	173.37	184.18	194.75	205.08
10	129.02	140.83	152.36	163.58	174.56	185.30	195.79	206.07
20	130.71	142.42	153.85	165.00	175.90	186.55	196.96	207.16
30	132.40	144.02	155.35	166.42	177.23	187.80	198.14	208.26
40	134.10	145.62	156.87	167.85	178.58	189.07	199.33	209.37
50	135.80	147.24	158.39	169.85	179.93	190.34	200.52	210.49
60	137.51	148.86	159.92	170.73	181.29	191.62	201.72	211.61
70	139.22	150.49	161.46	172.18	182.66	192.91	202.93	212.74
80	140.95	152.11	163.00	173.64	184.03	194.20	204.14	213.88
90	142.67	153.75	164.56	175.10	185.41	195.50	205.36	215.03
100	144.42	155.40	166.11	176.58	186.80	196.80	206.59	216.17
110	146.15	157.04	167.66	178.05	188.20	198.12	207.82	217.33
120	147.90	158.70	169.24	179.54	189.59	199.44	209.06	218.49
130	149.65	160.36	170.81	181.02	191.00	200.75	210.31	219.66
140	151.40	162.03	172.39	182.51	192.41	202.09	211.56	220.84
150	153.16	163.70	173.98	184.00	193.82	203.42	212.81	222.02
160	154.93	165.37	175.56	185.51	195.24	204.76	214.08	223.20
170	156.69	167.05	177.15	187.02	196.66	206.10	215.34	224.39
180	158.47	168.73	178.75	188.53	198.09	207.45	216.61	225.55
190	160.24	170.42	180.35	190.05	199.52	208.80	217.89	226.79
200	162.01	172.10	181.95	191.57	200.97	210.16	219.17	227.99
210	163.80	173.80	183.55	193.09	202.40	211.53	220.46	229.20
220	165.58	175.43	185.16	194.62	203.85	212.89	221.74	230.41
230	167.36	177.19	186.78	196.14	205.30	214.26	223.04	231.63
240	169.16	178.89	188.39	197.68	206.75	215.63	224.33	232.85
250	170.94	180.59	190.01	199.21	208.20	217.00	225.63	234.08
260	172.73	182.30	191.63	200.75	209.66	218.40	226.93	235.31
270	174.53	184.00	193.25	202.29	211.12	219.77	228.24	236.54
280	176.32	185.70	194.88	203.83	212.59	221.16	229.55	237.77
290	178.11	187.42	196.50	205.37	214.05	222.54	230.86	239.01
300	179.90	189.13	198.13	206.92	215.51	223.93	232.18	240.26

DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL THERMAL EXPANSION FACTOR ($^0C^{-1}$) (10^{-6})

TABLE -A

^{0}C Bar	24	25	26	27 28 29			30
0.981	215.22	215.14	234.88	244.41	253.79	263.00	272.03
10	216.13	225.99	235.66	245.13	254.44	264.59	272.57
20	217.15	226.94	236.53	245.94	255.18	264.27	273.18
30	218.18	227.88	237.41	246.75	255.93	264.95	273.80
40	219.21	228.85	238.30	247.58	256.69	265.64	274.42
50	220.25	229.82	239.20	248.40	257.45	266.33	275.07
60	221.30	230.79	240.11	249.24	258.22	267.04	275.70
70	222.35	231.78	241.02	250.08	258.99	267.75	276.35
80	223.42	232.77	241.94	250.93	259.78	248.47	277.01
90	224.48	233.76	242.87	251.79	260.57	269.19	277.66
100	225.56	234.76	243.79	252.66	261.36	269.92	278.33
110	226.64	235.78	244.73	253.53	262.17	270.77	279.01
120	227.73	236.79	245.68	254.40	262.98	271.41	279.69
130	228.82	237.81	246.63	255.28	263.69	272.16	280.38
140	229.92	238.84	247.59	25618	264.62	272.92	281.08
150	231.03	239.87	248.55	257.07	265.44	273.69	281.78
160	232.14	240.91	249.52	257.97	266.28	274.46	282.49
170	233.26	241.96	250.49	258.88	267.12	275.23	283.20
180	234.38	243.01	251.47	259.79	267.97	276.01	283.92
190	235.51	244.06	252.46	260.71	268.82	276.80	284.64
200	236.64	245.12	253.45	261.63	269.67	277.59	285.37
210	237.77	246.18	254.45	262.50	270.54	278.39	286.11
220	238.91	247.26	255.45	263.49	271.40	279.19	286.85
230	240.06	248.33	256.46	264.43	272.28	280.00	287.59
240	241.21	249.41	257.46	265.37	273.16	280.82	288.35
250	242.36	250.49	258.48	266.31	274.04	281.63	289.11
260	243.52	251.58	259.49	267.27	274.92	282.46	289.86
270	244.68	252.66	260.52	268.23	275.82	283.29	290.64
280	245.84	253.76	261.54	269.18	276.71	284.12	291.40
290	247.01	254.86	262.57	270.15	277.61	284.95	292.18
300	248.18	255.96	263.60	271.11	278.51	285.79	292.95

DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL THERMAL EXPANSION FACTOR (^{0}C $^{-1}$) (10 $^{-6}$)

Rev. : 0
Edition : 1

SPECIFICATION

FOR

FIELD JOINT COATING (ONSHORE PIPELINES)

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

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

1.0 SCOPE

This specification covers the minimum requirements of materials, equipment and installation of field joint anti-corrosion coating of underground onshore factory coated pipelines with either three layer polyethylene or fusion bonded epoxy (FBE) coating by heat shrink wraparound sleeves conforming to DIN EN 12068 – "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.

b) ASTM D-257 : Standard Test Methods for D-C Resistance or conductance of insulating materials.

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

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

e) ISO:8503-1 : Part-1 : Specification and definitions for ISO surface profile comparator for the assessment of abrasive blast cleaned surfaces.

f) ISO:8503-4 : Part-4 : Methods for calibration of ISO surface profile comparator and for the determination of surface profile – Stylus instrument procedure.

g) SIS-055900 : Pictorial surface Preparation Standard for Painting Steel Surfaces.

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

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

The Contractor shall be familiar with the requirements of these documents and shall make them readily available at the site to all personnel concerned with carrying out the works specified in this specification.

3.0 MATERIALS AND EQUIPMENT

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

3.2.1 Heat Shrinkable Wraparound Sleeve

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

The total thickness of heat shrinkable wraparound sleeve in the as applied condition shall be as follows :

Pipe Size (Specified Outside Diameter)	Thickness (mm)	
	On Pipe Body (Min.)	On Weld Bead (Min.)
4" (114.3 mm) to 10" (273.0 mm)	2.0 mm	1.6 mm
12" (323.9 mm) to 18" (457.2 mm)	2.2 mm	1.8 mm
20" (508.0 mm) to 30" (762.0 mm)	2.5 mm	2.0 mm
≥ 32" (812.8 mm)	3.0 mm	2.5 mm

The heat shrink wraparound sleeve shall have the required adhesive properties when applied on various commercial pipe-coating materials. The pre-heat and application temperatures required for the application of the shrink sleeve shall not cause loss of functional properties of the pipe coating.

Heat shrinkable wraparound field joint coating system manufactured by M/s Covalence and M/s Canusa are acceptable for the supply of field joint coating materials. The Contractor shall propose the specific grade of field joint coating system meeting the requirements of this specification from these manufacturers. In case the Contractor proposes to supply heat shrinkable wraparound sleeve from any other manufacturer, then the Contractor shall propose only those coating systems that have been previously used for pipelines of size same or higher than the size indicated in tender, for a length of 50 km and above in a single project for similar operating conditions.

3.2.2 **Cold Applied Tapes**

Cold applied tape system shall comprise of primer, an inner wrap and an outer wrap. The inner and outer wraps shall be asymmetric 3-ply tape with co-extruded polyethylene carrier film and butyl rubber adhesive layers on both sides. The inner layer of butyl rubber adhesive of inner wrap shall have a thickness of min. 1.0 mm. The inner and outer wraps are to be spirally wrapped with 55% overlap, equivalent to two layers each providing a total minimum thickness of 3.0 mm on the pipe body and 2.5 mm on the weld.

The Contractor shall propose only those cold applied tape coating systems that have been previously used in pipelines of size 16" and above and a length of 50 km and above in a single project for similar operating conditions.

3.3 **Functional Requirements of Field Joint Coating**

3.3.1 Properties of the PE backing and the as applied joint corrosion coating shall be as follows :

Sl. No.	Property Uni	t	Requirement	Test Method
i)	Tensile Strength @+25°C N/	mm^2	≥12 DI	N EN 12068
ii)	Ultimate Elongation % @+ 25°C	%	≥250 DI	N EN 12068
iii)	Dielectric withstand KV with 1000 Volts/sec	kv	≥30 AST	M D 149
iv)	Water absorption @+ 25°C for 24 hours	%	≤0.05 AST	M D 570
v)	Volume Resistivity @+25°C Oh	m-cm	$\geq 10^{15}$ AST	M D 257
vi)	Resistance to thermal aging at 100°C	% Chang e in elongation ≤ 250		DIN 30672

3.3.2 **Functional Properties of Joint Coating System (As applied)**

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

a) Cathodic Disbondm ent Resist ance at T_{max} i. e. 60°Cshall be 20m m w hen tested as per Annexure K of DIN EN 12068. T est shall be car ried out at (+) 60°C.

b) Peel Strength shall be as follows :

Peel Strength		Unit	Requirement for Mech Resistance Class C (Minimum)	Test Method as per DIN EN 12068
Inner to Inner + Outer to Inner	@23°C N/	mm	1.5	Annexure-B
	@T_{max} N/	mm	0.3	
Outer to Outer	@23°C N/	mm	1.5	
	@T_{max} N/	mm	0.3	
To Pipe Surface	@23°C N/	mm	3.5	Annexure-C
	@T_{max} N/	mm	0.3	
To Factory Coating	@23°C N/	mm	3.5	
	@T_{max} N/	mm	0.3	

Notes

(T_{max} shall be (+) 60°C)

Contractor shall obtain prior approval from Company regarding the manufacturer of the joint coating material. Complete technical details alongwith test certificates complying with the requirements of clause 3.2.1 and 3.2.2 shall be submitted to Company for this purpose. The Contractor shall furnish test certificates from an independent DIN recognized / approved laboratory for all the properties required for the specified EN designation of field joint coating and the requirements of this specification.

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

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

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

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

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

3.6 CONTRACTOR shall provide and maintain mobile facilities which contains all necessary equipment and its spares for cleaning, coating repairs, inspection and tests.

3.7 CONTRACTOR shall furnish sufficient number of the following equipment and the required spares as a minimum for inspection and test purpose for each crew.

a) Fully automatic full circle adjustable holiday detector with a visible and audible signal system for inspection of coatings.
b) Thickness gauge for measuring thickness.
c) Contact type temperature recording thermometer (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° 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 :

- Relative Humidity (RH) > 80% - 2 Hours
- Relative Humidity (RH) 70-80% - 3 Hours
- Relative Humidity (RH) < 70% - 4 Hours

Pipes delayed beyond this point or pipes showing any visible rust stain shall be blast cleaned again.

4.1.5 The field joint surface shall be inspected immediately after blast cleaning and any feature of the steel surface such as weld spatter, scabs, laminations or other imperfections considered injurious to the coating integrity made visible during blast cleaning shall be reported to the Company Representative and on permission from Company Representative, such defects shall be removed by filing or grinding. Pipes affected in this manner shall be then re-blast cleaned if the defective area is larger than 50 mm in diameter.

4.1.6 The ends of existing pipe protective coating shall be inspected and chamfered. Unbounded portions of the coating shall be removed and then suitably trimmed. Portions where parent coating is removed shall be thoroughly cleaned as specified. The adjacent chamfered areas of the line pipe coating shall be cleaned and abraded, to expose a clean uniform fresh surface of uncontaminated factory applied coating.

4.1.7 All steel joint surfaces shall be thoroughly examined before the application of the coating in order to ensure the surface are free of soil, grease, rust, mud, earth or any other foreign matter. All these substances shall be removed before coating, to the procedures herein described.

4.1.8 Protection coating shall be applied on the joints immediately after the completion of cleaning operation.

4.2 **Application of Heat Shrink Wraparound Sleeves**

In addition to the general requirements stated above, following shall be taken into account :

4.2.1 The wrap around sleeves shall be of a size such that a minimum overlap of 50mm is ensured (after shrinking) on both sides of yard applied corrosion coating of the pipes.

In cases where carrier pipe is installed by direct boring/jacking, the overlap on the mill coating for the leading edges of the joints shall be minimum 200mm. When this extra overlap is achieved by providing an additional patch of heat shrink tape/wraparound, it shall be applied in such a manner that the square edge of the patch on the joint coating is in the direction opposite to the direction of boring/jacking.

4.2.2 Before centering the wraparound sleeve, the bare steel surface shall be preheated with torch moved back and forth over the surface or by induction heating. The minimum preheat temperature shall be as recommended by manufacturer and shall be checked by means of contact type temperature recording thermometer (Digital Pyrometer with flat probe type contract) to check this, approved temperature indicates shall be used. Temperature indicating crayons shall not be used. Pre-heat temperature shall be checked on every joint. Care shall be taken to ensure that the entire circumference of the pipe is heated evenly. Temperature measuring instruments shall be calibrated immediately before the start of the works and thereafter at intervals recommended by the manufacturer of the instrument.

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

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

4.2.5 A heat shrinking procedure shall be applied to shrink the sleeve in such a manner to start shrinkage of the sleeve beginning from the center of the sleeve and heat circumferentially around the pipe. Continue heating from the center towards one end of the sleeve until recovery is completed. In a similar manner, heat and shrink the remaining side. Shrinking has been completed when the adhesive begins to ooze at the sleeve edges all around the circumference.

The complete shrinking of the entire sleeve shall be obtained without undue heating of existing pipe coating and providing due bonding between pipe, sleeve and pipe coating. The installed sleeve shall not be disturbed until the adhesive has solidified.

The coatings mentioned are for undergrounds installations.

For HDD Joint Coating fiber glass reinforced heat shrinkable sleeve certified to Stress class C60 type CANUSA- TBK or 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 aboveground pipe to underground pipe special coating material FIBAROLL or equivalent to be used over the coated part of U.G. pipe and painted part of A.G. Pipe end overlapping 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 to the adjoining yard applied coating. Outer wrap shall also be applied in similar method.

In the cases where carrier pipe is installed by direct boring/jacking, the overlap on the mill coating for the leading edges of the joints shall be minimum 200mm. The direction of spiral wrapping in these cases shall be such that the square edge of the wrapping with the joint coating is in the direction opposite to the direction of boring/jacking.

4.4 **Pre-Qualification of Field Joint Coating System**

The field joint coating system materials and the procedures proposed by the Contractor shall be pre-qualified during the sleeve installation start-up phase. Five joints (5) shall be coated with the requirements of this specification and then inspected and tested in accordance with the requirements of this specification with respect to the following :

i) Surface preparation cleanliness, roughness profile and dust contamination
ii) Pre-heat temperature (as applicable)
iii) Primer thickness
iv) As applied coating thickness
v) Holiday detection
vi) Peel test at (+) 23°C & (+) 60°C on pipe surface & factory applied coating and at overlaps (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 applied coating. (To establish voids adjoining the weld and factory coating a strip of 50 mm wide and 200 mm long shall be stripped and examined).

Company Representative shall witness the tests and inspection. Regular application of field joint coating shall commence only upon successful completion of the pre-qualification testing.

After successful completion of the pre-qualification testing as above, the entire field joint coating shall be removed, the pipe surface re-blasted and field joint coating re-applied as per the requirements of this specification.

5.0 **INSPECTION**

5.1 A visual inspection shall be carried out for the following :

- Mastic extrusion on either ends of the sleeve shall be examined. (applicable for heat shrink wraparounds).
- There shall be no sign of punctures or pinholes or bend failure. The external appearance of the sleeve shall be smooth, free of dimples, air entrapment or void formation.
- Weld bead profile shall be visible through the sleeve.
- The entire closure patch shall have changed colour uniformly (applicable for heat shrink wraparounds).

5.2 **Holiday Inspection**

The holiday detector used shall be checked and calibrated daily with an accurate DC voltmeter. The detector electrode shall be in direct contact with the surface of coating to be inspected.

The entire surface of the joint section shall be inspected by means of a full circle holiday detector approved by Company set to a DC voltage of at least 25 kV. Inspection of the sleeves shall be conducted only after the joint has cooled below 50°C. (applicable for heat shrink wraparounds).

5.3 No field joint shall be covered or lowered in the trench until it has been approved by the Company.

5.4 **As-applied Coating Thickness**

Coating thickness shall be checked by non-destructed methods for each field joint. Average thickness of the as-applied coating on pipe body shall be established based on measurement at min. eight locations i.e. four measurement on either sides of the girth weld at 3, 6, 9, & 12 O'clock positions. To establish the minimum thickness on the girth weld, four measurement shall be taken on apex on the weld at 3, 6, 9 & 12 O'clock positions. All such measurements shall be recorded. Company Representative reserves the right to ask for additional measurement at any location on the field joint coating, whenever doubt arises.

6.0 **TESTING**

6.1 Company reserves the right to remove and test one out of every 50 joint coatings or one joint coating out of every day's production whichever is stringent. Contractor shall provide all assistance in removing and testing of field joint coatings.

6.2 From each test sleeve, one or more strips of size 25mm x 200 shall be cut perpendicular to the pipe axis and slowly peeled off.

The required peel strength shall meet the requirements of clause 3.2.4.2 (ii) as applicable for 23 °C or 60 °C whichever is feasible. This test shall be conducted between wrapping & metal and mill coating & between layers at overlap with joint coating (wherever applicable). After removal of strip the bulk of adhesive shall remain adhered to the pipe showing on bare metal, otherwise, test shall be considered failed. The adhesive layer that remains on the pipe surface shall generally be free of voids resulting from air or gas inclusion. In case the peel strength test at a different temperature than that specified in warranted due to the ambient site conditions, then the peel strength shall comply the recommendation of the manufacturer. Manufacturer

shall be asked to furnish peel strength values corresponding to various expected temperatures, prior to start of the works.

6.3 If the sleeve taken away for test does not meet the requirements of clause 6.2 the adjacent two sleeves shall also be removed and inspected.

If the adjacent two sleeves are acceptable the test rate shall be increased to one sleeve in every twenty five until Company's Representative is satisfied. The test rate can then be reduced as per clause 6.1.

If either or both of the adjacent two sleeves do not meet the requirements of clause 6.2, the field coating shall be stopped. (Refer clause 7.0).

6.4 Company Representative reserve the right of 100% removal of sleeves if he is not convinced that the requirements of clause 6.2 are achieved.

6.5 Coating thickness shall be checked by non-destructive methods for each fields joints.

7.0 **REPAIRS**

7.1 If a field joint is detected to be unacceptable after testing as per section 6.0 of this specification the Contractor shall, at his own cost :

- determine the cause of the faulty results of the field coating.
- mobilise the expert of manufacturer, if required.
- test to the complete satisfaction of the Company, already completed field coatings.
- stop field coating until remedial measures are taken against the causes of such faults, to the entire satisfaction of the Company.

7.2 Contractor shall replace all joint coating found or expected to be unacceptable as per section 6.0 of this specification.

7.3 Contractor shall, at his own cost repair all areas where the coating has been removed for testing by the Company.

7.4 After the coating work on welded joints, fittings and repairs to the coating have been completed the coating as a whole shall be tested with a spark-tester before lowering or jacking the pipeline.

7.5 Company shall be entitled to check the coating on buried pipelines or parts of pipelines with equipment such as the " Pearson Meter" and the resistance meter. If Coating defects are establish, the Contractor shall be responsible for excavations at such points, repairing the coating, spark testing and backfilling the excavation without extra charge.

8.0 DOCUMENTATION

8.1 Prior to procurement of coating materials, Contractor shall furnish the following information for qualification of the Manufacturer and material :

i. Complete descriptive technical catalogs describing the materials offered along with samples of corrosion coating materials, its properties and application instruction as applicable specifically to the project.

ii. Test certificates and results of previously conducted tests, for all properties listed in clause 3.2.4 of this specification.

iii. Reference list of previous supplies, in last 5 years, of the similar material indicating the project details such as diameter, quantity, operating temperature, years of supply, project name, contact person and feed back on performance.

Once the 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.

Rev. : 0
Edition : 1

SPECIFICATION
FOR
VENTS, DRAINS AND WELLS

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

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION OIL & GAS SBU, DELHI		
TITLE	VENTS, DRAINS AND WELLS	DOCUMENT NO. MEC/S/05/21/15	Page 1 of 1 REVISION : 0 EDITION : 1

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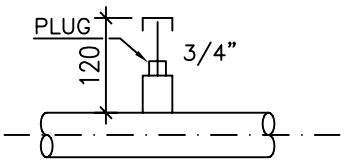
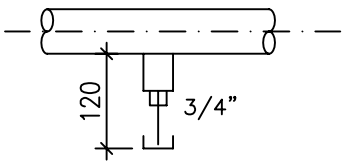
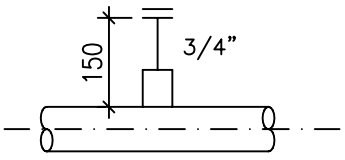
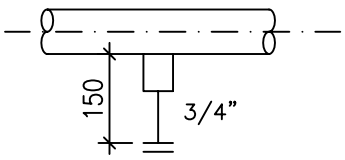
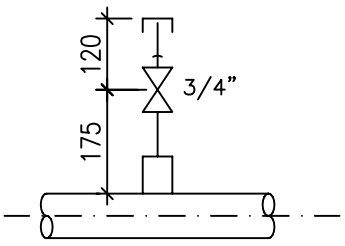
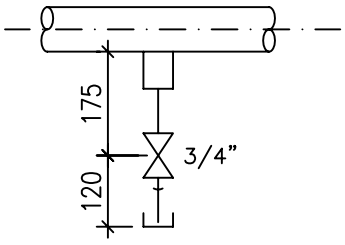
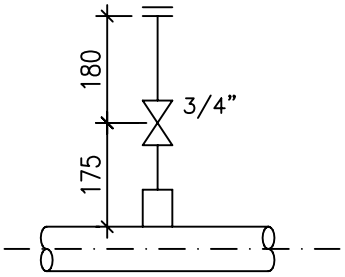
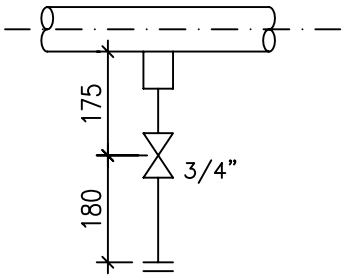
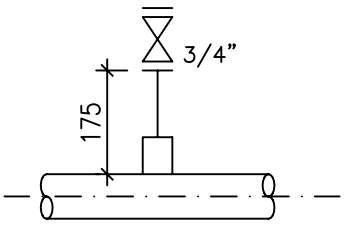
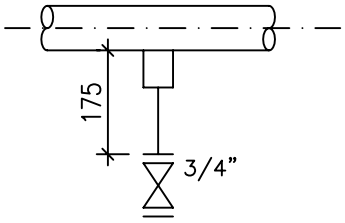
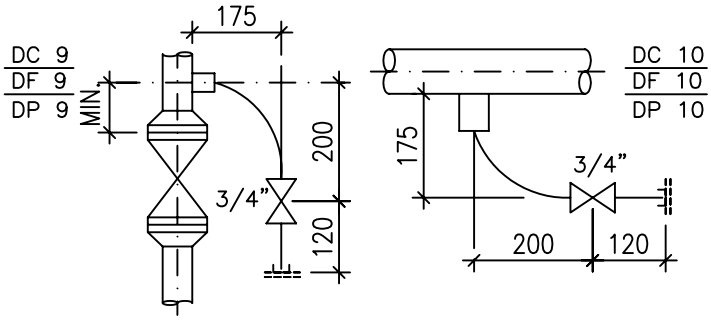
TYPE	VENT	DRAIN
V1 / V1P		D1 / D1P 
V2		D2 
V3 / V3P		D3 / D3P 
V4		D4 
V5		D5 

NOTES:–

1. DIMENSIONS ARE VALID FOR 75mm (MAX.) THICKNESS INSULATION FOR HIGHER INSULATION THICKNES INCASE DIMENSIONS AS REQUIRED.
2. VENTS & DRAINS SHALL BE PROVIDED WITH GATE, GLOBE OR PLUG VALVE WITH HALF COUPLING OR STUB IN WITH CAP OR FLANGE, BLIND FLANGE, AS PER PIPING SPECIFICATIONS.
3. VENTS/DRAINS CAN BE PROVIDED ON FLAT SIDE OF ECCENTRIC REDUCERS ON SIZES 4" & ABOVE.
4. LEGEND V=VENT, D=DRAIN, C=CAP, F=FLANGE, P=PLUG
5. PLUGGED END OF VALVE OR FITTING SHALL BE THREADED.



REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.

REVISIONS

SECTION: P&PD	NAME	DATE	CHKD	DATE
DSGN				
DRWN				
APPROVED				

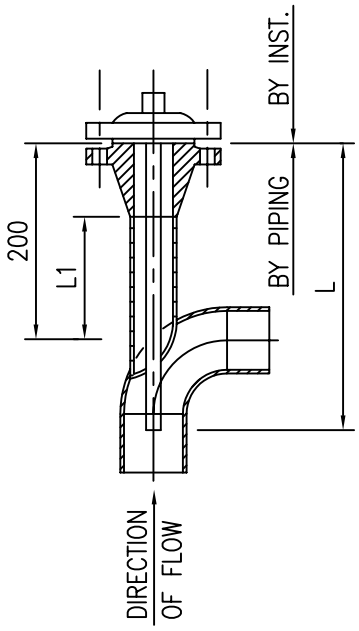
VENT & DRAIN FOR LINES 2" & ABOVE

MECON LIMITED

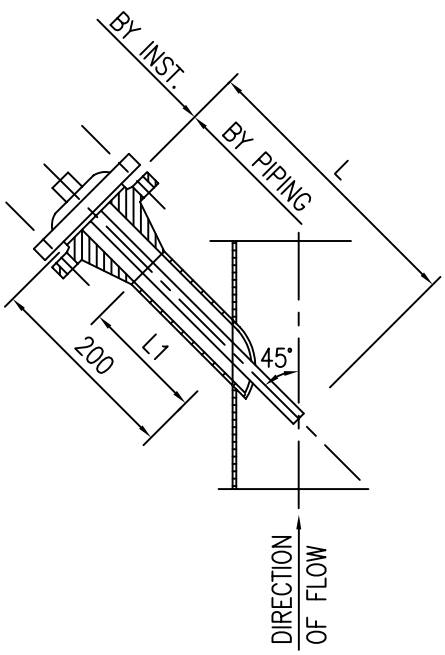
SCALE : N.T.S.

DRG.NO MEC/SD/05/21/15/01

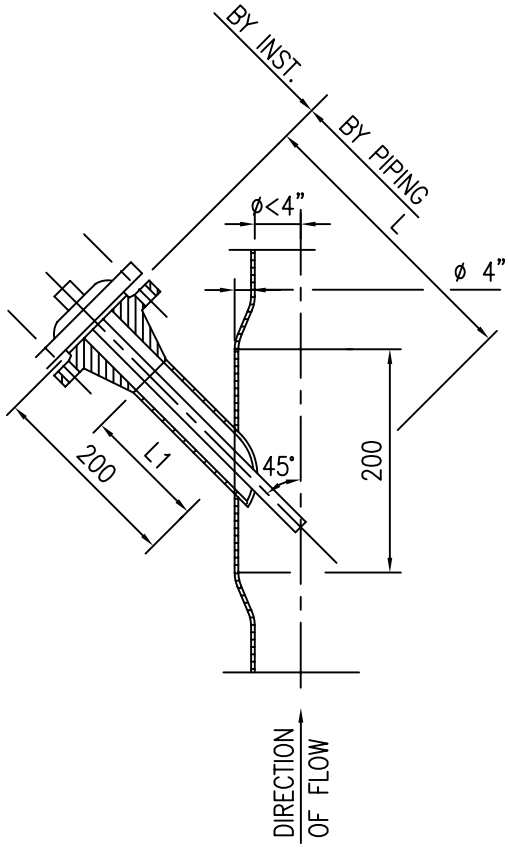
REV 0



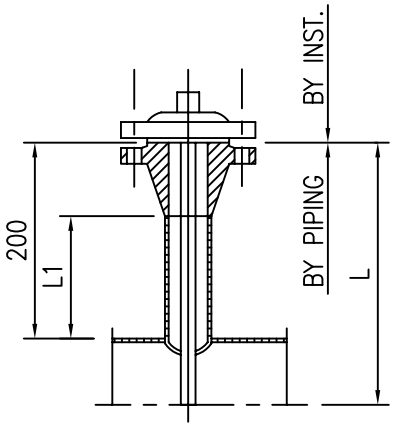
TYPE TW-1



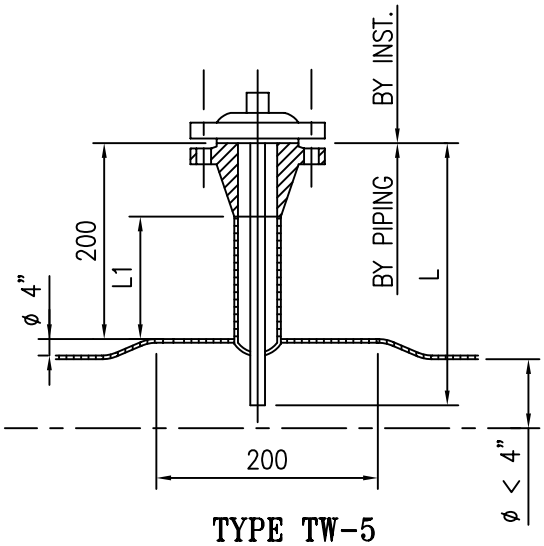
TYPE TW-2



TYPE TW-4



TYPE TW-3



TYPE TW-5

LINE DIA	L 1.5" FLANGED WELL
4"	200
6"	300
8"	300
10"	300
12"	300
14"	300
16"	400
18"	400
20" & LARGER	500
VESSELS	AS REQUIRED

1. ELBOW MIN. 4" ø OR LARGER
2. VERTICAL LINE 4" ø OR LARGER
3. HORIZONTAL LINE 4" ø OR LARGER
4. VERTICAL LINE DIA LESS THAN 4"
5. HORIZONTAL LINE DIA LESS THAN 4"

NOTES:

1. BOLTS, NUTS AND GASCKETS BY PIPING.
2. MIN. CLEARANCE FOR REMOVAL L+550
3. L1 DIMENSIONS ARE CALCULATED FOR WN, RF FLG. ONLY.
4. IN CASE ANY DEVIATION IS REQUIRED FOR INSTALATION TAPS FROM THIS STD. INST. DEPTT. TO BE CONSULTED.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
			REVISIONS				

SECTION: P&PD	NAME	DATE	CHKD	DATE
DSGN				
DRWN				
APPROVED				

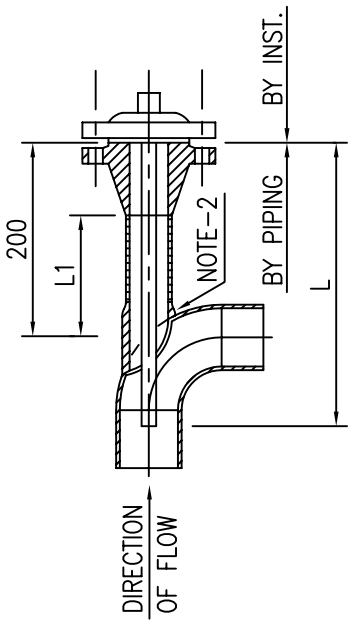
WELLS INSTALLATION
1½" DIA TAPS

MECON LIMITED

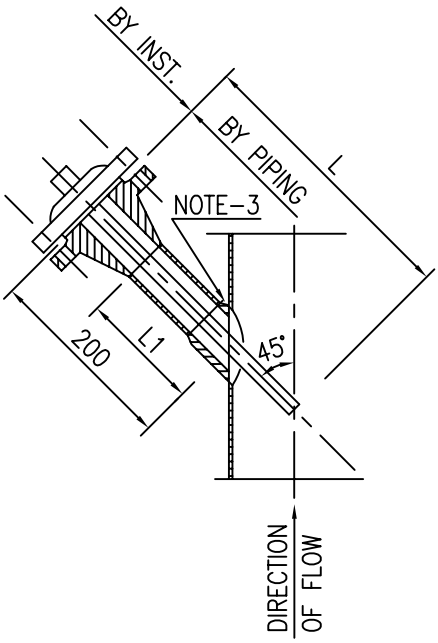
SCALE : N.T.S.

DRG.NO MEC/SD/05/21/15/02 (SH. 1 OF 2)

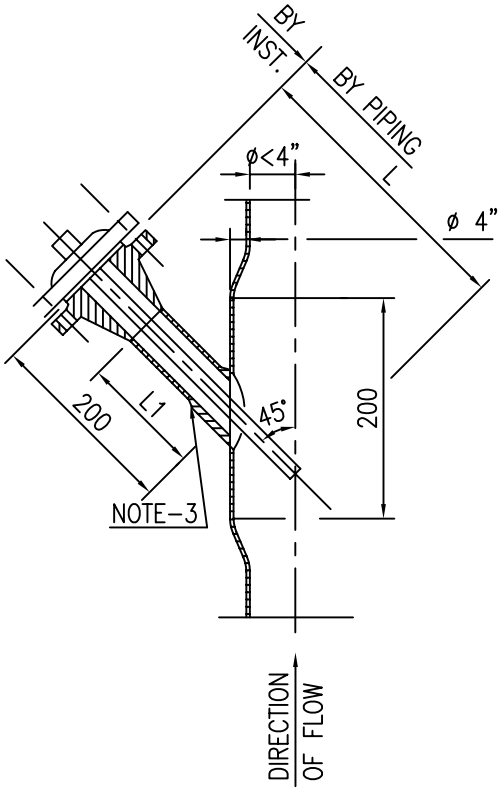
REV 0



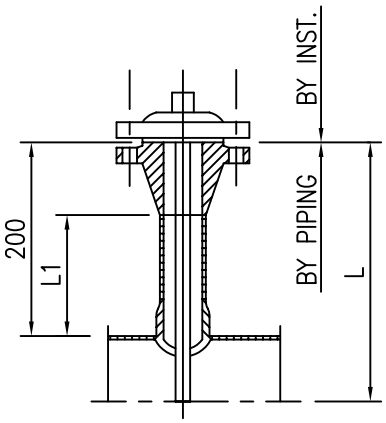
TYPE TW-6



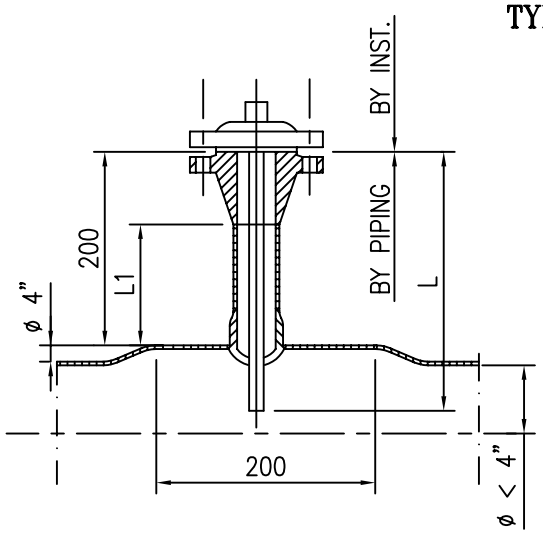
TYPE TW-7



TYPE TW-9



TYPE TW-8



TYPE TW-10

LINE DIA	L 1.5" FLANGED WELD
4"	200
6"	300
8"	300
10"	300
12"	300
14"	300
16"	400
18"	400
20" & LARGER	500
VESSELS	AS REQUIRED

6. ELBOW MIN. 4" ø OR LARGER
7. VERTICAL LINE 4" ø OR LARGER
8. HORIZONTAL LINE 4" ø OR LARGER
9. VERTICAL LINE DIA LESS THAN 4"
10. HORIZONTAL LINE DIA LESS THAN 4"

NOTES:

1. BOLTS, NUTS AND GASCKETS BY PIPING.
2. MIN. CLEARANCE FOR REMOVAL L+350.
3. COUPLING TO BE SPECIAL LENGTH.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
			REVISIONS				

SECTION: P&PD

	NAME	DATE	CHKD	DATE
DSGN				
DRWN				

APPROVED

WELLS INSTALLATION
1 1/2" DIA TAPS

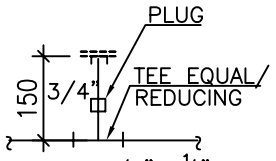
MECON LIMITED

SCALE : N.T.S.

DRG.NO MEC/SD/05/21/15/02 (SH. 2 OF 2)

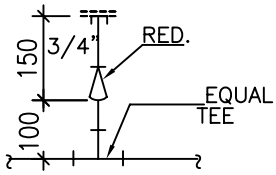
REV 0

VC 2
VF 2
VP 2



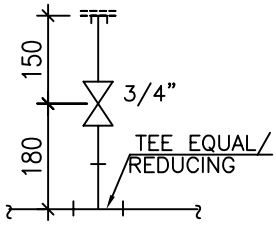
VENT ON LINE 3/4"–1½"

VC 2
VF 2
VP 2



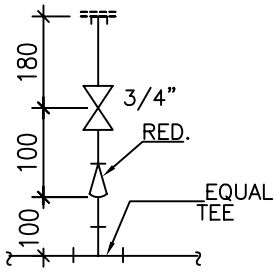
VENT ON LINE 1"–1½"

VC 3
VF 3
VP 3



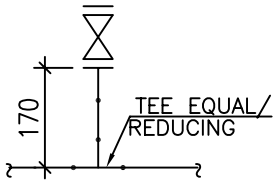
VENT ON LINE 3/4"–1½"

VC 4
VF 4
VP 4



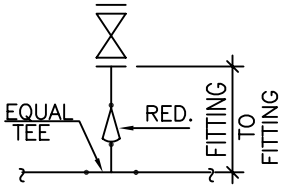
VENT ON LINE 1"–1½"

VC 5
VF 5

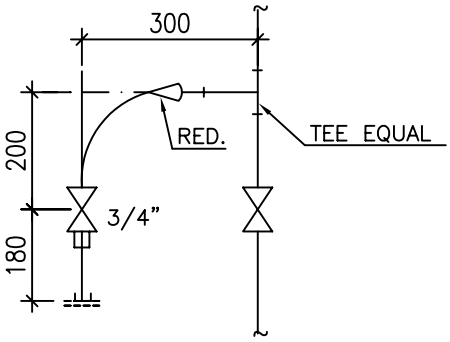


VENT ON LINE 3/4"–1½"

VC 6
VF 6

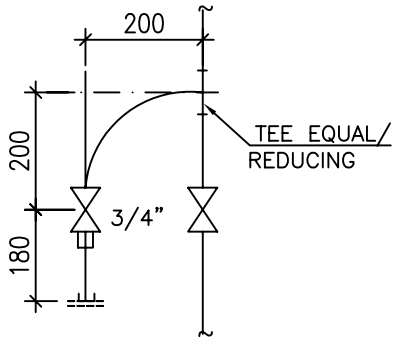


VENT ON LINE 1"–1½"



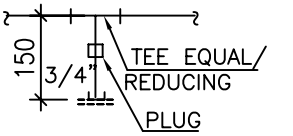
DRAIN ON LINE 1"–1½"

DC 7
DF 7
DP 7



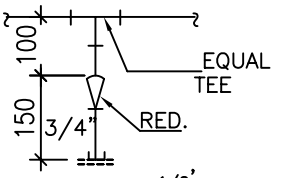
DRAIN ON LINE 3/4"–1½"

DC 8
DF 8
DP 8



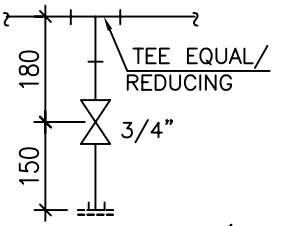
DC 2
DF 2
DP 2

DRAIN ON LINE 3/4"–1½"



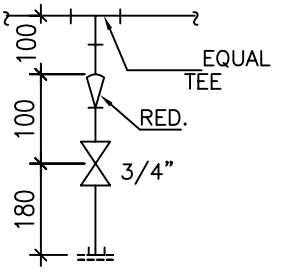
DC 2
DF 2
DP 2

DRAIN ON LINE 1'–1$^{1/2}$'



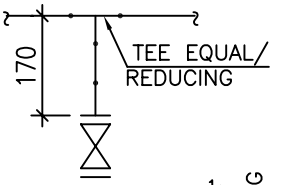
DC 3
DF 3
DP 3

DRAIN ON LINE 3/4"–1½"



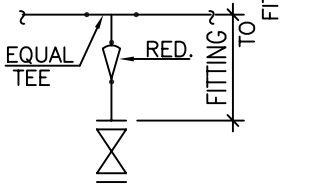
DC 4
DF 4
DP 4

DRAIN ON LINE 1"–1½"



DC 5
DF 5

DRAIN ON LINE 3/4"–1½"



DC 6
DF 6

DRAIN ON LINE 1"–1½"

NOTES:–

1. DIMENSIONS ARE VALID FOR 50mm (MAX.) THICKNESS INSULATION. FOR HIGHER INSULATION THICKNES INCASE DIMENSIONS AS REQUIRED.
2. VENTS & DRAINS SHALL BE PROVIDED WITH GATE, GLOBE OR PLUG VALVE
3. LEGEND V=VENT, D=DRAIN, C=CAP, F=FLANGE, R=REDUCER, COUPLING OR SWAGE, P=PLUG
4. PLUGGED END OF VALVE OR FITTING SHALL BE THREADED.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
			REVISIONS				

SECTION: P&PD

	NAME	DATE	CHKD	DATE
DSGN				
DRWN				

APPROVED

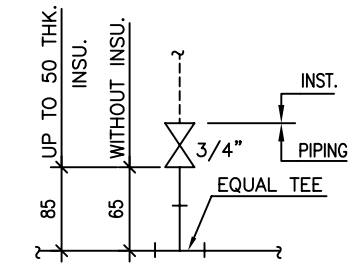
VENT & DRAIN ON LINES 1½" & BELOW

MECON LIMITED

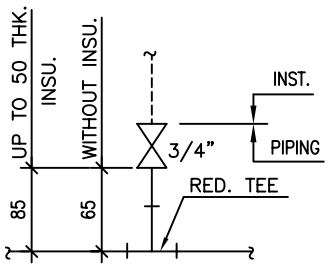
SCALE : N.T.S.

DRG.NO MEC/SD/05/21/15/03

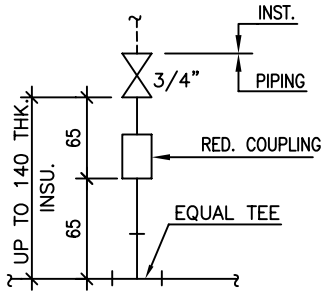
REV 0



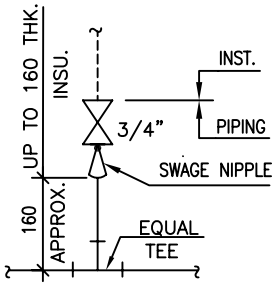
PC-1 ON LINE 3/4"



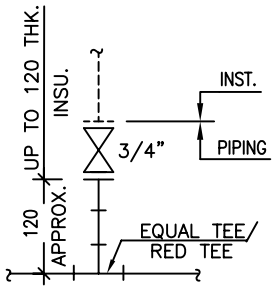
PC-2 ON LINE 1"-1 1/2"



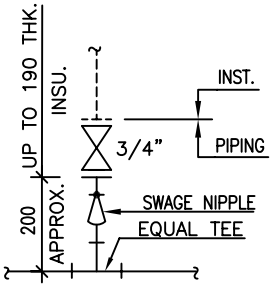
PC-3 ON LINE 1"-1 1/2"



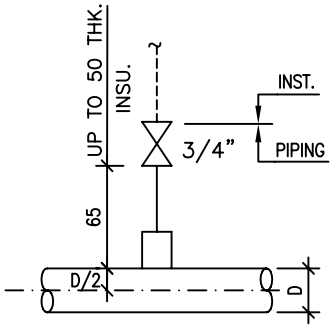
PC-4 ON LINE 1"-1 1/2"



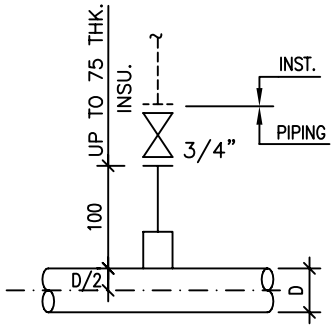
PC-5 ON LINE 3/4"-1 1/2"



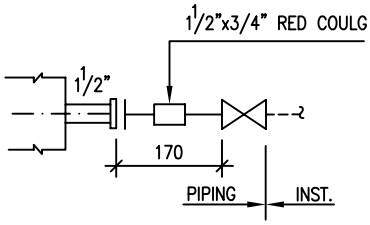
PC-6 ON LINE 1"-1 1/2"



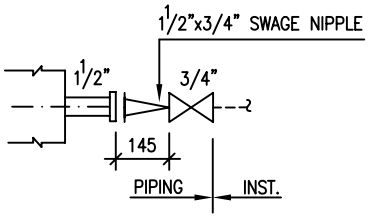
PC-10 ON LINE 2" & ABOVE



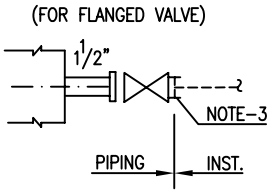
PC-11 ON LINE 2" & ABOVE



PC-12



PC-13



PC-14

PC-15 WITH 2" VALVE

ON VESSELS/ COLUMNS

NOTES:-

1. THE INDICATED DIMENSIONS ARE IN MINIMUM WHICH ALSO COVER INSULATION TO THE EXTENT SHOWN ABOVE. IN HIGHER THICKNESS OF INSULATION THAN INDICATED, THE DIFFERENCE SHALL BE ADDED IN THE DIMENSIONS SHOWN ABOVE ACCORDINGLY.
2. PRESSURE TAPPING SHALL BE PROVIDED WITH GATE, GLOBE OR PLUG VALVE WITH TEE, HALF COUPLING OR STUB-IN, AS PER PIPING SPECIFICATION.
3. IN CASE OF FLGD. VALVES BOLTING & GASKET ON BOTH SIDES OF VALVE SHALL BE IN PIPING SCOPE.
4. IN CASE OF TAPPINGS PROVIDED OTHER THAN INDICATED IN THIS STD FOR LAYOUT REASONS DETAILED DIMENSIONS WILL BE CALLED OUT.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD		
REVISIONS						REFERENCES	DRG. NO.

SECTION: P&PD

	NAME	DATE	CHKD	DATE
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APPROVED

PRESSURE TAPPING

MECON LIMITED

SCALE : N.T.S.

DRG.NO MEC/ SD/05/21/15/05

REV 0

Rev. : 0
Edition : 1

SPECIFICATION
FOR
GASKETS, BOLTS & NUTS

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

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

TECHNICAL NOTES FOR GASKETS

1.0 All gaskets shall conform to the codes/standards and specifications given in the requisition. Vendor shall strictly comply with MR / PR stipulations and no deviations shall be permitted.

2.0 Process of manufacture, dimensions and tolerances not specified in requisition shall be in accordance with the requirements of the manufacturer s standards.

3.0 Test reports shall be supplied for all mandatory tests for gaskets as per the standards specified in the requisition.

4.0 Chemical composition and hardness of RT gaskets shall also be furnished in the form of test reports on samples.

5.0 For Spiral wound material following shall be furnished:

a. Manufacturer s test certificate for filler material and spiral material as per the relevant material specifications.

b. Manufacturer s test certificate for raw materials and tests for compressibility / seal-ability & recovery as per the relevant material specifications.

6.0 Full face gaskets shall have bolt holes punched out.

7.0 Filler material for spiral wound gaskets shall not have any colour or dye.

8.0 All spiral wound gaskets shall be supplied with Outer ring. Material of the outer ring shall be CS unless other wise specified in the MR.

9.0 For spiral wound gaskets, material of Inner Compression ring shall be same as Spiral Strip material. In addition to the requirements as per code and as specified in the MR, inner rings shall be provided for the following:

a. Sizes 26 and above.

b. Class 900 and above.

10.0 Hardness of metallic RT gaskets shall not exceed the values specified below unless otherwise specified in MR :

Ring Gasket Material	**Maximum Hardness (BHN)**
Soft Iron	90
Carbon steel	120
5 Cr. Mo	130
Type 304, 316, 321, 347	140
Type 304L, 316L	120

11.0 Face finish of metallic RT gaskets shall be 32 to 63 AARH.

12.0 Gaskets of different types and si es shall be placed in separate shipping containers and each container clearly marked with the si e, rating, material specification and item code.

13.0 All items shall be inspected and approved by MECON Inspector or any other agency authori ed 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 si e) and to ASME B16.47B above 24 unless specified otherwise. For 22 si e, 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 si e) and to ASME B16.47B above 24 unless specifically mentioned otherwise. For 22 si e, 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 req uirements and marking for all stud bolts, m/c bolts, jack screws & nuts shall be in accordance with the codes / standards and specification give n in the requisition. The applic able 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 supplie d for all mandat ory tests as per t he relevant material specifications.

3.0 Material test certificate shall also be fu rnished. (Heat Analysis, Produc t Analysis and Mechanical Requirement)

4.0 Stress Rupture Test as detailed in AST M A453 shall be carried out for all AST M A453 bolting material irrespective of the temperature.

5.0 All bolting shall be as per ANSI B 18.2.1 for st uds. M/c bolts and jackscrews and ANSI BI8.2.2 for nuts.

6.0 Threads shall be unified (UNC for 1 dia and BUN for 1 dia) as per ANSI B.1.1 with class 2A fit for studs, M/c bolts and jackscrews and class 2B fit for nuts.

7.0 Stud bolts shall be threaded fu ll 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 bo lts shall be heavy hex agonal type. ackscrew end shall be rounded.

10.0 Each si e of studs & m/c bolts with nuts and jackscrews shall be supplied in se parate containers marked with si e and material specifications. CR O shall be marked additionally in case CR O is specified in the requisition.

11.0 All items shall be inspected and approved (stagewise) by MECON inspector or any other agency authori ed 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 t he material specification and also where the material specification is indicated as CR O . For S.S. nuts and bolts minimum impact energy absorption shall be 27 oules 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 galvani ed, the studs, m/c bolts and nuts shall be hot dip inc coated in accordance with requirements of class C of ASTM A 153 . As an alternative, electro-galvani ing as per IS 1573, Service Grade Number 2 is also acceptable.

18.0 All Stud Bolts of Bolt diameter si e 1 and above shall be provided with three nuts irrespective of whatever has been specified elsewhere in the MR.

Rev. : 0
Edition : 1

SPECIFICATION
FOR
SEAMLESS FITTINGS & FLANGES
[SIZE UPTO DN 400 mm (16”) NB]

SPECIFICATION NO.: MEC/TS/05/21/025

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

CONTENTS

1.0 SCOPE

This specification covers the minimum re uirements for the design, manufacture and supply of following car on steel flanges and fittings of si e upto DN 400 mm (16) to e installed in onshore pipeline systems handling non sour hydrocar ons in li uid or gaseous phase including Li uefied Petroleum Gas (LPG) :

- Flanges such as w elding neck flanges, lind flanges, spectacle linds, spacers and linds etc.

- Seamless fittings such as tees, el ows, reducers, caps, outlets etc.

2.0 REFERENCE DOCUMENTS

2.1 Reference has een made in this specification to the latest edition (edition enforce at the time of issue of en uiry) of the following Codes, Standards and Specifications :

ASME B31.4	Pipeline Transportation Systems for Li uid Hydrocar ons and Other Li uids
ASME B31.8	Gas Transmission and Distri ution Piping Systems
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.	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 R ules for Construction of Pressure Vessels
ASME Sec I	Boiler and Pressure Vessel Code Welding and Bra ing ualifications
ASTM A 3 0	Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
MSS SP 25	Standard Marking System for Valves, Fittings, Flanges and Unions

MSS SP — Forged Car on Steel Branch Outlet Fittings Socket Welding, Threaded and Butt welding Ends.

2.2 In case of conflict etween the re uirements of this specification and t he re uirements of a ove referred Codes and St andards, the re uirements of this specification shall govern.

3.0 **MANUFACTURER'S QUALIFICATION**

Manufacturer who intends idding for fittings must possess t he records of a successful proof test, in accordance with the provisions of ASME B16. / MSS SP 5 as applica le.

4.0 MATERIAL

4.1 The Car on Steel used in the manufacture of flanges and fittings shall e fully killed. Material for flanges and fittings shall com ply with the material standard indicated in the Purchase Re uisition. In addition, the material shall also meet the re uirements specified hereinafter.

4.2 Each heat of steel used for the manufacture of flanges and fittings shall have Car on E uivalent (CE) not greater than 0.45 calculated from check analysis in accordance with the following formula:

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

Car on contents on check analysis shall not e ceed 0.22 .

4.3 For flanges and fittings specified to e used for Gas service or LPG service, Charpy V notch test shall e conduct ed on each heat of steel. Unless specified otherwise, the Charpy V notch test shall e conducted at 0 C in accordance with the impact test provisions of ASTM A 3 0 for flanges and fittings.

The average a sor ed impact energy values of three full si ed specimens shall e 2 oules. The minimum impact energy value of any one specimen of the three specimens analysed as a ove, shall not e less than 22 oules.

When Low Temperature Car on Steel (LTCS) materials are specified for flanges and fittings in Purchase Re uisition, the Charpy V notch test re uirements of applica le material standard shall e complied with.

4.4 For flanges and f ittings specified to e used f or Gas service or LPG service, Hardness test shall e carried out in accordance with ASTM A 3 0. Hardness testing shall cover at least 10 per item, per si e, per heat, per manufacturing method. A full thickness cross section shall e t aken for this purpose and the ma imum hardness shall not e ceed 248 HV_{10}.

4.5 In case of RT (Ring Type oint) flanges, the groove hardness shall e minimum 140 BHN. Ring oint flanges shall have octagonal section of Ring oint.

5.0 DESIGN AND MANUFACTURE

5.1 Flanges such as w eld neck flanges and lind f langes shall conf orm to the re uirements of ASME B16.5.

5.2 Spectacle lind and spacer & lind shall conf orm to the re uirements of ASME B 16.48.

5.3 Fittings such as tees, el ows, reducers, etc. shall e seam less type and shall conform to ASME B16. for si es DN 50 m m (2) to DN 400 mm (16) (oth si es included) and ASME B 16.11 for si es elow ON 50 mm (2).

5.4 Fittings such as w eldolets, sockolets, nippolets, etc. shall e m anufactured in accordance with MSS SP .

5.5 Type, face and face finish of flanges shall e as specified in Purchase Re uisition.

5.6 Flanges and fittings manufactured from ar stock are not accepta le.

5. All utt weld ends shall e evelled as per ASME B 16.5 / ASME B 16. / MSS SP as applica le.

5.8 Repair y welding on flanges and fittings is not permitted.

5. Stu in or pipe t o pipe connect ion shall not e used in t he manufacture of tees. Tees shall e m anufactured y forging or e trusion methods. The longitudinal weld seam shall e kept at 0 f rom the e trusion. Fittings shall not have any circumferential oint .

6.0 INSPECTION AND TESTS

6.1 The Manufacturer shall perform all inspections and tests as per the re uirement of this specification and t he relevant codes, prior to shipment at his works. Such inspections and tests shall e, not ut limited to the following :

a) All flanges and fittings shall e visually inspected. The internal and e ternal surfaces of the flanges and f ittings shall e f ree from any strikes, gauges and ot her detrimental defects.

) Dimensional checks shall e carried out on finished products as per ASME B16.5 for flanges, ASME B16.48 for spacers and linds and ASM E B16. / MSS SP as applica le for fittings and as per this specification.

c) Chemical composition and m echanical properties shall e checked as per relevant material standards and this specification, for each heat of steel used.

d) All finished wrought weld ends su ect to welding in field, shall e 100 tested for lamination type defects y ultrasonic test. Any lamination larger then 6.35 mm shall not e accepta le.

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 g ive reasona le notice of time and shall provide, without charge, reasona le access and facilities re uired for inspection, to the Purchaser s Inspector.

Inspection and tests performed / witnessed y Purchaser s Inspector shall in no w ay relieve the Manufacturer s o ligation to perform the re uired 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.

) Test Reports on non destructive testing.

c) Certificates for each fitting stating that it is capa le of withstanding without leakage a test pressure, which results in a hoop stress e uivalent to 100 of

the specified minimum yield strength for the pipe with which the fitting is to e attached without impairment of servicea ility.

8.0 PAINTING, MARKING AND SHIPMENT

8.1 After all inspection and tests re uired have een car ried out all e ternal surfaces shall e thoroughly cleaned to remove grease, dust and r ust and shall e applied with standard mill coating for protection against corrosion during transit and storage. The coating shall e easily remova le in the field.

8.2 Ends of all f ittings and w eld neck flanges shall e suit a ly protected to avoid any damage during transit. Metallic or high impact plastic evel protectors shall e provided for fittings and flanges. Flange face shall e suita ly protected to avoid any damage during transit.

8.3 All flanges and fittings shall e m arked as per applica le dimension / manufacturing standard.

9.0 DOCUMENTATION

Documentation to e su mitted y Manufacturer to Company is summari ed elow. Num er of Copies (Hard copies / soft copies et c.) shall e as indicat ed in CONTRACT document / Material Re uisition.

.1 At the time of idding, Manufacturer shall su mit the following documents:

a) Reference list of previous supplies of similar fittings of similar specification.
) Clausewise list of deviations from this specification, if any.
c) Brief description of the manufacturing and uality control facilities at Manufacturer s works.
d) Manufacturer s ualification re uirement as per clause 3.0 of this specification.
e) uality Assurance Plan (AP) enclosed with this tender duly signed, stamped and accepted.

.2 Prior to shipment, the Manufacturer shall su mit test certificates as listed in clause .0 of this specification.

.3 All documents shall e in English Language only.

Edition : 1

SPECIFICATION
FOR
FLANGES AND WELDED FITTINGS
SIZE DN 450 mm (18) AND ABOVE

SPECIFICATION NO. MEC/TS/05/21/026

(OIL GAS SBU)
MECON LIMITED
DELHI 110 092

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION OIL & GAS SBU, DELHI		
TITLE	FLANGES AND WELDED FITTINGS [SIZE DN 450 mm (18ò) AND ABOVE]	DOCUMENT NO. MEC/TS/05/21/026	Page 1 of 1 REVISION : 0 EDITION : 1

C O N T E N T S

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

1.0 SCOPE

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

- Carbon Steel Welded Fittings 450 mm (18") NB and above, such as tees, elbows, reducers, caps, outlets etc.

- Carbon Steel Flanges 450mm (18") NB and above, such as welding neck flanges, blind flanges, spectacle bind, spacers & blinds etc.

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

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-44 - Steel Pipeline Flanges 22" & 26" and above.

MSS-SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions

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

2.2 In case of conflict between the requirements of this specification and the requirements of above referred Codes and Standards, the requirements of this specification shall govern.

3.0 MANUFACTURER S QUALIFICATION

The design of fittings shall be established by mathematical analysis contained in ASME Sec. VIII/ ASME B31.3. The design of fittings for which mathematical analysis is not available shall be established by proof testing. These records shall be submitted at the time of bidding, qualifying the complete range of fittings offered. Manufacturer who intends bidding for fittings must posses the records of a successful proof test in accordance with the provisions of ASME B16.9 and/ or MSS-SP-75. These records shall be submitted at the time of bidding, qualifying the complete range of fittings offered. Failure to submit such records at the time of bidding may become a cause of rejection of the offer.

4.0 MATERIALS

4.1 The steel used in the manufacture of fittings and flanges shall be fully killed carbon steel with a grain size of ASTM 7 or finer as defined in ASTM E112. This requirement shall not apply to quenched and tempered fittings. The basic material for fittings and flanges shall be as indicated in the Material Requisition. Additionally, the material shall also meet the requirements specified hereinafter.

4.2 Each heat of steel used for the manufacture of fittings and flanges shall have carbon equivalent (CE) not greater than 0.45 calculated from check analysis in accordance with the following formula:

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

4.3 Carbon contents on check analysis shall not exceed 0.22%.

4.4 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 MSS-SP-75 for all 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 in Material Requisition for flanges and fittings, the Charpy V-notch test requirements of applicable material standard shall be complied with.

4.5 Hardness test shall be carried out as per ASTM A370 for each heat of steel used. A full thickness cross-section shall be taken for this purpose and the maximum hardness of base metal, weld metal and heat affected zone shall not exceed 248 HV_{10}. Hardness testing shall cover at least 10% per item, per size, per heat, per manufacturing method.

4.6 One transverse guided weld bend test shall be performed for each lot of welded fittings produced from the same heat in accordance with provisions of MSS-SP-75. The dimension “A” in guided bend test shall not exceed 4.0 times the nominal wall thickness and dimension “B” shall be equal to A+2t+3.2mm, where “t” is nominal wall thickness.

4.7 One transverse weld tensile test shall be conducted on each heat/ lot of welded fittings in accordance with the requirements of MSS-SP-75.

4.8 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 upto size DN 600mm (24”) excluding DN 550mm (22”), MSS-SP-44 for sizes DN 550mm (22”) and ASME B16.47 for sizes DN 650mm (26”) and above.

5.2 Spectacle blind and Spacer & blind shall conform to the requirements of API 590 upto sizes DN 600mm (24”). For sizes above DN 650mm (26”) and above, Spectacle blind and Spacer & blind shall conform to Manufacturer’s standard.

5.3 Type, face and face finish of flanges shall be as specified in Material Requisition.

5.4 Fittings such as tees, elbows and reducers shall be either welded or seamless type. All fittings shall comply with the requirements of MSS-SP-75. Fittings such as weldolets etc. shall be manufactured in accordance with MSS-SP-97.

5.5 Tees shall be manufactured by forging or extrusion method. Stub-in or pipe to pipe connection shall not be used in the manufacture of tees. The longitudinal weld seam shall be kept at 90° from the extrusion. Fittings shall not have any circumferential weld joint.

5.6 All butt weld ends shall be bevelled as per ASME B16.5/ MSS-SP-44/ ASME B16.47 as applicable for flanges and MSS-SP-75 / MSS-SP-97 as applicable for fittings.

5.7 Inside weld projection for welded fitting shall not exceed 1.6 mm. The reinforcement of inside weld seam shall be removed for a distance of 100mm from each end of welded fittings.

5.8 All welds shall be made by welders and welding procedures qualified in accordance with provisions of ASME Sec. IX. The procedure qualification shall include impact test for weld/ heat affected zone, hardness test and guided bend test and shall meet the requirements of Clauses 4.4, 4.5 and 4.6 of this specification, respectively.

5.9 Repair by welding on flanges and parent metal of fittings is not allowed. Repair of weld seam by welding shall be carried out by welders and welding procedures duly qualified as per ASME Section IX and API 1104 and records for each repair shall be maintained. Repair welding procedure qualification shall include all tests which are applicable for regular production welding procedure qualification.

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, but not limited to, the following :

6.1.1 All fittings and flanges shall be visually inspected. The internal and external surfaces of the fittings shall be free from any strikes, gouges, burrs and other detrimental defects.

6.1.2 Dimensional checks shall be carried out on finished products as per ASME B16.5/ MSS-SP-44/ ASME B16.47 as applicable for flanges and ASME B16.9/ MSS-SP-75 /

MSS-SP-97 as applicable for fittings and as per this specification. Fittings not covered in MSS-SP-75 shall be checked as per Manufacturer's standard.

6.1.3 Chemical composition and mechanical properties shall be checked as per relevant material standards and this specification, for each heat of steel used.

6.1.4 The non-destructive inspection shall be carried out as given below :

a) All butt and repair welds for welded fittings shall be examined 100% by radiography. Acceptance limits shall be as per API 1104.

b) When elbows of size $\geq$ 18" NB are manufactured, the first elbow of each radius, diameter and wall thickness shall be ultrasonically checked for sufficient wall thickness in areas where a minimum wall thickness is to be expected. This shall be followed by random inspection of one out of every three elbows of the same radius, diameter and wall thickness.

c) All finished wrought weld ends shall be 100% tested for lamination type defects by ultrasonic test. Any lamination larger than 6.35mm shall not be acceptable.

d) Magnetic particle or liquid penetrant examination shall be performed on cold formed butt welding tees with extruded outlets, that are subjected to an extreme fiber elongation of greater than 5% shall be carried out as per the Supplementary Requirement SR3 of MSS-SP-75.

e) Welds which 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.

6.2 Purchaser's Inspector reserves the right to perform stagewise 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 and mechanical properties of the materials used for manufacture of flanges and fittings as per relevant standards and this specification.

b) Test Reports on radiography, ultrasonic inspection and magnetic particle examination.

c) Test reports of heat treatment carried out as per the specification.

d) Welding procedures and welders' qualification reports.

e) Test certificates for each fitting stating that it is capable of withstanding without leakage a test pressure which results in a hoop stress equivalent to 100% of the specified minimum yield strength for the pipe with which the fitting is to be attached without impairment of serviceability.

8.0 PAINTING, MARKING AND SHIPMENT

8.1 After all required inspection and tests have been carried out, all external surfaces shall be thoroughly cleaned to remove grease, dust & 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. Manufacturer shall furnish the details of paint used at the time of bidding.

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 fittings and flanges shall be marked as per applicable dimension / manufacturing standard.

8.4 Package shall be marked legibly with suitable marking ink to indicate the following :

a) Manufacturer's Name
b) Type of flange(s) and fittings(s)
c) Nominal diameter, thickness and material grade
d) Purchase order number and item serial number

9.0 DOCUMENTATION

9.1 Manufacturer shall furnish at the time of bidding, the following documents:

a) Reference list of similar supplies including all relevant details, viz. Project, Year, Client, Location, Size and Service.

b) Record of successful qualification test of fittings in compliance with the requirement of this specification.

c) Brief description of the manufacturing, heat treatment and quality control facilities of the Manufacturer's Works.

d) Clause-wise list of deviations from this specification, if any.

9.2 Within three weeks of placement of order, Manufacturer shall submit four copies of method of manufacture, testing and quality control procedure for raw material and finished product for Purchaser's approval.

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 flanges and fittings are manufactured.

9.3 Within four weeks from the approval date, Manufacturer shall submit six copies of all documents as listed in Clause 9.2 of this specification.

9.4 Prior to shipment, the Manufacturer shall submit six copies of the test certificates as listed in Clause 7.0 of this specification.

9.5 All documents shall be in English Language only.

STANDARD TECHNICAL SPECIFICATION FOR BALL VALVES

SPECIFICATION NO.: MEC/TS/05/21/002

(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

PREPARED BY:	CHECKED BY:	APPROVED BY:	ISSUE DATE :

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Rev.	Date	By		Verified	
					Name	Sig.	Name	Sig.
1.	Cl. No. 4.6	4	1	April 0	Gurdeep Singh		K.K. De	
2.	Overall Revision	All	1	uly 20	K.P. Singh		A.K. Tyagi	

Abbreviations :

ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society for Testing and Materials
API	:	American Petroleum Institute
BHN	:	Brinell hardness num er
DN	:	Nominal Si e
HA	:	Heat Affected one
LC	:	Lock Close (valve locked in full close position)
LO	:	Lock Open (valve locked in full open position)
MSS SP	:	Manufacturers Standardi ation Society Standard Practice
NDT	:	Non Destructive Testing
NPS	:	Nominal Pipe Si e
RT	:	Ring Type oint
SSPC	:	Steel Structures Painting Council

CONTENTS

1.0 **SCOPE**

This specification covers the minimum re uirements for design, manufacture, testing and supply of car on steel all valves of si e DN 50 mm (2) and a ove and ANSI pressure rating class 150 to 00 to e used in on shore pipeline systems handling non sour hydrocar ons in li uid or gaseous phase, including Li uefied Petroleum Gas (LPG).

This specification does not cover all valves for sour hydrocar on (li uid / gas) service as defined in NACE standard MR 01 5.

2.0 **REFERENCE DOCUMENTS**

2.1 All valves shall e 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 een 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 B16.4	:	Large diameter steel flanges
ASME B 31.3	:	Process piping
ASME B 31.4	:	Pipeline transportation systems for li uid hydrocar ons and other li uids
ASME B 31.8	:	Gas transmission and distri ution piping systems
ASME Sec VIII	:	Boiler and pressure vessel code Rules for construction of pressure vessels
ASME Sec I	:	Boiler and pressure vessel code Welding and ra ing ualifications
ASTM A 3 0	:	Standard test methods and definitions for mechanical testing of steel products
ASTM B 33	:	Autocatalytic nickel phosphorous coating on metals
API 6FA	:	Fire test for valves

API 60	:	Fire test for soft seated uarter turn valves
API 1104	:	Welding of pipelines and related facilities
BS EN ISO 104	:	Testing of valves Fire type testing re uirements
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** etween the re uirements of this specification, API 6D and the Codes, Standards and Specifications referred in clause 2.2 a ove, the re uirements of this specification shall govern. Order of precedence shall e as follows :

- Valve Data Sheets
- Material Re uisition
- This Specification
- API 6D Specification
- Other Referred Codes & Standards
- Manufacturer s Standard

3.0 **MATERIALS**

3.1 Material for ma or components of the valves shall e as indicated in Valve Data Sheet. Other components shall e as per Manufacturer s standard (suita le for the service conditions indicated in Data Sheet) and shall e su ect to approval y Purchaser. In addition, the material shall also meet the re uirements specified hereinafter.

3.2 Car on steel used for the manufacture of valves shall e fully killed.

3.3 The Car on E uivalent (CE) of valve end connections which are su ect to further field welding y Purchaser, shall not e ceed 0.43 (as calculated y the following formula) on check analysis for each heat of steel used:

$$CE \quad C \quad \frac{Mn}{6} \quad Cr \quad Mo \quad V \quad \frac{Ni}{15} \quad Cu$$

3.4 For Valves specified to e used for Gas service or LPG service, Charpy V notch test, on each heat of ase material shall e conducted as per API 6D Clause 8.5, for all pressure containing parts such as ody, end flanges and welding ends as well as olting material for pressure containing parts. Unless stated otherwise, the Charpy V notch test shall e conducted at 0 C. Test procedure shall conform to ASTM A3 0. The average a sor ed energy value of three full si ed specimens shall e 2 . The

minimum impact energy value for any one specimen of the three specimens analysed as a ove, shall not e less than 22 .

When Low Temperature Car on Steel (LTCS) materials are specified in Valve Data Sheet or offered y Manufacturer, the Charpy V notch test re uirements of applica le material standard shall e complied with.

3.5 For all such valves where car on steel is used as all material, the all shall have 5 micrometer (0.003 inch) thick Electroless Nickel Plating (ENP) as per ASTM B 33 with following classification : SC2, Type II, Class 2. The hardness of plating shall e minimum 50 RC.

3.6 For valves specified to e used for Gas service or LPG service, hardness test shall e carried out as per ASTM A3 0 for each method of manufacture and each heat of steel used in the manufacture of valves. A full thickness cross section shall e taken for this purpose and the ma imum hardness of the materials of valve components shall not e ceed 248 HV_{10}.

3. All process wetted parts, metallic and non metallic, shall e suita le for the fluids and service specified y the Purchaser. The service gas composition shall e as given elsewhere in the Material Re uisition. In addition, Manufacturer shall confirm that all wetted parts are suita le for treated water / seawater environment, which may e used during field testing.

3.8 Non metallic parts of the valves (including O rings, soft seal etc.) intended for hydrocar on gas service at pressures of PN 100 (600) and a ove shall e resistant to e plosive decompression.

4.0 **DESIGN AND CONSTRUCTION**

4.1 Valve design shall meet the re uirements of API 6D and other referred codes and shall e suita le for the service conditions indicated in Valve Data Sheet. The ASME Boiler & Pressure Vessel Code, Section VIII, Division 1, may e used to design the valve ody. Allowa le stress re uirements shall comply with the provisions of ASME B31.3. In addition, corrosion allowance indicated in Valve Data Sheet shall e considered in valve design. However, the minimum wall thickness shall not e less than the minimum re uirement of ASME B16.34. The Manufacturer shall have a valid license to use API 6D monogram for manufacture of all valves.

4.2 For a ove ground valves, valve ody design shall e either fully welded or olted type, as indicated in Valve Data Sheet. Valve ody oints with threads are not permitted.

For uried valves, valve ody design shall e fully welded type only. Valve ody oints with olts or threads are not permitted.

4.3 Ball shall e of single piece, solid type construction.

4.4 Valves shall e Full Opening (FO) or Reduced Opening (RO) as indicated in Valve Data Sheet. FO valves shall e suita le for the passage of all types of pipeline scraper and inspection pigs on regular asis without causing damage to either the valve component or the pig. The FO valve shall provide an uno structed profile for pigging operations in either direction. FO valves shall e designed to minimi e accumulation of de ris in the seat ring region to ensure that valve movement is not impeded.

The opening si e of RO valves shall e corresponding to that of a FO valve of smaller nominal diameter as indicated in ta le elow. For si es of a particular rating not covered in API 6D, the opening si es of the RO valve shall e as per Manufacturer s standard.

Nominal Valve Size	Nominal Valve Size for Reduced Opening	Nominal Valve Size	Nominal Valve Size for Reduced Opening
DN mm (NPS inches)	DN mm (NPS inches)	DN mm (NPS inches)	DN mm (NPS inches)
50 (2)	50 (2)	600 (24)	500 (20)
80 (3)	50 (2)	650 (26)	550 (22)
100 (4)	80 (3)	00 (28)	600 (24)
150 (6)	100 (4)	50 (30)	600 (24)
200 (8)	150 (6)	800 (32)	650 (26)
250 (10)	200 (8)	850 (34)	00 (28)
300 (12)	250 (10)	00 (36)	50 (30)
350 (14)	250 (10)	50 (38)	800 (32)
400 (16)	300 (12)	1000 (40)	850 (34)
450 (18)	350 (14)	1050 (42)	00 (36)
500 (20)	400 (16)	1200 (48)	1050 (42)
550 (22)	450 (18)		

4.5 Ball mounting shall e trunnion / pivot type or as indicated in Valve Data Sheet. Ball mounting, either trunnion or floating, unless otherwise specified, shall e as follows.

Sl. No.	ANSI Pressure Rating	Nominal Valve Size (NPS inches)	
		Floating Ball	Trunnion Mounted
1.	150	_ 8	8
2.	300	_ 4	4
3.	600	Nil	_ 2

Valve design shall minimi e the possi ility of de ris ingress into the trunnion as far as practica le.

4.6 Valve seats shall have metal to metal contact. O rings or other seals, if used for drip tight sealing, shall e encased in a suita le groove in such a manner that it can not e removed from seat ring and there is no e trusion during opening or closing operation of valve at ma imum differential pressure corresponding to valve class rating. The seat rings shall e so designed as to ensure sealing at low as well as high differential pressures.

4. Valves shall have dou le lock and leed feature to facilitate complete flushing, draining and venting of the valve ody cavity.

4.8 For valves to e used in li uid service, the ody cavity over pressure shall e prevented y self relieving seat rings / assem lies. A pressure relief hole in the all is not permitted. Self relieving seat rings shall relieve at a ody cavity differential pressure not e ceeding 50 of the valve class rating pressure.

4. Valves shall e designed to withstand a sustained internal vacuum of at least 1 (one) milli ar in oth open and closed positions.

4.10 FO valves of nominal si e DN 200 mm (8) & a ove and RO valves of nominal si e DN 250 mm (10) & a ove shall have provision for secondary sealant in ection under full line pressure for seat and stem seals. All sealant in ection connections shall e provided with a needle valve, a grease fitting and non return valve. Valve design shall have a provision to replace the sealant in ection fitting under full line pressure. Location and arrangement of sealant points shall e as per Figure 1.

4.11 Valves shall e provided with vent and drain connections. Location and arrangement of vents and drains shall e as per Figure 1. Body vent and drain shall e provided with valves (all or plug type). Num er and si e shall e 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 e either flanged or utt welded or one end flanged and one end utt welded as indicated in Valve Data Sheet. Flanges of the flanged end cast/ forged ody valves shall e integrally cast / forged with the ody of valve. Face to face/ end to end dimensions shall conform to API 6D. Face to face and end to end dimensions for valve si es not specified in API 6D shall e 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 e as per Manufacturer Standard and shall e su ect to approval y Purchaser.

) Flanged ends shall have flanges as per ASME B16.5 for valve si es up to DN 600 mm (24 inches) e cluding DN 550 mm (22 inches) and as per MSS SP 44 / ASME B 16.4 series A for valve si es DN 550 mm (22 inches) & for DN 650 mm (26 inches) and a ove. Flange face shall e either raised face or ring oint type (RT) as indicated in Valve Data Sheet. Flange face finish shall e serrated or smooth as indicated in Valve Data Sheet. Smooth finish when specified shall e 125 to 200 microinches AARH. In case of RT flanges, the groove hardness shall e minimum 140 BHN.

c) Butt weld end preparation shall e as per ASME B16.25. The thickness of the pipe to which the valve has to e welded shall e as indicated in Valve Data Sheet. Valves shall e without transition pups, unless otherwise specified in Valve Data sheet. In case significant difference e ists etween thickness of welding ends of valve and connecting pipe, the welding ends of valve shall have evel preparation as per ASME B31.4 or ASME B31.8, as applica le.

4.14 Design of weld end valves shall e such that during field welding operations, the soft seals or plastic components of the valve (where ever used) are not lia le to e 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 e provided with all position indicator and stops of rugged construction at the fully open and fully closed positions.

4.16 FO valves of nominal si e ≥ DN 200 mm (8) and RO valves of nominal si e ≥ DN 250 mm (10) shall e e uipped with support foot and lifting lugs. Tapped holes and eye olts shall not e used for lifting lugs. Height of support foot shall e kept a minimum. The location and si e of support foot / lifting lugs shall ensure unrestrictive operation of vent / drain valves.

4.1 Valve design shall e such as to avoid imetallic corrosion etween car on steel and high alloy steel components. Suita le insulation shall e provided as re uired.

4.18 Valves shall e of fire resistant design as per API 60 /BS EN ISO 104 /API 6FA, as indicated in Valve Data Sheet.

4.1 Valves shall e provided with anti static devices to ensure electrical continuity etween stem / all and valve ody.

4.20 Valves shall e suita le for either uried or a ove ground installation as indicated in Valve Data Sheet.

4.21 When stem e tension re uirement is indicated in Valve Data Sheet, the valves shall have the following provisions :

a) Valves provided with stem e tension shall have water proof outer casing. Length of stem e tension shall e as indicated in Valve Data Sheet. The length indicated corresponds to the distance etween centerline of the valve opening and the top of mounting flange for valve operating device (gear operator / power actuator as applica le).

) Vent and drain connections and sealant in ection lines shall e terminated ad acent to the valve operator y means of suita le piping anchored to the valve ody. Pipe used shall e API 5L Gr. B / ASTM A 106 Gr. B, with Sch. 80. Fittings shall e ASTM A 105 / ASTM 234 Gr. WPB, Socket Welded, ANSI class 6000.

c) Stem e tension and stem housing design shall e such that the complete assem ly will form a rigid unit giving a positive drive under all conditions with no possi ility of free movement etween valve ody, stem e tension or its operator.

d) Outer casing of stem e tension shall have 3/8 or NPT plugs at the top and ottom, for draining and filling with oil to prevent internal corrosion.

4.22 **Operating Devices**

a) Valves shall have a power actuator or manual operator as indicated in Valve Data Sheet. In case of manual operator, valve si es _ DN 100 mm (4 inches) shall e wrench operated and valve si es ≥ DN 150 mm (6 inches) shall e gear operated. Each wrench operated valve shall e supplied with wrench. Valve design shall e 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 e replaced without the valve cover eing removed.

) The power actuator shall e in accordance with the Purchaser specification issued for the purpose and as indicated in Valve and Actuator Data Sheet. Operating time shall e as indicated in Valve Data Sheet. Valve operating time shall correspond to full close to full open/full open to full close under ma imum differential pressure corresponding to the valve rating. For actuated valves, the actuator tor ue output shall e 1.25 times the reak tor ue re uired to operate the all valve under the ma imum 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 re uirements and e such that under ma imum differential pressure, the total force re uired to operate the valve does not e ceed 350 N. Manufacturer shall also indicate the num er of turns of hand wheel (in case of gear operators) re uired for operating the valve from full open to full close position.

d) Direction of operation of hand wheel or wrench shall e 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 e fully encased, in water proof/ splash proof/ dust proof/ weather proof enclosure and shall e filled with suita le grease.

f) Operating devices shall e designed for easy operation of the valve under ma imum differential pressure corresponding to the valve rating.

4.23 All welds shall e made y welders and welding procedures ualified in accordance with the provisions of ASME Section I . The procedure ualification shall include impact test and hardness test and shall meet the re uirements of clauses 3.4 and 3.6 of this specification, respectively.

4.24 All welds shall e stress relieved in accordance with ASME Section VIII.

4.25 Repair y welding is not permitted for fa ricated and forged ody valves. However, repair y welding as per ASME B16.34 is permitted for cast ody valves. Such repairs shall e carried out at casting supplier s care only. Repair shall e carried out efore any heat treatment of casting is done. Repair welding procedure ualification shall also include impact test and hardness test and shall meet the re uirements 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 e as per applica le connected pipe specification as indicated in Valve Data Sheet.

4.2 When indicated in Material Re uisition, valves shall have locking device to lock the valve either in full open (LO) or full close (LC) positions. Locking devices shall e permanently attached to the valve operator and shall not interfere with operation of the valve.

4.28 Valve stem shall e capa le of withstanding the ma imum operating tor ue re uired to operate the valve against the ma imum differential pressure corresponding to applica le class rating. The com ined stress shall not e ceed the ma imum allowa le stresses specified in ASME Section VIII, Division I. In case of power actuated valves, the valve stem shall e designed for ma imum output tor ue of the selected power actuator (including gear o , if any) at valve stem.

5.0 INSPECTION AND TESTS

5.1 The Manufacturer shall perform all inspection and tests as per the re uirements of this specification and the relevant codes, prior to shipment, at his works. Such inspection and tests shall e, ut not limited to, the following:

5.1.1 All valves shall e visually inspected. The internal and e ternal surfaces of the valves shall e free from any strikes, gouges and other detrimental defects. The surfaces shall e thoroughly cleaned and free from dirt, rust and scales.

5.1.2 Dimensional check on all valves shall e carried out as per the Purchaser approved drawings.

5.1.3 Chemical composition and mechanical properties shall e checked as per relevant material standards and this specification, for each heat of steel used.

5.1.4 Non destructive e amination of individual valve material and components consisting of, ut not limited to castings, forgings, plate and assem ly welds shall e carried out y the Manufacturer.

a) Body castings of all valves shall e radiographically e amined on 100 of the surface of critical areas as per ASME B16.34. Procedure and acceptance criteria shall e as per ASME B16.34. The e tent of radiography shall e as follows:

ANSI Pressure Rating	Valve Size	Extent of Radiography
150	All si es	Nil
300	_ DN 400mm (16) _ DN 450mm (18)	Nil 100
_ 600	All si es	100

All castings shall e wet magnetic particle inspected 100 of the internal surfaces. Method and acceptance shall comply with ASME B.16.34.

) All valves, with ody fa ricated from plates or made y forgings, shall e ultrasonically e amined in accordance with the procedure and acceptance standard of Anne ure E of ASME B16.34.

All forgings shall e wet magnetic particle inspected 100 of the internal surfaces. Method and acceptance shall comply with ASME B 16.34

c) Bodies and onnets made y welded assem ly of segments of castings, forgings, plates or com inations thereof shall e e amined, as applica le, y methods of clause 5.1.4 a) for cast components or clause 5.1.4) for forged components and plates.

5.1.5 Full inspection y radiography shall e carried out on all welds of pressure containing parts. Acceptance criteria shall e as per ASME B 31.4 or ASME B31.8, as applica le, and API 1104.

5.1.6 Welds, which in Purchaser s opinion cannot e inspected y radiographic methods, shall e checked y ultrasonic or magnetic particle methods and acceptance criteria shall e as per ASME Section VIII, Division 1, Appendi 12 and Appendi 6, respectively.

5.1. a) All finished wrought weld ends su ect to welding in field shall e 100 ultrasonically tested for lamination type defects for a distance of 50mm from the end. Laminations shall not e accepta le.

) Weld ends of all cast valves su ect to welding in field shall e 100 radiographically e amined and acceptance criteria shall e as per ASME B16.34.

c) After final machining, all evel surfaces shall e inspected y dye penetrant or wet magnetic particle methods. All defects longer than 6.35 mm are re ected, as are defects etween 6.35 mm and 1.5 mm that are separated y a distance less than 50 times their greatest length. Re ecta le defects must e removed. Weld repair of evel surface is not permitted.

5.1.8 All valves shall e tested in compliance with the re uirements 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 e

either included in the hydrostatic shell test or tested independently. Test pressure shall e held for at least 30 minutes. No leakage is permissi le during hydrostatic testing. The ody cavity self relieving feature meeting the re uirements of clause 4.8 of this specification shall also e checked.

5.1. A supplementary air seat test as per API 6D (Anne B, Clause B.3.3, Type II) shall e carried out for all valves. A u le tight seal is re uired without the use of any sealant. No leakage is allowed. Test pressure shall e held for at least 15 minutes.

5.1.10 Manufacturer who intends idding, must su mit at id stage, certificate and report for successful fire type tests for valves in accordance with API 60 / BS EN ISO 104 / API 6FA, as applica le in Valve Data Sheet.

Failure to comply with this requirement shall be a cause of rejection of the Bidderôs offer.

5.1.11 Valves shall e su ected to Operational Tor ue Test as per API 6D (Anne B, Clause B.6) under hydraulic pressure e ual to ma imum differential pressure corresponding to the valve pressure class rating.

For manual operator of all valves, it shall e esta lished that the force re uired to operate the valve does not e ceed the re uirements stated in clause 4.22(c) of this specification.

5.1.12 Power actuated valves shall e tested after assem ly 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 ma imum differential pressure shall e performed on the valve actuator assem ly. The time for Full Open to Full close shall e recorded during testing. If re uired, the actuator shall e ad usted 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 e checked after a ove testing, for satisfactory manual over ride performance.

These tests shall e conducted on minimum one valve out of a lot of five (5) valves of the same si e, rating and the actuator model / type. In case the tests do not meet the re uirements, retesting / re ection of the lot shall e decided y Purchaser s Inspector.

5.1.13 Su se uent to successful testing as specified in clause 5.1.11 and 5.1.12 a ove, one (1) valve out of the total ordered uantity shall e randomly selected y the Purchaser s Representative for cyclic testing as mentioned elow :

a) The valve shall e su ected to at least 100 Open Close Open cycles with ma imum differential pressure corresponding to the valve rating.

) Su se uent to the a ove, the valve shall e su ected to hydrostatic test and supplementary air seat test in accordance with clause 5.1.8 and 5.1. .

In case this valve fails to pass these tests, the valve shall e re ected and two more valves shall e selected randomly and su ected to testing as indicated a ove. If oth valves pass these tests, all valves manufactured for the order (e cept the valve that failed) shall e deemed accepta le. If either of the two valves fails to pass these tests, all valves shall e re ected or each valve shall e tested at the option of Manufacturer.

Previously carried out test of similar nature shall e considered accepta le if the same has een carried out y Manufacturer in last two years. Valves of two si es elow and two si es a ove the si e of valve previously tested, and rating similar or one rating lower of valve tested previously, shall e ualified.

5.1.14 Checks shall e carried out to demonstrate that the dissimilar metal used in the valves are successfully insulated as per the re uirement of clause 4.1 of this specification.

5.1.15 When indicated in Valve Data Sheet, valves shall e su ected to anti static testing as per supplementary test re uirement of API 6D (Anne B, Clause B.5).

5.2 Purchaser reserves the right to perform stage wise inspection and witness tests as indicated in clause 5.1 a ove at Manufacturer s works prior to shipment. Manufacturer shall give reasona le access and facilities re uired for inspection to the Purchaser s Inspector.

Purchaser reserves the right to re uire additional testing at any time to confirm or further investigate a suspected fault. The cost incurred shall e to Manufacturer s account.

In no case shall any action of Purchaser or his Inspector relieve the Manufacturer of his responsi ility for material, design, uality or operation of valves.

Inspection and tests performed/ witnessed y the Purchaser s Inspector shall in no way relieve the Manufacturer s o ligation to perform the re uired 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 uality Assurance Plan (AP) attached with this specification.

6.2 The hydrostatic testing and cyclic opening and closing of the valves with the operator shall e witnessed y Purchaser s Inspector.

7.0 TEST CERTIFICATES

7.1 Manufacturer shall submit the following certificates:

a) Mill test certificates relevant to the chemical analysis and mechanical properties of the materials used for valve construction as per the relevant standards.

b) Test certificates of hydrostatic and pneumatic tests complete with records of timing and pressure of each test.

c) Test reports on radiograph and ultrasonic inspection.

d) Test report on operation of valves conforming to clause 5.1.11, 5.1.12 and 5.1.13 of this specification.

e) All other test reports and certificates as required by API 6D and this specification.

The certificates shall be valid only when signed by Purchaser's Inspector. Only those valves which have been certified by Purchaser's Inspector shall be despatched from Manufacturer's works.

8.0 PAINTING, MARKING & SHIPMENT

8.1 Valve surface shall be thoroughly cleaned, freed from rust and grease and applied with sufficient coats of corrosion resistant paint. Surface preparation shall be carried out by shot blasting to SP-6 in accordance with "Steel Structures Painting Council – Visual Standard SSPC-VIS-1". For valves to be installed underground, when indicated in Valve Data Sheet, the external surfaces of the buried portion of valves shall be painted with three coats of suitable coal tar epoxy resin with a minimum dry film thickness of 300 microns.

8.2 Manufacturer shall indicate the type of corrosion resistant paint used, in the drawings submitted for approval.

8.3 All valves shall be marked as per API 6D. The units of marking shall be metric except Nominal Diameter which shall be in inches. Marking shall be done by die-stamping on the bonnet or on the housing. However, for buried valves, the marking shall be done on the above ground portion of the stem housing only.

8.4 Valve ends shall be suitably protected to avoid any damage during transit. All threaded and machined surfaces subject to corrosion shall be well protected by a coat of grease or other suitable material. All valves shall be provided with suitable protectors, for flange faces, securely attached to the valves. Bevel ends shall be protected with metallic or high impact plastic bevel protectors.

8.5 All sealant lines and other cavities of the valve shall be filled with sealant before shipment.

8.6 Packaging and shipping instructions shall be as per API 6D.

8.7 On packages, following shall be marked legibly with suitable marking ink :

a) Order Number
b) Manufacturer's Name
c) Valve Size and Rating
d) Tag Number
e) Serial Number

9.0 SPARES & ACCESSORIES

9.1 Manufacturer shall furnish list of recommended spares and accessories for valves required during start-up and commissioning and supply of such spares shall be included in the price quoted by Manufacturer.

9.2 Manufacturer shall furnish list of recommended spares and accessories required for two years of normal operation and maintenance of valves and price for such spares shall be quoted separately.

9.3 Manufacturer shall quote for spares & accessories as per Material Requisition.

10.0 DOCUMENTATION

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

a) General arrangement / assembly drawings showing all features and relative positions and sizes of vents, drains, gear operator / actuator, painting, coating and other external parts together with overall dimensions as well as weights of valve & actuator.

b) Sectional drawing showing major parts with reference numbers and material specification. In particular, a blow-up drawing of ball-seat assembly shall be furnished complying the requirement of clause 4.6 of this specification.

c) Reference list of similar ball valves manufactured and supplied in last five years indicating all relevant details including project, year, client, location, size, rating, service, etc.

d) Torque curves for the power actuated valves along with the break torque and maximum allowable stem torque. In addition, sizing criteria and torque calculations shall also be submitted for power actuated valves.

e) Descriptive technical catalogues of the Manufacturer.

f) Copy of valid API 6D certificate.

g) Details of support foot, including dimensions and distance from valve centre line to bottom of support foot.

h) Quality Assurance Plan enclosed with this tender duly signed, stamped and accepted.

i) List of recommended spares required during start-up and commissioning.

j) List of recommended spares required for 2 years of normal operation and maintenance.

k) Other documents / drawings / data as per Material Requisition.

10.2 Within two weeks of placement of order, the Manufacturer shall submit six copies of, but not limited to, the following drawings, documents and specifications for Purchaser's final approval :

a) Detailed sectional arrangement drawings showing all parts with reference numbers and material specifications as referred to in clause 10.1 above.

b) Assembly drawings with overall dimensions and features. Drawing shall also indicate the number of turns of hand wheel (in case of gear operators) required for operating the valve from full open to full close position and the painting scheme. Complete dimensional details of support foot (where applicable) shall be indicated in these drawings as referred to in clause 10.1 above.

c) Welding, heat treatment and testing procedures.

d) Procedure for cyclic testing.

e) Details of corrosion resistant paint to be applied on the valves.

f) Design calculation for pressure containing parts.

g) Other documents / drawings / data as per Material Requisition.

Manufacture of valves shall commence only after approval of the documents indicated in clause 10.2a) to 10.2c) above. Once approval has been given by Purchaser, any changes in design, material and method of manufacture shall be notified to Purchaser whose approval in writing of all changes shall be obtained before the valve is manufactured.

10.3 Within 2 weeks from the approval date, Manufacturer shall submit to Purchaser six copies of the approved drawings, documents and specifications as listed in clause 10.2 above.

10.4 Prior to shipment, Manufacturer shall submit six hard copies and six soft copies (on CD-ROMs) of the following:

a) Test certificates as per clause 7.0 of this specification.

b) Manual for installation, erection, maintenance and operation instructions, including a list of recommended spares for the valves.

c) Other documents / drawings / data as per Material Requisition.

10.5 All documents shall be in English language.

10.6 **The above documents & data requirements shall also be supplemented by all requirements of clause 2.0 of the Material Requisition.**

11.0 GUARANTEE

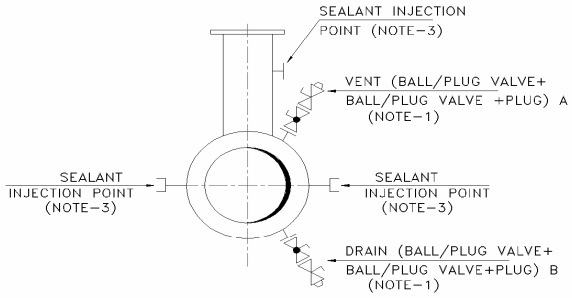
11.1 Manufacturer shall guarantee that the materials and machining of valves and fittings comply with the requirements in this specification and in the Purchase Order.

11.2 Manufacturer is bound to replace or repair all valve parts which should result defective due to inadequate engineering or to the quality of materials and machining.

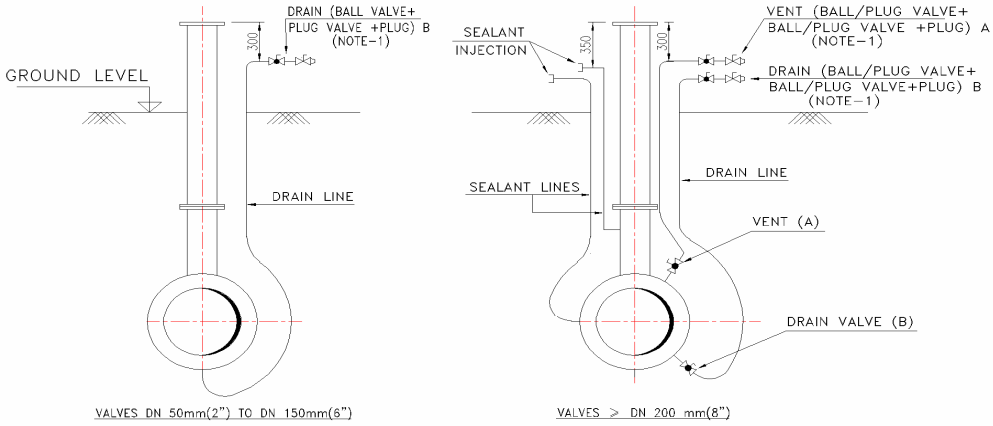
11.3 If valve defect or malfunctioning cannot be eliminated, Manufacturer shall replace the valve without delay,

11.4 Any defect occurring during the period of Guarantee shall be attended to by making all necessary modifications and repair of defective parts free of charge to the Purchaser as per the relevant clause of the bid document.

11.5 All expenses shall be to Manufacturer's account.



ABOVE GROUND INSTALLATION



UNDERGROUND INSTALLATION

SIZES OF VENT & DRAIN CONNECTIONS		
NOM. VALVE SIZE	A, DN(mm)	B, DN(mm)
50 TO 150	–	15
200 TO 600	15	25
750 & ABOVE	15	50 (REFER NOTE-2)

LEGEND:
- BALL VALVE
- PLUG VALVE
- PLUG

NOTES:
1. ALL VALVES (BALL OR PLUG) AND PLUGS FOR A AND B SHALL BE APPROVED BY THE PURCHASER.
2. VALVES OF SIZE 50mm SHALL BE MANUFACTURED AS PER API-6D.
3. SEALANT INJECTION POINTS SHALL BE PROVIDED FOR FULL OPENING VALVES OF NOMINAL VALVE SIZE 200mm (8") & ABOVE AND REDUCED OPENING VALVES OF NOMINAL VALVE SIZE, DN 250mm (10") AND ABOVE ONLY.
3. IN BURIED SECTION, ALL VENT & DRAIN CONNECTION SHALL BE OF WELDED CONSTRUCTION.

FIGURE-1

VENT, DRAIN & SEALANT INJECTION DETAILS

PROCESS & PIPING DESIGN SECTION
MECON LIMITED

DELHI - 110 092

TECHNICAL SPECIFICATION
FOR
PLUG VALVES
(NB $\geq$ 2)

SPECIFICATION NO.: MEC/TS/05/62/003, Rev-2

CONTENTS

1.0 **SCOPE**

This specification covers the minimum requirements for design, manufacture and supply of carbon steel plug valves of size DN 50mm (2) and above and ANSI Class 150 thru 900 for use in onshore pipeline systems handling non sour hydrocarbons in liquid phase or gaseous phase including Liquefied Petroleum Gas (LPG).

2.0 **REFERENCE DOCUMENTS**

2.1 All valves shall be manufactured and supplied in accordance with the Twenty Second Edition, January, 2002, or the latest edition of American Petroleum Institute (API) Specification 6D, twenty first edition, 1994 including supplement 1 & 2 thereof with additions and modifications as indicated in the following sections of this specification.

2.2 Reference has also been made in this specification to the latest edition of the following Codes, Standards and Specifications :

ASME B 16.5	:	Pipe flanges and flanged fittings
ASME B 16.25	:	Buttwelding ends
ASME B 16.34	:	Valves Flanged, threaded and welding end
ASME B16.47	:	Large diameter steel flanges
ASME B 31.3	:	Chemical & process plant piping system
ASME B 31.4	:	Liquid transportation systems for hydrocarbons and other liquids
ASME B 31.8	:	Gas transmission and distribution piping systems
ASME Sec.VIII	:	Boiler and pressure vessel code
ASTM A 370	:	Standard test methods and definitions for mechanical testing of steel products
ASTM B 733	:	Autocatalytic nickel phosphorous coating on metals
API 6FA	:	Fire test for valves
API 1104	:	Welding of pipelines and related facilities
BS:6755 (Part-II)	:	Testing of valves Specification for fire type - testing requirements
MSS-SP-6	:	Standard finishes for contact faces of pipe flanges and connecting-end flanges of valves and fittings

MSS-SP-44 : Steel pipeline flanges

SSPC-VIS-1 : Steel structures painting council-visual standard

2.3 **In ase of onfli t** between the requirements of this specification, API 6D and the Codes, Standards and Specifications referred in clause 2.2 above, the requirements of this specification shall govern. Order of precedence shall be as follows :

- Data Sheets
- This Specification
- API 6D Specification
- Other Referred Codes & Standards
- Manufacturer's Standard

3.0 MATERIALS & TEST PROCEDURES

3.1 Material for major components of the valves shall be as indicated in Valve Data Sheet. Other components shall be as per Manufacturer s standard which will be subject to approval by Purchaser.

3.2 Carbon steel used for the manufacture of valves shall be fully killed.

3.3 Chemical composition (check analysis) of valve end connection which are subject to further welding by Purchaser shall meet the following requirements for each heat of steel used:

a) Carbon : 0.22 (max.)
b) Manganese : 1.70 (max.)
c) Silicon : 0.55 (max.)
d) Phosphorus : 0.030 (max.)
e) Sulphur : 0.030 (max.)

Total percentage of Vanadium, Niobium and Titanium shall not exceed 0.20. Residual elements shall not exceed the following limits :

a) Nitrogen : 0.019
b) Nickel : 0.30
c) Copper : 0.20
d) Aluminum : 0.070
e) Chromium : 0.15
f) Molybdenum : 0.05

Carbon equivalent (CE) as calculated by the following shall not exceed 0.45 .

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

3.4 For valves specified for Gas Service or high vapour pressure liquid service, charpy V-Notch test on each heat of base material shall be conducted as per API 6D, for all pressure containing parts such as body, end flanges and welding ends as well as the bolting material for pressure containing parts. Unless specified otherwise in Valve Data Sheets, the Charpy impact test shall be conducted at 0 C. The Charpy impact test specimen shall be taken in the direction of principal grain flow and notched perpendicular to the original surface of plate or forging.

Unless specified otherwise in Valve Data Sheets, the minimum average absorbed energy per set of three specimens shall be 27 J with an individual minimum per specimen of 22 J.

3.5 For valves specified for Gas Service or high vapour pressure liquid service, the hardness of base material of body and principal parts of the valve such as plug, stem, etc., shall not exceed 22 RC.

3.6 Plug for valve size DN 200mm (8) and above or as specified in Valve Data Sheets shall have Electroless Nickel Plating (ENP) or equivalent. The hardness of plating shall be minimum 50 RC. Manufacturer shall ensure that the adhesive strength of plating is sufficient so as to prevent peeling of plating during operation of the valve.

3.7 All process-wetted parts, metallic and non-metallic, shall be suitable for the fluids and service specified by the Purchaser. The service gas composition when applicable shall be as given in Annexure-I.

4.0 DESIGN & CONSTRUCTION

4.1 The Manufacturer shall have a valid license to use API 6D monogram for manufacture of Plug Valves.

4.2 Valve pattern shall be short, regular or venturi as specified in the following table:

Class	Si e Range, NB mm (in h)	Pattern
150	50-100 (2-4)	Short
	150-300 (6-12)	Regular
	350 (14) & above	Venturi
300	50-100 (2-4)	Short
	150-250 (6-10)	Regular
	300 (12) & above	Venturi
600	50-250 (2-10)	Regular
	300 (12) & above	Venturi
900	50-250 (2-10)	Regular
	300 (12) & above	Venturi

4.3 Valve shall have an inherent feature using line pressure to ensure that the line pressure cannot cause taper locking of the plug/ plug movement into taper i.e. valves shall be of pressure balanced design.

4.4 Cover shall be bolted to the body and screwed connections are not acceptable.

4.5 Soft seats to achieve a seal between plug and body are not permitted.

4.6 All valves shall have provisions for secondary sealant injection under full line pressure for seat and stem seals. Sealant injection points shall be provided with a ball type check valve or needle valve to replace the sealant injection fitting under full line pressure.

4.7 Valves shall have vent and drain connections as per API 6D.

4.8 When specified in the Valve Data Sheet, valves shall be designed to withstand a sustained internal vacuum of at least one milli-bar in both open and closed position.

4.9 Valve design shall ensure repair of gland packing under full line pressure.

4.10 a) Valve ends shall be either flanged or butt welded or one end flanged and one end butt welded as indicated in Valve Data Sheet. Flanges of the flanged end cast/ forged body valves shall be integrally cast/forged with the body of valve. Face-to-face/ end-to-end dimensions shall conform to API 6D.

b) Flanged end shall have dimensions as per ASME B16.5 for valve sizes upto DN 600mm (24 inches) excluding DN 550mm (22 inches) and as per MSS-SP-44 for valve sizes DN 550mm (22 inches) & for DN 650mm (26 inches) and above. Flange face shall be either raised face or ring joint type as indicated in Valve Data Sheet. Flange face finish shall be serrated or smooth as indicated in Valve Data Sheet. Smooth finish when specified shall be 125 to 200 AARH. In case of RTJ flanges, the groove hardness shall be minimum 140 BHN.

c) Butt weld end preparation shall be as per ASME B16.25. The thickness of the pipe to which the valve has to be welded shall be as indicated in Valve Data Sheet. Valves shall be without transition pups. In case significant difference exists between thickness of welding ends of valve and connecting pipe, the welding ends of valve shall have bevel preparation as per ASME B31.4 or ASME B31.8, as applicable.

4.11 Valves shall be provided with position indicator and stops at the fully open and fully closed positions.

4.12 Valves of size DN 200mm (8) and above shall be equipped with lifting lugs. Tapped holes and eye bolts shall not be used for lifting lugs.

4.13 Valves shall have locking devices to be locked either in full open or full close position when indicated in the Valve Data Sheets. Locking devices shall be permanently attached to the valve operator and shall not interfere with operation of the valve.

4.14 Valves shall be of fire safe design as per BS:6755 (Part-II)/ API 6FA, if indicated in Valve Data Sheet.

4.15 Valves shall be suitable for either buried or above ground installation as indicated in the Valve Data Sheet.

4.16 Valves with stem extension, when indicated in Valve Data Sheet shall have following provisions :

a) Valves provided with stem extension shall have water proof outer casing. Length of stem extension shall be as indicated in the Valve Data Sheet. The length indicated corresponds to the distance between the centreline of the valve opening and the top of the mounting flange for valve operating device (gear operator/ power actuator as applicable).

b) Vent and drain connections shall be terminated adjacent to the valve operator by means of suitable piping anchored to the valve body. Pipe used shall be API 5L Gr. B/ ASTM A106 Gr. B, with Sch. 160. Fittings shall be ASTM A105/ ASTM A 234 Gr. WPB, Socket Welded, ANSI class 6000.

c) Sealant injection lines shall be extended and terminated adjacent to the valve operator in manner as indicated in (b) above.

d) Stem extension and stem housing design shall be such that the complete assembly will form a rigid unit giving a positive drive under all conditions with no possibility of free movements between valve body stem extension or its operator.

e) Outer casing of stem extension shall have 3/8 or NPT plugs at the top and bottom, for draining and filling with oil to prevent internal corrosion.

4.17 **Operating Devi es**

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 atleast 1.25 times the maximum torque required to operate the valve under maximum differential pressure corresponding to the valve class rating.

c) Operating device shall be designed for easy operation of valve under maximum differential pressure corresponding to the valve rating.

d) For manual operation of all valves, the diameter of the hand wheel or the length of operating lever shall be such that under the maximum differential pressure, the total force required to operate the valve does not exceed 350 N. Manufacturer shall also indicate the number of turns of hand wheel (in case of gear operator), required to operate the valve from full open to full close position.

e) Direction of operation of hand wheel or wrench shall be in clock-wise direction while closing the valve. Hand wheels shall not have protruding spokes.

f) Gear operators, if specified, shall have a self locking provision and shall be fully encased in waterproof/ dustproof/ weatherproof/ splashproof enclosure and shall be filled with suitable grease.

4.18 Repair by welding is not permitted for fabricated and forged body valves. However repair by welding as per ASME B16.34 is permitted for cast body valves. Repair shall be carried out before any heat treatment of casting is done. Repair welding procedure qualification shall also include impact test and hardness test when required as per Clause 3.4 and 3.6 of this specification and shall meet the requirements as specified therein.

4.19 The tolerance on internal diameter and out of roundness at the ends for welded ends valves shall be as per connected pipe specification as indicated in the Valve Data Sheet.

4.20 Valve stem shall be capable of withstanding the maximum operating torque required to operate the valve against the maximum differential pressure corresponding to applicable class rating. The combined stress shall not exceed the maximum allowable stresses specified in ASME section VIII, Division-1.

For Power Actuated Valves, the valve stem shall be designed for maximum output torque of the selected power actuator (including gear box, if any) at the valves stem.

5.0 INSPECTION & TESTS

5.1 The Manufacturer shall perform all inspection and tests as per the requirements of this specification and the relevant codes, prior to shipment at his works. Such inspection and tests shall be, but not limited to, the following :

5.1.1 All valves shall be visually inspected.

5.1.2 Dimensional check shall be carried out as per the Purchaser approved drawings.

5.1.3 Chemical composition and mechanical properties shall be checked as per relevant material standards and this specification, for each heat of steel used.

5.1.4 a) Non-destructive examination of individual valve material and component consisting of but not limited to castings, forgings, plates and assembly welds shall be carried out by the Manufacturer.

b) Valves castings shall be radiographically examined at the cover and body portion, seat location, flanged body ends and circumference of ends to be field welded. Procedure and acceptance criteria shall be as per ASME B16.34. The extent of radiography shall be as follows :

ANSI Class 150-	All Sizes	-	Nil
ANSI Class 300-	≤ DN 400mm (16)	-	Nil
	≥ DN 450mm (18)	-	100
ANSI Class 600- and above	All Sizes	-	100

All castings shall be wet magnetic particle inspected 100 of the internal surfaces. Method and acceptance shall comply with ASME B16.34.

c) Valve forgings shall be examined by ultrasonic method. Inspection procedure and acceptance criteria shall be as per Annexure E of ASME B16.34.

5.1.5 Areas which, in Purchaser s Inspector's opinion, cannot be inspected by radiographic methods shall be checked by ultrasonic or magnetic particle methods and acceptance criteria shall be as per ASME Sec-VIII, Division I, Appendix 12 and Appendix 6 respectively.

5.1.6 a) Weld ends of all cast valves shall be 100 radiographically examined and acceptance criteria shall be as per ASME B16.34.

b) After final machining all bevel surfaces shall be inspected by dye penetrant, or wet magnetic particle methods. Any defects longer than 6.35mm shall be rejected and also defects between 6.35mm and 1.59mm that are separated by a distance less than 50 times their greatest length. Weld repair of bevel surface is not permitted. Rejectable defects must be removed.

c) All finished wrought weld ends subject to welding in the field shall be 100 ultrasonically tested for lamination type defects for a distance of 50mm from the end. Laminations shall not be acceptable.

5.1.7 All valves shall be tested in compliance with the requirements of API 6D. Hydrostatic shell testing shall ensure that the whole of the shell is subjected to the test pressure. If necessary, the empty shell shall be pressure tested prior to assembly of the plug. The drain, vent and sealant lines shall be either included in the hydrostatic shell test or tested independently. No leakage is permissible during hydrostatic testing.

5.1.8 A supplementary air seat test as per API 6D shall be carried out for all valves. No leakage is allowed. Test pressure shall be held for at least 15 minutes.

5.1.9 Manufacturer who intends bidding must submit at bid stage, certificate and report for successful fire safe tests for all types of valves in accordance with BS:6755 (Part-II)/ API 6FA, as applicable in Valve Data Sheet.

Failure to comply with the requirement shall be a cause of rejection of the offer.

5.1.10 Valve shall be subjected to Operational Torque Test as per supplementary test requirement of API 6D under hydraulic pressure equal to the maximum differential pressure corresponding to the valve rating. The maximum handwheel force shall not exceed 350 N.

5.1.11 Power actuated valves shall be tested after assembly at the valve Manufacturer s works. Actuator shall be capable to allow minimum five consecutive opening and closing cycles. To achieve this, the Manufacturer shall provide closing and opening operations. This test shall be conducted on one valve out of a lot of five valves of the same size, rating and actuator type. In case the test result dose not meet the requirements, retesting/ rejection of the lot shall be as decided by Purchaser s Inspector.

The actuator shall be adjusted to ensure that opening and closing time is within the limits stated in Actuator Data Sheet issued for the purpose.

The hand operator installed on the actuator shall also be checked after the cyclic testing, for satisfactory manual over-ride performance.

5.2 Purchaser reserves the right to perform stagewise inspection and witness tests as indicated in para 5.1 at Manufacturer s works prior to shipment. Manufacturer shall give reasonable access and facilities required for inspection to Purchaser s Inspector.

Purchaser reserves the right to request additional testing at any time to confirm or further investigate a suspected fault. If the suspected fault is confirmed, the cost incurred shall be to Manufacturer s account.

In no case shall any action of Purchaser or his representative relieve the Manufacturer of his responsibility for material, design, quality or operation of valves.

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

6.0 E TENT OF INSPECTION & TESTING

6.1 Purchaser s Inspector shall perform inspection and witness test on all valves as indicated in the uality Assurance Plan (AP) attached with this specification.

6.2 The hydrostatic testing and cyclic opening and closing of the valves with the operator shall be witnessed by Purchaser s Inspector.

7.0 TEST CERTIFICATES

7.1 Manufacturer shall submit the following certificates :

a) Mill test certificates relevant to the chemical analysis and mechanical properties of the materials used for valve construction as per the relevant standards.

b) Test certificates on hydrostatic and pneumatic test complete with records of timing and pressure of each test.

c) Test reports conforming to clause 5.1.9 of this specification, if applicable.

d) Test reports on radiographic and ultrasonic inspection.

e) Test reports on operation of valves conforming to clause 5.1.10 and 5.1.11 of this specification.

f) All other test reports and certificates as required by API 6D and this specification.

The certificates shall be valid only when signed by Purchaser s Inspector. Only those valves which have been certified by Purchaser's Inspector shall be dispatched from Manufacturer s works.

8.0 PAINTING, MARKING & SHIPMENT

8.1 Valve surface shall be thoroughly cleaned, freed from rust and grease and applied with sufficient coats of corrosion resistant paint. Surface preparation shall be carried out by shot blasting to SP 6 in accordance with Steel Structures Painting Council - Visual Standard - SSPC-VIS-1 . For the valves to be installed underground, when indicated in Valve Data Sheet, external surfaces of the buried portion of valves shall be painted with three coats of suitable coal tar epoxy resin with a minimum dry film thickness of 300 microns.

8.2 Manufacturer shall indicate the type of corrosion resistant paint used, in the drawings submitted for approval.

8.3 All valves shall be marked as per API 6D. The units of marking shall be metric except Nominal Diameter which shall be in inches. Marking shall be done by die-stamping on the bonnet or on the housing. However for buried valves the marking shall be done on the above ground portion of the stem housing only.

8.4 Valve ends shall be suitably protected to avoid any damage during transit. All threaded and machined surfaces subject to corrosion shall be well protected by a coat of grease or other suitable material. All valves shall be provided with suitable protectors, for flange faces, securely attached to the valves. Bevel ends shall be protected with metallic bevel protectors.

8.5 All sealant lines and other cavities of the valves shall be filled with sealant before shipment.

8.6 Packaging and shipping instructions shall be as per API 6D.

8.7 Packages shall be marked legibly, with suitable marking ink, the following.

a) Order Number
b) Manufacturer s Name
c) Valve Size and Rating
d) Tag Number
e) Serial Number

9.0 SPARES & ACCESSORIES

9.1 Manufacturer shall recommend and quote separately the spares for valves required for commissioning and two years of normal operation. List of such spares without price shall be indicated alongwith technical bid and separately with price.

9.2 Manufacturer shall recommend and quote unit price separately for the accessories (like wrench, sealant injector, etc.), sealant and special tools required for maintenance of valves.

10.0 DOCUMENTATION

10.1 At the time of bidding, the bidder shall submit the following documents :

a) General arrangement/ assembly drawings showing all features and relative positions & sizes of vents, drains, gear box & other external parts together with overall dimensions.

b) Sectional drawing showing major parts with reference numbers and material specification.

c) Reference list of similar plug valves manufactured and supplied in last five years, indicating all relevant details including project, year, client, location, size rating, service, etc.

d) Torque curves for the power actuated valves alongwith break torque and maximum allowable stem torque. In addition, sizing criteria and torque calculations shall also be submitted for power actuated valves.

e) Descriptive technical catalogues of the Manufacturer.

f) Copy of valid API 6D certificate, wherever applicable.

g) Details of support foot, including dimensions and distance from valve centre line to bottom of support foot.

h) uality Assurance Plan enclosed with this tender duly signed, stamped and accepted.

IMPORTANT

The drawings to be submitted alongwith the bid shall be in total omplian e with the re uirement of te hni al spe ifi ation and data sheets of the valves with no ex eption & 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.

PROCESS & PIPING DESIGN SECTION
MECON LIMITED
DELHI - 110 092

TECHNICAL SPECIFICATION
FOR
LONG RADIUS BENDS

SPECIFICATION NO. : MEC/TS/05/62/015, Rev-1

CONTENTS

Revision No.	Date	Revised by	Checked by	Approved by

PREPARED BY :	CHECKED BY :	APPROVED BY :

1.0 SCOPE

This specification covers long radius steel pipe bends to be manufactured in accordance with the requirements of MSS-SP (Manufacturers Standardisation Society Standard Practice) 75, latest edition, to be used in pipeline system handling Natural Gas. The selection of options permitted by MSS-SP-75 shall be as described below. All applicable requirements contained in the MSS-SP-75 shall be fully valid unless cancelled, replaced or amended by more requirements as stated in this specification. In case of conflict between the requirements of this specification and MSS-SP-75, the requirements of this specification shall govern.

2.0 REFERENCE DOCUMENTS

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

a) ANSI B31.8 : Gas Transmission and Distribution Piping System.

b) ASME Sec. VIII Div. 1 : Boiler and Pressure Vessel Code

c) ASME Sec IX : Boiler & Pressure Vessel Code Welding and Brazing ualifications

d) API Spec. 5L : Line Pipe

e) ASTM Part-I : Steel Piping, Tubing, Fittings

In case of conflict between the above reference documents and this specification, the requirements of the specification shall prevail.

3.0 MATERIALS

3.1 Bends shall be fabricated from bare steel line pipe (to be issued as free issue item by Purchaser). The details of free issue line pipe material is given separately in LR Bend Data Sheet & Purchase Requisition.

3.2 All mechanical properties of the bends after finishing shall be same as pipe specification as referred in section 3.1. The following tests shall be conducted on finished bends and test procedures shall be as per pipe specification as referred in para 3.1.

3.2.1 One transverse tensile test will be conducted to establish the yield strength, ultimate tensile strength and elongation of :

a) Base material at inside radius of the bend.
b) Base material at outside radius of the bend.

3.2.2 One all weld tensile test will be conducted (wherever applicable) to establish yield strength, ultimate tensile strength and elongation of weld material on bend.

3.2.3 Three transverse Charpy-V-notch impact tests shall be conducted on full sized specimen of the same heat in accordance with ASTM A370 at 0 C for each of the following :

a) Base material at outside radius of the bend.
b) Weld material of bend

3.2.4 **Guided Bend Tests**

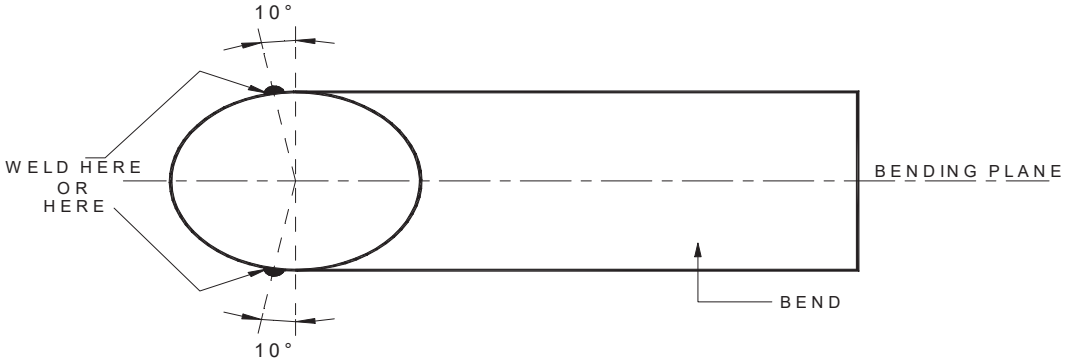
One face and one root guided bend weld test shall be performed on samples cut from one bend per heat of steel. The dimensions A' in guided bend test shall not exceed 4.0 times the nominal wall thickness and dimension B' shall be equal to A 2t 3.2mm.

4.0 MANUFACTURE

4.1 Bends shall be manufactured by hot bending of pipe applying induction heating only.

The adopted procedure shall be completed by suitable heat treatment to achieve the required mechanical and chemical properties of the finished bends and is accepted only after written approval of the Purchaser. The procedure shall ensure uniform bending without any defects other than those allowed in this specification and pipe specification as referred in para 3.1.

4.2 When bending, the weld wherever applicable shall be located at approx. 10 from the neutral zone, measured at outside of the bend as indicated in figure below.



4.3 Bevels at the ends shall be as specified in MSS-SP-75 unless otherwise specified differently in the material/ purchase requisition.

4.4 Bends shall not have any circumferential joint.

4.5 No repair by welding is allowed on any part of the bends.

4.6 The cooling of the bend immediately after bending shall be an interval cooling, alternatively with water and air at a minimum pressure of 2 atmospheres.

4.7 The procedure shall be such which shall not require any additional heat treatment after bending. If such a heat treatment is required, it is permitted only after the written approval of purchaser and shall be carried out at Manufacturer's expense.

4.8 Bulges, dents and flat areas shall not appear within 100mm from end of the bend.

For the remaining part of the bend these deviations from the original contour of the pipe are permitted but the same shall be repaired, provided these deviations shall not exceed 6.5 of nominal wall thickness in height/ depth and the same shall not extend (in any direction) over a distance of more than 25 of nominal diameter.

4.9 The excess weld material wherever applicable at the inside of the bend shall be removed over a distance of 100mm at both ends.

4.10 **Toleran es**

The dimensions of bends shall be controlled to make sure that they are manufactured according to the tolerances indicated below over and above the requirements of MSS-SP-75

4.10.1 Minimum Inside Diameter : -2.5 of inside nominal diameter except 200mm from ends

Bend Angle : 1

Bend Radius : 1 of bending nominal Diameter

4.10.2 The manufacturer shall check the wall thickness of the pipe before and after bending along the outside radius either at distances approximately equal to pipe diameter or 300mm whichever is less. The measured wall thickness shall be atleast equal to :

tmin 0.95 (tnom. -△ t)

tnom nominal wall thickness as specified in the material/ purchase requisition.

△ t 0.35mm for a wall thickness smaller than 10mm.

△ t 0.50mm for a wall thickness 10mm or more.

4.10.3 Ovality may be defined as :

$$\frac{OD_{max.} - OD_{min}}{OD_{nom.}}$$

The above value shall be 1 within 100mm from each end and 6 for remaining part of the bend. The measurement shall be made over the circumference of the bend either at distance approximately equal to pipe diameter or 300mm whichever is less.

4.10.4 **Wrin les**

Measurements of the outside diameter shall be taken in the plane of the bend at locations where wrinkles are present (OD max.) and at locations where wrinkles are not present (OD min,). The acceptance limit shall be as defined below.

$$\frac{OD_{max.} - OD_{min}}{OD_{nom.}} \quad 1$$

5.0 INSPECTION AND TESTS

5.1 The manufacturer shall perform all inspection and tests as per the requirements of this specification and MSS-SP-75 prior to shipment at his works. Such inspection and tests shall be, but not limited to, the following :

a) Verify that the unfinished product arriving at manufacturer's shop is in full compliance with the pipe specification as referred in para 3.1.
b) Visual Inspection.
c) Dimensional and tolerances check as per MSS-SP-75 and requirements of section 4.0 of this specification.
d) Check heat treatment, if carried out, as required and maintain its records.
e) Temperature against time recorder charts for each induction heating.
f) Material properties shall be checked to meet the requirements of section 3.0 of this specification.
g) The non-destructive inspection on the finished bend shall be carried out as given below :

- All longitudinal seam welds shall be fully radiographed and acceptance limits shall be as per pipe specification as referred in para 3.1.
- The full circumference of both ends of each bend after bevelling shall be ultrasonically tested for laminations over a length of 25mm and acceptance limits shall be as per pipe specification as referred in para 3.1.

5.2 Purchaser's Representative reserves the right to perform stagewise inspection and witness tests on all bends as indicated in para 5.1 at Manufacturer's works, prior to shipment.

Manufacturer shall give reasonable notice of time and shall provide without charge reasonable access and facilities required for inspection, to the Purchaser's Representative. Inspection and test performed or witnessed by Purchaser's Representative shall in no way relieve the Manufacturer's obligation to perform the required inspection and tests. Under no circumstances any action of the Purchaser's Representative shall relieve the Manufacturer of his responsibility for the material, design, quality and operation of the equipment.

5.3 **Test Certifi ates**

The Manufacturer shall produce the Certificates (in original) for all, but not limited to, the following :

a) Certificates of chemical analysis and mechanical tests carried out on pipe and bends separately.

b) Certificates of required non-destructive test inspection.

c) Certificates of heat treatments, if any.

d) Certificates of all other tests as required in this specification.

In case any of the above said certificates are not available during the final inspection, the supply shall be considered incomplete.

6.0 **MARKING, PACKING AND SHIPMENT**

6.1 All bends shall be marked as per MSS-SP-75.

6.2 All loose and foreign material i.e. rust, grease, etc. shall be removed from inside and outside of the bends.

6.3 All bends except bevelled ends shall be coated internally and externally with a thin film of zinc chromate red oxide paint for protection against corrosion during transit and storage. The coating shall be easily removable in the field. Manufacturer shall furnish the details for the same.

6.4 Both ends of all bends shall be suitably protected to avoid any damage during transit by means of metallic bevel protectors.

6.5 Package shall be marked legibly with suitable marking to indicate the following:

a) Order Number
b) Package Number
c) Manufacturer's Name
d) Size (Inches) and wall thickness (mm)

7.0 WARRANTY

Purchaser will be reimbursed by Manufacturer for any bend furnished on this order that fails under field hydrostatic test if such failure is caused by a defect in the bend which is outside the acceptance limits of this specification. The reimbursement cost shall include bend cost, labour cost and equipment rental for searching, excavation, cutting out and installation of replaced bend in position. The field hydrostatic test pressure will not exceed that value which will cause a calculated hoop stress equivalent to 100 of specified minimum yield strength of the attached pipe.

8.0 DOCUMENTATION

8.1 All documents shall be in English language.

8.2 At the time of bidding, bidder shall submit the following documents :

a) Reference list of previous supplies of bends of similar specifications.

b) Clause-wise list of deviation from this specification, if any.

c) Brief description of manufacturing and quality control facilities of the Manufacturer's works.

8.3 Within one week of placement of order the Manufacturer shall submit four copies, of the manufacturing process and quality assurance plan for pipe and bends.

Once the approval has been given by Purchaser any change in material and method of manufacture and quality control shall be notified to Purchaser whose approval in writing of all such changes shall be obtained before the bends are manufactured.

8.4 Within four weeks from the approval date Manufacturer shall submit one reproducible and six copies of the documents as stated in para 8.3 of this specification.

8.5 Prior to shipment, the Manufacturer shall submit one reproducible and six copies of test certificates as listed in para 5.3 of this specification.

PART V

ELECTRICAL WORKS

STANDARD DATA SHEETS (ELECTRICAL SYSTEM)

LIST OF DATA SHEETS/ANNEXURES (ELECTRICAL)

Sl. No.	Description of Data Sheets	Data Sheet No.
1	LV SMALL POWER DISTRIBUTION BOARD	MEC/DS/05/E9/076A
2	DISTRIBUTION TRANSFORMER	MEC/DS/05/E9/080
3	UPS	MEC/DS/05/E9/071

Rev. :1
Edition : 1

DATA SHEET

FOR

UN-INTERRUPTED POWER SUPPLY (UPS) SYSTEM

SPECIFICATION NO.- MEC/DS/05/E9/071

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

ANNEXURE - I

PURCHASER S DATA FOR UPS

1.0	**INPUT POWER SUPPLY**	
1.1	Voltage/freq./ phase	415 V (+) 10% & (-) 15% TPN, 50 Hz ± 5% or 230V AC single phase (voltage range-To be provided by Bidder) As per SOR.
1.2	System fault level	10 kA for 1 Sec
2.0	**SITE CONDITION**	
2.1	Design Maximum /Minimum temperature	48˚C/2˚C
2.2	Max. Relative humidity	95%
2.3	Altitude	Below 1000.0 M MSL
3.0	**OUT PUT REQUIREMENT**	
3.1	Voltage/ Phase	230V ± 1% AC, Single phase 2 wire
3.2	Output waveform & frequency	Pure Sinusoidal Wave
		50 Hz ± 0.1%
		Voltage distortion (THD): Less than 3% for linear loads & Less than 5% for non linear loads.
4.0	**SYSTEM REQUIREMENTS**	
4.1	Rating KVA	**As per SOR**
4.2	Type of inverter	The inverter circuit should be IGBT based, fully microprocessor controlled with PWM Technology or Latest proven technology
4.3	Overload capacity	125% of the rated output for 10 minutes & 150% for 1 minute.
4.4	Mode of operation	Dual/Parallel Redundant with static bypass & Dual Redundant rectifier as specified in SOR/Design basis/Block diagram
4.5	Inverter efficiency	>90% for normal load and not below 85% for 25% of load
4.6	Installation	Floor Mounted
4.7	Type of enclosure	Minimum IP-31
4.8	External Cable Connection	From Bottom
4.9	Internal protection	All live parts shrouded
4.10	Earthing	Doubly Earthed (Two distinct terminals to be made available)
4.11	Cooling	Forced ventilation with fans

4.12	Noise Level	<65 dB at full Load from 1 mtr distance
4.13	Crest Factor	≥3:1
4.14	Input Power Factor	>0.9
4.15	Load Power Factor	with variation between 0.6 to 1.0
4.16	UPS Line Power factor	>0.8
4.17	Overall efficiency	>85%
4.18	Harmonics	As per IEEE 519 (Total demand distortion not more than 5.0%)
5.0 Rectifier/Charger		
5.1	Input voltage	415 V (+) 10% & (-) 15%, TPN, 50 Hz ± 5% or 230V AC single phase (voltage range-160V AC to 270V AC) or 230V ± 1% AC from UPS (As per SOR).
5.2	Automatic phase selection device	As per SOR
5.3	Output DC voltage/Load	**As per Manufacturer Design**
5.4	Input Power factor	>0.8 (minimum) at rated load
5.5	Input current THD (Total Harmonic Distortion) at nominal load	
5.6	Overload Capability	125% minimum for 15 min. 150% minimum for 1 min.
5.7	Inrush current	Limited by soft-start circuit
5.8	Output voltage tolerance	+/- 1%
5.9	DC voltage ripple	<1% with battery connected <2 % Without battery connected
5.10	Rectifier	IGBT Based
5.11	Filter	Input side line filter
5.12	Harmonics	As Per IEEE-519 (Voltage THD<5%, largest single voltage harmonics<3%, Total demand distortion <5%
5.13	Charging	Automatic Float and Boost charging (selection as per battery charging state(voltage level))
6.0 Bypass		
6.1	Automatic Bypass	Static bypass to provide an un interruptible transfer of load in case of failure of any system component or malfunctioning or overload & the load shall return on the UPS when the malfunctioning or overload is cleared.
6.2	Input connection	Separate for each UPS

6.3	The switching time from inverter to bypass & vice versa	No break type
6.4	Manual/Maintenance Bypass	Shall be provided
6.5	Overload on bypass	150% (minimum) for 1 min., 125% (minimum) for 15 min.
6.6	Connectivity	Ethernet
7.0 Battery Bank		
7.1	Type of Battery	**As per SOR**
7.2	Battery Arrangement	**2 X 50**
7.3	i) Battery end cell voltage ii) Battery stand formation iii) Battery back up time iv) De-rating factor	As per specification (clause no. 3.5) As per battery manufacturer As per SOR (i) Ageing -- 0.8 (ii) State of Charge -- 0.88 (iii) Temp. Correction -- As per min. site temp. (Ref. 2.1 above) The rectifier/charger output current & voltage shall be limited to the battery supplier's recommendation.
8.0 Alarms, Indications and LCD Display		
8.1	Single line Power Flow Diagram (Mimic diagram) with LED indications of UPS status (i.e. Mains present, Battery charging & discharging, Low battery Voltage and unit on bypass).	
8.2	Digital panel Meter with LCD display shall be provided for monitoring viz.	a) Input AC Voltage, current, frequency b) Output AC Voltage, current, frequency. c) Battery current and voltage d) Total run time e) Mains ON/OFF, Mains Over/Under voltage, Phase fail f) Inverter ON/OFF, Inverter Over/Under voltage, inverter overload, over heat & load in % on inverter. g) Battery voltage low, battery level in % & battery fault h) Battery Operation Boost Charge, Float Charge with of status - "in charge" or "discharge" i) Load on bypass or inverter. Detailed UPS Status with Operation/faults history

8.3	Audible Alarms With LCD Display-	a) Mains Failure b) Battery Low c) UPS fault (Continuous) d) Inverter Under-voltage e) Over Temperature (Continuous) f) Inverter Overload (Continuous)
9.0 Protective Features		
9.1	Input	Mains Over voltage, under voltage, phase failure
9.2	Inverter	Over voltage, short circuit, overload, over temperature
9.3	Battery	Under voltage at battery terminal, Battery over charge, Battery Over current
9.4	Rectifier & Battery charger	Maximum current limiting Over temp. Trip Boost charging and float charging current limiting with back up protection against over charging.
10.0 Distribution boxes		
10.1	Distribution Board Details	**(As per tender drawings/SOR)** **(1) ACDB 230 V, Single Phase (1 No.)** Incomer : DP MCB Outgoing : 3 Nos 50A (Combination) DP MCCB's and 32 A MCB DP-3 nos., 6 A DP 6 Nos.
11.0	**Battery monitoring System**	**Yes with communication**
12.0	**UPS communication**	**Ethernet**
13.0	**Selector switch**	**For Auto manual switch for Float and boost selection**
14.0	Toggle switch	**Float and Boost selection**

ANNEXURE-II (A)

TECHNICAL DATA FROM MANUFACTURER
(To be filled up by the Tendered)

1.0	**INVERTER**	
1.1	Manufacturer's Model No. (**Enclose catalogue**)	
1.2	Rating (at specified ambient) / no. of phases	
1.3	Applicable codes/standards	
1.4	Steady state output volt/freq (230 V ± 1%) (50 Hz ± 0.1%)	
1.5	Input voltage - DC	
1.6	Synchronization (inv. phase locked with main) in percentage	
1.7	Synchronization manually adjustable in steps of	
1.8	Allowable unbalance between phases (for 3 Phases only)	
1.9	Harmonics distortion for linear & non-linear loads	
1.10	Mode of operation	Dual/Parallel Redundant with static bypass as specified in SOR/Design basis/Block diagram
1.11	Dynamic Responses at following conditions a) ± 50% step load (for parallel redundant UPS) b) ± 100% step load (for hot standby and single UPS system). c) Power supply interruption and restoration. d) Load Transferred to bypass line e) When one inv. gets faulty and load transferred to healthy inv. (for parallel redundant UPS)	
1.12	Recovery time to reach steady state after above disturbance (not more than 100m Sec)	
1.13	Overload capacity (125% minimum for 15 min. 150% minimum for 1 min.)	
1.14	Short circuit capacity and duration (in % and m sec.)	
1.15	Noise Level (dB at 1 m) (Not more than 65 dB)	

1.16	Efficiency at 100%/75%/50% loads (not less than 90% at 100% load)	
1.17	Type of control circuit	
1.18	Out put voltage & phase angle (for 3 Phase only) a) For 30% unbalance load b) For 40% unbalance load c) For 50% unbalance load d) For 100% unbalance load	
1.19	Crest Factors	
2.0	**STATIC SWITCHES**	
2.1	Nos. of static switches in each set	
2.2	Current rating at specified ambient	
2.3	Transfer time (m sec.) a) Synchronized mode (not more than 4msec) b) Unsynchronized mode (not more than 20msec)	
3.0	**BATTERY CHARGER**	
3.1	Rating (Amp.) / MAKE (**Enclose back up calculation).**	
3.2	Type of charger (Basic configuration)	
3.3	Output volt under float/boost charging condition	
3.4	Volt. Accuracy under specified input (± 1%)	
3.5	Max. Ripple content on DC side (% RMS) (not more than 2% without battery & 1% with battery connected)	
3.6	Efficiency at 100%/75%/50 % of load	
3.7	Mode of Change over from float to boost and vice-versa	
4.0	**BATTERY**	
4.1	Make	
4.2	Type (**Enclose catalogue)**	
4.3	AH rating **(Enclose back up calculation)**	
4.4	End cell voltage at specified discharge rate (V/ cell)	
4.5	Output (Nominal) volts	
4.6	No. of battery banks	

4.7	No. of cells in each bank	
4.8	Battery charging requirements (V/ cell) a) Volts/Cell/Nominal b) Float c) Boost	
4.9	Voltage variation from fully charged battery to discharged battery (volts)	
4.10	Charging time (Hrs.)	
4.11	Max. Permissible ripple content (% RMS)	
4.12	Overall dimension (L*W*H)	
4.13	Container type	
4.14	Accessories for battery as per specification included	Cell testing Voltmeter, Pair of Gloves, Insulated Spanner, Extra Electrolyte, Hydrometer, Thermometer etc.
4.15	Type/Formation of battery stand	
5.0	**MANUAL TRANSFER DEVICES**	
5.1	Rating (Amp.)	.
5.2	Make/Type	
6.0	**STEP DOWN BYPASS TRANSFORMER WITH SOLID STATE VOLTAGE STABILISER**	
6.1	Make/type	
6.2	Rating and Voltage ratio	
6.3	Accuracy of stabilizer (not more than ± 2%)	
6.4	Type of control (Solid state)	
6.5	Type of cooling	Natural
7.0	**AC DISTRIBUTION BOARD**	
7.1	Nos. of feeder/rating	
7.2	Cable entry from (Bottom)	
7.3	Max. Rating of outgoing feeders possible for fault clearance by UPS with and without supply back up (as percentage of UPS rating) not less than 25%. a) With fast acting semi conducting fuses	
9.0	Indications and Alarm	
10.0	Metering	

11.0	**UPS Dimension** (L x W x H) except Battery (Including inverter, charger, rectifier, bypass stabilizer, ACDB etc.)	
12.0	**OVERALL EFFICIENCY OF UPS SYSTEM**	
12.1	Ratio of output load to input drawn from mains when inverters are on and synchronized with bypass. a) At 100% load b) At 75% load c) At 50% load	
13.0	**RELIABILITY** a) Safety factor used for selecting electronic components/ other electrical components (not less than 200%/ 125% respectively) b) MTBF / MTFR c) Availability factor	
14.0	**DEGREE OF PROTECTION OF THE PANEL** (Minimum IP – 31)	
15.0	**Heat loss** for total system (W)	
16.0	**Potential free contracts** (for duplicating of fault status in remote panel).	
17.0	**Fault status** shall be compatible to hook-up with Owner's PC through Ethernet interface.	

ANNEXURE- II (B)

TECHNICAL DATA FROM MANUFACTURER

1.0	2x100% RECTIFIER UNITS	
1.1	Mains Input	
	a) Voltage & Frequency	415 V (+) 10% & (-) 15%, TPN, 50 Hz ± 5% or 230V AC single phase (voltage range-160V AC to 270V AC) or 230V ± 1% AC from UPS. (Rectifier may be fed from UPS output. However it shall also be suitable for these variations if operated independent of UPS).
	b) Input harmonics (max.) at full load.	5% RMS (Voltage)
1.2	**Out put details**	
1.2.1	**Rectifier**	
	a) Voltage / Wattage	24 V DC , Watt as per SOR
		(-) 48 V DC, Watt as per SOR
	b) Method of Voltage /Current Control	
1.2.2	**Load Bus**	
	a) Voltage Regulation from Full load to no load (for mains variation of ±10%)	+ 5%
	b) Ripple Content (<30 mV)	
	c) Rating of Double pole MCB and fuses for DCDB	(DP MCB's with semiconductor fuses and DC bus for 4 outgoing feeders)
1.3	Efficiency of Rectifier (at 50%, 75%, 100% load)	
1.4	Power Factor of Rectifier (at all load)	0.6 to 0.7 (lag)
1.5	**Annunciator details**	
	a) Audio – Visual	DC over voltage Rectifier Failure Load C.B. Trip

	b) Push buttons	Acknowledge, reset
	c) Remote	One no. potential free common alarm annunciation contact.
1.6	Indication Lamps	AC Power ON, Rectifier ON
1.7	Meters	A.C. input ammeter and voltmeter. Output ammeter and voltmeter.
1.8	MTBF (Hrs.)	60,000 Hrs.
1.9	MTTR (Hrs.)	4 Hrs. (Approx.)
1.10	PTRV (Peak Transient reverse voltage)	600 V on AC side 200 V on DC side
1.11	**Construction Details**	
	a) Type of Cooling	Natural
	b) Cable entry	Same as UPS Panel
	c) Access	Same as UPS Panel
	d) Painting	Same as UPS Panel
	e) Degree of Protection	Same as UPS Panel
1.12	Safety Factor	2

ANNEXURE III

PREFERRED MAKES

UPS System and Inverter

1. EMERSON
2. DB POWER
3. APLAB
4. KELTRON
5. HI-REL

Batteries (Lead Acid)

1. Amco Batteries Ltd.
2. Exide Industries Ltd.
3. HBLNIFE Power System Ltd.
4. Amara Raja Batteries Ltd.

Batteries (Nickel Cadmium)

1. Amco Batteries Ltd.
2. HBLNIFE Power Systems Ltd.

ANNEXURE - IV

CHECK LIST (To be filled up by tenderer)

Sl. No	Description	REMARKS
1	Deviation from specification	
2	Charger sizing calculation enclosed	
3	Battery sizing calculation enclosed	
4	Battery catalogue enclosed	
5	UPS Catalogue enclosed	
6	Confirm compliance to Block diagram	
7	Confirm Inspection for UPS and battery as per specification.	
8	Dimension for UPS Panel, rectifier and Battery Bank enclosed.	
9	Break up for two years operation & maintenance spares enclosed for UPS & Rectifier	

REV. : 0
Edition : 1

DATA SHEET
FOR
LV SMALL POWER DISTRIBUTION BOARD

DATA SHEET NO. - MEC/DS/05/E9/076A

(OIL GAS SBU)
MECON LIMITED

ANNEXURE - I

	Switch Board	
1.1	Rated voltage and frequency	415V, 3phase, 4 wire, 50Hz
1.2	Maximum voltage	500V
2.0	Continuous current rating at design ambient temperature	As per approved SLD at 45˚C with IP 52 enclosure
3.0	Type of enclosure as per IS 2147	IP 52
3.1	Minimum thickness of sheet steel	2mm
4.0	Applicable standards	IS 2147, 8623
5.0	Design ambient temperature	45˚C
6.0	One second short time rating of switch board with minimum busbars, feeder busbars, kA(RMS)	As per SLD
7.0	Dynamic through fault current with complete busbars, kA (peak)	
8.0.	The formation (Max.)	Max 6
9.0	Maximum No. of cable terminations in each type of cubicle	
9.1	Size and no.	As per SLD
10.0	Incoming termination of LT switch board	As per SLD
11.0	Incoming termination top/bottom	Bottom for cable Top for busduct
12.0	Outgoing feeder cable entry top/bottom	Bottom
13.0	Minimum clearances at front and back of board	1.5m/1m
14.0	Dimensions LxBxH	
15.0	Maximum Dimensions of shipping sections LxBxH	2.5 x 1.5 x 2.4M
16.0	Min. clearances in air in mm	
16.1	Between phases	25.4mm
16.2	Between live parts and ground	19.0mm
17.0	One minute PF withstand voltage	2.5kV
18.0	Paint shade	631 of IS-5
	Busbars	
1.0	Busbar material & cross section	

1.1	Main busbars	E91E aluminium' Max. current density 0.6A/mm^2
1.2	Bus connections to circuit breakers	
2.0	Continuous rating at design ambient	
2.1	Main busbars	As per SLD
2.2	Bus connections to circuit breakers	As per rated current of
3.0	Temperature rise at rated continuous current of the busbar in the busbar chamber	40deg.C over 45deg.C
4.0	Type of busbar insulators	Resin cast/fibre glass
	Breakers/SFU	
1.0	Type of breakers	As per SLD
2.0	Standards applicable	IS 13947-2/IEC947 – part-II
3.0	Rated service voltage	415V, 3ph., 50Hz
3.1	Highest system voltage	500V, 3ph., 50Hz.
4.0	Rated current at design ambient for breakers	As per SLD
4.1	Rated with breaker in IP 52 enclosure in two tier formation in the LT switch board	As per SLD
5.0	Symmetrical breaking capacity im kA (RMS)	
	-at 415V, 0.25 PF	50 kA RMS
	-at 440V, 0.25 PF	50 kA RMS
6.0	Making capacity kA (Peak)	105kA Peak
7.0	Capacitor breaking capacity at 440V	Incomer: 600A (min.) Outgoing: 300A(min.)
8.0	1 sec. Short time rating, kA (RMS)	50kA RMS
8.1	With release in any setting	50kA RMS
9.0	Thermal release setting ranges (temperature compensated)	As per SLD
10.1	Short circuit release range	As per SLD
10.2	Short circuit release timer setting range	0.1 to 0.6 sec. mechanical
Note	All the releases O/L, S/C and E/F shall be Static/microprocessor based.	

Rev.: 0
Edition: 1

DATA SHEET

FOR

DISTRIBUTION TRANSFORMER

DATA SHEET NO. - MEC/DS/05/E9/080

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

ANNEXURE I

PURCHASER S DATA DISTRIBUTION TRANSFORMER

GENERAL DATA		
1	Type of Transformer	ONAN, Hermetically sealed type
2	Quantity	As per SOR
4	Continuous Rating	As per SOR
5	Type of cooling	ONAN
6	Oil type	Mineral and comply the requirements of IS: 335.
7	Climate	Humid & Heavy Rainfall during Monsoon
8	Altitude	As per design basis
9	System earthing	Solidly earthed
10	Ambient temperature	Max. / Min. — As per design basis
11	Temperature rise	Oil measured by thermometer — 45° C Windings measured by resistance method — 55° C
12	Paint shade	631 of IS - 5
13	Name Plate	As per IS: 1180
15	Oil	Included
16	Duty	Continuous
17	No of Phases	3
Electrical data		
18	Frequency	50 (± 3%)
19	Phase	Three
20	Winding Conductor	Copper

21	Voltage ratio	11/ 0.433KV
22	Winding Connection	Δ/ λ
23	Vector group	DYN 11
25	% impedance	4.5 % (Tolerance as per IS:1180)
27	Insulation class	Type E
28	Neutral Grounding	Solidly Earthed/ As per SOR
30	Tap Changer on primary side	N/A
31	One minute dry & wet power frequency withstand voltage	
	HV side	10kV for 3.3 kV incoming supply 20kV for 6.6 kV incoming supply 28 kV for 11kV incoming supply
	LV side	3kV
32	Impulse Withstand voltage	45kV for 3.3 kV incoming supply 60kV for 6.6 kV incoming supply 75 kV for 11kV incoming supply
33	Withstand time without injury for 3 Phase Short circuit in transformer	3 Sec
34	Short circuit levels on HV terminal	Min 26.2 kA for 3 sec or As per SEB regulation
35	Short circuit levels on LV terminal of transformer	25 kA for 3 Sec
37	Auxiliary Supply Voltage	230V AC
38	Over load capacity	As per IS: 1180 and 2026
39	Max. Permissible Flux density	As per IS: 1180
40	Magnetizing Currents	As per IS: 1180
41	Winding insulation	Uniform
42	Neutral CT rating	As per manufacturer standard
43	Radiators	Detachable type on tank as applicable
44	Marshalling box	Shall be provided with OTI & WTI

45	HV Termination, LV Termination details	Primary	Cable box/Suitable Connector Provided for connection of ACSR conductor.
			Cable size/ Conductor Size/ Type: Decided During detail Engg.
		Secondary	Cable box
			Cable size / Type: Decided During detail Engg.
	Neutral Termination	Through NCT to Neutral Bushing at Cable Box	
46	Primary fault level	**500 MVA**	

Annexure-II

TECHNICAL DATA TO FURNISH BY CONTRACTOR

1.	% Reactance at rated current & frequency	
2.	% Resistance at rated current & frequency	
3.	Total loss at rated voltage & frequency	
4.	Component Loss	
	a) No load loss at rated voltage & frequency	
	b) Load loss at rated current at 75°C	
5.	No load current	
	At 10 % V	
	At 110 % V	
6.	Efficiency at 75°C and unity pf	
	At full load	
	At ¾ load	
	At ½ load	
7.	Efficiency at 75°C and 0.8 pf lag	
	At full load	
	At ¾ load	
	At ½ load	
8.	% Regulation at full load at 75°C	
	At unity pf	
	At 0.8 pf lag	
9.	Efficiency at 0.9 pf @ 40% load	
Mechanical data		
A)	Weights in kg	

1.	Core & Winding	
2.	Tank, fittings & accessories	
3.	Radiator W /O oil	
4.	oil	
5.	Total Mass	
6.	Oil quantity required for first fill ltrs.	
B)	Overall Dimension (mm)	
1.	Length	
2.	Breadth	
3.	Height	
4.	Paint	
5.	Paint Shade	
6.	Roller	

Annexure III

LIST OF SPARES FOR 2 YEARS OPERATION MAINTENANCE

1.	Set of gasket	1 Set
2.	Bushing	
	HV	1 Set
	LV	1 Set
	LV Neutral	1 Set
3.	Breather	1 Set
4.	Oil temperature Thermometer	1 Set

Annexure-IV

CHECK LIST (To be filled up by Tenderer)

Sl.No	Description	Remarks
1	Deviation from specification	Offer may be rejected if there is any deviation.
2	Filled-Up Data sheet	
3	Transformer Mounting Arrangement	
4	List of bought out items	
5	General arrangement Drawing showing overall transformer dimensions with radiator & conservator	
6	Unpriced item wise break up for two years operation & maintenance spares for transformers.	
7	Unpriced schedule of rate (SOR) enclosed.	

STANDARD SPECIFICATIONS (ELECTRICAL SYSTEM)

LIST OF STANDARD SPECIFICATIONS (ELECTRICAL)

Sl No.	Description	Document No./ Drawing No.	Rev. No.
1	Cable laying	MEC/TS/05/E9/25	Rev. 0
2	Earthing and Lightning Protection	MEC/TS/05/E9/26	Rev. 0
3	Electrical Installation In Buildings	MEC/TS/05/E9/27	Rev. 0
4	Outdoor Lighting	MEC/TS/05/E9/23	Rev. 0
5	UPS	MEC/TS/05/E9/16	Rev.0
6	Electrical Equipment Installation	MEC/TS/05/E9/28	Rev. 0
7	HV & LV Cable	MEC/TS/05/E9/24	Rev. 0
8	Power & Lighting Distribution Board	MEC/TS/05/E9/11	Rev. 0
9	Light Fittings For Hazardous Locations	MEC/TS/05/E9/22	Rev. 0
10	Capacitor Bank	MEC/TS/05/E9/14	Rev. 0

Rev.: 0
Edition: 2

SPECIFICATION

FOR

CABLE LAYING

SPECIFICATION NO. - MEC/TS/05/E9/25

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

C O N T E N T S

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 SCOPE

The intent of this standard specification gives recommendation & Board Guideline for selection, transportation, laying, jointing, termination, testing and commissioning of the cabling system up to 33kV.

2.0 STANDARDS

The work shall be carried out in the best workmanship like manner in conformity with this specification, the relevant specifications, codes of practice of Indian Standards Institution, approved drawings and instructions of Engineer-in-Charge or his authorised representative issued from time to time. In case of any conflict between the standards, the instruction of Engineer-in-Charge shall be binding.

In general the equipment covered by this specification shall, unless otherwise specified, be in line with the requirement of any of the latest applicable standards of

a) Bureau of Indian Standards
b) British Standard Institution
c) American Standard Institution
d) International Electro Technical Commission

2.2 Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.2 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 GENERAL REQUIREMENTS

3.1 ENVIRONMENTAL CONDITIONS

The cables shall be laid for continuous operation at full load under the climatic and environmental conditions as described in the specification “Design Basis Electrical”.

3.2 COMPONENTS AND EQUIPMENT

a) The Contractor has to take care that all components, equipment & cable routes are selected considering easy maintenance, simple and quick diagnosis and long maintenance intervals. All components and equipment shall be designed for continuous duty at rated load and under the given climatic conditions. Standard industrial high performance systems and components shall be used as far as possible.

3.3 TAGGING

All components, equipment, cable route and installations shall receive the respective tagging plates, labels, etc which have to be of extremely durable material resistant against the environmental conditions.

4.0 CABLE SPECIFICATIONS

Refer Specification for HV & LV Cable (Specification No. MEC/TS05/E9/24)

5.0 MISCELLANEOUS MATERIALS SPECIFICATIONS

5.1 Connectors

The cable accessories shall include end termination kits, straight through joints and also any special tool and tackles and accessories required for making the joints/terminations.Cable terminations shall be made with Aluminium/tinned copper crimped type solder less lugs of approved make for all Aluminium/Cu conductors cables and stud type terminals and shall be as per IS: 8309.

The straight through joint/termination arrangement shall be complete with all fittings and consumables. The joint shall have electrical and mechanical withstand capability, same as that of the associated cable. For all cables, a minimum extra length of 2 metres will be left before jointing. The termination kit shall be of heat shrinkable type only.

The termination kits/straight through joints shall have the following features:

- Electrical stress control to be provided at the cable insulation shield terminus.
- An external leakage insulation to be provided between the cable conductors and ground.
- Adequate protection to be provided at the end of the cables against the entrance of the moisture and, provision to maintain the constant pressure in the cable

5.2 Cable Identification

Cable tags shall be of 2 mm thick, 20 mm wide aluminium strap of suitable length to contain cable number, equipment no etc.
All cables shall be provided with identification tags indicating cable numbers in accordance with the cable/circuit schedule. Tags shall be fixed at both ends of cable, at joints and at 20 m spacing for straight runs. When a cable passes through a wall, tags shall be fixed at both sides of the wall. The tags shall be of aluminium sheet with the numbers punched on them and securely attached to the cables with non-corrosive wire. For single core cables wire shall be non-ferrous material. Individual cores of control cables shall have for identification, plastic ferrules with engraved numbers at both ends of the circuit.

5.3 Ferrules

Ferrules shall be of approved type size to suit core size mentioned and shall be employed to designate the various cores of control cable by the terminal numbers to which the cores are connected for case in identification and maintenance. Ferruling shall be done at both end of cables.

5.4 Cable Glands

Cable glands shall be nickel-plated Brass double compression type of approved/ reputed make with tinned copper lugs. Sealing kits with associated accessories like stress relieving cones, insulating tape, trifurcating boot, HT insulating tape, etc. Glands for classified hazardous areas shall be certified by CMRS and approved by CCE, Nagpur.

5.5 Cable trays

This shall be either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron trays as specified elsewhere. Prefabricated hot dip galvanized sheet steel cable trays shall be used for maximum support span of 2000 mm unless design is approved for larger span. For requirements of larger than 750 mm width two trays shall be run side by side. Cable trays shall be suitable for a cable weight of 50 kg/meter running length of tray. Minimum thickness of sheet steel/galvanizing shall be 2mm/86 microns respectively.

Power cables shall be laid on ladder type cable trays. Ladder type cable racks shall be selected from three sizes viz., 300, 450 and 600 mm and shall be fabricated from 50 x 50 x 6 mm MS angles for longitudinal members and 30 x 6 mm MS flats for cross members placed at an interval of 300 mm along the length of the rack with a provision of double cross members at locations, where cables are to be clamped. Supporting brackets for ladder type racks shall be provided at an interval not exceeding 1500 mm. Both horizontal and vertical members shall be of 50 x 50 x 6 mm MS angle and the bracket shall be welded to the embedded inserts or as approved by engineer-in-charge. Alternatively prefabricated sheet steel/ aluminium racks and supporting brackets of bolted construction may be used for power and control cables.

Vertical spacing between cable racks shall be between 300 mm to 250m depending upon size and number of cables.

If unit rate is not included in schedule of rates, then cable trays if required, shall be fabricated and installed at site as per ton rate for electrical structural supports etc.

5.6 GI Pipes

GI pipes shall generally be adopted for routing cables embedded through concrete foundations/ floors/walls (including the portion above floor level to be laid in continuation for protection against mechanical damage) generally in plant buildings. These shall be medium gauge, hot dip □galvanized□, electric resistance welded (ERW) screwed type conforming to IS:1239-1990 (Part-I). All pipe fittings shall conform to IS:1239 -1992 (Part-II). Not more than 40% of GI pipe cross sectional area shall be used(Blocked).

G.I conduits shall generally be used for exposed cabling along building walls/structures etc. in both plant and non plant buildings as well as concealed cabling in offices, canteens and other non plant buildings. These shall be of □galvanized□□ steel, screwed type conforming to

IS:9537-1981 (part-II). Conduit accessories and fittings shall be of standard types conforming to IS:3837-1976.
All GI pipes/conduits shall be provided with pull wires to facilitate cable pulling.
GI pipe/conduit runs shall not have more than three 900 bends (2700 total) including bends immediately at the outlet or fitting. Straight runs shall be limited to 30 m by providing approved type pull/junction boxes as required.
Normally, no joints shall be made in through runs unless same is more than standard cable lengths. In cases where a jointing is to be done, the same shall be made with proper jointing material and kits.

G.I conduit/PVC pipe systems shall be firmly supported in position by means of heavy gauge saddles either screwed to concrete/brick walls using suitable plugs or screwed to MS brackets/cleats welded on to building structures. The spacing between support for both horizontal and vertical runs shall not be more than 1000 mm for straight runs. At or termination to junction/pull boxes, the nearest support shall be 300 mm from such fittings. Exposed GI conduits shall run parallel or perpendicular to column/building lines to match the existing architectural arrangement. Embedded GI pipes shall however, run in direct lines with minimum bends. Bends for GI pipes/conduit where required shall be made such that the diameter of the pipe is not deformed. The radius of inner edge of field bend shall not be less than 8 times diameter for GI pipes and 6 times for conduits.

In damp locations exposed GI conduit and fittings shall be made water tight. Also, the conduit shall be mounted on steel spacers having a minimum thickness of 6 mm. Stub ups of embedded GI pipes shall be fitted with coupling plugged suitably to avoid damage to threads or entry of foreign matters during construction.
GI pipes/conduits shall be selected on the basis of percent fill in area as given in IS:1239-2004 (Part-I) for medium gauge GI pipe as per IS 9537-1981 (Part-II).

6.0 CABLE LAYING

Cable network shall include power, control, lighting and communication/signal cables, which shall be laid in trenches, cable trays or conduits as detailed in the relevant drawings and cable schedules. Erection of cable trays as required shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc and minor adjustments shall be done to suit the field conditions wherever deemed necessary without any extra cost.

High voltage, medium voltage and other control cables shall be separated from each other by adequate spacing or running through independent pipes, trenches or cables trays, as applicable as per IS 1255.

All cable routes shall be carefully measured and cables cut to the required lengths, leaving sufficient lengths for the final connection of the cable to the terminal of the equipment. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. The quantity indicated in the cable schedule is only approximate. The contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works

Before the start of cable laying, cable drum schedule shall be prepared by contractor and get that approved by Engineer-in-Charge to minimize/avoid straight through joints required. Contractor shall work out the actual number of straight through joints required.

Laying installation of Cable Routes

6.1 Cables laid on walls, structures, concrete trenches cable tunnels

6.1.1 In the plant buildings, substations, switch/control rooms etc. power and control cables shall generally be taken exposed on brackets, cable racks/hooks laid in tunnels, concrete trenches, cable cellars, basements, cable galleries or along building and technological structures.

6.1.2 In the auxiliary shops and utility buildings, power and control cables shall generally be taken on cable racks either laid in concrete trenches or supported from building structures, walls, ceiling etc.

6.1.3 Power and control cables installed along buildings and technological structures, ceiling, walls etc which are required to be protected against mechanical damage and/or radiation of heat shall be taken in GI conduits. GI conduits shall also be used for flame-proof installation, where required. In corrosive atmosphere where 1,100 V grade cables are required to be taken in pipes, rigid heavy duty PVC pipes shall be adopted. Where direct heat radiation exists, heat isolating barrier shall be provided.

6.1.4 Cables to individual drives, control devices etc shall be taken in embedded/ exposed rigid GI pipes/ flexible conduits. Extra length of cables shall be provided suitably where possible for any future contingency.

6.1.5 For interplant cabling in plant outdoor yard, the power and control cables shall generally be laid in the manner as follows:

- Directly buried in ground or in concrete trenches with cables laid on rack.
- In underground cable tunnels and overhead cable galleries, for main distribution feeders and for locations having large number of cables.
- In concrete ducts buried in ground, where direct burial and provision of concrete trench/tunnel are not possible due to presence of other service lines.

6.1.6 All cables irrespective of type of installation shall be protected by means of GI pipes or sheet metal protective cover up to a height of 1500 mm from the working floor level and platforms for protection against mechanical damage.

6.1.7 For higher size cables a loop of about 4/5m is to be kept in the cables for meeting future contingency of jointing/termination length.

6.1.8 For 415 V power wiring in auxiliary buildings offices and laboratories etc cables shall be taken in embedded/exposed GI conduits or rigid PVC pipes.

6.1.9 The installation work shall be carried out in a neat workman like manner by skilled, experienced and competent workmen, with experience in jointing and termination of aluminium conductor cables. Cable runs shall be uniformly spaced, properly supported and

protected in an approved manner. All bends in runs shall be well defined and made with due consideration to avoid sharp bending and kinking of the cable.

6.1.10 The bending radius of various types of cables shall be as per IS: 1255-1983:

Type of cable and voltage	Minimum bending radius		
Grade	Single core	Multi core	
		Unarmoured	Armoured
11 kV XLPE cables	20 D	15 D	15 D
1.1 kV PVC cables	15 D	12 D	12 D

6.1.11 Cable installation shall be properly co-ordinated at site with the routing of other services/utilities. Where necessary, suitable adjustment shall be made in the cable routings with a view to avoid interference with any part of the building, structures, equipment, utilities and services. Exit of cables from underground trenches or tunnels shall be through pipe sleeves. Pipe sleeves shall be properly sealed. Pipe sleeves shall be laid at an angle of maximum 45˚ to the trench wall. In case of larger diameter cables, i.e., 50 mm and above, adequately sized pipe with larger bend radius shall be provided for ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Engineer-in-Charge.

6.1.12 All cables shall be tested for proper insulation prior to laying. The cable drums shall be transported on wheels to the place of work. The cable shall be laid out in proper direction as indicated on the drum using cable drum stands. In case of higher size cables, the laid out finally transferred carefully on to the trenches and racks. Care shall be taken so that kinks and twists or any mechanical damage does not occur in cables. Approved cable pulling grip or other devices shall be used.

6.1.13 Adequate length cables shall be pulled inside the switchboards, control panels, terminal boxes etc so as to permit neat termination of each core/ conductor. Control cables entering switchboard or control panels shall be neatly bunched/strapped with PVC perforated tapes and suitably supported to keep it in position at the terminal block. All spare cores shall be neatly dressed and suitably tapped at both ends.

6.1.14 Power cable terminations shall be carried out in such a manner as to avoid strain on the terminals by providing suitable clamps near the terminals. All power cable terminations shall be by means of crimping type cable lugs. Control cables shall be terminated directly at the terminal blocks by screws.

6.1.15 No joint shall normally be made at any intermediate point in through runs of cables unless the length of the run is more than the length of standard cable drum. In cases where jointing is unavoidable, the same shall be made by means of standard cable jointing kits. All opening for cable entry in the equipment shall be sealed and made proof against entry of creeping reptiles.

6.1.16 Power cables of different voltage grades shall be laid in separate racks/ hooks. Control cables as well as signal and communication cables shall be laid in separate racks. The cables in racks/hooks shall be laid in the order of their voltage grades such that the cables

of lowest voltage grade are on the topmost tier and highest voltage grade on the bottom-most tier. Where there is possibility of mechanical damage to cable rack, sheet steel covers shall be provided for adequate protection.
All communication/signal cables (telephones, P.A.S, Instrument) RTD Cables shall run on instrument trays/ducts/trenches. Wherever these are not available, cables shall be taken in a separate trench with a minimum clearance of 300 mm away from electrical trench as per IS 1255 & direction of Engineer-in-Charge. Communication cables shall cross power cables at right angles.

Clearance –The desired Minimum clearance are as follows-

Power Cable to Power Cable - Clearance is not necessary. However, there would be some clearance so that, the current carrying capacity become better.

Power cable to control cable	-	0.2m
Power cable to communication/ Signal cable	-	0.3m
Power cable to Gas/Water Main	-	0.3m

Inductive influence/interference on signal/control/communication cable should be checked.

The Power cable should not be laid above the Communication Cable. While laying of power cables the likely interference to existing communication/signal cable should be avoided by referring to and coordinating to appropriate authority.

6.1.17 For future installation of cables, provision shall be made to keep 20 percent space as spare on each rack. Alternatively, one spare rack can be provided all along the route. Cable racks shall be so arranged that they do not obstruct or impair movement in passage way. Particular attention shall be given to this aspect at rack crossing in cable tunnels and cable cellars where a minimum clearance of around 1800 mm shall be kept for free movement. For dusty area cable racks shall be vertical type(for horizontal run).

6.1.18 For laying cables along steel/ technological structures on concrete walls/ceiling etc. the cable shall be taken by clamping with MS saddles screwed on to MS flats welded to the structure or to embedded inserts provided in walls. Where inserts are not available the saddles may be directly fixed to the walls using drawl plugs and MS flat spacers of minimum 6 mm thick.

6.1.19 The MS saddles shall be placed at an interval of not less than 500 mm both for horizontal and vertical runs. However, at bends, it shall be placed within 300 mm and when terminated to equipment/junction box the cable shall be clamped immediately before such termination. In areas prevailing with corrosive atmosphere, PVC saddles instead of MS saddles shall be provided.

6.1.20 The termination of GI pipes/conduits to rotating or other equipment subject to vibration or connection/disconnection at intervals shall be made by means of flexible metallic conduits. The use of flexible metallic conduits in outdoor locations shall be avoided as far as practicable.

6.1.21 Flexible pipes shall be liquid tight, □galvanized□□ heavy duty interlocked type with extruded PVC jacket on top generally conforming to IS:3480-1966The adapter for coupling flexible conduit to rigid pipes/equipment shall be of cast aluminium, screw/gland type. Alternatively, steel wire reinforced PVC hose may be used with matched adapters.

6.1.22 All fabricated pull/junction boxes shall be made of 3 mm thick sheet steel, painted as specified. The pull boxes shall be sized to suit the largest recommended bending radius of the cables to be accommodated. Larger boxes (generally exceeding 600 mm in length) shall be fabricated with standard steel sections.

6.1.23 RCC cable trenches with removable covers as shown on the drawings will be provided by the Owner. Cables shall be laid in 3 or 4 tiers in these trenches as indicated on the sectional drawings. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases, RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purpose of cable laying and reinstalling them in their proper positions after the cables are laid shall be done by the electrical Contractor at no extra cost.

6.1.24 Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection upto a minimum of 300 mm above grade or as shown in the standard drawings.

6.2 Buried Cables

6.2.1 Power and control cables laid directly buried in ground shall be laid as per the requirements of code of practice IS: 1255-1983. Generally cables shall be taken at a depth of 1000 mm from finished ground level.

6.2.2 For laying of multiple 11 kV grade power cables horizontal axial spacing shall be 250 mm. For 1100 V grade power cables, the horizontal axial spacing shall be 150 mm. Control cables shall be laid touching each other without any horizontal spacing. However, the distance of the control cable from the nearest power cables shall be 200 mm. Power and control cables may be laid in a common trench, but power cables for each voltage grade and the control cables shall be laid separately in groups. Generally cables shall be laid in one layer. In general, communication cables shall not be taken in a common trench. In case the same is required to be taken along with power cables, the minimum axial spacing between two cables shall be 300 mm.

6.2.3 Directly buried cables shall be laid underground in excavated cable trenches where specified in layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables correctly spaced and arranged with a view of heat dissipation and economy of design.

6.2.4 Desired Minimum depth of laying from ground surface to top of cable is as follows-

High voltage cables, 3.3kV to 11kV Rating	:	0.9m
High voltage cables, 22kV to 33kV Rating	:	1.05m
Low voltage & control cable	:	0.75m
Cables at Road Crossing	:	1.00m
Cables at railway crossing (Measured from Bottom of sleepers to top of pipe)	:	1.00m

The depth and the width of the trench shall vary depending upon the number of layers of

cables.

6.2.5 Precast concrete protective cover shall be placed centrally along the cables. The concrete slab shall be of RCC type as per Appendix-C of IS:1255-1983 having suitable provision for dovetailing with the adjacent slab. The length depending on the number of cables in the trench as well as axial s spacing. The minimum width of slab shall not be less than 200 mm.

6.2.6 After laying of cables, the trench shall be back filled with good excavated soil and well rammed in successive layers not less than 300 mm depth. The excavation of trenches shall be done with vertical sides and trenches shall be kept as straight as possible. The width of trench shall be in accordance with the number of cables to be laid out but in no case shall be less than 400 mm. The minimum clearance between trench edge and cable shall not be less than 100 mm. At turning and tee-off points of the cable trench suitable chamfering shall be made keeping in view the minimum bending radius of cables.

Cable ends shall be carefully pulled through the conduits, to prevent damage to the cable. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

Following grade of the pipe fill shall be used for sizing the pipe size:

a)	1 cable in pipe	-	53% full
b)	2 cables in pipe	-	31% full
c)	3 or more cables	-	43% full
d)	Multiple cables	-	40% full

6.2.7 Where cables are required to cross roads, railways tracks and surface drains they shall be taken through reinforced concrete spun pipes at a minimum depth of 1000 mm. For crossing water oil, gas or sewage pipes etc. cables shall be taken above the pipes where minimum 500 mm clearance is available from top of pipes. Where 500 mm clearance is not available, the cables shall cross these pipes through RC pipes at minimum depth of 750 mm from finalized ground level keeping distance of 300 mm between the utility and cable pipes.

6.2.8 In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made in case the cable develops fault at a latter date. Also when group of cable are laid together the cable length shall be adjusted to stagger the straight through joints.

6.2.9 Directly buried underground cable shall be generally laid by the utility alley along the roads and cable routing shall follow the road layout. However, in special cases to keep the cable lengths minimum the cables may be laid by the shortest route and the same shall be taken through RC pipe where required.

6.2.10 Galvanised iron cable markers and identification tags shall be provided at each joint, entry to building/tunnels, each turn, either side of the road crossings and at 30 m intervals for straight cable runs. The markers shall be conspicuous and fixed in concrete block in a durable manner.

6.2.11 Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving trenches shall be coiled and provided with a protective pipe or cover, until such times the final termination to the equipment is connected. Minimum bending radii of cable shall be as specified in IS: 1255.

6.2.12 Cables shall be laid in trenches at depth as shown in the drawing with protective GI earth conductor (runs along the cable). Before cables are placed, the trenches bottom shall be filled with a layer of sand. This sand shall be leveled and cables laid over it. These cables shall be covered with 150 mm of sand on top of the largest diameter cable and sand shall be lightly pressed. A protective covering of 75 mm thick second class red bricks shall then be laid flat. The remainder of the trench shall then be back-filled with soil, rammed and leveled.

6.2.13 As each row of cables is laid in place and before covering with sand every cable shall be given an insulation test in the presence of Engineer-in-Charge / Owner. Any cable, which proves defective, shall be replaced before the next groups of cables are laid.

6.2.14 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/ lined trench.

6.2.15 After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/ `PUTTI' for sealing purpose. The cost for the same shall be deemed to have been included in the installation of G.I. Pipe and no separate payment shall be allowed.

6.2.16 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures, the electrical contractor shall determine their location and obtain approval of the Engineer-in-Charge before cutting is done.

6.2.17 Individual cables or small groups which run along structures/walls etc. will be clamped by means of 10 SWG GI saddles on 25x6 mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables and no separate payment shall be made on this account. Alternatively small group of cables can be taken through 100 mm slotted channel/ISMC 100.

6.2.18 They shall be rightly supported on structural steel and masonary, individual or in groups as required, if drilling of steel must be resorted to, approval must be secured and steel must be drilled where the minimum weakening of the structure will result.

6.2.19 Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300 mm for cables upto 25 mm diameter and maximum 450 mm for cables larger than 25 mm diameter.

6.2.20 Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable trays shall be suitably clamped by means of G.I. Saddles/Clamps, whereas cable in horizontal run of cable trays shall be tied by means of nylon cords.

6.2.21 Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint unless otherwise specified.

7 TERMINATION

7.1 All PVC cables upto 1.1 KV grade shall be terminated at the equipments by means of double compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.

All Cable entries shall be through bottom only and top entry terminations are made only after getting approval of Engineer-in-Charge.

7.2 Power cables wherever colour coding is not available shall be identified with red, yellow and blue PVC tapes. Where copper to aluminum connections are made, necessary bimetallic washers shall be used for trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.

7.3 In case of control cables, all cables shall be identified at both ends by their terminal numbers by means of PVC ferrules or self-sticking cable markers. Wire numbers shall be as per schematic/ wiring /inter- connection diagram. Bidders shall have the samples of PVC ferrules/cable markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends.

7.4 Where threaded cable gland is screwed into threaded opening of different size, suitable galvanized threaded reducing bushing shall be used of approved type, at no extra cost. All switchgear and control panels shall have un-drilled gland plate.

Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables.

7.5 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

7.6 In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom close fit hole should be drilled in the bottom plate for all the cables in one line, then bottom plate should be split in two parts along the center line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.

7.7 Cable leads shall be terminated at the equipment terminals, by means of crimped type solderless connectors.

7.8 Crimping shall be done by hand crimping hydraulically operated tool and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

7.9 Termination and jointing of aluminium conductor power cables shall be by means of compression type aluminium lugs. Alternatively, tinned copper compression type lugs may also be used with application of corrosion inhibiting compound. Copper conductor control cables shall be terminated directly into screwed type terminals provided in the equipment.

7.10 The jointing and end sealing kits shall be complete with stress relief system and all accessories, straight through joint for direct burial installations shall be provided with cast resin enclosure for protection against water and corrosion.

7.11 Straight-through joints for 1100 V grade PVC insulated cables shall be with epoxy resin compound for direct burial cables. Cable glands for terminating PVC insulated, armoured/ unarmoured cables shall be made of brass or aluminium alloy.

7.12 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all XLPE/PVC insulated cables shall be taped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.

7.13 Cable accessories for H.V. Systems

7.13.1 The 11, 6.6 and 3.3 KV cables terminations joints shall be done by skilled and experienced jointers duly approved by the Engineer-in-Charge. Termination including supplying of jointing kit shall be in the scope of contractor unless specified otherwise.

7.13.2 The termination and straight through joint kit for use on high voltage system shall be suitable for the type of cables or the type of cables issued by owner for installation. Supply of termination kit shall be in the scope of contractor. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fitting and consumables items. An installation instruction shall be included in each sheet.

7.13.3 The termination kits shall be suitable for termination of the cables to indoor switchgear/panels or outdoor weatherproof cable box or outdoor transformer & motors or Double/Four pole structure. The terminating kits shall preferably be of the following types:

a) Heat-shrinkable power cable termination/joint kit of M/s. Raychem or equivalent.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

7.13.4 The straight through jointing kits shall be suitable for underground-buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types.

a) Heat-shrinkable sleeve type of M/s. Raychem or equivalent.

7.13.5 Makes of kits other than those specified above may be considered, provided the Contractor furnishes type test certificates, along with the offer for approval of the same.

7.13.6 Type tests are to be carried out at manufacturer's works to prove the general qualities and design of a given type of termination/jointing system. The type tests shall include the following tests conforming to the latest IEC 502.2, 466 and VDE 0278 specifications. The type test certificates shall be submitted by the Contractor along with the offer for indicating the jointing system considered.

a. A.C. Voltage withstand dry test for 1 minute
b. Partial discharge test - Discharge magnitude shall be less than 20 p.c.
c. Impulse voltage withstand test with 10 impulses of each polarity.
d. A.C. high voltage test following load cycling test with conductor temperature at 95˚C.
e. Thermal short circuit test of 250˚C for 1 second.
f. DC Voltage withstand test for 30 minutes.
g. Humidity test.
h. Dynamic short circuit test.
i. Salt log test
j. Impact test

8 TESTING

8.1 Before energizing, the insulation resistance of every circuit shall be measured from phase to phase and from phase to ground.

8.2 Where splices or termination are required in circuits rated above 600 volts, measure insulation resistance of each length of cable before splicing and or/ terminating. Repeat measurement after splices and/or terminations are completed.

8.3 Measure the insulation resistance of directly buried cable circuits before cable trenches are back-filled. Repeat measurement after back- filling.

Rating of IR tester for cables of different voltage rating as follows-

Cable Voltage grade	IR Tester Voltage Rating
1.1kV	500V
3.3kV	1000V
6.6kV	1000V
11kV	1000V

8.4 Cables after jointing & termination are subjected to DC high voltage test. The

recommended values of test voltage are given below.

Uo/U	Test Voltage Between Any conductor and metallic Sheath/ Screen /Armour	Conductor to Conductor (For Unscreened Cable)	Duration (Min.)
0.65/1.1	3	3	
1.9/3.3	5	9	
3.3/3.3	9	9	
3.8/6.6	10.5	18	15
6.6/6.6	18	18	
6.35/11	18	30	
11/11	30	30	

8.5 All cables shall be tested as per standard test Performa available with site engineer.

8.6 Cable schedule and layout drawings must be marked for AS BUILT conditions during the installation work and shall be approved by Site Engineer.

9 DOCUMENTATION

After commissioning & testing of all power & control cables, contractor shall submit the following document to Client/MECON for As-Built status in hard copy (5 set) plus one soft copy.

i) Complete commissioning report of cables
ii) Drawing showing Cable rout of all laid cables in trenches/trays including respective cable numbers.

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Rev.: 0
Edition: 2

SPECIFICATION

FOR

EARTHING AND LIGHTNING PROTECTION

SPECIFICATION NO: - MEC/TS/05/E9/26

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

CONTENTS

AMENDMENT STATUS

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1.0 SCOPE

The intent of this specification is to define the requirements for the supply, installation, testing, and commissioning of the complete Earthing & lightning protection System.

2.0 STANDARDS

The work shall be carried out in the best workmanlike manner in conformity with this specification, the relevant specifications/codes of practice of Indian Standard Institution, approved drawings and instructions of the Engineer-in-Charge or his authorized representative issued from time to time. In case of any conflict between the standards, the instructions of Engineer-in-Charge shall be binding.

IEC 62305 Protection against Lightning

IS 2309 Protection of building and allied structure against lightning

IS 3043 Code of practice for earthing

NBC 2016 National Building code

2.1 Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.2 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 TAGGING

All components, equipment and installations shall receive the respective tagging plates, labels, etc., which have to be of extremely durable material resistant against the environmental conditions. For further requirements, reference is made to the specification “Design Basis-Electrical”.

4.0 EARTHING SYSTEM

General

Entire system shall be earthed in accordance with the provisions of the relevant IEC recommendations/ IS code of practice IS 3043-1987 and Indian Electricity Rules, so that the values of the step and contact potentials in case of faults are kept within safe

permissible limits.Parts of all electrical equipment and machinery not intended to be alive shall have two separate and distinct earth connections each to conform to the stipulation of the Indian Electricity Rules and apparatus rated 240V and below may have single earth connections.

The stations shall be equipped with an equipotentially meshed grounding network. All exposed conductive parts or elements of the station systems will be connected to this network. The earthing systems of the various stations are part of the protection systems for electrical power supply, instrumentation, control and supervisory system. The earthing system consists of the main grounding grid, the grounding rods, the building foundation grounding and the equipment grounding.

Supply of all other erection/consumable required to complete the installation shall be the responsibility of the contractor. All hardware used for earthing shall be hot dip galvanized.

Any other items not specifically mentioned here but necessary for completeness of job shall be in the scope of contractor & shall be supplied by contractor without any extra cost.

All shops and buildings as well as the electrical sub-stations and electrical rooms shall be provided with a ring main earthing system each. Individual ring main earthing systems shall again be interconnected as a network.

For stations, which are to be extended, the existing earthing system shall be considered. The layout of new earthing system shall match to the existing installations. The new and the existing grounding network must be interconnected at two (2) locations, at least.

The ring earthing system around each building shall be laid at a distance of approximately 1.5 m from the building and at a depth of approximately 0.8m. The ring shall be bonded at intervals to the building steel structures, reinforcement of building columns and also to pipes, wherever they are crossing. The earth ring shall further be connected at intervals to deep earthing electrodes to achieve a combined earth resistance of less than one ohm.

The grounding network system will be installed in different locations have different soil characteristics according to the location of the stations. Before design and installation of the grounding network the actual soil conditions in the station areas must be determined by adequate soil resistance measurements by the contractor & submit for review & approval.

Station earthing should have low earth resistance, low touch & step potential.

5.0 EARTHING CONDUCTOR

The main grid conductor shall be hot dip galvanized G.I. Flat or PVC insulated copper conductor. Size & type of conductor shall be as marked on the drawings. Thickness of hot dip galvanizing shall not be less than 75 microns.

6.0 DESIGN REQUIREMENTS

6.1 The earth resistance of the overall interconnected station grounding network shall not exceed 1 Ω.

6.2 For the purpose of dimensioning the earthing lines/conductors, the duration of the earth fault current shall be taken as 0.3 seconds.

6.3 All exposed metal part such as HT/LT switchgear, DP/FP structure, distribution board, metal clad switchgear enclosure, lamp brackets, lamp holder, plug sockets, lighting poles, junction boxes, high mast etc shall be properly earthed by connecting these to the earth electrode by means of GI wire/Flat or PVC insulated Cu conductor of approved size to pass the fault current safely to earth in case of any fault.

6.4 For different floors in a building, localized ground mats shall be formed and connected to the ground earthing ring through vertical risers. The earthing mat shall be common to both power and lighting installations.

6.5 For the UPS, the SCADA and telecommunication systems with their equipment a separate grounding network with sufficient cross-section to avoid interference shall be installed. This grounding network shall be connected to the common station grounding network on one (1) separable and indicated connection point, within the electrical building or equipment container/enclosure.

6.6 Before design and installation of the grounding network the actual soil conditions in the station areas must be determined by adequate soil resistance measurements.

6.7 The required conductor spacing, the total length of the grounding grid and the required grounding material cross-section shall be calculated under consideration of the maximum earth fault current, to maintain touch and step voltages within reasonable limits. The impedance of the fault current path and protective devices shall be chosen that the faulted circuit will be disconnected from the supply within the required time. A respective grounding calculation with report shall be performed for each station and is to be submitted to the Client/MECON for approval.

6.8 Multiple connections of grounding conductors shall only be carried out above ground. For these connections the respective grounding bars are to be installed. Extensions of single grounding conductors can be permitted below ground under use of compression connectors or welding connections, with repair painting and coating of the connection point.

6.9 All connections of conductors on equipment shall be performed with pressure type lugs or connectors and threaded bolts, screws, spring-washers and washers. Special care must be taken to avoid the arising of a chemical element. Connections between bare copper and iron parts must be protected in a special manner and shall only be executed on above-ground connection points (grounding bars) or inside of pits.

6.10 The power supply cables (LT) from the sub-station and the distribution cables to individual motors shall have 4/3.5 cores. LT power supply cables shall have four cores and the fourth core shall have cross-sectional area of 50% of the other cores generally. The fourth core of the main supply lines shall be connected to the solidly earthed neutral bar in the substation switchgear as well as at the earth bars in MCC/distribution boards.

6.11 Separate electonic earthing system shall be provided for all electronic equipment like PLC"s, weighing panel, computer etc.

7.0 EARTHING NETWORK

7.1 The earthing installation shall be done in accordance with the earthing drawings and the standard drawings of reference attached with this document. The entire earthing system shall fully comply with the Indian Electricity Act and Rules. The contractor shall carry out any changes desired by the Electrical Inspector or the owner, in order to make the installation conform to the Indian Electricity Rules at no extra cost. The exact location on the equipment shall be determined in field, in consultation with the Engineer-in-Charge or his authorized representative. Any changes in the methods, routing, size of conductors etc shall be subject to approval of the Owner/ Engineer-in-Charge before execution.

7.2 Excavation and refilling of earth, necessary for laying underground earth bus loops shall be the responsibility of the contractor.

7.3 The main earth grid shall be laid at a depth of minimum 700 mm below grade level. Wherever RCC cable trenches are available, the earth lead shall be laid in the trenches and shall be firmly cleared to the walls of concrete lined trenches. The earthing strip shall be protected against mechanical damage.

7.4 A common grounding system network (Main earthing grid) will be made underground by using 50 mm x 6 mm GI earthing strip connected to earth electrodes in loop-in & loop-out system and connecting the electrical equipment to network. In RCC cable trench one number earth strip of size 50 x 6 mm shall be run throughout the length of the trench.

7.5 Earthing system around each building shall be laid at distance approximately 1.5 meter from the building & at a depth of approximately 0.8m. The ring shall be bonded at intervals to the building steel structure, reinforcement of building columns & pipes wherever they are crossing. The earth ring shall further be connected to deep earthing electrodes to achieve a combined earth resistance of less than One or Two ohm as specified earlier.

7.6 In process unit areas, the earthing cable shall be run along cable trays wherever specified in the layout drawings. The earthing cable shall be suitably cleated and electrically bonded to the cable tray at regular intervals.

7.7 Joints and tapping in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below ground shall be welded and suitably protected by giving two coats of bitumen and covering with Hessian tape. All joints above ground shall be by means of connectors/ lugs as far as practicable. Tee connectors shall be used for tapping, earth leads from the main earth loop wherever it is installed above ground. Earthing plates shall be provided for earthing of two or more equipment at a place from earth grid. Where aluminium cable risers are to be connected to the underground GI earth bus, the aluminium cable riser shall be taken to the nearest earth pit and terminated through a bolted joint. If this is not practicable, then G.I. risers shall be brought above grade and a bolted joint shall be made between this GI riser and the aluminium cable termination. This G.I. Riser shall be protected applying two coats of bituminous paint/bitumen on the

exposed portion.

7.8 Conduits in which cables have been installed shall be effectively bonded and earthed. Cable armours shall be earthed at both ends.

8.0 INSTALLATION OF EARTH ELECTRODES

8.1 Earth pipe electrodes shall be installed as shown in the earthing layout drawings shall be in accordance with the standard drawings, specification and IS: 3043. Their location shall be marked to enable accurate location by permanent markers.

8.2 All earth electrodes shall preferably be driven to sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. Wherever practicable, the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes.

8.3 All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months. If necessary, a number of electrodes shall be connected in parallel to reduce the earth resistance, shall be in the scope of contractor. The distance between two electrodes shall not be less than twice the length of electrode.

8.4 The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.

8.5 Tentative no of earth pits shown in drawing are only for reference to the contractor. The exact location and number of earth electrodes required at each location shall be determined in the field in consultation with the owner/Engineer-in- Charge, depending on the soil strata and resistivity, to meet the ohmic values prescribed in clause 6.1. The contactor shall design the earthing system accordingly & submit for review & approval.

8.6 Earth Electrodes shall be located avoiding interference with road, building foundation, column etc. Individual earth electrode shall be provided for each lightning arrestor and lightning mast. The electrodes shall be so placed that all lightning protective earths may be brought to earth electrode by a short and straight a path as possible to minimize surge impedance.

8.7 The disconnect facility shall be provided for the individual earth pits to check their earth resistance periodically. All the earth electrodes shall be suitably numbered and this should be indicated in as built drawings.

9.0 CONNECTION

9.1 All electrical equipment is to be doubly earthed by connecting two points on equipment to a main earthing ring. The earthing ring will be connected via links to several earth electrodes. The earth grid formed shall be a closed loop as shown in the drawing with earth electrodes connected to the grid with double strip connection. The cable armour will be earthed through the cable glands.

9.2 In hazardous areas all major process equipments shall be connected to the earthing ring by

means of anti- loosening connections and all pipelines will be bonded and earthed on entering the battery limit of the process area.

9.3 The following shall be earthed.

1. Transformer neutrals & body
2. Double Pole & Four Pole structures
3. CT/PT neutrals
4. Neutral Grounding Resistors
5. Lightning Arrestors
6. All switchgear and their earth buses, bus duct
7. Motor Frames
8. UPS, Telecommunication system, RTU's, Control panels & other instruments etc.
9. Non-current carrying metallic parts of electrical equipment such as switchgear, switch racks, panel boards, motor control centres, lighting, power and instrument panels, push button stations, cable trays, pipes, conduits, terminal boxes, etc.
10. All fences, gates/enclosures, housing electrical equipment
11. All steel structures, rails etc. including bonding between sections
12. Shield Wire
13. Structural steel and Columns
14. Loading racks
15. Lighting Mast, poles
16. Lighting rods (Mast)
17. Tanks and vessels containing flammable materials.
18. Rotating parts of the agitators, pumps etc. through spring loaded brushes of suitable grade.
19. Earth continuity conductor shall be provided for flanges.

Conductor size for connection to various equipments shall be as indicated on Earthing Layout Drawings.

9.4 Two distinct conductors directly connected to independent earth electrodes, which in turn shall be connected to the earth and earth system. The earth connection shall be properly made. A small flexible aluminium cable loops to bridge the top cover of the transformer and the tank shall be provided to avoid earth fault current passing through fastening bolts when there is a Lightning surge, high voltage surge or failure of the bushings.

9.5 The shield wire shall be connected with the main grid solidly and not through supporting steel structures.

9.6 All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.

9.7 All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground. In case of G.I. Earth Loop all underground "T" connections shall be

of the same size as main loop however in case of PVC insulated aluminium conductor loops underground joints shall be completely avoided. Connections to motors from earth plate or main loop conductor brought above ground shall not be less than following:

E uipments		**Earthing Conductor si e (Indicative)**
Grid & equipment such as Main Electrical Distribution Board, LT Switchboard, PDB, MLDB, Silent D. G. Set	:	50 x 6 mm GI Flat
Motors and starters over 45 kW and HT motors, Cable trays	:	50 x 6 mm GI Flat
Mechanical equipment / Vessels,Tanks, Pipe/cable racks, structure, fencing	:	50 x 6 mm GI Flat
Utility building PDB, LDB, Switch Socket DB, UPSDB, Lighting DB etc	:	25 x 5 mm GI
Motors and starters above 15 kW, and upto and including 45 kW	:	25 x 5 mm GI
RTU, Telecom, UPS	:	25 x 5 mm copper
Motors and starters above 3.7 kW and upto and including 15 kW.	:	16 sq mm stranded GI Wire
Product pipe line	:	16 sq mm flexible copper wires
Motors and starters upto and including 2.2kW, Light fitting, JBs, etc.		6 sq mm stranded GI Wire
FLP – WP lights/control station	:	6 sq mm stranded GI Wire
Instruments and miscellaneous small items protected by fuses of ratings not exceeding 15A.	:	6 sq mm stranded GI Wire
Field Instruments	:	2.5 sq mm PVC Cu Wire
Jumper for flanges	:	50 x 2 mm Copper Strip

Anchor bolts or fixing bolts shall not be used for earthing connection.

9.8 All hardware used for earthing installations shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections of equipment.

9.9 Lighting fixtures shall be earthed through the extra core provided in the lighting cable for this purpose.

10.0 TESTING OF EARTHING SYSTEM

Earthing systems/connections shall be tested as follows:

10.1 Resistance of individual electrodes shall be measured after disconnecting it from the grid.

10.2 Earthing resistance of the grid shall be measured after connecting all the electrodes to the grid. The resistance between any point on the metallic earth grid and the general mass of earth shall not exceed 1 ohm.

10.3 The resistance to earth shall be measured at the following:

1) At each electrical system earth or system neutral earth.
2) At each earth provided for structure lightning protections.
3) At one point on each earthing system used to earth electrical equipment enclosure.
4) At one point on each earthing system used to earth wiring system enclosures such as metal conduits and cable sheaths or armour.
5) At one point on each fence enclosing electrical equipment.

Measurement shall be made before connection is made between the ground and the object to be grounded.

11.0 LIGHTNING PROTECTION

11.1 Lightning protection system shall generally comprise air termination system (lightning finials, air terminals or collector rods, roof conductors or collector lines), down conductor system (down conductors & test links) and earth termination system (earth electrodes along with pits and strips). These individual elements of an LPS should be connected together using appropriate lightning protection components to ensure that in the event of a lightning current discharge to the structure, the correct design and choice of components will minimize any potential damage.

11.2 The number, types, materials and sizes shall be in accordance with the drawings. All lightning arrestor earth leads of the buildings and plant units shall be connected to the cage ring.

11.3 All buildings and plant structures vulnerable to lightning strokes owing to their height or exposed situation shall be protected against atmospheric flash-overs and lightning strokes in such a manner as to eliminate any danger to the personnel employed therein.

11.4 Lightning affecting a structure can cause damage to the structure itself and to its occupants and contents, including failure of internal systems. The damages and failures may also extend to the surroundings of the structure and even involve the local

environment. The scale of this extension depends on the characteristics of the structure and on the characteristics of the lightning flash.

11.5 IEC 62305 consists of the following parts, under the general title Protection against lightning:
Part 1: General principles
Part 2: Risk management
Part 3: Physical damage to structures and life hazard
Part 4: Electrical and electronic systems within structures

11.6 The lightning current is the source of damage. The following situations shall be taken into account, depending on the position of the point of strike relative to the structure considered:
- S1: flashes to the structure;
- S2: flashes near the structure;
- S3: flashes to the services connected to the structure;
- S4: flashes near the services connected to the structure.

11.7 Each source of damage may result in one or more of three types of damage:
- D1 Injury of living beings due to step and touch voltages
- D2 Physical damage (fire, explosion, mechanical destruction, chemical release) due to lightning current effects including sparking
- D3 Failure of internal systems due to Lightning Electromagnetic Impulse (LEMP)

11.8 The following types of loss may result from damage due to lightning:
- L1 Loss of human life
- L2 Loss of service to the public
- L3 Loss of cultural heritage
- L4 Loss of economic value

11.9 Damages & loss in a structure according to different points of strike of lightning:

Point of strike	***Source of damage***	***Type of damage***	***Type of loss***
Structure	S1	D1 D2 D3	L1,L4 L1,L2,L3,L4 L1,L2,L4
Near a structure	S2	D3	L1,L2,L4
Service connected to the structure	S3	D1 D2 D3	L1,L4 L1,L2,L3,L4 L1,L2,L4
Near a service	S4	D3	L1,L2,L4

11.10 In order to evaluate whether or not lightning protection of an object is needed, a risk assessment in accordance with the procedures contained in IEC 62305-2 shall be made. The following risks shall be taken into account, corresponding to the types of loss:

−R_1: risk of loss of human life;
−R_2: risk of loss of services to the public;
−R_3: risk of loss of cultural heritage.

Protection against lightning is needed if the risk R(R_1 to R_3) is higher than the tolerable level R_T

$$R > R_T$$

In this case, protection measures shall be adopted in order reduce the risk R(R_1 to R_3) to the tolerable level

$$R \leq R_T$$

11.11 The role of an air termination system is to capture the lightning discharge current and dissipate it harmlessly to earth via the down conductor and earth termination system. Therefore it is vitally important to use a correctly designed air termination system. BS EN/IEC 62305-3 advocates the following, in any combination, for the design of the air termination:

- Air rods (or finials) whether they are free standing masts or linked with conductors to form a mesh on the roof
- Catenary (or suspended) conductors, whether they are supported by free standing masts or linked with conductors to form a mesh on the roof
- Meshed conductor network that may lie in direct contact with the roof or be suspended above it (in the event that it is of paramount importance that the roof is not exposed to a direct lightning discharge)

11.12 Air terminals shall be mounted on top of buildings or structure as required. All air terminals shall be inter-connected with roof conductors, pipes, hands rails or any other metallic projection above the roofs shall also be bonded to the roof conductors. All metallic chimneys, ducts and the like above the roof of the structure shall be bonded to and form part of the air termination network. Vertical air termination points shall project at least 30 cm above the object on which it is fixed.

11.13 The three basic methods recommended for determining the position of the air termination systems are:

- The rolling sphere method
- The protective angle method
- The mesh method

11.14 Down conductors from air terminals or from roof conductors shall be routed as directly as possible to the test links on earth buses, with minimum bends.

11.15 Four protection levels have been determined based on certain parameters and each level has a fixed set of maximum and minimum lightning current parameters.

LPL	***I***	***II***	***III***	***IV***
Maximum current (kA)	200	150	100	100
Minimum Current (kA)	3	5	10	16

11.16 Each Lightning Arrestor shall be connected to a separate electrode located as close as possible to it and within the fenced area for each set of arrestors. The two nos. electrodes for each set of arrestors shall be spaced about 5 meters apart so that they are all within the enclosing fence. Each of these electrodes shall be connected to the main earth grid.

11.17 All provisions regarding connections of conductors for equipment earthing system shall also apply to lightning protection system.

11.18 In corrosive atmospheres, plumbing metal for corrosion protection shall cover lightning finials or air terminals.

11.19 The layout and design of lightning protection systems for building extensions or new buildings and structures provided within existing station areas shall match the existing design.

11.20 All connections between the different parts of lightning protection systems and the connections to the earthing system must be performed in a manner such that the arising of chemical elements will be avoided.

11.21 Natural Components Of Collectors

Metal cladding, metal roof structures, metal components of roof Structures, gutters and railings may be considered as natural components of collectors.

The requirements of the standards, such as the following, have to be considered:

- Parts must be permanently conductively connected,
- Minimum thickness of the metal involved,
- Cross-sections of the parts.

Installations with metal casings need not to be fitted with collectors taking into consideration the above-mentioned minimum requirements.

Protective coatings or insulation between metal parts shall be electrically bridged.

11.22 Mesh Type Collectors

Buildings shall be provided with mesh-type collector lines. Protruding roof superstructures, such as ladders, chimney stacks, pipes, antenna mounting brackets, etc. and other metallic parts of buildings which are located near the roof (e.g. louvers of ventilation openings) must be directly connected to the collector lines.

This method is suitable where plain surfaces require protection if the following conditions are met:

- Air termination conductors must be positioned at roof edges, on roof overhangs and on the ridges of roof with a pitch in excess of 1 in 10 (5.7º).

- No metal installation protrudes above the air termination system.

Modern research on lightning inflicted damage has shown that the edges and corners of roofs are most susceptible to damage. The air rods should be spaced not more than 10 m apart and if strike plates are used as an alternative, these should be strategically placed over the roof area not more than 5 m apart.

Class of LPS	Mesh si e (m)
I	5 x 5
II	10 x 10
III	15 x 15
IV	20 x 20

11.23 Collector Rods

Collector rods shall be used for roof superstructures featuring mechanically or electrically operated equipment, such as ventilators and non-conductive parts projecting from the mesh plane by 0.3 m. The angle of protection and a certain minimum distance have to be observed.

Outdoor electrical facilities for HVAC or other purposes not located in the protective area of earthed structures, installations or buildings, including exposed electrical equipment shall be protected by collectors.

Buildings with sheet metal roofs where the thickness of the sheet is smaller as the required value, the collector mesh must be equipped with collector rods of sufficient quantity and length to avoid lightning strokes in the sheet metal.

11.24 Down Conductors

Down conductors shall be selected in a manner such that there are several parallel current paths between the collector and the earthing system. The length of each down conductor is to be kept as short as possible.

Steel structures and steel columns of buildings may be used as down conductor, if the minimum sizes according to the standards are guaranteed. In each case the connections with the earthing system and collectors respectively must be visible and removable.

Starting from the corners of the structure involved, conductors should be distributed around the exterior as evenly as possible. They must be configured in such a way as to constitute the direct continuation of the collector. The minimum distance between conductors and doors,

windows and other apertures must be 0.5 m.

If not already connected with the collectors or with the internal potential equalisation, larger metal parts mounted in/on the building outer walls (e.g. frames of doors, ventilation louvers) shall be terminated on the down conductors.

The down conductor spacing should correspond with the relevant class of LPS :

Class of LPS	Typical Distances (m)
I	10
II	10
III	15
IV	20

All down conductors which are connected to the earthing system must be provided with an accessible isolating point for measuring purposes. For termination the grounding bars of grounding loops shall be used, preferably. No conductors are required for outdoor metal structures of adequate size.

11.25 Inadmissibly Short Distances

Inadmissibly short distances between the lightning protection system and metal installations or electrical equipment shall be prevented. In the event of potential hazard due to flash-over or disruptive discharge caused by lightning, appropriate measures shall be taken.

Admissible distances between lightning protection systems and metal installations, electrical wiring and equipment shall be determined in compliance with the standards. This also applies to the use of special roof-mounted collectors.

11.26 Lightning E uipotential bonding

Equipotential bonding is simply the electrical interconnection of all appropriate metallic installations/parts, such that in the event of lightning currents flowing, no metallic part is at a different voltage potential with respect to one another. If the metallic parts are essentially at the same potential then the risk of sparking or flashover is nullified. Bonding can also be accomplished by the use of surge protective devices (SPDs) where the direct connection with bonding conductors is not suitable.

12.0 TESTS OF LIGHTNING PROTECTION SYSTEM

After erection of the earthing and lightning protection system all installations shall be tested in accordance with applicable regulations

The following tests shall be carried out, at least:

- Measures against corrosion protection and arising of chemical elements,

- Check of all connections,
- Measurements of earthing system resistance,
- Measurements of lightning protection system conductivity,
- Check of mechanical details,
- Compliance with specifications.

The aim of the tests is to ensure the proper function of the complete scope. The measuring results and the locations of the measuring points have to be indicated in respective drawings as a basis for future measurements.

13.0 DOCUMENTATION

Complete documentation shall be provided for the design, construction, testing, maintenance and repair of the earthing and lightning protection systems and their components.

The documentation shall be in English language.

The following drawings/documents shall be submitted for approval within 3 weeks of award of contract.

a) Soil resistivity survey report
b) Technical data sheets
c) Earthing design calculations
d) Lightning protection design calculations
e) Earthing grid layouts
f) Construction drawings
g) Spare parts list
h) Operation and maintenance manuals
i) Test reports

The documents listed above shall be handed over for approval. Special attention has to be given to the fact, that documentation must be submitted with sufficient time allocated for approval prior to manufacturing / assembly. The documentation has to be prepared in accordance with the relevant ISO standards. The final documentation shall be delivered on paper in sufficient number and with exception of the signed protocols in electronic form, also. The type of the electronic files and the number of copies shall be agreed with the Client.

After commissioning & testing of earthing system contractor shall submit the following document to Client/MECON for As-Built status in hard copy (5 set) plus one soft copy.

a) Soil resistivity survey report
b) As built earthing grid layouts & earth electrode installations
c) Construction drawings

Rev.: 0
Edition: 2

SPECIFICATION

FOR

ELECTRICAL INSTALLATION IN BUILDINGS

SPECIFICATION NO.- MEC/TS/05/E9/27

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

CONTENTS

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 SCOPE

The intent of this specification is to define the requirements for the design, testing at manufacturer works, supply, erection, testing and commissioning of the electrical installation inside buildings, shelters, sheds etc.

2.0 STANDARDS

2.1 The work shall be carried out in the best workman like manner, in conformity with this specification, the relevant specifications/ codes of practice of the Indian Standard Institution, approved drawings and instructions of the Engineer-in-Charge or his authorized representative issued from time to time.

In addition the design, manufacturing, construction, installation, test and commissioning of illumination system shall be in accordance with the following codes and standards, at least. The latest revision of the publication referred to shall apply.

i) Indian Electricity Act and Rules framed thereunder.

ii) Regulations laid down by the Chief Electrical Inspector of the State, State Electricity Board.

iii) Regulations laid down by the Factory Inspector of the State.

iv) Any other regulations laid down by the local authorities.

IS: 418/ IEC 60598	-	Tungsten Filament Lamps for Domestic and Similar General Lighting Purposes/Luminaries
IS: 1112	-	Glass shells for general lighting service lamps
IS: 1944	-	Code of Practice for Lighting of Public Thoroughfares
IS: 2147/ IEC 60529	-	Degrees of protection provided by enclosures (IP Code)
IS: 2165/ IEC 60664	-	Insulation coordination for equipment within low-voltage systems
IS: 2206	-	Flameproof electric lighting fittings
IS: 2418	-	Tubular Fluorescent Lamps for General Lighting Service
IS-3646	-	Code of practice for interior illumination (Part-I, II & III)
IS: 4012	-	Dust-proof Electric Lighting Fittings
IS: 5571	-	Guide for Selection of Electrical Equipment for Hazardous Areas
IS: 6665	-	Code of practice for Industrial Lighting

IS: 16105 - Method of Measurement of Lumen Maintenance of Solid State Light (LED) Sources

IEC 60085 - Thermal evaluation and classification of electrical insulation

2.2 Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.3 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates/Price schedule
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 GENERAL REQUIREMENTS

3.1 COMPONENTS AND EQUIPMENT

The Contractor has to take care that all components and equipment are selected considering easy maintenance, simple and quick diagnosis and long maintenance intervals. All components and equipment shall be designed for starting and continuous duty at rated load and under the given climatic conditions. Standard industrial components shall be used as far as possible. Components and equipment of same kind and type shall be selected for equivalent functions & shall have interchangeability.

3.2 TAGGING

All lighting fixtures shall receive the respective tagging plates, labels that indicate lamp type and lighting circuit etc, which have to be of extremely durable material, resistant against the environmental conditions. All equipment and installations must be tagged regarding the function and according to the drawings.

3.3 RATED DESIGN DATA

The electrical installation is to be designed for the following rated voltages:

Indoor Lighting: 230 V AC, 50 Hz, single phase (distribution should be in phase balance)

Socket outlets: 230 V AC, 50 Hz, single phase

Power socket/Welding socket outlets: 415 V AC, 50 HZ, three phase and neutral

For extension of existing buildings, the available voltage level and distribution system must be considered.

4.0 LIGHTING SYSTEM

4.1 INDOOR

GENERAL

Lighting installation for all indoor rooms and buildings, structural sheds, walk-ways, sheltered process installation etc includes the luminaries and all necessary switches, push buttons, switchboards, terminal boxes and installation facilities/accessories.

The lighting system inside and outside plant units are designed based on the desired illumination levels recommended by IS and the practices followed in industries, architectural arrangement, building dimensions including mounting height, environmental considerations, ease of maintenance and reliability of the lighting distribution network.

i) The distribution of lighting power supply for the individual areas shall be done at 415V, 3 phase, 4 wire bus system through Main Lighting Distribution Boards (MLDB) for the area. The MLDB shall be fed through a lighting transformer unless specified in TS. The outgoing feeders of the MLDB shall feed the required numbers of Sub Lighting Distribution Boards (SLDB) for lighting. Each SLDB shall receive power at 415V AC, 3 phase, 4 wire and distribute it into 240V, 1 phase circuits for connection to the lighting fixtures and 240V receptacles. The SLDB shall be located in the rooms, bays etc. covering the respective zone. The SLDB shall be located in the electrical rooms in the respective area.

ii) The lighting fixtures in the plant/structural shed are fed from lighting panel and group controlled from SLDB as per construction drawing/Cable schedule and site requirement. Electrical cable between Main Lighting panel (MLDB) and SLDB shall be as per Cable schedule. Wiring between SLDB and lighting fixtures in the plant/structural shed shall be done by PVC insulated, PVC inner Sheathed, PVC outer sheathed, FRLS 3-core (phase, neutral and earth) un-armoured/armoured cable for hazardous areas & non-hazardous areas in GI conduits/Cable tray. GI conduit shall be supported at minimum distance of 1000mm. The lighting fixtures are grouped (3-5 fixtures or as per site condition and construction drawing) & controlled from SLDB through MCB's.

iii) The minimum size of the cable for feeding power to SLDB or MCBDB having 32A incomer shall be 4x25sq.mm or as specified in TS/Cable schedule. Cable size for SLDB (or MCBDB) to light fittings shall be 3x2.5sq.mm. or 4x2.5sq.mm as per the configuration of fittings..

iv) Wiring between switchboard and lighting fixtures in the building shall be done by PVC insulated copper conductor flexible wires in PVC conduit as specified. All joints of conductors in Switch board/JBS/Fitting shall be made only by means of approved Mechanical connectors (nylon/ PVC connectors). Bare or twist joints are not permitted anywhere in the wiring system. Cost toward mechanical connectors is deemed to have been included in wiring. In case of concealed wiring, single core, PVC insulated, stranded copper conductor wire of size 2.5 sq mm in MS conduit shall be used. For utility sockets, cable size shall be 4sq.mm

v) The lighting layouts furnished by MECON in drawings shall indicate approximately locations of lighting fixtures. The electrical contractor shall determine the exact nos. of lighting fixtures

according to lux level indicated else where in this specification with approval of the Engineer-in-Charge or his authorized representative at the site. The exact locations of each fixture in order to avoid interference with beams/columns, piping/ducts or other mechanical equipment and also with a view to obtain as uniform illumination as practicable, and to avoid objectionable shadows. Conduit run shown on drawing are only indicative. The contractor shall decide the conduit run according to site conditions as per directions of the Engineer-In-Charge.

vi) Socket outlets in process areas shall be approximately 1200mm above finished grade and 300mm above grade in office area.

vii) In electrical room, battery room buildings & corridors, twenty (20) percent but at least two (02) & In the control rooms, additionally thirty (30) percent but at least three (03) of the lighting fixtures per room & shall be supplied with power from Emergency DG set or Emergency Inverter or UPS power supply. In all other rooms, at least one lighting fixture per room shall be supplied with electric energy by the Emergency DG set or Emergency Inverter or UPS power supply. The wiring for these emergency lighting shall be in scope of contractor.

viii) Fixtures shall be firmly supported from the structures, support clamps etc. may be bolted or welded to the existing steel work or metal inserts. In case of concrete structures, where metal inserts are not available, fixtures will be fixed to or supported from concrete surfaces with the help of anchor fastener. In such cases special care shall be taken to see that anchoring is firm.

ix) All hardware shall be galvanized or zinc passivated. Circuit cables shall be group cleared to structure by using galvanised strip clamps or run in cable trays wherever they are available. Spacers and cleats shall be of suitable size to accommodate the cables shall be got approved by Engineer-in-Charge before fixing from at site. For isolated structures lighting cables may be taken in underground G.I. pipes.

x) The cost for cable clamps, metal spacers, anchors bolts, etc. shall be deemed to have been included in the installation of cables.

xi) Contractor shall have close watch on the lighting drawings issued to him. Any discrepancy noticed between the figure given in the drawing and the actual requirement at site, shall be immediately brought to the notice of Engineer-in-Charge by the Contractor.

xii) All the fluorescent lighting wirings to be supplied under this contract shall consist of chokes, starters and capacitors. The fittings shall be high power factor type and shall be supplied with white light fluorescent tubes. All the lighting fittings shall be supplied complete with cable glands wherever applicable and the cost for the glands shall be deemed to have been included in the supply of fixtures.

xiii) Mounting details shall be indicated on the drawings. If specified on the drawings, a group of fluorescent lighting fixtures, which are to be mounted end to end, shall be fixed to mild steel cold rolled sections "Metsec channel". The entire assembly will then by fixed to the ceiling with necessary number of supports as required to reduce the deflection. The `Metsec' channel shall run continuous in suitable sections from one end to other end of wall. The complete channel shall be spray painted, with approved colour as per the directions of Engineer-in- Charge. Nylon tape & buttons shall neatly bunch all wires inside channel.

xiv) Fixtures shall be firmly supported from the structures. Support clamps etc., may be bolted or welded to the existing steel works or metal inserts. In case of concrete structures minimum two numbers metallic anchor fasteners of approved size shall support fixtures. All supports shall be thoroughly cleaned and painted in an appropriate colour to suit the fixture.

xv) In case of false ceilings employing minimum tee grid system, fixtures shall be supported from true ceiling. Exact locations of fixtures shall be supported from true ceiling. Exact locations of fixtures shall be finalized in consultation with air-conditioning contractor and as indicated on Architectural drawings. Wiring above false ceilings shall not be left loose and shall be supported along the structures/ceilings. Wiring above false ceiling shall be on surface and below false ceiling it shall be concealed. To facilitate easy maintenance `Looping back system' of wiring shall be followed throughout. Accordingly supply tapping and other interconnections are made only at fixtures connector blocks or at switch boards. Intermediate junction boxes shall be used for wire pulling as inspection boxes.

xvi) All wires in conduit shall be colour coded as specified/as per IS. Each circuit shall have independent phase neutral and earth wire. Unless otherwise specified, insulated conductors of ac supply and dc supply shall be bunched in separate conduits.

4.2 INDOOR LIGHTING

For the purpose of illumination of electrical rooms (Buildings/Indoor areas), the lighting system shall be divided into the following lighting sub-systems:

4.2.1 Control rooms

The illumination of control room housing PLC, HMI, VFD, UPS, Soft starters etc will be provided with Decorative mirror optic luminaire for recessed mounting with energy efficient CFL 2x36W or Decorative type diffused optics for recessed mounting LED TL.

4.2.2 Electrical rooms

The illumination of electrical room housing MCC, PDB, MLDB and other distribution boards shall be provided with Surface mounted / Suspended luminaires suitable for T5 lamps 2x28 W or Surface mounted / Suspended luminaires suitable for LED.

4.2.3 The illumination system shall be designed as per IS:3646-1992. The level of illumination, type of fittings, maintenance factor to be considered is as given below:

Area	Type of Light Fittings Lamps	Lux level	MF
Control rooms	Decorative mirror optic luminaire for recessed mounting with energy efficient CFL 2x36W OR Decorative type diffused optics for recessed mounting LED of 40W TL OR equivalent.	300	0.75
Electrical rooms having PCC, PDB, MLDB etc. without false ceiling	Surface mounted / Suspended luminaires suitable for T5 lamps 2x28 W OR Surface mounted / Suspended luminaires suitable for LED of 40W OR equivalent.	200	0.7
Battery Room	General purpose batten luminaire with energy efficient T5 lamps 2x28W OR	100	0.6

	General purpose batten luminaire with LED of 40W OR equivalent.		
Transformer Room	General purpose batten luminaire with energy efficient T5 lamps 2x28W OR General purpose batten luminaire with LED of 40W OR equivalent.	100	0.6
Civil Staircases of plant buildings	General purpose batten luminaire with energy efficient T5 lamps 2x28W OR General purpose batten luminaire with LED of 40W OR equivalent	100	0.6
Toilets	General purpose batten luminaire with energy efficient T5 lamps 1x28W OR General purpose batten luminaire with LED of 20W OR equivalent.	100	0.6
Pump Houses (near equipment / metering area), structural sheds	Industrial well-glass integral type luminaire suitable for 70W HPSV lamps OR Industrial well-glass integral type luminaire suitable IP66 and IK08 protection for LED of 30W/40W OR equivalent.	200	0.6
Offices rooms, I/C Room, workshops	Decorative mirror optic luminaire for recessed mounting with energy efficient CFL 2x36W OR Decorative type diffused optics for recessed mounting LED of 40W TL OR equivalent.	300	0.7
Cable cellars, walkable ducts, Corridors etc.	Industrial well-glass integral type luminaire suitable for 70W HPSV lamps OR Industrial well-glass integral type luminaire suitable IP66 and IK08 protection for LED of 30W/40W OR equivalent.	50	0.7

The illumination level and the type of luminaries in the various rooms must ensure a smooth and good illumination according to the demand, application and lay-out of the rooms.

4.2 LUMINARIES AND ACCESSORIES

All the luminaires will be designed, manufactured and tested in accordance with the Indian Standards as far as they are applicable.

All the luminaires will be industrial type. Specification for the various types of sodium vapour and fluorescent fittings mentioned in the schedule of quantities will be followed. All the lighting fixtures will be complete with all parts along with lamps/tubes, control gears and accessories for installation and efficient performance whether specifically mentioned in the specification or in the schedule of items or not.

The luminaries provided shall be suitable for standard lamps, preferably 11 W, 18 W, 25 W, 36 W or higher for fluorescent lamps/LED lights (as per Scope of work/ detail engineering) and 70 W, 150 W, 250 W or 400 W HPMV/HPSV lamps or LED lights as specified in Scope of work & design basis. All luminaries must be fully equipped with starter and power factor compensation.

FLUORESCENT FITTINGS

4.2.1 DECORATIVE FLUORESCENT LIGHT FITTING

Decorative type light fitting suitable for energy efficient CFL lamps and T5 lamps/ LED Lamps, mirror optic luminaries for recessed mounting. Housing shall be made of CRCA sheet steel, epoxy polyester powder coated accommodating all electrical accessories pre wired upto a terminal block. It shall have optimum glare control and shall be aesthetically appealing with distinguished looks.

4.2.2 INDUSTRIAL TYPE FLUORESCENT LIGHT FITTING

The fitting will have channel and reflector made of CRCA sheet steel with white cover plate. Channel and reflector will be finished with light Grey stove enamelled outside and white stove enamelled inside. The fitting will be complete with all electrical accessories like polyester filled ballast, starter, spring loaded rotor lamp holders, starter holder, power factor improvement capacitor to improve the power factor upto 0.95 etc. All the fluorescent tube lights fixtures shall have electronic ballast having third harmonic distortion less than 6% and total harmonic distortion less than 12 % .

All types of fluorescent fittings will be suitable for mounting on wall/ceiling/conduit suspension.

Power factor improvement

Power factor of all the light fittings shall be improved so that it is not less than 0.90. Power factor shall be improved by providing capacitor banks with discharge resistor in the light distribution or by providing capacitors with individual fittings.

4.3 SOCKET OUTLETS

i) Power Socket Outlets/Welding receptacles

Power socket outlets shall be three phases, neutral and earth in compliance with IEC/IS-standard.

- 415V, 100 A/ 63A, 3 pole load break switch
- 3 phase and one earth pin socket
- Switch socket interlocked so as to prevent insertion or withdrawal of plug when switch is "ON".
- Facilities for terminating two cables of 3.5 x 50/70 sq. mm aluminium cables.
- All the switch socket outlet shall be fed from PDB directly.

Power socket outlets shall be provided in sufficient quantity in all workshops, pump houses, structural sheds, electrical rooms etc as per drawings & instruction of Engineer-in Charge.. Each Power socket outlet must be protected by means of a dedicated miniature circuit breaker located in the distribution boards.

Welding switch socket outlets shall be provided at every 60m distance in conveyer galleries and atleast one at every working platform of junction houses. The number of welding socket outlets for main technological plant units shall be decided based on requirement, approach etc. Generally the socket outlets shall be provided in such a manner so that using 30m flexible cable with welding set, total plant area can be covered. Upto Three switch socket outlets can be looped per feeder circuit.

ii) Industrial Socket Outlets

Socket outlets shall be single phase, neutral and earth according to IEC/IS. Socket outlets shall be installed in sufficient number in each room as per tender drawings enclosed and instruction of Engineer-in-Charge. Socket outlets shall be protected by means of miniature circuit breakers as per construction drawing. Socket outlets designed for supplying dedicated consumers e.g. AC, boilers, heaters, refrigerators, etc.

240V SWITCH SOCKET OUTLET

1.0	Type	:	1 pole, 3 pin with third pin earthed industrial type receptacles . non-reversible, metal-clad, dust proof, industrial type suitable for horizontal insertion.
2.0	Rating	:	240 V AC , 15A,
3.0	Construction	:	Metal clad gasketted construction, weatherproof All socket outlets will be supplied with heavy-duty type plug and cap with chain.
4.0	Isolation Switch	:	rotary type switch mounted flush in the socket outlet box. The isolating switches will be manually operated industrial type of category AC 22.
5.0	Protection	:	Operating handle of the rotary switch will be fixed in such a manner that it will not be possible either to insert or withdraw the plug without switching off the supply.
6.0	Cable entry	:	Suitable for cable entry through 20mm dia. conduit.
7.0	Mounting	:	Wall / column mounting
8.0	Inscription	:	Inscription plate will be provided indicating the voltage and current rating of the switch socket outlet.
9.0	Miscellaneous	:	In hazardous area, flame proof switch socket outlet will be provided.

iii) Receptacles/Convenience Socket Outlets

5A/15A combination type receptacles manufactured in accordance with IEC/IS: 1293 shall be used with the third terminal connected to the earth. All receptacles shall be provided with a switch mounted on the same enclosure but shall be a separate unit to facilitate replacement by part. Flush mounting type receptacles shall be used in areas where concealed wiring has been adopted and surface type shall be used in other areas.

Transformer for 24V AC Sockets -

1.0	Type	:	Dry type

Step-down transformer
Air-cooled

2.0	Rating	:	Minimum 2500VA
3.0	Primary / secondary voltage	:	240V /26.5 V AC , single-phase
4.0	Construction	:	The transformer shall be enclosed in industrial wall mounting stainless steel (2 mm thick) box having separate chambers for the transformer, incoming and outgoing MCB's.
5.0	Cable entry	:	Suitable knock-outs shall be provided at the top and bottom for cable entry through GI pipes.
6.0	No. of winding	:	Two winding
7.0	Protection	:	SPN MCB's on primary and secondary side incorporating overload and short circuit releases.
8.0	Utility	:	Power supply to 24V repair network
9.0	Location	:	On structural platforms

24 V AC SWITCH SOCKET OUTLET

1.0	Type	:	2 pole, 3 pin with third pin earthed industrial type receptacles
2.0	Rating	:	24 V AC , 5A
3.0	Construction	:	Metal clad gasketted construction, weatherproof
4.0	Cable entry	:	Suitable for cable entry through 20mm dia. conduit.
5.0	Mounting	:	Wall / column mounting

iv) Switches

Switches, manufactured in accordance with IS: 3854 shall be used. Switches in areas where concealed wiring has been adopted shall be flush mounting piano type unless otherwise specified. The switches shall be Shock proof, Fire retardant & Dust proof with more switching operations. Electronics type fan regulator shall be used for ceiling fans. Design and models of the regulator shall be same as that of switches.
Outlet Boxes

Control Room Switchboard

1.0	Location	:	Control room for controlling the lighting fixtures
2.0	Type	:	Flush mounted type
3.0	Construction	:	Fabricated from 14 SWG MS sheet with 6mm thick bakelite cover Shall have conduct knockouts on the sides.
4.0	Switch mechanism	:	Modular switches shall be provided
5.0	Power source	:	The switchboards shall be fed from SLDB of respective area.

240 V SINGLE/ DOUBLE POLE SWITCHES

1.0	Application	:	The switches are intended for controlling lighting circuits
2.0	Type	:	Weather and dustproof and industrial type
3.0	Design	:	The rotary or toggle switches provided will be of sturdy design

4.0	Standard	:	As per IS : 6875 (Part-3) - 1980
5.0	Housing	:	The unit will be housed in cast iron or cast aluminium box having gasketted, screwed front cover plate, fixing lugs and suitable provision for terminating conduit/cable at the top, bottom or sides as specified.
6.0	Mounting	:	DIN Channel mounting . Single phase MCBs mounted adjacent to each other and connected to different phases will be provided with adequate insulated phase barriers.
7.0	Terminal suitability	:	Terminals suitable for aluminium conductor cables.

5.0 OUTDOOR LIGHTING

For outdoor lighting refer specification for outdoor lighting-**MEC/TS/05/E9/23**.

6.0 CONDUIT SYSTEM

Surface or concealed conduit system of wiring shall be adopted, as specified in the drawings. Suitable pull boxes or inspection type fittings will be used to facilitate drawing of wires.

SURFACE WIRING

6.1 Only threaded type GI conduit fittings shall be used. Pin Grip type or clamp type fittings are not acceptable. Conduit ends shall be free from sharp edges or burrs. The ends of all conduits shall be reamed and neatly bushed with bakelite bushings.

6.2 In order to minimize condensation of sweating inside the conduit system, all cables shall be properly drained & sealed with non hardening silicon compound in such a manner so as to prevent entry if insects.

6.3 The outer surface of the GI conduit pipes, including all accessories forming part of the conduit system, shall be adequately protected against rust, particularly when such system is exposed to weather. In all cases, bare threaded portion of conduit pipe shall not be allowed unless such bare threaded portion is treated with anti corrosive preservative or covered with approved plastic compound.

6.4 Conduit connection to outlet boxes shall be by means of screwed hubs or check nuts on either side.

6.5 Conduit pipes shall be fixed by 16 gauge G.I. Saddles on 25x6 mm G.I. Saddle bars in an approved manner at intervals of not more than 500 cms vertical support & 1000mm for horizontal support. Saddles shall be fixed on either side of couplers, bends or similar fittings, at a distance of 30 cm from the center of such fittings. The cost of saddle bars, FLP junction box, saddles, clamps, etc. Shall be deemed to have been included in the installation of conduits.

CONCEALED WIRING

6.6 Where concealed wiring is to be adopted, PVC conduits shall be laid in time before concreting

of the slab. The Contractor shall coordinate his work with other agencies involved in the civil works in such a way, that the work of these other agencies is not hampered or delayed because of any section on his part. Vertical conduit runs shall be made either through columns or chases prepared in the walls. Contractor shall fill these chases or any other openings made by him after completing. During Installation, care shall be taken to see that adequate covers are provided to the conduits. If required, conduits run may be concealed in the floor for low-level receptacles and exhaust fans. Contractor shall submit as built conduit layout drawing.

6.7 Wiring for exhaust fans shall be terminated at wall/receptacles and the connection from ceiling roses/ receptacles to the exhaust fan shall be by means of a flexible cord equivalent in size to the main run of wires.

6.8 After erection, the entire conduits system shall be tested throughout, for mechanical and wiring in conduit shall be tested for electrical continuity and shall be permanently connected to earth by means of approved type earthing clamps, in accordance with Indian Electricity Rules.

7.0 HAZARDOUS AREA

7.1 Wiring in hazardous area shall be done by minimum 2.5 mm2 Copper Conductor armoured, PVC insulated, FRLS cables.

7.2 Correct type of lighting equipment (fixtures and JBs etc.) as specified in the drawing, shall be installed for the particular classified zone 1 (Class I Div. I) and Zone 2 (Class I Div.II) locations as specified in design basis.

7.3 The wiring in hazardous area shall be carried out by highly skilled wireman with due regard for perfect terminations. The terminations in the junction boxes and the lighting fittings shall be done so as not to work loose due to vibrations. After the terminations are made the cover of the junction boxes and the lighting fittings shall be closed to make the complete fittings weatherproof. In fixtures having double cable entries, both the entries shall be used for looping in and looping out connection. Thus avoiding the use of a separate junction box.

7.4 Suitable size double compression nickel plated brass cable glands (Approved by CMRI as suitable for flameproof area) shall be provided for cable entry/exit to any of the flame proof apparatus.

7.5 The rate quoted shall include the cost of accessories required like FLP JB's, saddles, consumables etc for supply and installation of complete wiring system.

8.0 EQUIPMENT SPECIFICATIONS

All materials, fittings and appliances to be supplied by the contractor shall be of the best quality and shall confirm to the specifications given hereunder. The equipment shall be manufactured in accordance with the latest revision of respective Indian Standards. In the absence of any specifications, Material samples shall be brought to site by Contractor and get it approved by Engineer-in-Charge or his authorized representative before installation.

Each circuit phase/neutral shall be given ferrule numbers. Complete wiring inside the panel shall be neatly bunched with PVC tape & button. All cables entries shall be as marked in the schedule. Cables glands for PVC insulated armoured cables of sizes as specified on panel

schedule shall be provided for the incoming cables of all surface mounted panels. For the outgoing circuits of these panels cable glands or conduit entry shall be provided as specified on panel schedule. Conduit entry shall be provided for the incoming and outgoing circuits of all flush mounted panels. All metal surfaces shall be cleaned free of rust given a coat of red-oxide primers and finished with 2 coats of approved paints.

8.1 Outlet Boxes

Outlet boxes for sockets, switches, fixtures and fan regulators etc shall be of minimum 16 gauge & M.S. Sheet 3" deep. Junction/Outlet boxes shall be used in roof slab where concealed wiring has been adopted. Front cover plate shall be of sheet steel in areas where surface wiring has been adopted. For concealed wiring the front cover plate shall be of Formica or approved equivalent with colour to suit the walls. Outlet boxes shall be electro-galvanized after fabrication. Cover plate shall be fixed by Nickel plated brass screw and suitable C.P. brass cup washers. Engineer-in-Charge shall approve samples of these.

8.2 Conduit and Fittings

GI conduits-

GI conduits shall be of galvanized iron, rigid, screwed type. The internal bore of all conduits shall be smooth 7 free from burrs. Conduits upto 32mm dia shall of 1.6 mm thick & conduits above 32 mm shall be 2mm thick.

PVC conduits-

PVC conduits shall be used in concealed wiring of 1.8 mm thickness.
For surface wiring GI conduit (in industrial buildings) and ERW conduit (in non industrial buildings) shall be used.

Point wiring shall included the length of conduits (GI & PVC) including all other accessories like joints, bends, junction/pull boxes etc as required for illumination & wiring.

Care shall be taken to see that all conduit ends have no burrs and ends are neatly reamed to avoid damage to wires. All metal conduit accessories shall be only of threaded type. Pin grip or clamp type accessories are not acceptable. Samples of these shall be furnished for approval by Engineer-in-Charge at site, before installation.

8.3 Wires

Wires shall be PVC insulated 660/1100 Volts grade as per IS: 1554. Conductor shall be stranded copper and size shall be Min. 2.5 mm^2 for lighting and Min. 4 mm^2 for power socket and industrial socket for Air Conditioner circuits. Red/ Yellow/ blue wires for phases black wire for neutral and green wire for earth shall be used. Wiring in conduits without colour coddling is not acceptable. Engineer-in-Charge shall approve make and samples of this before lying.

9.0 TESTING AND COMMISSIONING

Lighting installation shall be tested as per the instruction of Engineer-in-Charge and shall include but not be limited to the following:

9.1 Measure the insulation resistance of each circuit without the lamps (load) being in place and it should not be less than 500,000 ohms to earth.

9.2 Current and voltage of all the phases shall be measured at the lighting panel bus bars with all the circuits switched on with lamps, if required load shall be balanced on the three phases.

9.3 Check the earth continuity for all sockets outlets. A fixed relative position of the phase and neutral connections inside the socket shall be established for all sockets.

9.4 After inserting all the lamps and switches on all the circuits minimum and maximum illumination level should be measured in the area.

9.5 Ensure switch ON/OFF control for each point (light/fan/socket) is only on live side.

9.6 Contractor shall submit and forward the test reports of complete electrical installation in buildings to Engineer-in-Charge.

10.0 DOCUMENTATION

Complete documentation shall be provided for the design, manufacturing, testing, commissioning, start-up, operation, maintenance and repair of the electrical building installation and its components. The final documentation shall include the following documents and drawings (minimum requirements):

The following documents shall be submitted along with the offer:

a) Recommended list of two years operation and maintenance spare.

The following drawings shall be submitted for approval within 3 weeks of award of contract.

a) Data sheets of components
b) Single line diagrams
c) Wiring diagrams
d) Cable lists
e) Cable calculations
f) Cable route drawings within buildings
g) Installation details
h) Type test reports of various equipments

The documents listed above shall be handed over for approval. Special attention has to be

given to the fact, that documentation must be submitted with sufficient time allocated for approval prior to manufacturing/assembly.

Documentation has to be prepared in accordance with the relevant ISO standards. The final documentation shall be delivered on paper in sufficient number and in electronic form, too.

Rev.: 0
Edition: 2

SPECIFICATION

FOR

OUTDOOR LIGHTING

SPECIFICATION NO. - MEC/TS/05/E9/23

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

C O N T E N T S

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 SCOPE

a. The intent of this specification is to define the requirements for the design, supply, installation, erection, testing and commissioning of the outdoor lighting within the station area.

b. **Tenderer to refer separate Technical specification (TS) / SOR item details for following minimum details / re uirements as part of the pro ect needs**

1. **Type of areas to be illuminated, ha ardous or non-ha ardous classification for suitability of installation of light fittings.**
2. **Type of Light fittings and its uantities in line with SOR.**
3. **Conventional type Well glass luminaire/ industrial grade LED luminaire**
4. **Lux levels other than mentioned in GS or pro ect specific details, if any.**

Any other item / component / e uipment / accessories / services as necessary for satisfactory completion of the pro ect shall also be covered in separate Technical specification (TS) / SOR item.

2.0 STANDARDS

The work shall be carried out in the best workman like manner, in conformity with this specification, the relevant specifications/ codes of practice of the Indian Standard Institution, approved drawings and instructions of the Engineer-in-Charge or his authorized representative issued from time to time.

In addition the design, manufacturing, construction, installation, test and commissioning of illumination system shall be in accordance with the following codes and standards, at least. The latest revision of the publication referred to shall apply.

i) Indian Electricity Act and Rules framed thereunder.

ii) Regulations laid down by the Chief Electrical Inspector of the State, State Electricity Board.

iii) Regulations laid down by the Factory Inspector of the State.

iv) Any other regulations laid down by the local authorities.

IS: 418/ IEC 60598	-	Tungsten Filament Lamps for Domestic and Similar General Lighting Purposes/Luminaries
IS: 1112	-	Glass shells for general lighting service lamps

IS: 1944	-	Code of Practice for Lighting of Public Thoroughfares
IS: 2147/ IEC 60529	-	Degrees of protection provided by enclosures (IP Code)
IS: 2165/ IEC 60664	-	Insulation coordination for equipment within low-voltage systems
IS: 2206	-	Flameproof electric lighting fittings
IS: 2418	-	Tubular Fluorescent Lamps for General Lighting Service
IS-3646	-	Code of practice for interior illumination (Part-I, II & III)
IS: 4012	-	Dust-proof Electric Lighting Fittings
IS: 5571	-	Guide for Selection of Electrical Equipment for Hazardous Areas
IS: 6665	-	Code of practice for Industrial Lighting
IS: 16105	-	Method of Measurement of Lumen Maintenance of Solid State Light (LED) Sources
IEC 60085	-	Thermal evaluation and classification of electrical insulation

2.1 Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.2 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates/Price schedule
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 ENVIRONMENTAL CONDITIONS

The outdoor lighting shall be suitable for continuous operation at rated load under the climatic and environmental conditions defined in the “Design Basis”. The various equipment shall be appropriate for outdoor installation.

4.0 DESCRIPTION OF LIGHTING SYSTEMS

The lighting system inside and outside plant units are designed based on the desired illumination levels recommended by IS and the practices followed in industries, architectural arrangement, building dimensions including mounting height, environmental considerations, ease of maintenance and reliability of the lighting distribution network.

4.1 OUTDOOR LIGHTING

The light fittings shall be complete with all accessories like electronic ballast, reflector etc. External area lighting including street/road lighting / tower lights shall be fed from MLDB through separate SLDB located at suitable places. Automatic switching ON/OFF of these circuits shall be done through timers. Flood light towers shall be fed through 415/240V, 3 phase, 4 wire circuit with individual fittings distributed at 240V, single phase, with control and protection located at bottom of each tower. Rewireable fuse in a sheet steel box shall be provided near each fitting to facilitate removal of lamp in off position.

In high bays walkway shall be provided for maintaining light fittings. At other places suitable ladder/platform/approach shall be provided for maintaining/replacement of light fittings.

For the purpose of illumination of outdoor areas within stations, the lighting system shall be divided into the following lighting sub-systems:

4.1.1 Station area lighting

The station area lighting will be provided by high Mast, Flood Light & Pole/Bracket Mounted Lighting fixture as per Schedule of rates.
The lighting shall mainly consist of flood light and street light fixtures (Pole/Bracket Mounted) equipped with high pressure discharge lamps (HPMV/HPSV/MH) or LED lamps mounted on poles and if necessary, with Pole/Bracket Mounted fixtures fluorescent lamp/LED light may be used as per particular requirement.

As far as possible, the maximum horizontal illumination levels of the lighting shall be near the equipment located in outdoor area.

4.1.2 Shed/Shelter lighting

The Shed/Shelter area lighting will be provided by Industrial High/Medium/Low Bay Integral/non-integral fixture, Industrial Integral/non-integral well glass fixture, Industrial T5 fixture as per Schedule of rates.

The lighting fixtures shall mainly consist of high pressure discharge lamps (HPMV/HPSV/MH).

As far as possible, the maximum horizontal illumination levels of the lighting shall be near the equipment located in Shed/Shelter.

4.1.3 Road/street and parking area lighting

The road/street and parking area lighting will be provided for all roads and parking areas. The lighting shall mainly consist of Pole/Bracket mounted street lighting fixtures, equipped

with high pressure discharge lamps (HPMV/HPSV) or LED lights mounted on poles, if necessary, with Pole/Bracket Mounted fixtures fluorescent lamps/LED lights may be used as per particular requirement. The maximum horizontal illumination level of the lighting shall be in the middle (axis) of the roads and parking areas, respectively.

4.1.4 Entrance lighting

The entrance lighting will be provided for all doors and gates all buildings. The entrance lighting shall mainly consist of wall mounted lighting fixtures, equipped with fluorescent lamps/LED lights.

4.1.5 Periphery/Fence lighting

The Periphery/fence lighting will be provided for the boundary of stations. The lighting shall mainly consist of pole/bracket mounted flood light equipped with high pressure discharge (HPMV/HPSV) lamps or street light or T5 fixture with fluorescent lamp or pole/bracket mounted LED lights. The poles of Periphery/Fence lighting have to be installed inside the boundary or on the wall for bracket mounted fixture. Illumination level and the design of the devices of Periphery/Fence lighting must be in accordance with the relevant IS/IEC requirements.

4.1.6 Post top lantern

Two no. of post to lantern with CFL/LED luminary shall be provided at Main Gate of terminal.

4.1.7 Emergency solar street light

A stand alone dusk-dawn solar photovoltaic street lighting system comprises of solar PV module, CFL/LED lamp, lead acid battery, control electronics, Inter-connecting wire/cables, Battery box, Module mounting hardware, GI-Pole etc.

4.1.8 The illumination system shall be designed as per IS:3646-1992. The level of illumination, type of fittings, maintenance factor to be considered is as given below:

Area	Type of Light Fittings Lamps	Lux level	MF
Station area lighting	Industrial well-glass integral type luminaire suitable for 70W HPSV/HPMV/MH lamps OR Industrial well-glass integral type luminaire suitable IP66 and IK08 protection for LED of 30W/40W OR equivalent.	30	0.6
Platforms near technological areas	Industrial well-glass integral type luminaire suitable for 70W HPSV/HPMV/MH lamps OR Industrial well-glass integral type luminaire suitable IP66 and IK08 protection for LED of 30W/40W OR equivalent.	50	0.6
Shed/ shelter/ DG	Industrial well-glass integral type luminaire	150	0.6

Area	Type of Light Fittings Lamps	Lux level	MF
Shed lighting	suitable for 70W HPSV/HPMV/MH lamps OR Industrial well-glass integral type luminaire suitable IP66 and IK08 protection for LED of 30W/40W OR equivalent.		
Main Technological/ Operational areas	High bay/Medium bay integral type light fittings suitable for 400W /250W/150W/70W HPSV/HPMV/MH lamps OR High bay/Medium bay integral type light fittings suitable for bay upto 15m high with LED 140 NW/CW PSD wide beam /narrow beam as per requirement OR Equivalent	50	0.6
Pump house/ Compressor/ Exhauster houses/ Conveyor houses	Industrial well-glass integral type luminaire suitable for 150W/70W HPSV/HPMV/MH lamps OR Industrial well-glass integral type luminaire suitable IP66 and IK08 protection for LED of 30W/40W OR Equivalent	100	0.6
Flood lighting	Weather proof non integral type (integral type in case of high mast) flood light fittings suitable for 1x250/400W HPSV lamps OR equivalent.	50	0.5
Street light Fittings	Street light luminaire suitable for 150/250 W HPSV HPMV/MH lamps of 150/250 W OR equivalent.	30-15	0.6
Parking areas	Industrial well-glass integral type luminaire suitable for 70W HPSV/HPMV/MH lamps OR High bay/Medium bay integral type light fittings suitable for bay upto 15m high with LED 140 NW/CW PSD wide beam /narrow beam as per requirement OR Equivalent	15	0.6
Entrance lighting	Surface mounted / Suspended luminaires suitable for T5 lamps 2x28 W OR Surface mounted / Suspended luminaires suitable for LED of 40W OR equivalent.	30-40	0.6
Periphery lighting	Industrial well-glass integral type luminaire suitable for 70W HPSV/HPMV/MH lamps Industrial well-glass integral type luminaire suitable IP66 and IK08 protection for LED of 30W/40W OR equivalent.	5-10	0.6
Aviation obstruction	Aviation obstruction light fittings, flame retardant type consisting of multi ultra high intensity 60 mscp LED module, without flashing module, steady in red colour, having omni directional capability and shall be suitable to deliver maximum light	As required	

Area	Type of Light Fittings Lamps	Lux level	MF
	output in the zone between 70° above and 10° below the horizontal with a maximum of condition at 20° above the module -240 V OR equivalent.		

4.1.9 RATED DESIGN DATA

The outdoor lighting shall be designed on basis of the following minimum requirements:

a) Average of illumination levels

- Station areas 25-30 lx
- Roads, streets 15 - 20 lx
- Parking areas 15 lx
- Entrances 30-40 lx
- Fences 5 – 10 lx

b) Uniformity of illumination levels

- Station areas 1: 3
- Roads, streets 1: 6
- Parking areas 1: 6
- Fences 1: 5

The uniformity of illumination levels means the ratio between the lowest and the highest measured horizontal illumination level in the reference area.

The outdoor lighting shall be fed with a voltage of 3 x 415V/1x230 V, 50 Hz, or with other voltages if supplied from existing switchboards.

MB Lal committee recommended lux level for outdoor area shall be followed for various terminal system field area / tank access areas etc.

5.0 LIGHTING POLES

For specification of lighting poles please refer **Annexure-I.**

6.0 LIGHTING FIXTURE FOR HAZARDOUS AREA

Refer specification no **MEC/TS/05/E9/22** for hazardous area fixtures.

7.0 HIGH MAST

Refer specification no **MEC/TS/05/E9/21** for High Mast.

8.0 LIGHTING FIXTURES

8.1 Flood Light Fixture

The flood light fixtures shall consist of the following main parts:

- High pressure die-cast aluminium body and front cover frame, polyester powder coated (IP65)
- Electro polished, anodized and sealed aluminium reflector
- Lamp holder with adjustable for centralising the lamp within the fixture
- Heat resistant toughened front glass
- Hinged front cover
- Non-integral gear
- Galvanized steel stirrup with protractor for setting of elevation angle.

The flood light fixtures shall be equipped with HPMV/HPSV/MH/LED lamps of sufficient wattage to meet the lux level requirements as per the Design Basis/ Scope of work.

8.2 Street Light Fixture

The street light fixtures shall consist of the following main parts:

- Die-cast LM6 aluminium housing, polyester powder coated (IP65)
- Hydro formed, one piece reflector in high purity aluminium, anodised and electrochemically brightened
- A toughened heat resistant clear glass fixture.
- Integral/Non-integral gear with power factor improvement capacitor as per Scope/Design Basis.

The flood light fixtures shall be equipped with HPMV/HPSV/MH/LED lamps of sufficient wattage to meet the lux level requirements as per the Design Basis/ Scope of work.

LED lights/ Mercury Vapour or MH lamp used for lighting as per Scope of Work /Design basis, unless otherwise specified Sodium vapour lamps may be used.

The fixtures shall be specially protected against damage in case of storms/heavy wind flow.

8.3 Street Lighting Fixture with CFL/LED Lamps

The lighting fixtures with fluorescent lamps shall consist of the following main parts:

- Canopy of CRCA MS, epoxy powder coated (IP54)
- Integral/Non-integral gear with power factor correction, steel column bracket for side entry or brackets for wall/structure mounting.

The lighting fixtures shall be equipped with CFL/LED lamps up to 1 x /2x 18W/36W etc (As specified in Scope of Work or Design Basis)

8.4 CONTROL GEAR, LAMP ACCESSORIES

- **Lamps**

Sodium vapour lamps will be suitable for universal burning position. The characteristics of the lamps will be in line with the relevant Indian Standards. The outer bulbs will be elliptical hear resistant type, evacuated to minimise heat losses and coated with light diffusion film for pleasing colour discharge. The lamp will be provided with corrosion resistant, nickel-plated screw base.

- **Ballast s**

  All ballast's will be of proven design and capable of delivering long trouble free service. The ballast's will be made up of low loss silicon with steel lamination and will be wound with polyester-based super enamelled copper wire. The ballast will be polyester filled and able to dissipate the heat efficiently so as to keep the temperature rise well within the limits specified in the IS.6616-1972. The ballast will be provided with tapping at 200,220 and 240 volts and will be suitable for HPSV lamps.

- **Capacitors**

  Capacitors will have element wound from layers of high purity Aluminium foils laid over the two faces of capacitor paper. The Aluminium cylindrical case containing the elements will be dried under high vacuum and impregnated before being sealed. The solder type lug terminals will be mounted over porcelain insulators at the sealed end and the capacitor will conform to IS: 1569. The value of capacitance will be chosen as to raise the power factor of burning lamps to above 90%.

- **Igniters and Starters.**

  Igniters for HPSV lamps will be of proven design and capable of delivering long trouble free operations. The igniter and starters will be suitable for tropical condition and conform to IS: 2215-1968.

- **Lamp and Starter Holders**

  Lamp and starter holders will have good spring contacts and of well tried out design. The spring contact will be such as to prevent disconnection due to vibration during cleaning. They will also have facility for easy removal.

8.5 Cables and Grounding

The lighting cables shall be three phase for connection to single pole fixture. The connection shall take into consideration the load balance on the three phase system. The cross section must be determined according to the current capacities and the voltage drops. The minimum cross section shall be 4 mm² for Cu cable & 6 mm² for Al cable. Separate grounding connection of the lighting poles and lighting towers with the grounding network shall be provided. Cables installations and the grounding shall be in accordance with specification "Cable Laying" and "Earthing and Lightning Protection", respectively.

9.0 TESTS

After erection of the outdoor lighting system all electrical installations shall be tested in accordance with applicable IEC/IS regulations. The horizontal lighting levels shall be checked by the Contractor in the presence of the Client/Consultant. The test results of the lighting level measurements shall be recorded in a respective report by the Contractor. The checking method shall be worked out by the contractor prior to tests and shall be

subject to the Client's approval. The aim of the tests is to ensure the proper function of the complete scope.

10.0 DOCUMENTATION

Complete documentation shall be provided for the design, manufacturing, testing, commissioning, start-up, operation, maintenance and repair of the outdoor lighting and its components.

The following documents shall be submitted along with the offer:

10.1.9 Technical data sheets & catalogues
10.1.10 Type test reports

The following drawings (in three sets) shall be submitted for approval/review within 3 weeks of award of contract.

a) Street light pole GA & Mounting arrangement
b) Technical data sheets
c) Circuit diagrams
d) Wiring diagrams
e) Calculation of stability for poles
f) O & M Manual
g) Tests reports

ANNEXURE-I

SPECIFICATION FOR GALVANIZED IRON OCTAGONAL POLES

1.0 DESIGN

The Octagonal Poles shall be designed to withstand the maximum wind speed as per IS 875. The top loading i.e area and the weight of Fixtures are to be calculate maximum deflection of the poles and the same shall meet the requirement of BS: 5649 Part VI 1982.

Length of poles shall generally be 9m /6m/3m as specified in technical specification. If not specified in TS then length to be considered as 9m.

2.0 POLE SHAFT

The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by Submerged Arc welding (SAW) process.

3.0 DOOR OPENING

The octagonal poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall be suitable arrangement for the purpose of earthing.
The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

4.0 MATERIAL

Octagonal Poles	HT Steel Conforming to grade S355JO
Base Plate	Fe 410 conforming to IS 226/IS 2062
Foundation Bolts	EN.8 grade.

5.0 WELDING

The welding shall be carried out conforming to approved procedures and duly qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal shafts.

6.0 POLE SECTION

The octagonal poles shall be in single section (upto 11 mtr). There shall not be any circumferential weld joint.

7.0 GALVANIZATION

The poles shall be hot dip galvanized as per IS 2629/ IS 2633 / IS 4759 standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.

8.0 FIXING TYPE

The octagonal poles shall be bolted on a pre cast foundation with a set of four foundation bolts for greater rigidity.

9.0 TOP MOUNTINGS

The galvanized mounting bracket shall be supplied along with the octagonal poles for installation of the luminaries.

Rev: 0
Edition: 2

SPECIFICATION

FOR

UN-INTERRUPTED POWER SUPPLY (UPS) SYSTEM

SPECIFICATION NO.- MEC/TS/05/E9/16

(ELECTRICAL SECTION)

MECON LIMITED

DELHI 110 092

C O N T E N T S

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 INTENT

a) The intent of this specification is to define the general requirements for design, manufacture, assembly and testing at manufacturer's works, packing, transportation and receipt at site with all materials and accessories of uninterrupted power supply system with static bypass, solid state voltage stabilizer for by-pass supply, Rectifiers, Inverter system, distribution boards and the associated battery sets.

b) Tenderer to refer separate Technical specification (TS) / SOR item details for following minimum details / re uirements as part of the pro ect needs

1. **Re uirement of UPS (3 Phase/ Single Phase) for specific application and its rating voltage level.**
2. **Re uirement for Parallel redundant / Standalone UPS**
3. **Type of battery and its AH/kWH capacity**
4. **Re uirement for SCR/ Thyristor based / IGBT Based rectifier bridge and corresponding THD allowable limit.**
5. **Incoming power feeder details**
6. **Location of UPS and its cooling re uirements**

Any other item / component / e uipment / accessories / services as necessary for satisfactory completion of the pro ect shall also be covered in separate Technical specification (TS) / SOR item.

2.0 CODES STANDARDS

The UPS System & its accessories shall comply with the latest edition of the following and other relevant Indian standards. Incase equipment is supplied by foreign manufacturers relevant international standards shall be applicable.

IS:16242-2014	-	Specification for Uninterruptible power systems
IS:3700- 1970	-	Essential ratings and characteristics of semi-conductor devices
IS:5469- 1973	-	Code of practice for the use of semi-conductor junction devices
IS:12970 - 2010	-	Specification for Semiconductor Devices – Integrated circuits
IS :1652 -1991	-	Specification for stationary cells and batteries Lead acid type with Plante positive plates.
IEC-623	-	Specification for Nickel cadmium rechargeable batteries
IS:8623 - 1999	-	Specification for Low Voltage Switchgear And Controlgear
IEC-60240-1:2008	-	Specification for Uninterruptible power systems
IEEE	-	Recommended practice for electrical power distribution (Std. 141) for industrial plants

3.0 TECHNICAL FEATURES

3.1 UPS SYSTEM

The UPS shall consist of Rectifier / Charger, Battery, Inverter, Static Transfer Switch, Maintenance Bypass Switch, Synchronizing Equipment, Protective Device and other Accessories. The UPS shall provide continuous electric power within specified tolerance, without interruption, to the critical loads. Normally electric energy from normal plant power source shall be supplied to UPS System. The solid-state rectifier / charger shall convert incoming AC power to DC power. The rectifier / charger output shall be fed to solid-state inverter. The inverter shall convert the DC power into AC power, which shall supply the load.

Upon failure of AC power, input power for inverter shall automatically be supplied from the battery with no interruption / disturbance in inverter output in excess of limits specified

herein (in these specifications). At the same time, UPS shall energize an alarm circuit. The duration for which Battery shall supply A/C power to O/P shall be minimum 30 minutes.

When A/C power is restored, the input power for the inverter and for recharging the battery shall automatically be supplied from rectifier / charger output without interruption/ disturbance in inverter output in excess of limits specified herein (in these specifications). The solid-state circuitry used for both Rectifier & Inverter shall be IGBT technology. Rectifier may be SCR/Thyristor based if specified in TS.

Intelligent RS-232 Communication shall be possible which will Provide UPS status indications, electrical parameters such as Input & Output Voltage, Load levels etc and unattended shutdown. User-friendly LCD Display to indicate all important UPS parameters such as Input Voltage, Output Voltage, Battery Level and Load Level shall be provided.

3.2 Design criteria for Uninterrupted Power Supply (UPS)

UPS shall meet the following requirements:

1. a) Parallel redundant UPS system shall be provided if not specified in TS . Each UPS shall be rated for full capacity and under normal condition both shall be sharing the load. In case of failure of any UPS, the remaining UPS shall take the full load.
   b) Standalone UPS (without redundancy) may be considered based on application requirements if specified in TS.
2. Spare capacity of UPS shall be 50%.
3. Load factor or diversity factor shall not be considered while calculating the load on UPS.
4. Two separate power supply from different sources shall be provided to UPS – one for UPS and the other for Bypass.
5. Three phase input supply with single phase output shall be considered for UPS rating of 10 KVA and above.
6. Three phase input supply (Or Single phase input supply if specified in TS) with single phase output shall be considered for UPS rating from 5KVA up to below 10 KVA / as per standard manufacturing practices of OEM.
7. Single phase input supply with single phase output shall be considered for UPS rating of below 5 KVA.
8. Single Bypass supply to equipment shall be through constant voltage transformer.UPS system shall have bump less transfer from UPS to by pass and vice versa.
9. UPS panel shall preferably be located in ventilated room / control room.
10. Separate battery room with proper exhaust ventilation shall be considered for battery bank.

Other design particulars shall be as follows:

1.0 Basic Design parameters

(i)	Input Voltage	:	415 V AC / 240VAC +/- 10, -15% , 3-Phase ,4 wire, grounded neutral system with a symmetrical fault level of 50 KA RMS
(ii)	Input Frequency	:	50 Hz. +/- 5%
(iii)	Output Voltage	:	240 V AC , 1-Phase
(iv)	Output Voltage tolerance	:	+/- 1%
(v)	Output Frequency	:	50 Hz. +/- 0.1%
(vi)	Output Voltage wave form	:	Sine wave
(vii)	Harmonic Distortion	:	Less than 3% for individual harmonics Less than 5% for total harmonics distortion
(viii)	Voltage Distortion	:	Less than 3% for 100% linear loads Less than 5% for nonlinear loads
(ix)	Phase Displacement	:	120 deg. +/- 1deg. for balanced load 120 deg. +/- 3deg. for unbalanced load
(x)	Transient recovery	:	Shall return to steady state condition in less than 100 msec . after a disturbance
(xi)	Maximum ambient	:	50 deg.C

2.0 Basic details

(i)	Duty type	:	Online continuous
(ii)	Reference standard	:	Features and performance in line with IEEE 446
(iii)	Overload	:	125% of the rated output for 15 minutes 150% of the rated output for 30 sec
(iv)	Configuration	:	With isolating transformer, rectifier, inverter unit and necessary DC batteries
(v)	Power device	:	Inverter power circuit shall comprise of IGBT using PWM control technique
(vi)	Redundancy	:	The system shall be of parallel redundant type with bumpless transfers.
(vii)	Static bypass		Automatic static bypass and common DC battery bank . The load shall normally be fed from the inverter. In addition to static bypass switch , a manual

			changeover switch (MCCB) of adequate rating shall be provided to supply the load directly (bypassing the rectifier/charger, inverter, and static transfer switch) from the mains instead of through the UPS system .
(viii)	Battery bank	:	Sealed maintenance free NiCd batteriesOR VRLA batteries (As per TS) shall be provided for the battery bank . The batteries shall be housed in a separate battery cabinet/battery Stand. A battery disconnect circuit breaker with undervoltage release (UVR) shall be included for isolation of the battery pack from the UPS module. The UPS shall automatically be disconnected from the battery by opening the breaker when the battery reaches the minimum discharge voltage level. Casters and leveling feet shall also be provided with the battery power pack cabinet for ease of installation.
(ix)	Battery backup	:	Battery shall be suitable to maintain the power supply for at least 30 minutes (or as specified n TS) in the event of mains failure with rated capacity of the UPS at full load
(x)	Battery management system	:	UPS shall have latest 'Battery Management System' to charge / discharge the entire battery automatically
(xi)	AC DB	:	Necessary distribution board for distribution of power from UPS output to individual consumers
(xii)	Loading capability	:	UPS shall be capable of taking 100 % non linear loads
(xiii)	Interchangeability of sub assemblies	:	The UPS shall be constructed of replaceable subassemblies. PCB's shall be plug-in type . Like assemblies and like components shall be interchangeable
(xiv)	Noise level	:	Maximum noise level shall be less than 60 dB at a distance of 1 m from the body of the UPS
(xv)	Efficiency	:	The efficiency values of UPS under 50% unbalanced load & 100 % linear loads shall be as near as possible to normal efficiency
(xvi)	Isolation transformer	:	The isolation transformer shall be of dry type and shall be provided on both input and output side of the UPS
(xvii)	Grounding	:	The AC output neutral shall be electrically isolated from the UPS chassis.

The UPS chassis shall have an equipment ground terminal. Provisions for local bonding shall be provided.

Component mounted doors shall be separately earthed through 2.5 sq.mm PVC insulated green/green-yellow color flexible copper wire .

(xviii) Communication port : The UPS shall have inbuilt RS 485 port for display of online status of UPS on HMI .

3.0 Rectifier :

- Dual rectifier with each unit rated for supplying both inverter load and battery charger load in different modes.
- Rectifier unit shall consist of minimum six pulse IGBT (Or as specified in TS) bridge connection .
- With necessary smoothing reactor and filters
- Automatic boost and float charging control.
- Equalizing mode for compensating the charge lost by the battery after a discharge automatic changeover from equalizing mode to float mode and vice-versa .

4.0 Protective features :

- Maximum current limiting .
- Automatic reduction of current limit in the event of cooling fan failure .
- Boost charging and float charging current limiting

5.0 Inverter :

- With input circuit consisting of battery contactor, battery filter and smoothing reactor .
- DC/AC converter for voltage control .
- Inverter proper and control electronics .
- Series reactor and parallel filter .
- Output transformer

6.0 Protection :

- Abnormal output voltage (over voltage & under voltage) .
- Abnormal link voltage . understanding
- Over current on output .
- Over current on input or commutating failure .
- Low battery voltage .
- High transformer temperature .
- Auxiliary supply failure .
- Fan failure
- Logic failure
- Clock failure
- Fast acting HRC fuse for inverter circuit and control circuit

- Reverse power protection for parallel inverters.

7.0 Static by-pass switch :

- Static switch automatically switches the load to the reserve power supply for the mains whenever there is failure in inverter supply to the load.
- Fast acting inverter contactor shall connect the inverter output to the load.
- High speed fuses shall be provided for protecting the thyristor against accidental overload.

8.0 Indicating meters to be provided on the ACDB panel :

- Input voltmeter with selector switches.
- Input ammeter with selector switches
- DC voltmeter with selector switches
- Centre zero type DC ammeter for measurement of charging/discharging current from the battery .
- AC output voltmeter with selector switch
- Separate frequency meter to see Input and Output frequency .
- AC output ammeter with selector switch
- AC voltmeter with selector switch for bypass circuit .
- AC ammeter with selector switch for bypass circuit .
- Frequency meter for bypass circuit .

9.0 MIMIC on UPS panels :

- MIMIC of the system power flow diagram as single-line diagram of the UPS shall be provided on UPS panels front door with long-life LED's integrated within the single line diagram to indicate the operating status of different components/sections of the UPS.

10.0 Display and Operating system :

- The UPS shall be provided with a microprocessor based keypad and display unit mounted on UPS panels front door for operating and viewing the UPS status for convenient and reliable user operation .
- The monitoring functions such as metering, status and alarms shall be displayed on an alphanumeric LCD display.

Additional features of the monitoring system shall include:

- Menu-driven display with text format
- Real time clock (time and date)
- Alarm history with time and date stamp (minimum upto 16 faults in memory with FIFO sequence)

- Battery back-up memory

11 Metering :

The following parameters shall be displayed:

- Input AC voltage line-to-line and line-to-neutral for each phase.
- Input AC current for each phase
- Input frequency
- Battery voltage status
- Battery charge/discharge current
- Output AC voltage
- Output AC current
- Output frequency
- Percent of rated load being supplied by the UPS
- Battery time left during battery operation .

12 Alarm Messages :

- Input power out of tolerance
- Input phase rotation incorrect
- Incorrect input frequency
- Charger in reduced current mode
- Battery charger problem
- Battery failed test
- Low battery voltage warning or blown battery fuse
- High battery voltage
- DC bus overvoltage
- Bypass frequency out of range
- Load transferred to bypass
- Excessive retransfers attempted
- Static switch failure
- UPS output not synchronized to input power
- Input power single phased
- Input voltage sensor failed
- Inverter leg overcurrent in X-phase
- Output undervoltage
- Output overvoltage
- Output overcurrent
- System output overloaded
- Load transferred to bypass due to overload
- Fan failure
- Overtemperature shutdown
- An audible alarm shall be provided and activated by any of the above alarm conditions.

13 Status Messages :

- Normal operation

- Load on maintenance bypass
- Load on UPS
- Load on static bypass
- System shutdown
- UPS on battery

14 Controls :
- UPS start-up / shutdown shall be done by push button / rotary control switch
- Normal operation / bypass operations shall be done by a single rotary control switch.
- An advisory display and menu-driven user prompts writeup sticker (pasted inside the panel door) shall be provided to guide the operator through system operation without the use of additional manuals.
- Pushbuttons shall be provided to display the status of the UPS and to test and reset visual and audible alarms.

15.0 Constructional features : The UPS system shall consist of a dedicated ACDB panel consisting of Incoming and Outgoing terminal blocks, MCCB's, power and auxiliary contactors, isolation transformers.

(i) Isolation devices :
- MCCB in incoming side
- SPN MCB (of adequate rating) in outgoing side.
- Power circuit isolation device to have pad locking in the OFF position with the door closed

(ii) Installation :
- Metal clad , indoor installation

(iii) Mounting :
- Floor mounting with base channel of ISMC-75

(iv) Enclosure protection :
- Totally enclosed dust and vermin proof.
- IP – 31 or better (with exhaust arrangement)

(v) UPS housing :
- Each UPS system shall be housed in a separate cubicle, complete with an individual front and back access door with concealed type hinges.
- For UPS panel all the switches, indication lamps and meters shall be flush mounted on the respective compartment door.
- For ACDB panel the input MCCB's and output MCB's shall be operated from outside the panel door .

(vi) Back access :
- Each panel shall have a door on back side . All the doors shall have neoprene/polyurethene gasket .

			• Natural rubber gasket shall be provided between adjacent panel doors and removal covers.
(vii)	**Lifting hooks**	:	• Lifting hooks for each panel shall be provided
(viii)	**Designation plate for UPS**	:	Inscription plate for each panel :- • Name plate shall be provided at top centre of the UPS panel. • Name plates will be of AnodisedAluminium with white letters engraved on black background and in English language. • Letter height for UPS designation plate shall be in the range of 25-50 mm . • Individual components shall be identified with identification plateand shall match with the identification tags mentioned in the drawing. • Danger board shall be provided on front and rear side of the UPS both in Hindi, English & regional languages.
(ix)	**Thickness of sheet steel (CRCA)**	:	• Load bearing members : 2.0 mm • Non load bearing member : 1.6 mm
(x)	**Door earthing**	:	• Hinged door at front and back with flexible earthingconnection.
(xi)	**Cable entry**	:	• Incomer :- Bottom cable entry • Outgoing :- Bottom cable entry
(xii)	**Gland plates**	:	• Undrilled removable bottom gland plates (3 mm thick)
(xiii)	**Output power indication**	:	• Auxiliary contactors shall be provided in output side of the UPS for potential free contacts for indication of UPS and non UPS power supply at different location. • Proper transducers shall be provided for voltage and frequency indication at different locations .
(xiv)	**Cooling of panels**	:	• Panels shall have fan installed vertically at top for forced air draft and louvers with screen protection in bottom. • Fans shall be powered from UPS output. Low velocity fans shall be used to minimize audible noise output. • The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices before excessive component or internal cabinet temperatures are exceeded. • The UPS shall be installed in air conditioned

environment.

(xv)	**Bolts , nuts cable glands**	:	• All bolts and nuts for terminations shall be cadmium coated. • Double compression cable glands for receiving external power & control cables. • Compartment door interlocked with the isolating device for safety with provision for defeating it by authorized person
(xvi)	**Indicating lamps**	:	• All indicating lamps shall be of LED high density type.
(xvii)	**Finish**	:	• Interior and exterior :- RAL 7035
(xviii)	**Terminal block**	:	• Terminal block for incoming cable shall be located in back side and outgoing cables shall be in front side of the ACDB panel. • All incoming terminal blocks shall be fully insulated for the working voltage. • The terminal blocks shall be sleeved color coded Red , Yellow , Blue , Black for R,Y,B,N respectively using heat shrinkable PVC sleeve . • All outgoing terminal blocks shall be sleeved color coded Red and Black for line and phase respectively using heat shrinkable PVC sleeve. • All the terminal blocks shall be shrouded. • Not more than two connections shall be made at one terminal. • Terminal blocks shall be suitable to connect two cores of 2.5 sq.mm. • There shall be 20 % spare terminal blocks
(xix)	**Minimum air clearance for bare busbars**	:	• Phase to phase :- 25.4 mm • Phase to earth :- 19.0 mm
(xx)	**Output power bus**	:	• The solid output power bus shall be of bare copper with a minimum rating of 100 A at 240 V AC (1 pair).
(xxi)	**Earth bus**	:	• The main earth bus shall be of 50 x10 mm GI with extension at both ends of switchboard for connection to safety grounding network. Earth busbar shall run continuous throughout the UPS panel at bottom.
(xxii)	**Panel internal wiring**	:	The panel internal wiring shall be carried out by 1100 V grade , single core , black color PVC

insulated , stranded copper wire of following size

- Current transformer circuit :- 4.0 sq.mm
- Control and potential circuit :- 2.5 sq.mm
- Identification of wire shall be numbered by plastic/ ceramic ferrules.
- Ferrules shall be self locking type.

(xxiii) Incoming Feeders :

- 3 pole MCCB.
- Ammeter with 4-position selector switch (three phases & OFF)
- Voltmeter with 4-position selector switch and fuses (three line-line & OFF)
- Current transformers (for metering)
- 3 nos. indicating LED type lamps (R,Y,B)
- 3 nos. indicating LED type lamps (CB ON-Red , CB OFF- Green, CB TRIP - Amber)
- Following protections are required for the MCCB controlled
  - Incomers :-
    - Overcurrent releases.
    - Short circuit.
    - Earth fault.

(xiv) Outgoing Feeders :

- Each outgoing feeder shall have followings:-
- Outgoing feeders shall have SPN MCB
- MCB of 09 kA rating with Thermo-magnetic releases.

(xv) Testing :

- All routine tests shall be as per IS-8623 (Part-II) 1993
- Type test certificate shall be submitted.

3.2 Battery and Accessories

3.2.1 Battery unit

Ampere-hour capacity of the battery shall be selected on the following basis:

- Load power factor of 0.8
- Aging factor of 0.8
- Battery state of charge factor of 0.88 or as specified by the approved manufacturer
- Temperature correction factor shall be taken as specified in data sheet
- Minimum end cell voltage shall be 1.1V per cell for Ni-Cd battery & 1.85 V per cell

for SMF LA/VRLA battery as per TS.

3.2.2 The type of battery (Ni-Cd/SMF LA/VRLA) shall be as perTS :

Sets of Indoor Stationary batteries of type as per enclosed data sheet complete with all required accessories as applicable including but not limited to the following shall be supplied with each battery set;

- Battery stands in two rows/ two tier formation. Stand Material shall be as per battery manufacturer's standard.
- Cell testing voltmeter complete with leads- (1 no. Per set).
- Spanner - (1 no. Per set).

Overall dimensions of complete battery set shall be such that it can be accommodated in existing room if indicated in data sheet.

Ni-Cd Battery

The nickel cadmium cell/ battery shall be suitable for float duty operation at constant voltage permanently applied to its terminals which is sufficient to maintain it in a state close to full charge and shall be designed to supply load in the event of normal power supply failure. Battery shall be Fiber plate or Pocket plate type.

Supplier shall carry out battery sizing calculations based on load as specified and in line with various standards. The same shall be submitted to owner/consultant for approval.

Ampere-hour capacity of the battery shall be selected on the following basis:

a) Nominal voltage of cell shall be 1.2 V.
b) Load power factor of 0.8
c) Aging factor of 0.8
d) Battery state of charge factor of 0.88
e) Minimum ambient temperature as specified in datasheet
f) Backup time as specified in datasheet
g) Minimum end cell voltage shall be 1.1V per cell for Ni-Cd battery
h) Depth of discharge as specified in datasheet

The number of cells shall be determined as per load and system voltage as specified in datasheet.

Battery assembly shall be supplied in dry and uncharged condition in line with client's instructions. Electrolyte with 10% extra quantity shall be delivered with the battery in suitable, non-returnable, sealed containers.

The battery shall be charged at site and made available for working by the supplier as per client's directives.

Each cell shall have a separate container. The cell shall be housed in high strength impact resistant and alkali resistant container and should be transparent/translucent material and designed to withstand mechanical stresses, shocks and vibrations.

The components such as containers, lids/covers and seals used in the manufacture shall be fire, flame and smoke resistant.

The terminal post shall be nickel plated. The terminals shall be suitable for short circuit current and specified discharge current without damage to cell as a result of terminal heating.

Accessoriestobesupplied:

i) GalvanizedSteelMetallicStand with2coats ofblackpaintcompletewith cell number plates and fixing arrangement.Suitableforrowsingletier arrangement
ii) Alkaliforfirstfillingincluding 10%sparesquantity.
iii) Celltestingvoltmeter3-0-3voltscompletewith leads.
iv) Syringe type hydrometer
v) Mercury in glass chemical thermometer 0-100 deg.
vi) Float type level indicator
vii) Copper cell connectors
viii) Spanner for cells, acid resistant funnel and 2 litre jug, rubber syphon, gloves and apron.
ix) Well type teak wood holders.
x) Alkali proof tiles/PVC sheet to be put in floor and 1/3 of the wall in battery room.

3.2.2 Lead Acid (Plante) battery

The battery shall comprise station class, plante type lead acid cells with tubular + ve plates in hard rubber container conforming to IS: 1652-1991. AH capacity and number of

cells shall be as specified in design criteria. AH capacity shall correspond to 10-hour discharge rate to final voltage of 1.85 VPC at 27°C.

- Calculationsinsupportofbatterycapacityselectionshallbefurnished.
- Construction of positive and negative plates shall ensure trouble free service. The cells shall have top lids to exclude dust. Vent plugs shall be provided on top lids. The battery shall be mounted on anti-acid painted teak wood stands in two rows, in double tier arrangement. The polarity of terminals shall be clearly marked.
- Accessories

  All accessories required for installation, operation and maintenance of the battery shall be suppliedwith the battery as specified in design criteria. First filling of acid with 10% excess quantity shall be supplied in non-returnable containers.
- Accessories required for installation, operation and maintenance of battery shall be provided:

  i) Teakwood Battery stand suitable for double row, double tier arrangement for 110V system.
  ii) Cell and stand insulators.
  iii) Plastic cell number plates with fixing accessories.
  iv) Copper cell connectors with adequate lead coating.
  v) Syringe type hydrometer.
  vi) Thermometer with specific gravity correction scale.
  vii) 3-0-3V, cell testing voltmeter, class 1.0
  viii) Acid resisting funnel, rubber siphon, pair of rubber gloves, rubber apron, acid resisting jug of 2 liters, wall type teak wood holders.
  ix) Wooden Spanner and special tools (if any).
  x) First filling of acid plus 10% spare in non-returnable plastic containers.

3.7 Details to be furnished in datasheet of UPS

i) Name of manufacturer
ii) Type of UPS

iii) AC Input details – Voltage, Frequency with %age variation
iv) kVA rating
v) Overall dimensions
vi) Panel enclosure details – material, thickness, IP class, paint shade etc.
vii) Rectifier details
viii) Static inverter details
ix) Rated full load capacity
x) Output voltage distortion – linear & non-linear load
xi) Harmonic distortion
xii) Overload capacity
xiii) Synchronization limits
xiv) Slew rate
xv) Static transfer switch details
xvi) Protections & indication details
xvii) Battery type and rated voltage
xviii) No. of cells
xix) Minimum cell voltage
xx) Maximum charging current
xxi) Battery back up time
xxii) Voltage stabilizer with isolation transformer details

4.0 DRAWINGS AND DOCUMENTS

4.1 The following documents shall be submitted along with the offer:

a) List of two years operation and maintenance spare.
b) Technical data sheet (Annex-II) and check list duly filled.

4.2 The following calculations/ dimensions shall be submitted:

a) UPS sizing calculation.
b) Battery sizing calculation.
c) Battery bank/stand size.
d) UPS panel size including solid-state stabilizer panel.

4.3 The following drawings shall be submitted for approval within 3 weeks of award of contract.

a) G.A. of panel, battery bank with stand & ACDB

b) Single line diagram
c) Display & mimic details
d) Bill of Material
e) Schematic & Wiring diagram for reference
f) Battery sizing calculation
g) Battery bank/stand size
h) UPS Control & Protection philosophy
i) List of LCD indication & audio alarms

4.4 Final drawings, operation & maintenance manual and erection Instructions shall be submitted along with despatch of equipments in four sets in hard copy & two sets in soft copy (CD).

5.0 INSPECTION AND TESTING

Inspection and testing of equipment shall be carried out by the owner/ consultant at the works of the contractor on final product to ensure conformity of the same with the acceptable criteria of technical specification, approved drawings and national/ international standards.

Tests shall be carried out at manufacturer's works under his care and expense.

The manufacturer shall submit a QAP inline with the format enclosed for approval of MECON. All tests and documents of inspection shall be done based on this.

The bidder shall submit the Type Test reports along with the drawing for approval for the following type tests conducted on UPS as per relevant IS and IEC within five years from the date of opening of the bid and test-witnessed by any Government Department / Government undertaking, failing which the offer is liable for rejection.

UPS testing shall be performed after wiring of the functional units to form a complete UPS either at the factory or at the installation site. The interconnecting cables shall be checked for correct wiring, insulation and quality of wiring terminations.

Type tests

1) Interconnection cable check

2) Overload capability test

3)Radiofrequency interference test

4) On-site ventilation test

5) Earth Fault

Routine tests

1) Full load test
2) Transfer test
3) Overload capability test
4) Short Circuit current capability test
5) Overvoltage test
6) Radiofrequency interference test
7) Noise test
8) On-site ventilation test
9) Earth Fault
10) Environmental tests
11) Vibration and shock tests

All other tests, as may be necessary to ensure that all equipment's are satisfactory shall also be carried out. In addition to the above tests, manufacturer's test certificates, vendor's test certificates for different equipment's, accessories, instruments etc. shall be submitted, whenever required by the purchaser.

6.0 PACKING AND TRANSPORT

The UPS, ACDB & other boards shall be shipped to site packed in wooden crates. They shall be wrapped with polythene sheets before being placed in crates to prevent damage to the finish. Crates shall have skid bottoms for handling.

7.0 TYPICAL CALCULATIONS (To be submitted by the bidder for reference/ approval)

A) UPS Si ing calculation

Steps to calculate

1. List all equipment to be protected by the UPS. (Remember to include monitors, external hard drives, routers, etc.)
2. List the amps and volts for each device. These ratings can typically be found on the label on the back of the equipment. Multiply amps by volts to determine VoltAmps

(VA). Some devices may list their power requirements in watts. To convert watts to VA, divide the watts by power factor. For servers, the power factor is often 0.9.

3. Multiply the VA by the number of pieces of equipment to get the VA subtotals.
4. Add the VA subtotals together.
5. Multiply the total by 1.6 to get the total capacity. This step accounts for future expansion.Spare capacity of UPS shall be 60 %.
6. Use the grand total to select a UPS. When choosing a UPS, be sure that the total VA requirement of supported equipment does not exceed the VA rating of the UPS.

B) Battery si ing calculation

$$\text{No. of cells} = \frac{\text{Max. DC voltage}}{\text{Boost Voltage}}$$

$$\text{No. of cells} = \frac{\text{Min. DC Voltage}}{\text{End cell voltage}}$$

$$\text{DC Current} = \frac{\text{UPS (KVA) x 1000 x Load power factor}}{\text{Inverter efficiency x End voltage}}$$

$$\text{Capacity of battery (AH)} = \frac{\text{DC Current x Duration in Hrs}}{\text{\%age capacity utilization}}$$

Rev: 0
EDITION : 2

SPECIFICATION

FOR

HT VCB PANEL

SPECIFICATION NO.- MEC/TS/05/E9/28

(ELECTRICAL SECTION)

MECON LIMITED

DELHI 110 092

CONTENTS

1.0 CODES AND STANDARDS

The equipment shall comply with the requirements of latest revision of following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified:

IS 5 Colours for ready mixed paints and enamels

SP 30 (BIS)	National Electrical Code 2011
IS 816	Code of practice for use of metal arc welding for general construction in mild steel
IS 1239	Steel tubes, tubulars and other wrought steel fittings
IS 1255	Code of practice for installation and maintenance of power cables up to and including 33kV rating
IS 1364	Hexagon head bolts, screws and nuts of product grades A and B IS
1573	Electroplated coatings of zinc on iron and steel
IS 2309	Code of practice for the protection of buildings and allied structures against lightning
IS 2629	Recommended practice for hot dip galvanizing of iron and steel IS
2633	Methods for testing uniformity of coating of zinc coated articles IS
3043	Code of practice for earthing
IS 3618	Phosphate treatment of iron and steel for protection against corrosion IS 4759

Hot-dip zinc coatings on structural steel and other allied products

IS 6005	Code of practice for phosphating of iron and steel
IS 7689	Guide for the control of undesirable static electricity
IS 7816	Guide for testing Insulation resistance of rotating machines
IS 10028 : Part 2	Code of practice for selection, installation and maintenance of Transformers: Part 2 - Installation
IS 10118 : Part 3	Code of practice for selection, installation and maintenance of switchgear and control gear : Part 3 - Installation
OISD-RP-110	Recommended practices on static electricity
OISD-STD-137	Inspection of Electrical Equipment
OISD-RP-147	Inspection and safe practices during electrical installations

In addition to the above it shall be ensured that the installation conforms to the requirements of the following as applicable:

a) Indian Electricity Act and Rules.

b) Regulations laid down by CEA/Electrical Inspectorate.

c) Regulations laid down by PESO/ DGMS (as applicable).

d) The petroleum rules (ministry of Industry Government of India).

e) Any other regulations laid down by central/state/local authorities and Insurance agencies.

In case of any contradiction between various referred standards, specifications and statutory regulations the following order of priority shall govern:

- Statutory regulations
- This specification
- Codes and standards

However the Contractor shall bring any such contradiction to the notice of Purchaser for prior approval.

2.0 EQUIPMENT INSTALLATION

Prior to start of installation of the electrical equipment contractor shall verify that equipment and complete materials have been received. Handling, shifting to required site location, installation, testing and commissioning of all electrical equipment shall be done by vendor/contractor with utmost care as per the scope matrix between the site installation contractor and respective equipment vendor attached in the each tender. Manufacturer's instructions and the requirements given in their technical manuals shall be strictly adhered. The substation/switchgear room wherein the equipment shall be installed shall be kept clean, dry and free from all debris. Panel floor cutouts not in immediate use shall be suitably covered to avoid any mishap. When handling the switchboard panels, care shall be taken to observe the correct lifting arrangements and to make sure that slings are attached to the manufacturer's designated lifting arrangements and to make sure that slings are attached to the manufacturer's designated lifting points. No parts shall be subjected to undue strains or sudden stresses which could cause damage to the equipment.

The lifting position mark indicated on packing casing shall be adhered to strictly, for keeping it in required vertical position.

Contractor shall check and report to the Purchaser about any damaged item and / or missing component for getting the same replaced as per specifications. During installation, all accessories and loose items shall also be inspected by the contractor before their assembly/mounting.

In case of any modifications/replacement of existing equipments or Tie-ins with existing Electrical systems, approvals shall be obtained from Purchaser before any work to be implemented. The tie-in and shutdown philosophy shall be developed by Contractor in coordination with production, operation and maintenance department. Detailed Task Risk Assessment (TRA) shall be developed by the Contractor for all modifications/replacement or tie-ins activities and shall be approved by all concerned authorities.

The following philosophies provide the frame work for modifications/replacement or tie-in approach:

a) The existing facilities shall continue to operate normally. Contractor shall verify the requirements for modifications, replacement and interface or tie-in with existing / new electrical systems.

In general, a planned construction campaign shall be scheduled to facilitate the modifications/replacement or tie-in work. However, preparation for modifications/replacement or tie-in work can be proceed on an opportunistic or scheduled shutdown prior to the planned construction campaign in consultation with Purchaser. Associated shutdown co-ordination shall be carried out by the Contractor as per Purchaser procedure to complete the modifications/replacement of existing electrical equipments or tie-in hook up for all electrical systems.

Switchboards and Bus Ducts

The term switchboard here includes all HV / MV/ LV switchboard panels, motor control centres, power and lighting distribution boards, UPS panels, ACDB, charger panels, DCDB etc. The switchboard panels shall be handled with care, avoiding any impact to the equipment. Dragging of the panels directly on floor shall be avoided. Roller bars may be used for shifting of panels: Use of a crane and trailer shall be made for handling of equipment. The switchboard panels shall be properly supported on the truck or trailer by means of ropes to avoid any chance of tilting. The switchboards shall be lifted after ensuring that panel supports, nuts and bolts are all intact and tightened. While lifting the panels in packed conditions utmost care shall be taken to avoid any damage to insulators, bushings, metering and protective equipment. The panels shall be preferably kept inside the packing cases till foundations are ready.

The switchboard panels shall be installed on prepared foundations or floor cutouts. Steel base channels shall be welded to inserts provided in floor slab. Cross members shall be provided at the junctions of each shipping section and other places as required. Alternatively when the floor is being-laid, base channel frame of panels supplied by the vendor shall be grouted and levelled in cement concrete. It shall be ensured that the base plate level of HV switchboard shall match with the finished floor level. The foundation pockets and the grouted bolts shall be cured for a minimum period of 48 hours.

The switchboard panels shall be taken out from the packed cases and shifted one by one to its proper place. All the panels shall be assembled, aligned and levelled: Alignment of panels shall be checked in both longitudinal and lateral directions. It shall be ensured that panel to panel coupling bolts, bus bar links etc. fit properly without any strain on any part. No new holes for jointing of the panels other than those recommended by the vendor shall be drilled. No gaps shall be left between the panels. The lifting, racking in and out operation of the breaker and all other motions shall be free from any obstruction.

The panels shall be checked for correct vertical position using pendulum weight and spirit levels. The switchboard panels shall be tack welded at suitable intervals at base channel.

After erection of switchboard panels, all uncovered portions of floor cutouts shall be covered with 6 mm thick removable chequered plates finished with floor level. The design of the chequered plates shall be such that the maximum allowable deflection is L/200 (where L is the span of the chequered plates in metres) for a live load of 500 kg./sq. meters. Suitable lifting arrangements shall be provided for chequered plates: The chequered plates shall be painted with a coat of red oxide zinc chromate primer after proper surface preparation as per specifications. Where specified, panels cutouts provided for future use shall be filled with lean concrete.

After completion of erection of switchboards, all the cubicles, switchboard components such as switches, starters, C.T. and P.T. chambers, busbar chamber shall be cleaned and checked for tightness of all the components. Vacuum circuit breakers shall be checked for integrity of bottle seals. All loosely

supplied items shall be fitted up. Bus bar sections or links shall be inserted and where specified, of high voltage equipment shall be insulated. Interconnection wiring between shipping sections shall be made by vendor. All the wiring connections shall also be checked. Phase sequence and polarity of PTs and CTs shall be checked. Contact resistance of all busbar joints and contactors shall be checked. Insulator shall be checked for any damage. All the starters, switches, contacts shall be cleaned with C.T.C. where required. All the moving parts shall be checked for easy and free movement. Hinges of panel doors shall be lubricated to give free and noise free movement. All openings shall be kept completely closed to avoid ingress of any foreign particles inside the panel.

Functional scheme verification of individual feeder shall be carried out and minor wiring modifications in the panel wiring, if required shall be done as per the directions of Purchaser. Special attention shall be paid to CT circuits polarity, wiring continuity and correctness in the protection as well as measurement circuits. Auto transfer scheme shall be simulated and verified. During the course of scheme verification tests, defective components if any shall be taken out, after bringing to the notice of Purchaser. The same shall be replaced by component supplied by Purchaser.

Where switchboard is damp or having a low IR value due to damaged insulators/ bushings/any other insulated parts, or any other reason, the entire switchboard shall be dried. up according to the instruction of the Purchaser for the I.R value to improve to a sate level for commissioning. Care shall be taken to protect the surrounding insulation from direct local heating during the drying up process.

All the metering instruments, protective relays and other relays and contactors shall be tested as per manufacturer's recommendations and according to the instructions of the Purchaser. Protection relays shall be inserted and connected and settings adjusted as required by the Purchaser.

All moving parts, of closing/tripping mechanism, racking in and racking out mechanism, spouts and shutter closing mechanism shall be checked for proper operation. All the auxiliary contacts of breaker shall be checked-up, cleaned and contact pressure measured.

All the control wiring, PTs, bushings, bus bars, other live parts of switchgear, incoming and outgoing cables shall be meggered.

Electrical simulation tests shall be carried out for all the protective, alarm and annunciation relays and external interfaces to ascertain proper functioning.

Safety insulation mats of approved make and of required voltage grade shall be provided in the sub- Station.

Pre-Commissioning Check List:

Before commissioning any switchboard, following points shall be checked and ensured for safe energizing of the switchboard:
That the installation of equipment to be commissioned is complete in all respects with its auxiliaries and all other mounting including earthing. Openings in floor within and outside panels have been sealed off. All cover and door gaskets are intact to make the enclosure vermin proof.

a) All the metering instruments have been checked and found in working order. Indicating lamps are healthy and are in correct position. All power and control fuses are of proper rating.

b) That the polarity test and ratio test of all the P.T.s and C.T.s is complete and phase sequence of C.T.s conforms to the correct vector group connections. Wiring continuity and correctness are ensured

in the protection and measurement circuits. Polarity of D.C. supply for all the circuits is correct.

c) That the high voltage tests of incoming and outgoing cables have been conducted and results are satisfactory.

d) That all the protective relays including both conventional and microprocessor based numerical relays and thermal overload relays have been tested for secondary injection tests. (Primary injection tests shall be carried out for differential protection, Restricted Earth fault protection at full / reduced current to ensure correctness of complete wiring). Relay settings, status indications, fault annunciations, data logging, display of switchboard SLDs shall be verified from MMI in case the same is provided.

e) That I.R. Value has been recorded for bus bars, circuit breaker, incoming and outgoing cables, control wiring and potential transformers. Where required joint resistance of bus bars have been recorded and found to be satisfactory. All the surroundings and panels have been cleaned and temporary earth leads have been removed.

Bus Ducts:

The bus ducts as per issued drawings will be supplied in parts and all the parts shall be assembled and the bus bar connections shall be made at site. The insulators in bus ducts shall be inspected for any possible damage during transit and the defective ones shall be replaced. The insulators shall be cleaned. Contact surface of bus bars, bus bar bolts and nuts shall be thoroughly cleaned. Petroleum jelly shall then be applied and bolted connection made. The bus duct enclosure shall be checked for earth continuity and then earthed at two places. The bus duct shall be properly supported between switchgear and transformer. The opening in the wall where the bus duct enters the switchgear room shall be completely sealed to avoid rain water entry. Expansion joints, flexible connections etc. supplied by the manufacturer of the bus duct shall be properly connected. The bus duct levelling shall be checked with spirit level and pendulum weight.

Transformers

Transformers on receipt at site shall be unloaded by means of crane or lifting devices of adequate capacity. All lifting lugs shall be used to avoid unbalanced lifting and undue stresses on lugs. Lifting lugs if any provided for partial lifting (e.g. for active part, conservator) etc. shall not be used for lifting complete transformer. Parts other than those identified for lifting of the transformer shall not be used for lifting. While slinging, care shall be taken to avoid slings touching other parts.

Before lifting transformer, it shall be ensured that all cover bolts are tightened fully. In case when it is necessary to use jacks for lifting, projections provided for the purposes of jacking shall be used. Lifting jacks shall not be used under the valves or radiator tubes. For transporting transformers from stores to site, the transformers shall be loaded on a suitable capacity truck or trailer. The transformers shall be properly supported by steel ropes and stoppers on the trailer to avoid tilting of the transformers in transit due to jerks and vibrations. At no instance the transformer shall be kept on bare ground. Where it is not possible to unload the transformer directly on a foundation, it shall be unloaded on a properly built wooden sleeper platform. A transformer shall never be left without putting stoppers to the wheels.

Transformer shall be examined, for any sign of damage in transit. Particular attention shall be given to the following in this regard:

a) Dents on tank wall or cooling tubes.

b) Damage to protruding parts like valves, sight glass etc.

c) Loosening of bolts due to vibration in transit.

d) Cracked or broken bushings.

e) Oil leakage particularly along welds.

If anything adverse is noted the same shall be brought to the notice of Purchaser.

Contractor shall examine the transformer base, oil pit, tire walls and foundations laid by the civil contractor. It shall be ensured that oil spills cannot propagate along cable trenches. Any discrepancy noted will be brought to the notice of Purchaser. Transformers shall be placed on channels or rails over concrete foundations. The transformers shall be levelled, aligned and checked for free movement on the channels or rails. Stoppers shall be provided to the transformers immediately to prevent any movement. Normally transformers upto 1000kVA rating shall be received duly fitted with radiator tubes, conservator tanks, valves, wheels and other accessories. While the transformers of above 1000kVA rating may be supplied with loose accessories. All the accessories like radiators, cooling fans, valves, conservator tanks, explosion vent pipe, bushings and other devices which are supplied in different packages shall be checked for any transit damage and cleaned thoroughly before fixing on the transformer. All loosely supplied parts shall be assembled as per manufacturer's instruction manuals/ drawings and documents. All the connections for C.T.s bushings and other wiring shall be checked for tightness and correctness before replacing the lid or tightening all the bolts.

Topping of transformer with oil:

Before topping up with oil, transformer shall be fitted with all accessories such as valves, gauges, thermometers etc. Oil samples shall be taken from each drum and tested for determination of dielectric strength. Any sign of leakage of the barrel or of its having been opened shall be recorded and reported. It is necessary to filter the oil before the transformers are filled. It shall be ensured in oil filling operation that no air pockets are left in the tank and that no dust or moisture enters the oil. All air vents shall be opened. Oil shall be filled through a streamline oil filter using metal hose. To prevent aeration or the oil, the transformer tank shall be filled through the bottom drain valve. In a transformer with conservator tank, the rate of oil flow shall be reduced when the level is almost upto the bottom of the main cover to prevent internal pressure from rupturing the pressure relief-pipe diaphragm. Sufficient time shall be allowed for the oil to permeate the transformers and also for the locked -up air bubbles to escape. Any air accumulation in the buchholz relay shall be released.

Transformer Oil

a) Sample of oil from the transformer shall be taken from the bottom of the tank.

b) Testing of Oil:

For dielectric test, the oil shall be tested as described in IS 335. The oil shall also be tested for acidity in accordance with the methods prescribed.

Drying out of the transformers, if required, shall be carried out and record maintained in accordance

with IS 10028. Normally a streamline filter shall be used for drying-up. I.R. value versus time of both windings shall be recorded during the drying-up process.

Precautions when drying

a) The maximum sustained temperature to which transformer oil may be subjected shall be limited to 80^0C.

b) The transformer shall be carefully monitored throughout the drying out process and all observations shall be carefully recorded.

c) Drying out shall be continued so that the insulation resistance as prescribed in the standard code of practice is attained and the value remains constant for more than 12 hours. However, a minimum number of cycles shall be done for each transformer as found necessary by the Purchaser. Generally a megger reading of 2 megohms / kV at 60^0 C temp with a 5kV Megger may be a rough indication for stopping the dehydration.

The following work on transformers shall be performed by the vendor if specifically called for:

a) Before finally commissioning the transformer it may sometimes be desired to run it for a few hours on short-circuit, applying a low voltage, approximately equal to the impedance voltage of the transformer. During this process, regular readings of the insulation resistance of the winding to earth and winding to winding and temperature against time shall be recorded.

b) Testing of radiator tubes for any leakage and rectifying these by welding / brazing.

Pre-commissioning Check List:

Before commissioning of any transformer, the following points shall be checked for safe energisation of the transformer:

a) That all the accessories have been fixed properly and transformer body and neutral are properly earthed. The transformer dehydration is over and results are satisfactory and approved by the Purchaser. In case transformers are idle for more than one month after dehydration, transformer oil has been given at least two circulations.

b) That the oil level, in the transformer conservator tank and all the bushings is upto the marked point and the oil has been tested for dielectric strength and acidity.

c) That the silicagel is in reactivated condition. The breather pipe is clear from any blocking and contains oil upto the proper level.

d) The explosion vent diaphragm does not have any dents. Accumulation of any oil and air had been released.

e) That the operation of off-load and on-load tap changers on all the tap positions is satisfactory. The mechanical parts of the on-load tap changer are lubricated. Motor IR value has taken and found satisfactory. Tap position mechanical indicator on the transformer and tap position indication meter on the control panel are reading the same tap positions. Tap changer limit switches are operating satisfactorily on the maximum and minimum tap positions. On-load tap changer contact pressure and resistance is as per manufacturers recommendations. Oil level of tap changer tank is upto the required level and oil has been tested for dielectric strength. The tap setting on which the off load tap switch is locked shall be

recorded. Generally the off-load tap switch shall be kept on nominaltap.

f) That the buchholz relay has been tested and checked up for any friction in the movement, and floats are free, all the other protective relays, alarm and annunciation relays have been tested.

g) That all the metering equipment have been tested and polarity test of P.T's and transformer winding is satisfactory. Phase sequence and connections have been checked for proper vector group.

h) That the ratio test and winding resistance on all the tap positions is satisfactory.

i) That gaps of arcing horns for the bushings where provided are in order and earth connections for the surge diverters have been checked

j) That the winding and oil temperature thermometer pockets contain oil and the winding and oil temperature settings on dial gauges are in order.

k) That the transformers fitted with fans for forced air cooling have been checked up for automatic starting and stopping of the fans and air-displacement has been verified (If applicable).

l) That the simulation tests for all external interface connection alarm, annunciation and trip circuits have been checked and are in order.

m) That the insulation resistance of all the control circuits and IR value of the transformer windings and all the incoming and outgoing cables have been checked.

n) That all the valves in the cooling system and valve between the buchholz relay and the conservator tanks are in open position.

o) That the setting of all the protective relays is at the desired value and D.C. Trip supply is healthy.

Observations after Commissioning

After switching on the transformer the following points shall be observed and recorded.

a) The inrush magnetizing current and no-load current.

b) Alarm, if any, or if any relay flag hasoperated.

c) Voltage and current on all the three phases.

d) Transformer hum or abnormal noise.

e) Circulation of oil and leakages.

f) Record current, voltage, cooling air temperature, winding temperature and oil temperature readings, hourly for 24 hours.

g) Cable end boxes, for any over-heating.

H.V. and M.V. Motors

All the motors generally would be erected by the mechanical contractor.

Contractor shall keep the motor space heater energized as per the directions of Purchaser. Contractor shall measure the insulation resistance of motor windings. Insulation resistance of the motors shall be measured between the winding of the machine and its frame by means of a 500 / 1000V Meggar

in case of 415V motors. A minimum value of 1 megohm for 415V motors shall be considered a safe value. In case of lower I.R. Value, the insulation value shall be improved by any of the following methods as directed by the Purchaser.

a) Blowing hot air from external source.

b) Putting the motor in oven:

c) Placing heaters or lamps around and inside after making suitable guarding and covering arrangements so as to conserve the heat.

In case the insulation is low, the following method of drying has to be adopted, after consultation with Purchaser. During drying the temperature rise of winding shall not exceed the permissible value for the class of insulation used:

a) By locking the motor so that it cannot rotate and then applying such a low voltage to the stator terminals so as to pass full load current in the stator keeping the stator winding temperature below 90° C . In this case a close watch shall be kept for any possible overheating and I.R. Values vs. temperature shall be plotted and heating continued till I.R. value becomes steady.

b) By blasting hot air from external source, Maximum temperature of winding while drying shall be 70° C to 80°C (thermometer) or 90° C to 95° C by resistance method. Heating shall be done slowly first till steady temperature of winding is reached after 4 to 5 hours, and for large machines after 10 hours. A record has to be kept for drying process, with half an hour readings and, till steady temperature is reached. In case it is essential, the drying process can be supplemented by blower.

It shall be ensured that the motor leads are correctly connected in the terminal box, as indicated in the 'Name Plate'. The covers of all terminal boxes shall be properly fixed, the gaskets intact. The control circuit shall be tested for proper functioning as per circuit diagram.

In case of synchronous machines, slip rings and brush gear shall be polished and brushes shall be fixed in their holders with clearance and pressure as recommended by the manufacturers.

Before commissioning, the ventilation and cooling system of the motor must be inspected. In case of motor with forced ventilation the air inlet shall be examined to ensure that it is free from moisture and any foreign material. It shall also be ensured that recommended flow and pressure of air is available to produce the required cooling effect.

The motor control gear shall also be carefully examined, the over-load settings may be reduced or time lags bypassed from protective gear to ensure rapid tripping of switchgear in event of faults. The direction of rotation of a new motor specially of large capacity, and phase sequence of supply shall be kept in view while joining and connecting to the motor terminals.

Finally the motor shall be started on no-load after decoupling, and shall be allowed to run for a minimum period of 4 hours, or for a time as instructed by Purchaser. Attention shall be given to the proper running of the bearings, vibration or unusual noises if any. Voltage, starting current, no load current, stator winding and bearing temperature shall be recorded after every 1 hour during this test. Direction of rotation shall be checked and recorded. Normally the motors run in clockwise direction as viewed from the driving end with reference to the phase sequence R, Y, B.

After switching off the motor, the insulation resistance of the motor shall be recorded under hot and

cold conditions.

If the no load test run is found satisfactory, the motor shall be allowed to run for 8 hours and all readings shall be recorded.

The following work on motors, may be performed by the contractor if specifically called for.

a) The proper level of bearing oil has to be checked. The condition of grease in bearings shall be checked and in case it is necessary, complete replacement of bearing with specified grade of grease after proper cleaning of the bearing shall have to be done. Wherever external greasing facility exists, the condition of grease may be checked by pumping some new grease of specified grade at start. If the grease coming out is deteriorated grease shall be replaced.

b) All the motors, motor exciter set and induction generators directly coupled or coupled through reduction gears shall be checked for abnormal vibration, if any Large rated HV motors with journal type bearings are liable to get damaged from shock, rough handling during transit. Any minor defect in a race or roller may give rise to considerable amount of vibration and noise. Contractor shall check and bring to the attention of Purchaser any defect noticed in this regard.

c) Due care shall be taken to avoid any damage to bearing insulation wherever provided.

Batteries

Battery (Lead acid, Nickel Cadmium or VRLA type as specified) shall be erected on stands and insulators supplied by the manufacturer of the batteries. The installation shall be done as per the layout drawings and manufacturer's instructions. Electrolyte if required / as applicable shall be filled as per manufacturer's instructions. Inter row connections shall be made with the leads supplied by the manufacturer.

Neutral Earthing Resistor

The neutral earthing resistor shall be inspected for any damage to the resistor grid and other components. The resistor shall be levelled and installed. All covers etc. shall be checked for tightness to ensure that the enclosure of the resistor is dust, vermin and weatherproof. Earthing conductors shall be taken from the out end terminal of the resistor, for connection to earth electrodes and to the main grid.

Welding Receptacles

The welding receptacles shall be erected on steel/concrete structures as per the drawings. In isolated places a separate support shall be fabricated and installed.

Push Button/Control Stations

The push buttons / control stations shall be installed near to the motors to be controlled. Individual channel supports shall be installed as per standard. If control stations for hazardous areas are to be supplied by contractor, these shall be of Ex (d) type, tested by CMRI and approved by CCE or other applicable certifying authorities. All outdoor push buttons / control stations shall preferably have integral canopies for additional weather protection. The canopy shall be made of 2 mm thick galvanized sheet steel or FRP where these are not integral with the equipment.

Gang operated Isolators/outdoor Disconnectors

The isolators shall be transported to site in the dismantled condition. All the insulators may be also supplied loose. The contractor shall inspect, clean, assemble and install the isolator on the base structure previously fabricated, erected and levelled by him. The operating mechanism shall be installed on the structure and connected to the isolator poles. The operating mechanism shall be tested by slowly bringing the isolator to the closed position and carrying out the necessary adjustment as per the manufacturer's instructions. The earthing switches, frames and operating handle etc. shall be earthed.

Miscellaneous Items

Contractor shall provide the following items in substation, as per Indian Electricity Rules

Fire buckets filled with clean dry sand and ready for immediate use for extinguishing fires and fire extinguisher (carbon dioxide, dry chemical extinguisher etc.) suitable for dealing with electric fires shall be conspicuously marked and kept.

First aid boxes containing ointments and medicines for immediate treatment of injuries (As prescribed by Indian Red Cross Society or equivalent).

Instructions of restoration of persons suffering from electric shock in English, Hindi and local language of the district shall be affixed in a conspicuous place.

Danger boards (H.V., M.V.) shall be provided on transformer gate, switchboards, entrance to switchgear room and at other places as required by Purchaser.

Generators

Contractor shall install main, emergency or standby generators with their gas turbine or diesel engine drivers, and equipment associated with these 'packages', in locations as shown on the AFC contract drawings and in accordance with manufacturer's instructions. Contractor shall install and terminate interconnecting cables in accordance with equipment vendor's drawings and contract drawings.

Contractor shall check the installation and correctness of the various protection devices fitted to medium voltage machines. Anti-condensation heaters where fitted shall be connected up to a temporary supply and left energized as soon as equipment is delivered.

CABLE INSTALLATION

General

Cable installation shall include power, control and lighting cables. These shall be laid in trenches/cable trays as detailed in the power layout drawings. Cable routing given on the power layout drawings shall be checked in the field so as to avoid interference with other services such piping, instrumentation, civil, structural, mechanical etc. Any change in routing shall be done to suit the field conditions suitably interfacing with other services wherever deemed necessary, after obtaining approval of Purchaser.

High voltage, medium voltage power and control cables shall be separated from each other by adequate spacing or by running through independent pipes, trenches or cables trays, as shown on power layout drawings/installation details. Details of cable routes and cable spacings not shown in detail drawing shall be determined by the Contractor and approved by the Purchaser.

High voltage, medium voltage power and control cables shall be separated from each other by adequate spacing or by running through independent pipes, trenches or cable trays, as shown on layout drawings/installation standards. Details of cable routes and cable spacings not shown in detail on these drawing shall be determined by the Contractor and approved by the Purchaser.

When single core cables are laid in flat formation, the individual cable fixing clamps and spacers shall be of non-magnetic material. As a general practice, the sheath of single core cables shall be earthed at one point to keep sheath at earth potential unless otherwise stated. Single core cables, when laid in trefoil formation shall be braced by suitable clamps at a distance, not exceeding 3 meters along the cable routing.

If straight through joints are required to be provided on single core cables, amour shall be broken at joints as per Supplier's recommendations. For single core cables, armour shall be earthed at one end for the cable run length as per Supplier's recommendation.

Minimum spacing of 300 mm between power, control cables and Telephone, Communication, Fire alarm cables shall be maintained.
The lengths indicated in the cables schedule are only approximate. The Contractor shall ascertain the exact length of cable for a particular feeder by measuring at site. All cable routes shall be carefully measured. Before the start of cable laying, the Contractor shall prepare cable drum schedule and get that approved by Purchaser to minimize/avoid.

straight though joints and then the cables cut to the required lengths, leaving sufficient lengths for the terminations of the cable at both ends. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. Extra loop length shall be given for feeder cables where required as per the directions of Purchaser to meet contingencies.

Cables shall be laid in directly buried trench or in RCC trench (underground trench) or in cable tray along pipe sleepers or in over head trays as shown on power layout drawings.

Overhead trays shall be installed 2700 mm (minimum) above grade level. At road crossings overhead trays shall be installed at 7000 mm (minimum) above level or cables shall be routed cable tray culvert/Electrical road crossings as per power layout drawings.

Sufficient care shall be taken while laying cables to avoid formation of twist, sharp bend etc. in order to avoid mechanical injuries to cables. Rollers shall be used for pulling of cables.

Cable installation shall provide minimum cable bending radii as recommended by cable Supplier.

Cables shall be neatly arranged in the trenches/trays in such a manner that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be in line with power layout drawings. Cable routing between cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 45 to the trench wall. Bending radii of pipes shall not be less than 8D. It is to be ensured that both the ends of GI pipe sleeves shall be sealed with approved whether proof sealing plastic compound after cabling. In places where it is not possible, cables shall be laid in smaller branch trenches.

All cables shall be identified close to their termination point by cable tag numbers as per cable

schedule. Cable tag numbers shall be punched on aluminium straps (2mm thick, 20 mm wide and of enough length) securely fastened to the cable and wrapped around it.

Each underground cable shall be provided with cable tags of lead securely fastened every 30 m of its underground length with at least one tag at each end before the cable enters/leaves the ground. In unpaved areas, cable trenches shall be identified by means of cable markers as per installation drawing. These cable markers shall be placed at location of changes in the direction of cables and at intervals of not more than 20 m and also at cable straight through joint locations.

All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of cables shall be taped with an approved PVC end cap or rubber insulating tape.

Each row of cables shall be laid in place and before covering with sand. All wall opening/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building /lined trench. Every cable shall be given an insulation test in presence of Purchaser before filling the cable trench with sand. Any cable which is found defective shall be replaced.

Where cables pass through foundation walls, the necessary openings shall be provided in advance for the same by another agency. However, should it become necessary to cut holes in existing structures for example floor slab etc., the Contractor shall determine their location and obtain approval of the Purchaser before carrying out the same.

Cables for road crossings shall be taken through ERC (Electrical Road Crossing) as shown in the power layout drawings.

At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.

Wherever cable trench crosses storm water, waste water channel/drain, cables shall be taken through PVC/RCC pipes. Where cables are required to cross drains of depth more than 1200 mm, cables shall be taken over the drain on cable trays supported suitably using ISMC 150/200 sections.

Ends of cables leaving trench shall be coiled & capped and provided with protective cover till such time the final termination to the equipment is completed.

Cables laid direct in ground

Cables shall be laid underground in excavated cable trenches where specified in cable layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables. Cables shall be properly spaced and arranged with a view of heat dissipation and economy of design. Maximum number of cable layers in trench shall be preferably limited to 5 layers.

Minimum depth of cable trench shall be 750 mm for medium voltage and 900 mm for H.V. Cables. The depth and the width of the trench shall vary depending upon the number of layers of cables

Cables shall be laid in buried trenches at depth as shown in the power layout drawings. It is to be insured by the Contractor that the bottom of buried trenches shall be cleared of all rocks, stones and sharp objects before cables are placed. The trench bottom shall be filled with a layer of sand. This sand shall be levelled and cables laid over it. These cables shall be covered with 150 mm of sand on top of the largest diameter cable and sand shall be lightly compacted. A flat protective covering of 75

mm thick second class red bricks shall than be laid and the reminder of the trench shall then be back – filled with soil, rammed and levelled.

Cables laid in concrete trench

Cables shall be laid in 3 or 4 tiers in concrete trench as shown on power layout drawings. Concrete cables trenches shall be filled with sand in hazardous area to avoid accumulation of hazardous gases and oil. RCC covers of trenches shall be effectively sealed to avoid ingress of chemical and oil in process area. Removal of concrete covers where required for the purpose of cable laying and reinstating them in their proper position after cables are laid shall be done by Contractor.

All wall opening /pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water.

Above ground cables

a) Cables installed above grade shall be run in cable trays, clamped on walls, ceiling or structures and shall be run parallel or at right angles to beams, walls or columns. Cable routing shall be planned to be away from heat sources such as hot piping, gas, water, oil drainage piping, air- conditioning duct etc. Each cable tray shall contain only one layer of cables as far as possible for power cables. However control cables may be laid in double layer in the cable trays.

b) Individual cable or small group of cables (upto 3 to 4 cables) which run along structures/walls etc. shall be clamped by means of 16 SWG GI saddles on 25 x 6 mm saddle bars. Alternatively small group of cables can be taken through 100/150 mm slotted channel tray/ISMC 100.

Cables shall be supported so as to prevent sagging. In general, distance between supports shall be approximately 300 mm for cables upto 25 diameters and maximum 450 mm for cables larger than 25 mm dia. To prevent the sagging of cables.

c) Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable trays shall be suitably clamped by means of G.I. saddles/clams, whereas cables in horizontal run of cable trays shall be tied by means of nylon cords. Distance between supporting angles shall not exceed 600 mm.

d) All cable trays (other than galvanized trays) and supporting steel structures shall be painted before laying of cables. The under surfaces shall be properly degreased, derusted, descaled and cleaned. The painting shall be done with one coat of redoxide zinc chromate primer. Final painting shall be done with two coats of approved bituminous aluminum paint unless otherwise specified.

e) Where cables rise from trench to motor, lighting panel, control station, junction box etc., they shall be taken in GI pipe for mechanical protection upto a minimum of 300 mm above grade. Cable ends shall be carefully pulled through conduit to prevent damage to cable.

f) All G.I. Pipes shall be laid as per layout drawings and site conditions. Before fabrication of various profiles of pipes by hydraulically operated bending machine (which is to be arranged by the Contractor) all the burrs from the pipes shall be removed. GI Pipes having bends shall be buried in soil/concrete in such a way that the bend shall be totally concealed. For G.I. pipes buried in soil, bitumen coating shall be applied on the buried lengths. Installation of G.I. pipes shall be undertaken

well before paving is completed and necessary co ordination with paving agency shall be the responsibility of Contractor.

Following guide shall be used for sizing of G.I. pipe.

i) 1 cable in a pipe - 53 % of pipe cross-sectional area occupied by cables.

ii) 2 cables in a pipe - 31 % of pipe cross-sectional area occupied by cables.

iii) 3 cables in a pipe - 43 % of pipe cross-sectional area occupied by cables.

iv) 4 and above cables in a pipe - 40 % of pipe cross-sectional area occupied by cables.

After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound / bitumen / suitable sealing compound. Alternatively rubber bushes shall be employed for the purpose of sealing

Terminations

a) All HV and MV cables shall be terminated at the equipment by means of single/double compression type cables glands as specified suitable for the cable size. They shall have a screwed nipple with conduit electrical threads and check nut. The cables shall be identified close to their termination points at both the ends of cable (cable numbers shall be punched on aluminium strips 2mm thick and securely fastened to the cables wrapped around it) and also along the route at recommended intervals, by cable tag numbers.

All cable entries for outdoor termination shall be preferably through bottom. Outdoor cable termination through top of equipment shall not be permitted.

b) Power cables cores wherever colour coding is not available shall be identified with red, yellow and blue PVC tapes. Where copper to aluminum connections are made, necessary bimetallic washers shall be used.

c) In case of control cables, all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules suitable for core size. Wire numbers shall be as per schematic/wiring/inter-connection diagram. All unused spare cores of control, cables shall be neatly bunched and ferruled with cable tag at both ends, for future use.

For trip circuit identification additional red ferules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.

d) Contractor shall drill holes for fixing glands wherever necessary. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables. All unused cable entries on equipment/panels shall be plugged/sealed.

e) The cable shall be terminated at electrical equipment /switchboards through glands of proper size. The individual cores shall then be dressed and taken along the cables ways or shall be fixed to the panels with polyethylene straps. The cable glanding shall be done as per Supplier's instructions. Cable armour shall not be exposed after termination is complete. In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom close fit holes shall be drilled in the gland plate for all the cables in one line, and then gland plate shall be split in two parts along

the centre line of holes. After fixing bottom plate, uncovered cable holes/gaps shall be sealed with cold setting compound.

f) Crimping of lugs to cable leads shall be done by hand crimping/hydraulically operated tool as per requirement. Insulation of the leads shall be removed before crimping. Conductor surface shall be cleaned and shall not be left open. Suitable conducting jelly shall be applied on the conductor lead. Lugs shall enclose all strands of cable core. Cutting of stands shall not be allowed.

g) HV cables shall be terminated with heat shrinkable termination kits, indoor or outdoor type as specified by approved HV cable jointers. Supplier's instructions shall be followed for applying heat shrinkable termination kits.

h) The Contractor shall bring to the notice of Purchaser any mismatch in cable glands, lugs provided with the equipment vis-à-vis to the cable size indicated in cable schedule for taking corrective action.

i) The cable joints in power and control cables shall be avoided as far as possible. In case a joint is unavoidable, the following shall be insured:

i) The number of joints shall be restricted to minimum as far as possible.

ii) The location of joints shall be identified with permanents markers.

iii) No joints shall be allowed in hazardous areas without the approval of Purchaser.

iv) No joints will be allowed in the Cable seller.

The jointing and termination of medium voltage power cables shall be carried out by trained personnel only. Jointing and termination of high voltage cables shall be done by skilled and experienced jointer duly approved by Purchaser. Only type tested termination kits of approved make shall be used.

j) No unauthorized repairs, modifications shall be carried out on the hazardous area equipment terminal boxes and junction boxes. Damaged enclosures of hazardous area equipment shall be brought to the notice of Purchaser by Contractor. After termination is complete, all the bolts, nuts, hard wares of terminal box shall be properly placed in its position and tightened.

k) Where required, cable sealing boxes intended to be used with the apparatus shall be filled with solid setting type bituminous compound unless otherwise specified.

LIGHTING INSTALLATION

General

The lighting fixtures in the plant shall be fed from lighting and small power distribution board. All outdoor lighting shall be group controlled manually or through photoelectric synchronous timer. Lighting wiring between distribution boards and lighting fixtures shall be done with 3-core (phase, neutral and earth) Cu/XLPE/SWA/PVC cable for plant areas and substation building. Wiring in the other building shall be done by means of 3-core Cu/PVC cables, or PVC insulated copper conductor wires in conduit/Metsec channel as specified. All joints of conductors in Switch boards/JBs Fittings

shall be made only by means of approved mechanical connectors (nylon/PVC connectors). Bare twisted joints shall not be permitted any where in the wiring system.

The lighting and small power layouts furnished by Purchaser will indicate approximate locations of lighting fixtures. The Contractor shall determine, with approval of Purchaser, the exact locations of each fixture in order to avoid interference with other services such as piping, instrumentation, civil, structural, mechanical etc and also with a view to obtain as much uniform illumination as practicable, and to avoid objectionable shadows. Conduits shall be laid out by the Contractor to suit field conditions suitably interfacing with other services and as per directions of the Purchaser.

On walkways, platforms and other outdoor area, lighting fixtures shall be located nearer to landing of stairs or ladders, gauges, flowmeters, panel boards and other equipment to provide proper illumination.

The minimum height of any lighting fixture shall be preferably not less than 2.5 meters above the floor level.

All outdoor cable terminations to outdoor junction boxes, panels, socket outlets etc. shall be through bottom or from side. Top entries for cables shall be avoided to avoid water entry. All cable glands for outdoor terminations shall be double compression type and the gland shall be covered with PVC or rubber boot shroud. All unused cable entries shall be plugged with suitable blanking plugs.

Mounting height of equipment shall be as under :-

Top of Switch Box : 1200 mm from FFL (Finished floor level)

Bottom of Lighting/Power Panel : 1500mm from FFL

5/15 Amp. Receptacle : 300mm from FFL unless otherwise specified

(1200 mm for process areas and industrial sheds)

Lighting fixture : As indicated in layout drawing

Exhaust fan : In the cutout provided / as indicated in Layout drawings.

Fixtures shall be firmly supported from the structures. Support clamps etc. may be bolted or welded to the existing steel work or metal inserts. In case of concrete structures, where metal inserts are not available, fixtures shall be suspended from concrete surfaces with the help of anchor fasteners. In such cases special care shall be taken to see that anchoring is firm. In places where ceiling fans are provided, lighting fixtures shall be suspended below the level of fan to avoid shadow effect.

Circuit cables in a group shall be cleated to structure by using galvanised strip clamps or cable run in cable trays wherever trays are available. Spacers and cleats shall be of required size to accommodate the cables. All hardware shall be galvanised. Underground lighting cables (in paved areas) shall be taken in suitable G.I. sleeves buried at a minimum depth of 300 mm from FFL. GI pipe sleeves shall be extended to 300 mm above FFL. Exact termination/layout of G.I. pipes (for protection of cables) shall be decided at site as per site convenience in consultation with Purchaser.

Wiring for all outlet sockets shall be done with 3 cores of equal sizes for phase, neutral and earth. The

terminals of switch sockets shall be suitable to receive the size of wire specified.

All lighting fixtures shall be provided with terminal block with required terminals suitable for connection of wire up to 2.5 sq. mm copper conductor.

The cable shall be straightened after unwinding it from the drum. All cables be clamped/laid in straight run without any sag and kink.

For location where fan points are shown, fan hooks with junction box shall be provided during concreting. Where fan hooks and J.Bs. are provided separately JB shall be located within a distance of 300mm from hook for mounting of ceiling rose.

Industrial type plug sockets with 20A switch or rating as specified shall be provided at a height of 500mm from FFL for window AC units. Socket outlets and plugs for installation in MCC room, DG room, etc. shall be of industrial metal clad type.

Wiring for exhaust fans shall be terminated in receptacles as specified in layout drawing and the connection from receptacle to the exhaust fan shall be by means of a flexible cord equivalent in size to the main run of wires. Switch for exhaust fan shall be located in a separate switch board along with other switches

Conduit System

Surface or concealed conduit system of wiring shall be adopted, as specified in the drawings. Required number of pull boxes shall be used at intervals to facilitate easy drawing of wires. Separate conduit shall be run for lighting and power circuits. Further, conduits for Normal lighting/Emergency lighting/DC critical lighting shall be separate. Conduit layout shall be decided at site as per site conditions. Drop conduits for switch boards shall be decided by Contractor as per wall locations shown in Architectural drawings. All exposed run of conduits on surface, shall be vertical or horizontal.

Only threaded type conduit fittings shall be used for metallic conduit system. Pin grip type or clamp type fittings are not acceptable. Conduit ends shall be free from sharp edges or burrs. The ends of all conduits shall be reamed and neatly bushed.

Conduit shall be of minimum 25mm dia. Maximum number of wires permissible in a conduit shall be seven for wire size of 2.5 sq mm.

The exposed outer surface of the conduit pipes, including all accessories forming part of the conduit system, shall be adequately protected against rusting. In all cases, bare threaded portion of conduit pipe shall not be exposed unless such bare threaded portion is treated with anti corrosive preservative or covered with approved plastic compound.

Conduit connection to outlet boxes shall be by means of screwed hubs or check nuts on either side. Where concealed wiring is done, junction boxes (65mm deep) shall be used so as to rest on shuttering properly. All conduit connections shall be properly screwed and Junction box covers shall be properly fitted so as to avoid entry of concrete slurry.

Where concealed wiring is to be adopted, conduits shall be laid in time before concreting of the slab. Pull wire (GI or steel) shall be provided inside conduit for the ease of wire pulling. The Contractor shall coordinate his work with other agencies involved in the civil works in such a way, that the work of the

other agencies is not hampered or delayed. Vertical conduit runs shall be made in wall before plastering is done so as to avoid chasing. Where chases are made for conduit run Contractor shall fill these chases or any other openings made by them after completing the work and patch the surface. During installation, care shall be taken to see that proper covers are provided to prevent rusting of conduits. Locations of all point outlets, junction boxes shall be marked with brick powder or sand so that these are easily identified after shuttering removal. As built conduit layout drawing shall be submitted by Contractor after completion of the work.

All junction boxes, bends and other accessories shall be of the same material as that of conduit and shall have the same protective coatings.

After erection, the entire conduit system shall be tested, for mechanical and electrical continuity and shall be permanently connected to earth by means of approved type of earthing clamps.

Hazardous Area Installation

Wiring in hazardous area shall be done by using minimum 2.5mm^2 copper conductor armoured cable. Circuit wiring feeding hazardous areas shall be controlled by two pole switches/MCBs (for phase as well as neutral isolation).

Correct type of lighting equipment (fixtures and JBs) with regard to hazardous protection as specified in the drawing shall be installed for the areas classified as Zone 1, Zone 2 etc.

The terminations in the junction boxes and the lighting fittings shall be done avoiding possibility of loose connections due to vibrations. After the terminations are made the cover of the junction boxes and the lighting fittings shall be closed properly with all bolts and hard wares in correct position, retaining its explosion and weather protections. In fixtures having double cable entries, both the entries shall be used for looping in and looping out connection, thus minimising the use of a separate junction box. Wherever separate control gear boxes (C.G. box) are provided looping in and looping out connections shall be through CG box, thus avoiding the use of a additional junction box. All unused cable entries shall be sealed with suitable plugs.

Circuit cables shall be firmly cleated in a group along columns/ beam/ladders/side channels/platform using 1.6mm thick GI saddles on 25x3 mm GI saddle bar at intervals of 400mm to 500mm for straight run and on either side close to bending and at both termination ends as per the directions of Purchaser. Where required, 3 or more of cables may be taken in slotted channel tray after obtaining approval of the Purchaser. Cables shall not be routed along hand rails.

Where fire proofing column/structures are encountered, all cabling shall be taken in GI pipes of required size and both ends shall be sealed, well before fire proofing is done. Similarly equipment such as lighting fixture, control gear box, lighting/ power panels, field call stations, junction boxes etc. shall be installed on suitable steel mounting frame/distance bracket, thereby avoiding direct contact with the concrete used for fire proofing.

Cable glands for terminating cable on flameproof equipment shall be of double compression FLP type. Any material/equipment specified to be supplied by Contractor for installation in hazardous areas, shall be tested by CMRI and duly approved by PESO Nagpur or DGMS Dhanbad or any other applicable statutory authority. All indigenous FLP equipment shall also have valid BIS license as required by statutory authorities.

High Mast Lighting

The high masts shall be installed on concrete foundations with the base plate bolted on to the anchor bolts. The high mast shall be painted with a coat of primer and two coats of aluminium paint, the second coat to be given just before handing over to the Purchaser. The high masts shall be numbered as per drawings. The high masts shall be connected to the plant earth grid at two points.

Exact orientation of flood lighting fixtures shall be decided at site to achieve optimum utility of these fixtures.

EARTHING INSTALLATION

This consist of main earth conductor (grid conductor) forming a closed ring network with required number of earth electrodes connected to it to provide a common earth for electrical device and metallic structures. From each earth electrode two distinct connections shall be made of the main earth conductor. The earth plates shall be used for taking multiple earth connections to two or more equipment.
The earth conductors shall be laid in ground, along cable trays / cable trench / pipe rack etc as indicated on the earthing layout drawings. The location shown on the earthing layout drawings are indicative. The exact location of earth conductors in the filed shall be determined by Contractor in consultation with the Purchaser. Earth conductors shall be located avoiding interferences with other services such as piping, instrumentation, civil,structural, mechanical etc.

Where lined cable trenches are available, the earth conductor shall be laid in the trenches and shall be firmly cleated to the sidewall of concrete trenches using GI clamps at interval of 400 mm to 500 mm and near to the termination end. The earthing conductor shall run along one of the cable trays along a cable route. The earthing conductor shall be suitably cleated and electrically bonded to all the other cable trays on the same cable route at regular interval of 25 to 30 metre. The earthing for equipment shall be tapped from the main earth conductor and not from cable tray support structure. Earth conductor when laid underground shall be at a depth of 600mm below finished grade level.

Joints and tapping in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and shall be suitably protected by giving two coats of bitumen and covering with Hessian tape. Earth strip laid above ground shall be welded across straight through joints and joints shall be suitably protected by giving two coats of bitumen to avoid oxidation and insulation film formation of the strip surface. When two earth strips are to be jointed by means of welding, lap welding with an overlapping of strip equivalent to double the width of the strip and all four sides shall be continuously welded. All joints at tappings above ground shall be means of connector/ lugs. A minimum of two bolts of adequate size shall be used for this purpose. Earthing strip joints at earth plate and equipment shall be through GI bolts, nut etc.

Installation of Earth Electrodes

Earth electrodes shall be installed as shown on earthing layout drawings and installation details. The location shown on the earthing layout drawings are indicative. The exact location of earth electrodes in the filed shall be determined by Contractor in consultation with the Purchaser, depending on the

soil strata and resistivity. Earth electrodes shall be located avoiding interferences with other services such as road, building foundation, column, pipelines etc. The civil area drawings shall be referred for this. The distance between two earth electrodes shall not be less than twice the depth of electrode.

Earth electrodes shall preferably be located in a moist soil which has a fine texture, grain size and distribution. Wherever practicable the soil be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes and soil packed by watering and ramming as tight as possible.

The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.

All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months, preferably after a protracted dry spell.

The disconnect facility shall be provided for the individual earth electrode to check its earth resistance periodically.

Location of earth electrodes shall be marked by permanent markers for easy identification. All earth Electrodes shall be serial numbered and also marked on 'As Built' drawing for future reference.

Individual earth electrodes shall be provided for each lighting arrestor and flood light mast.

Earthing system provided for concrete paved area by other agency where applicable; shall be connected to the plant earthing system below ground by minimum two earth connections.

Connection

The earth system connections shall generally cover the following:

- Equipment earthing for personnel safety
- System neutral earthing
- Static and lighting protection

The following shall be earthed.

- System neutral
- Current and potential transformer secondary neutral
- Metallic non-current carrying parts of all electrical apparatus such as transformers, switchboards, bus duct, motors, neutral earthing resistors, capacitors, UPS , battery charger panels, welding receptacles, power sockets, lighting / power panels, control stations, lighting fixtures etc.
- Steel structures/ columns, rail loadings platforms etc.
- Cable trays and racks, lighting mast and poles.
- Storage tanks, spheres, vessels, columns and all other process equipment.
- Fance and gate for electrical equipment (e.g. transformer, yard etc.)
- Cable shields and armour
- Flexible earth provision for Wagon, Truck
- Shield wire

Conductor size for branch connection to various equipment shall be as per Installation details unless otherwise stated on earthing layout drawings.

All process pipelines shall be bonded and earthed at the entry and exist points of battery limit of hazardous area. Earth continuity conductors across pipe flanges shall not be provided as per OISD 110.

Steel pipe racks in the process units and offsite area shall be earthed at every 24 metres.

Equipment / street light pole etc. located remote from main network may be earthed by means of individual earth electrode and earth conductor unless otherwise stated in specifications.

The main earthing network shall be used for earthing of equipment to protect against static electricity.

All medium and high voltage equipment (above 250V) shall be earthed by two separate and distinct connections with earth.

Plant instrument system clean earthing, UPS system clean / safety earth shall be separate from the electrical earthing system.

All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.

All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground wherever provided. Equipment foundation bolts shall not be used for earthing connection.

Earth connections shall be made through compression type cable welded lugs.

All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections and all connections adequately locked against loosening.

Lighting fixtures and receptacles shall be earthed through the extra core provided in the lighting circuit/ cable for this purpose.

The reinforcement of sub-station building and the sub-station floor shall be connected to main earth grid.

LIGHTNING PROTECTION INSTALLATION

Lightning protection shall be provided for the equipment, structure and buildings as shown on lightning protection layout drawings. Self conducting structures shall not require separate aerial rod and down conductors. These shall however be connected to the earthing system at two or more points as shown on earthing layout drawing. An independent earthing network shall be provided for lightning protection and this shall be bonded at least at two points with the main earthing network below ground. Lightning down conductor shall be brought to earth electrode in shortest straight path as feasible to minimize surge impedance. Aerial and down conductors shall be located avoiding interferences with other services such as ducts, pipes, equipment, supports etc.

3.0 LIST OF CONSTRUCTION EQUIPMENT

The contractor shall have all necessary construction equipment, tools and tackles and testing instruments to carry out the erection works and to commission the system as specified. These shall include but not be limited to the following, and these shall be brought to site by contractor before the start of work.

Equipment

1. Portable grinder.
2. Portable welding machine.
3. Portable gas cutting / welding set.
4. Pipe threading machine.
5. Pipe bending machine (hydraulic).
6. Portable drill machine suitable to take up drilling for different sizes as per requirement.
7. Dewatering pump sets (diesel driven).
8. Power Hacksaw.
9. Conduit Dyset.
10. Hydraulic crimping Machine
11. Hand crimping tool.
12. Portable electric blowers, vacuum cleaners.
13. Miscellaneous items such as slings, pulleys, tarpaulins, wooden sleepers, ladders, etc. as required.
14. Safety belts, safety goggles, and gloves.
15. Separate tool kit for each Electrician.

Test Instruments

1. Insulation tester 1000V hand driven.
2. Insulation tester 2500V motor/hand driven.
3. Insulation tester 5000V motor/hand driven
4. Phase sequence indicator.
5. Earth Resistance tester.
6. Single phase variac
7. 3 phases variac of adequate capacity.
8. Secondary injection testing kit (By Vendor).
9. Multimeter both analogue and digital
10. Portable Ammeters, Wattmeters, P.F. meters.
11. Portable Voltmeters.

12. Clip on meters of different ranges.
13. Tacho-meter.
14. Kelvins double bridge for measurement of very low resistance.
15. D.C. high -pot test kit.
16. Oil filtration machine of adequate capacity.
17. LUX METER to measure illumination levels.

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SPECIFICATION

FOR

HV & LV CABLES

SPECIFICATION NO. - MEC/TS/05/E9/24

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

CONTENTS

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 SCOPE

a. This specification is intended to detail the selection criteria of HV power & LV Power and control cables besides covering general requirements, testing at manufacturer's works, packing, transportation and receipt at site.

b. **Tenderer to refer separate Technical specification (TS) / SOR item details for**

following minimum details / re uirements as part of the pro ect needs

1. **Voltage grade, Conductor material, type of insulation and si e of cables.**

2. **Schedule of uantities of cables**

Any other item / component / e uipment / accessories / services as necessary for satisfactory completion of the pro ect shall also be covered in separate Technical specification (TS) / SOR item.

2.0 CODES STANDARDS

The work shall be carried out in the best workman like manner in conformity with this specification, the relevant specifications, codes of practice of Indian Standards Institution, approved drawings and instructions of Engineer-in-Charge or his authorized representative issued from time to time. In case of any conflict between the standards, the instruction of Engineer-in-Charge shall be binding.

The cables shall comply in design, material, testing and performance to the following codes and standards. The latest revision of the publication referred to shall apply.

IS-1554	PVC insulated (heavy duty) electric cables.
IS-3961	Recommended current ratings for cables; PVC insulated and PVC sheathed heavy duty cables.
IS-3975	Mild steel wires, straps and tapes for armouring of cables.
IS-5831	PVC insulation and sheath of electric cables.
IS-7098	Cross-linked poly ethylene XLPE insulated PVC sheathed cables.
IS-8130	Conductors for insulated electric cables and flexible cords.
IS-10418	Drum for electric cables.
IS- 10810	Method of test for cables
IS-13573	Joints and terminations for polymeric cables for working voltages from 6.6 KV & including 33KV; performance requirements & type tests.

The cables and accessories shall conform to the provisions of Indian Electricity Rules and other statutory regulations as applicable.

2.1 Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.2 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 ENVIRONMENTAL CONDITIONS

The cables shall be designed and calculated for continuous operation at full load under the climatic and environmental conditions as described in the "Design Requirements and Cable technical specifications".

4.0 DESIGN REQUIREMENTS

The cross section of all power cables shall be determined in accordance with the current demand of the linked power consumer, the maximum permissible voltage drop, the operating temperature, thermal short-circuit capacity, maximum cable loop impedance for earth faults and laying conditions.

Cable cross-sections shall be determined using the manufacturer's published data and the respective reduction factors according to installation conditions. The current-carrying capacities of power cables shall be calculated according to the type of operation, the conditions of installation and the ambient condition. The factors/parameters influencing cable sizing/ selection are as follows:

- Above ground or underground
- Installation / arrangement - e.g. for underground cables, is it directly buried or buried in conduit? For above ground cables, is it installed on cable tray / ladder, against a wall, in air, etc.
- Ambient or soil temperature of the installation site
- Cable bunching, i.e. the number of cables that are bunched together
- Cable spacing, i.e. whether cables are installed touching or spaced
- Soil thermal resistivity (for underground cables)
- Depth of laying (for underground cables)

Following points shall be taken into consideration during selection of cables:

- All LT power cables shall be 3.5 / 4 cores XLPE/PVC.
- Minimum size of the cables used in LT power feeders shall be 6 sq.mm for aluminium conductor and 4 sq.mm for copper conductor.
- Maximum cable size shall be 240 sq.mm for incomers to MCCs, PCCs etc.
- The minimum cable size selected for applications in the power circuits of cranes and other moving mechanisms shall be 6sq.mm with copper conductor.
- Flexible copper cables shall be used for power supply to vibrating mechanisms,

- For hoists, cranes, conveyors etc. shall be provided with flexible / festoon cable system, through butyl rubber / EPR insulated PCP/CSP sheathed flexible cables.
- Cables used for circuits of tacho generators, brakes, solenoids, field windings and secondary windings of measuring transformers shall be copper conductor with cross-sectional area not less than 2.5sq.mm.
- For control circuits, PVC insulated and PVC sheathed multicore cables with copper conductors having a minimum cross-sectional area of 2.5sq.mm shall be used. The number of cores may be standardized as 3, 5, 7, 10, 14, 19, and 24.
- Special screened/shielded cables shall be used for mA and mV signals.
- 20% spare cores shall be provided with minimum 1 spare core in multi-core control and signal cables
- For calculating the current rating of LT power cables de-rating factor of 0.65 shall be considered.

HT Cable si es for LT sub-station transformers

- The cable size shall be calculated based on the short circuit calculation considering breaker opening time of 0.25 seconds

Cable for Incomer of MCC / PDB / MLDB

- Cable size for incomer of MCC & PDB shall be selected on the basis of current rating corresponding to MD and voltage drop.
- Cable size for incomer of MLDB shall be selected on the basis of current rating corresponding to lighting transformer and voltage drop.

Cables for LT HT Motors

- Cable size for LT motors shall be selected on the basis of rated nameplate current and starting & running voltage drop as per specification.
- Cable size for HT motors shall be selected on the basis of rated nameplate current, starting & running voltage drop as per specification and short circuit capacity of the system. The cable size shall be calculated based on the breaker opening time of 0.25 seconds.

Cables for Illumination System

- The minimum size of the cable for feeding power to SLDB or MCBDB having 32A incomer shall be 4x25sq.mm
- Cable size for SLDB (or MCBDB) to light fittings shall be 3x2.5sq.mm. or 4x2.5sq.mm as per the configuration of fittings.
- In case of concealed wiring, single core, PVC insulated, stranded copper conductor wire of size 2.5 sq mm in MS conduit shall be used. For utility sockets, cable size shall be 4sq.mm.

Cables for Automation System

- All Cables connecting I/Os from field to PLC or remote I/O panel shall be of stranded copper conductor of type YRY as per IS: 1554 and of size 2.5/1.5 sq.mm.

- Communication bus shall be laid in GI pipe. The route for redundant communication bus shall be different.

5.0 CABLES SPECIFICATION

5.1 HT Power Cables for Voltage up to 33kV.

Sl.No.	Parameter	Description
1.0	Voltage Grade	33 kV (UE)/ 11 kV (UE)/ 6.6 kV (UE) / 3.3 kV (UE) as applicable
2.0	Duty type	Heavy duty
3.0	No. of cores	3 cores
4.0	Reference standard	IS:8130 – 1984 IS:5831 – 1984 IS:3975 -1988 IS:1554, part - 1, 1988 IS:3961 (Part-II) - 1967. IS:7098 Part-I & II IEC-60502
5.0	Conductor type	Compact circular stranded (rm/V) aluminum conductor, with extruded conductor shielding of semi conducting material. Conductor construction as per IS 8130-1984.
6.0	Insulation type	XLPE insulated, with insulation shielding over individual cores, consisting of extruded semi conducting compound , followed by lapped semi conducting material and copper tape (non magnetic) metallic screen , cores stranded together with a holding tape provided with a common covering of extruded inner sheath of type ST2 compound . The cable shall conform to IS:7098(Part-2)-1985.
7.0	Armour	Galvanized steel wire armoured. For multi core cables, armouring shall be applied over the inner sheath of flat steel wires (strips) . Round steel wire armouring can also be offered. For single core armoured cables non-magnetic armour consisting of hard drawn flat or round aluminium wires shall be provided.
8.0	Outer sheath	PVC outer sheathed of type ST2 compound. Black in colour. Suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack.
9.0	Miscellaneous	Copper screen shall be suitable to carry 1 KA E/F current for one second.
10.0	Temp. rise on continuous load	90 deg.C

11.0	Oxygen index of outer sheath material for XLPE Cable	Shall not be less than 29 at 27 ± 2 deg. C.
12.0	Temperature index	Not below 250°C.
13.0	Max. conductor withstand temperature during short circuit.	250°C

5.2 LT Power Cables of 1.1kV Voltage grade.

Sl.No.	Parameter	Description
1.0	Voltage Grade	1.1 kV grade
2.0	Duty type	Heavy duty
3.0	No. of cores	- 3.5 / 4 core cables shall be used for motor feeders. - For other consumers or for power supply to other panel 4 core (upto conductor size of 50 sq.mm) or 3.5 core (for conductor size beyond 50 sq.mm) cables shall be used.
4.0	Reference standard	IS:8130 – 1984 IS:5831 – 1984 IS:3975 – 1988 IS:1554, part - 1, 1988 IS:3961 (Part-II) - 1967. IS:7098 Part-I & II IEC-60502
5.0	Conductor type	- Plain aluminium conductor. - All power cables of size 10 sq.mm and above shall have standard sector shaped (sm) or compact circular stranded (rm/V) or circular stranded (rm) aluminum conductors as applicable. - The conductors will be H2 or H4 grade. - The solid conductor shall be class - 1 and the stranded conductor will be class - 2. - The conductors shall be solid for conductor of nominal area upto and including 6 sq. mm. and stranded beyond 6 sq. mm. Conductors of nominal area less than 25 sq. mm. shall be circular or shaped. Cables with reduced neutral conductor shall have sizes as per Table 1 of IS 1554 (Part-1) -1988.
6.0	Insulation type	- XLPE insulation - The insulation compound shall be conforming to IS:7098 (Part I) - 1988.
7.0	Inner sheath	- For armoured / unarmoured cables a tough inner sheath of heat resisting PVC compound

		(wrapped / extruded as per size),Type ST2 as per IS 5831 . - Black in colour.
8.0	Armour	- Galvanised steel wire armour shall be used for 3Cx10 sq.mm / 4Cx6 sq.mm cable. - Galvanised flat steel wires (strips) armour shall be used for bigger size cables. - Single core armoured cables are provided with non-magnetic armour consisting of hard drawn flat or round aluminium wires.
9.0	Outer sheath	- For armoured / unarmoured cables a tough outer sheath of heat resisting PVC compound (Type ST2 as per IS 5831) . - Black in colour .
10.0	Miscellaneous	- Minimum cross - sectional area of the power cable shall be 6 sq.mm in case of aluminium conductor and 2.5 sq.mm in case of copper conductor. - Power cables shall be selected from core sizes of 6, 10, 16, 25, 50, 70, 120, 150, 240 & 300 sq.mm (Aluminium conductor).
11.0	Temp. rise	Shall be limited to 90 deg.C.
12.0	Core identification	- Cable identification will be provided by embossing on the outer sheath the following: • Manufacturer's name & trade mark • Voltage grade • Year of manufacture • Type of insulation • R,Y,B for phases . • Black for neutral (fourth core)

5.3 LT Control Cables of 1.1kV Voltage grade.

Sl.No.	Parameter	Description
1.0	Voltage Grade	1.1 kV grade
2.0	Duty type	Heavy duty
3.0	No. of cores	As per requirement .
4.0	Reference standard	IS:8130 – 1984 IS:5831 – 1984 IS:3975 -1988 IS:1554, part - 1, 1988 IS:3961 (Part-II) - 1967. IEC-60502
5.0	Cross sectional area	Shall be 1.5 / 2.5 sq.mm.
6.0	Conductor type	Solid annealed circular stranded copper conductor.
7.0	Insulation type	PVC Type- C insulated
8.0	Inner and outer sheath	- Type ST-2 PVC shall be used for inner sheath . - Type ST-2 PVC shall be used for outer sheath .

		- Both inner and outer sheath shall be extruded type upto 7 core and after 7 core inner sheath shall be wrapped ..
9.0	Armour	- Galvanised steel wire armour / galvanised steel strip
10.0	Spare Cores	- 3, 5 and 7 cores cables shall have at least one spare core, cables with 10 core and above shall have at least 2 spare cores.
11.0	Miscellaneous	- The Tenderer shall furnish necessary calculations to show that the selected cable satisfy the criteria including for voltage drop. - Cables for temperature detectors shall be screened type of required technical parameters with core size not less 1.5 sq.mm.
12.0	Core identification	- Cable identification will be provided by embossing on the outer sheath the following: • Manufacturer's name & trade mark • Voltage grade • Year of manufacture • Type of insulation - Cores of the cables upto 5 cores shall be identified by colouring of insulation. - For cables having more than 5 cores, core identification shall be done by numbering insulation of core sequentially. - All the numbers shall be of same colour, which shall contrast with the colour of insulation. - Numbers shall be written in figures and words both - The numerals shall be legible and indelible. - The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. - When number is a single numeral a dash shall be blacked underneath. - If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. - The spacing between consecutive numbers shall not exceed 100 mm.

5.4 LT Power Screened/special cables.

Sl.No.	Parameter	Description
1.0	Voltage Grade	1.1 kV grade
2.0	Duty type	Heavy duty
3.0	No. of cores	As per requirement .
4.0	Cross sectional area of conductor & Armouring	- Shall be 1.5 sq.mm & Armoured . - For weighing system 1.0 sq mm un-armoured

		cables in GI conduit from field to controller panel shall be provided.
5.0	Conductor type	- Solid annealed circular stranded copper conductor. - For twisted pair cables , the conductors shall be of stranded tinned copper having proper flexibility to provide limpness and extended flex-life as required for these small diameter cables.
6.0	Insulation type	- PVC insulated, Type A - Type ST-1 PVC shall be used for inner sheath. - Both inner and outer sheath shall be extruded type. - Outer sheath made of PCP (Chloroprene rubber), abrasion resistant, oil resistant and flame retardant conforming to IS:434 –1964 (Part - I), as amended upto date.
7.0	Screen	- Tinned annealed copper mesh over metallised tape , in a close woven braid .
8.0	Shielding	- Special aluminium foil to provide 100% shield coverage for optimum protection against radiated interference and ingress of audio and radio frequencies. - It shall have shorting fold for metal to metal contact and isolation fold to prevent adjacent shields from shorting to one another, so as to improve the voltage breakdown characteristics. The drain wire shall be of stranded tinned copper wire of 0.518 sq. mm. (20 AWG) cross-section.
9.0	Spare Cores	- 20% spare cores but not less than 2 spares shall be provided in all the multi core cables .
10.0	Reference standard	As per relevant IS with latest amendments
11.0	Miscellaneous	- The Tenderer shall furnish necessary calculations to show that the selected cable satisfy the criteria including for voltage drop. - Cables for temperature detectors shall be screened type of required technical parameters with core size not less 1.5 sq.mm. - The special twisted paired cables shall be of the type to provide balanced signal transmission and shall have good noise immunity.
12.0	Core identification	- Cable identification will be provided by embossing on the outer sheath the following: • Manufacturer's name & trade mark • Voltage grade • Year of manufacture • Type of insulation - Cores of the cables upto 5 cores shall be identified by colouring of insulation. - For cables having more than 5 cores, core

		identification shall be done by numbering insulation of core sequentially. - All the numbers shall be of same colour, which shall contrast with the colour of insulation. - Numbers shall be written in figures and words both - The numerals shall be legible and indelible. - The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. - When number is a single numeral a dash shall be blacked underneath. - If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. - The spacing between consecutive numbers shall not exceed 100 mm.

5.5 Flame retardant low smoke (FRLS) cables.

Sl.No.	Parameter	Description
1.0	Voltage Grade	1.1 kV grade
2.0	Reference standard	Category AF as per IS : 10810 ASTM-D 2863 (Critical Oxygen Index) ASTM-D 2863 (Temperature Index) ASTM-D 2843 (Smoke density) IEC 754-1 (Acid gas generation) IEEE-383 (Flammability test on group of cables) Swedish chimney test SS 424175, class F3. (Flammability test) IEC 332-1 (Flammability test) IEC 332-3 (Flammability test) IS 5831 (Fire resistant test)
3.0	Duty type	Heavy duty
4.0	No. of cores	Single or multicore as per requirement
5.0	Cross sectional area	As per requirement .
6.0	Conductor type	Annealed tinned copper conductor
8.0	Insulation type	XLPE insulation
11.0	Sheath	Specially designed with thermoplastic or thermosetting materials , superior resistance to ignition and flame propagation with smoke emission and toxicity or corrosive characteristics Flame retarded Oil resistant
12.0	Armouring	GI wire / strip armoured as per requirement and size (as specified in respective TS)
13.0	Test values	Critical Oxygen Index : Minimum 29 Temperature Index : Minimum 250 deg. C Smoke density : Minimum average light

		transmission of 40% Acid gas generation : HCl gas released 20% maximum Flammability test on group of cables : As per standards mentioned Flammability test : As per standards mentioned Fire resistant test : As per standards mentioned

5.6 Details to be furnished in datasheet of HT LT Cables

i) Name of manufacturer
ii) Type
iii) Applicable standards
iv) Voltage grade
v) Maximum temperature of conductor
- Continuous rating
- Short circuit withstand rating

vi) Conductor
- Material & type
- Type & shape of conductor
- Cross sectional area
- Number and diameter of wire in each conductor

vii) Insulation
- Material & type
- Nominal thickness
- Identification of cores

viii) Laying up
- Direction of lay

ix) Inner sheath
- Material & type
- Minimum thickness

x) Armour
- Material & type

xi) Outer sheath
- Material & type
- Colour
- Minimum thickness
- Embossing/printing
- Diameter of cable
- Sequential length marking

xii) General
- Total quantity
- Packing length
- Net weight

xiii) Acceptance and routine tests
- Tensile strength of insulation & sheath
- Elongation at break of insulation & sheath

- Volume resistivity
- DC Resistance of conductor at 20°C
- High voltage at room temperature

xiv) Other parameters
- Short circuit rating of conductor for 1 sec
- Minimum permissible bending radius

xv) Current rating
- Direct in ground
- In air
- In Duct

6.0 GENERAL REQUIREMENT

The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installations.

They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions. The XLPE /PVC insulated L.T. power cables shall withstand without damage a 3 phase fault current for 1 second as specified in "Design Basis" at rated conductor temperature (70° C for PVC insulated cables and 90°C for XLPE insulated cables).

The XLPE insulated cables shall be capable of withstanding a conductor temperature of 250°C during a short circuit without any damage. The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a short circuit.

The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects.

Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of all cables.

The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.

When armouring is specified for single core cables, the same shall consist of aluminium wires/strips.

7.0 CABLE DRUMS

7.1 Cables shall be supplied in returnable wooden or steel drums of heavy construction. Wooden drum shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum.

7.2 Standard lengths for each size of power and control cables shall be 500/1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard

drum length. The owner shall have the option of rejecting cable drums with shorter lengths. However if shorter length of cable (Not standard as specified) is required shall be provided by the contractor in drums.

Maximum, One (1) number non standard length of cable si e(s) may be supplied in drums for completion of pro ect.

7.3 A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.

7.4 Each drum shall carry the manufacturer's name, the purchaser's name, address and contract number and type, size and length of the cable, net and gross weight stencilled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

7.5 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

8.0 TRANSPORTATION AND UNLOADING

All cables shall be shipped and transported on cable drums of adequate size. Drums shall be lifted by means of a crane or by means of a loading ramp. Throwing and dropping down of cable drums shall be strictly avoided. In order to prevent drums moving during transportation, these must be securely wedged to prevent movement. Before unloading it is necessary to verify that the drum is received in proper condition. The directional arrow of the drums has to be observed during rolling. Empty cable drums have to be stored on a suitable central store place. Retransport to the cable manufacturer of returnable drums is the Contractor's responsibility.

9.0 DRAWINGS AND DOCUMENTS

Following minimum information shall be furnished with bid:

a) Data sheet for cables
b) Type Test Reports of cables
c) Catalogues of cables

The following drawings (in three sets) shall be submitted for approval/review within 3 weeks of award of contract.

a) Data sheet for cables
b) Type Test Reports of cables

10.0 INSPECTION

Inspection and testing of equipment shall be carried out by the owner/ consultant at the manufacturer's works of the contractor on final product to ensure conformity of the same with the acceptable criteria of technical specification, approval drags. and reference national/ international standards.

The inspector shall have free access to the manufacturer's works for the purpose of inspecting the process of manufacture in all its stages and he shall have the power to reject any material which appears to be unsuitable description or of unsatisfactory quality. The vendor shall give at least 2 weeks advance notice to the purchaser regarding the date of testing to enable them or their representative to witness the tests.

The contractor shall submit Quality Assurance Plan (QAP) for respective equipments within 3 weeks of award of contract.

QAP shall be prepared and furnished by the contractor in MECON Form No. 11.20(4.4) F-10 along with their internal in process quality checks.

After completion of manufacture of cables and prior to despatch, the cables shall be subjected to type, routine, acceptance and special tests as per the approved QAP. Purchaser / Consultant reserve the right to witness all tests with sufficient advance notice from vendor.

All routine tests, acceptance tests, type tests and additional type tests for improved fire performance shall be carried out on cables as per IS:1554 Part 1 and IS:7098 Part – 2 and international standards as may be applicable.

Routine test and type test certificate shall be furnished for review.

Acceptance test shall be witnessed by owner/consultant.

The following special tests may be performed on the cables as per sampling plan and as may be applicable as per approved QAP. These tests will be witnessed by Purchaser / Consultant before despatch of cables.

a. Accelerated water absorption test for insulation as per NEMA – WC – 5. (For PVC insulated cables) and as per NEMA WC – 7 (for XLPE insulated cables). Sampling for this test to be done randomly and once for each size per order wise provided outer sheath remains same.

b. Dielectric Retention Test: The dielectric strength of the cable insulation tested in accordance with NEMA WC – 5 at 75 +/- 1 deg C will not be less than 50% of the original dielectric strength (For PVC insulated cables.) Test certificates with respect to this test from recognized testing laboratory to be furnished for review by purchaser/ consultant before inspection of cables. In case test certificates are not available, test to be conducted by the manufacturer at his own cost in any recognized test laboratory before inspection of cables.

c. Oxygen index test: The test will be carried out as per ASTMD 2863 or applicable Indian Standard. Sampling to be done for every offered lot / size as per sampling plan.

d. Flammability test: The test will be carried out on finished cable as per IS-10810 (Part 61 & 62). Sampling for these tests to be done randomly once for each size per lot provided outer sheath remains same.

e. Test for rodent and termite repulsion property: The vendors will furnish the test details to analyse the property by chemical method. Sampling will be done for every offered lot / size as per sampling plan.

11. TYPICAL CALCULATIONS (For si ing and design)

a) Selection criteria for HV/MV cable si e for primary distribution

i) Temperature of conductor just prior to short circuit:
   1) With XLPE insulation - 90 Deg. C
   2) With PVC insulation - 70 Deg. C

ii) Maximum permissible conductor temperature during short circuit:
   1) With XLPE insulation - 250 Deg. C
   2) With PVC insulation - 160 Deg. C

iii) Volumetric specific heat of the conductor:
   1) With Aluminium conductor - 2.5 x 10 J/Deg. C/MM
   2) With Copper conductor - 3.45 x 10 J/Deg. C/MM

iv) Reciprocal of temperature co-efficient of resistance at 9 Deg. C:
   1) With Aluminium conductor - 228
   2) With Copper conductor - 234.5

Short circuit current rating at different duration may be calculated as –

Ish (for t duration) = Ish (for 1Sec.) Ish for 1 Sec. Duration (kA)

t = Time duration required to be calculated of short circuit in Sec

Formula for calculating HT Cable si e

With Aluiminium cond./XLPE insulated cable = Ish X$\sqrt{}$ t / 0.094

With Copper cond./XLPE insulated cable = Ish X$\sqrt{}$ t / 0.143

b) Calculation for number of runs of incoming cable

Maximum demand (MD) on MCC = (Total working load x LF)/DF

Where

LF – Load factor
DF – Demand factor

Current based on maximum demand (I_M)= (KWX1000)/(1.732 X V X pf)

Current rating as per catalogue (In air) for selected size of cable - I_C

Derated current rating (I_{CD}) = Derating factor X I_C

Minimum no. of runs (n) = I_M / I_{CD}

c) Voltage drop calculation

Voltage drop of cable = ($\sqrt{3}$ x I_M x Z_{cab} x L) / n Volts.

Where

I_M - Current based on maximum demand
Z_{cab} – Impedence of cable
L – Route length of cable
N – no. of runs

Rev: 0
Edition: 2

SPECIFICATION

FOR

PDB PANEL

SPECIFICATION NO. - MEC/TS/05/E9/11

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

CONTENTS

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 INTENT

a. The intent of this standard specification is to define the general requirements for design, manufacture, assembly and testing at manufacturer's works, packing, transportation and receipt at site with all materials and accessories of PDB Panel.

b. **Tenderer to refer separate Technical specification (TS) / SOR item details for following minimum details / re uirements as part of the pro ect needs**

1. **Details of PDB Single /double front, Draw out/ Non-drawout, Busbar details Alumimium/copper etc.**
2. **Single incomer/ double incomer with buscoupler along with ratings.**
3. **Outgoing feeder details (Ratings Quantity)**
4. **Make list of PDB and its components**
5. **Quantity location of PDB**

Any other item / component / e uipment / accessories / services as necessary for satisfactory completion of the pro ect shall also be covered in separate Technical specification (TS) / SOR item.

2.0 CODES STANDARDS

IS: 375	-	Marking and arrangement for switchgear busbars, main connections and auxiliary wiring
IS: 722	-	AC Electric meters
IS: 2147	-	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS: 2705	-	Current transformers
IS: 3156	-	Voltage transformers
IS: 3231	-	Electrical relays for power system protection
IS: 4237	-	General requirements for switchgear and controlgear for voltages not exceeding 1 000 volts ac or 1 200 volts dc

IS: 8623	-	Specification of low voltage switchgear and controlgear assemblies
IS: 10118	-	Code of Practice for selection, installation & maintenance of switchgear & controlgear.
IS: 13947	-	Specification of low voltage switchgear and controlgear
IEEE	-	Recommended practice for electrical power distribution (Std. 141) for industrial plants

3.0 TECHNICAL REQUIREMENTS

3.1 Construction features

- 415V, 3 phase, 4 wire, 50 kA (short time rating for 1 sec.) indoor type.
- Single front/ double front design(as per TS), Draw –out / Non-draw out (as per TS), free standing, compartmentalized, floor mounting type suitable for both front and rear access.
- The panel shall be extendable on both sides at site through provision of coupling holes at bus end & removable type side end covers.
- Unless specified in TS, the PDB shall have one incomer.
- Incoming Circuit breakers (ACBs – 800A & above / MCCBs from 500A upto 630A with contactor) shall be mounted on fully draw-out truck with service, test and isolated positions and complete with following safety interlocks and safety shutters with padlock facility;
    - It shall not be possible to move the truck in or out of cubicle when the breaker is closed.
    - CB compartment door shall be mechanically interlocked so that it will not be possible to close the CB in plug position when the door is open.
    - It shall not be possible to push the truck in close position if either of the safety shutter is not free and not in close position.
- Incomer MCCB below 500A rating shall be a non-drawout panel.
- Outgoing feeders shall be drawout / non-drawout type as per TS.
- Shall have an integral base channel.
- A transport section shall not exceed 3 vertical panels (Limited to 2400 mm).
- Rear face of each panel cubicle shall be openable and accessible for maintenance purpose. Panel shall have removable type bolted door on the rear side.
- Lifting facility shall be provided for each section.

- Dust & vermin proof design.
- Degree of protection for enclosure kept in a premise shall be IP 52 as per IS: 13947 – 1993 Part – 1.
- Incomer shall have analogue type of Voltmeter & Ammeter with selector switches. All feeders shall have ON/OFF/TRIP lamps. Each Incomer panel shall have 3 nos lamps for R/Y/B and 6 nos lamps for Breaker ON/OFF/TRIP and for breaker fault conditions.
- Shall have isolated busbar chamber for main busbar at the top, running through out the length of the board. Chamber shall have removable cover.
- Cable alley shall have sufficient space for aluminium power cables and bottom cable chamber shall be left free completely isolated from the vertical busbars.
- Busbars shall have same cross section throughout the length. Rating of the neutral busbar shall be 50% of the main busbar. Earth bus bar shall run in bottom chamber throughout the length of the panel.
- Polyurethene/ Neoprene gaskets shall be used for cable alley doors, busbar chamber covers to ensure tightness and making it dust proof.
- Feeder module doors and cable alley doors shall open in opposite direction for providing more working area for maintenance purpose.
- Each feeder module shall have door interlock, defeat interlock and padlocking facility.
- All outgoing feeders from PDB's shall be TPN MCCB with miminum 2 NO+2NC auxiliary contacts.

3.2 Busbars Supports

- Main busbars shall be made of high conductivity EC grade aluminium alloy equivalent to E91E WP (IS-5082/198l) or electrolytic copper as per IS-1897-1983.
- Three phase, neutral (with atleast 50% rating of main buses) and continuous earth bus. Bus bar shall be provided with proper grade &colour of heat shrinkable sleeve.
- Rating of horizontal buses shall be same as that of incomer circuit breakers and vertical run shall be same as that of outgoing breaker rating.
- Temperature rise of bus bars shall not be more than 40 deg. C above an ambient of 50 deg. C.
- Three phase and Neutral bus shall have facility for connection with earth bus.
- Shall be heat shrinkable PVC shrouded except at the points of tap-off. The bus bars shall be colour coded for phase identification.
- All incoming and outgoing bus bars shall be TP&N type and shall be sleeved.
- Busbars shall be housed in totally enclosed compartments (Bus bar chambers) having removable type covers for easy maintenance.
- Power and control bus bars shall be segregated.

- Main bus bars shall run throughout the length of transport section and vertical bus bars throughout the height of PDB.
- Busbar joints shall be of bolted type with suitable spring washers to ensure tight fittings. Bolts and washer shall be galvanized or cadmium plated.
- GI earth strip of size 50 x 6 mm or equivalent shall be run at the bottom of PDB with a provision of a link for connecting to neutral bus bar.
- Provision shall also be made for terminating the 4th core of incoming & outgoing cables.
- Bus bars shall be sized for the current rating specified (with temperature derating) to withstand a short circuit current of 50kA for 1 sec.
- Bus bar supports shall have adequate mechanical strength, high dielectric strength, and low moisture absorption characteristics.
- Bus bar supports shall be rigidly held to the frame work of PDB and shall be so spaced as to ensure rigid support for bus bars.
- Bus bar supports shall be designed to withstand thermal and dynamic stresses resulting from specified short circuit current.
- Min. clearance between live parts shall be 25 mm and live to earth 19mm.
- All core type CTs mounted on bus bars shall be supported separately and not supported on bus bars. CT secondary-connecting cables shall be properly dressed and clamped such that these do not hang loose / pass directly over bus bars.

3.1 Circuit Breaker

3.3.1 Electrical Features

- Air break triple pole (4 pole in case of DG power incomer) drawout type conforming to IS 13947 for incomers & buscoupler for ratings of 800A & above.
- MCCB TPN, air break type with independent manual quick make and quick break type for incomer ratings of upto 630A and all outgoing feeders. MCCB shall withstand the fault current envisaged for 415V system.MCCB shall have set point adjustable feature for instantaneous thermal overload & shall have trip coil.
- Under voltage release provision shall be kept in ACB.
- Electrically operated mechanism for incomers & Bus-couplers. Manual operated mechanism for outgoing feeders or as specified
- Incomer shall have analogue type of Voltmeter & Ammeter (144 X 144 sq.mm) with selector switches. All outgoing feeders shall have ON/OFF/TRIP lamps with ammeters of 96 X 96 sq.mm.
- All outgoing feeders shall have TPN.
- Rated continuous current as specified:

- Symmetrical breaking capacity and 1 second rating of the breaker not less than the system short circuit level specified.
- Making capacity 2.55 times breaking capacity.

– Auxiliary contacts : 4 NO + 4 NC minimum, convertible from NO to NC and vice versa at site.

Ratings :

Continuous	10 amps
AC 11	4 amps at 240 V
DC 11	0.5 amps at 110 V

3.3.2 Moulded Case Circuit Breaker (MCCB)

MCCB shall conforms to IS/IEC 60947-2 and the rating shall be as per SLD with ICS=ICU=100% for the complete range. MCCBs must be suitable for "Positive Isolation" as per IEC 60947-2 and should have Class-II Front Facia as per IEC 60441. MCCB rated upto 250 A shall have Thermal Magnetic release or Microprocessor based release with variable O/L, S/C& E/F settings. Accessories should be continuously rated with Shunt Trip Coils and shall be snap fit type and should be common throughout the range. MCCB shall have Cross Bolted Termination to withstand higher short circuit Levels.
Operating handle, door interlock and padlocking at ON/OFF position shall be provided. At least 1 NO and 1 NC auxiliary contacts shall be provided.

3.3.3 Air Circuit Breaker (ACB)

3.3.3.1 Electrical Features

– Air break TPN (4 pole in case of DG power incomer) drawout type conforming to IS 13947.
– Motor operated spring charge mechanism
– Rated continuous current as specified.
– Symmetrical breaking capacity and 1 second rating of the breaker not less than the system short circuit level specified.
– Making capacity 2.55 times breaking capacity.
– Performance category : P2
– Auxiliary contacts : 4 NO + 4 NC minimum, convertible from NO to NC and vice versa at site.

Ratings :

Continuous	10 amps
AC 11	4 amps at 240 V
DC 11	0.5 amps at 110 V

3.3.3.2 Operating Mechanism

- Electrically operated mechanism for incomers & Bus-couplers
- Manual operated mechanism for outgoing feeders or as specifiedwith MCCB + Contactor as per SLD/TS.
- Spring charged stored energy mechanism to ensure high speed closing and tripping independent of the operating forces.
- Anti pumping and trip free feature
- Emergency tripping by mechanically operated trip push button (shrouded to prevent accidental closing) acting directly on the trip bar.
- Closing operation of the breaker to charge the tripping spring, ready for tripping.
- Mechanical indication to show :
- Closing spring charged
- Breaker ON/OFF/TRIP
- Breaker to close only when spring fully charged
- Non-reset type operation counter
- For manually operated breakers (if specified).
  - ⇒ Independent manual charging of closing spring and closing by handle.
  - ⇒ Alternatively, closing by mechanical push button with spring previously charged by handle.
- For electrically operated breakers :
  - ⇒ Charging of closing spring by motor
  - ⇒ closing by closing coil
  - ⇒ spring charging motor and closing coil suitable for rated control voltage (240 AC unless otherwise specified).
  - ⇒ One opening and one closing operation without control supply.
  - ⇒ Provision also for manual closing with spring charging motor automatically decoupled as soon as charging handle is inserted.

3.3.3.3 Drawout Features

- 3 distinct positions viz. service, test, and isolated with the door closed.
- Mechanical position indication and locking/latching facility for all 3 positions.
- Power connections -self aligning, plug-in type.
- Control connections - sliding or plug socket type, mechanically coded, to prevent wrong insertion.
- Automatic safety shutters to prevent accidental contact with live parts when the breaker is withdrawn.

3.3.3.4 Safety Interlocks

- It shall not be possible to close the breaker in any intermediate position other than

the 3 fixed positions.

- With the breaker closed, it shall not be possible to rack it in from any of the 3 position to another.
- Mechanical stopper to prevent accidental falling while withdrawing.
- It shall not be possible to rack in the breaker from isolated to 'test' position with the door open together with provision for defeat of this interlocking, however, it shall be possible to close the door only when the breaker is brought back to 'isolated' position.
- It shall be possible to open the door only when breaker is OFF andis in 'Isolated' position.
- Remote closing of breaker is not permitted with door open.
- Insertion of breaker into 'Service' position shall not be possible if the shutters are not free.

3.3.3.5 Microprocessor based releases

General

- The control unit shall be interchangeable on site for adaptation to changes in the installation.
- Sensors shall be non-magnetic or of the Rogowsky type for accurate current measurements.
- The control unit shall measure the true RMS value of the current.
- The control unit shall comprise a thermal memory to store temperature-rise data in the event of repeated overloads or earth faults. It shall be possible to disable this function if necessary.

Protection

- The control unit shall offer the following protection functions as standard:
  1. Long-time (LT) protection with an adjustable current setting and time delay;
  2. Short-time (ST) protection with an adjustable pick-up and time delay;
  3. Instantaneous (INST) protection with an adjustable pick-up and an OFF position.

- Digital Microprocessor based relay shall be used to obtain data processing regarding protection.
- It shall display the phase current with highest load.
- It shall also express the true energy content of the current.
- Current and time-delay settings shall be indicated in amperes and seconds respectively on a digital display. Acknowledgement that the setting change should translate to the trip threshold.
- Earth-fault protection with an adjustable pick-up and time delay shall be provided if indicated on the single-line diagram.

3.3.3.6 Communication

- The circuit breaker shall be capable of communicating the following data via a bus:
  - Circuit-breaker status (open/closed, service/test/isolated, tripped on a fault, ready to close);
  - Control-unit settings;
  - Tripping causes;
  - The measurements processed by the control unit: current, voltage, frequency, power
- It shall be possible to remotely control the circuit breaker. All Protection parameters are adjustable from Remote.
- RS-485 Standard serial interface shall be provided for communication of microprocessor based relay
- It shall be possible to remotely modify circuit-breaker settings:
  - Settings within the range defined by the switches on the front panel of the control unit;
  - Settings of the protectionfunctions and the alarms.
  - Communications functions shall be independent of the control unit

3.2 Internal Panel Wiring Terminal Blocks

- Suitable provision shall be made to terminate control / power connections near the respective module. The terminals selected shall be suitable for the termination of armoured cables, as per the details of cable required. Adequate space shall be kept for cabling.
- Feeders up to 100A shall be terminated to terminal block located in cabling chamber and feeders above 100A rating shall be terminated directly to suitably staggered taped bus bars.
- PDB shall be completely factory wired, ready for connecting to equipment.
- Power circuit wiring shall be with 1100 V grade single core stranded, PVC insulated copper cable of minimum 4 sq. mm or aluminium cable of 6 sq.mm..
- Control circuit wiring shall be with 1100 V grade multi strand, PVC insulated copper cable of 2.5 sq. mm.
- Internal control wiring shall be laid in PVC ducts with detachable snap - on covers and there shall be enough length to avoid the necessity to stretch the cables for door movement/connection, disconnection or changing.

- Wires identified at each end in accordance with schematic diagrams by interlocked type ferrules.
- Necessary cable clamping arrangement shall also be provided in the cable alley/chamber inside compartment on perforated sheet steel section.
- All connections external to a feeder, all the auxiliary contacts of the LT breaker, and all spare contacts of the relays shall be wired on to the terminal blocks.
- Interconnection between panels of adjacent shipping sections to be brought out to a separateterminal block, wires for interconnection properly labeled, looped and bunched inside the panel for connection at site.
- All terminals, as well as terminations, at various control devices inside the compartment shall be provided with interlocking type ferrules having engraved numbers. Terminals having connections from other modules shall be marked with red ferrules.
- There shall be no joints or tappings between two terminations. No more Than two connections shall be made to any terminal.
- 20% spare terminals shall be provided in each control terminal block.
- The wiring shall be terminated in the respective terminal with suitable crimp type sockets.
- Interlocking type ferrules for identification shall be provided.
- All spare contacts to be wired to terminal block.
- Interpanel wiring shall be through horizontal bus bar chamber.
- All holes or tubes for wiring runs shall be bushed and shall have room for reasonable additions.
- All power cable terminal blocks / boards shall be stud and nut type with phase barriers.
- For higher rated feeders, suitable staggered extension links shall be provided to permit direct termination of cables.
- Cable supports / clamps shall be provided in cable alley.
- Removable cable gland plate shall be provided.

- All cable termination nut / bolts and washers (for all cables at panel bus bar /link inside all the supplied panels must be supplied as part of Tenderer's panel supplier's scope.

- Double compression type GI / brass glands, accessories including tinned copper lugs to outgoing cable sizes to be supplied loose.

- The color-codes for the wires shall be as follows:

415V, 3phases	Red, yellow & blue
Neutral	Black
Earth	Green
Single phase - line	Red
110V AC - line	Brown
24V DC +ve	Orange
-ve	Black

3.3 Control Transformers

415V/230V Control transformers of adequate rating (Minimum 2.5 kVA each) shall be provided for 230 V AC control supply for each PDB. Higher rating shall be selected based on actual requirement with 50% margin and voltage drop in control transformer shall be less than 3% at peak KVA requirement during coil pickup.

MCB& fuse shall be provided for primary side of control transformers. MCB of suitable rating shall be provided on the secondary side.

Voltmeter class 1.5 and scale 0-250 V.

Control transformer shall be horizontally mounted in one of the bottom compartments with adequate ventilation.

The transformer shall be double wound, dry type with class E insulating materials.

The control supply for the motor feeders shall be fed through suitable rated MCBs.

Control transformers shall be provided with +/- 5% and +/-10% voltage taps on 415 V side.

The control bus of the PDB shall be electrolytic grade aluminium/copper only and will be designed to carry the transformer rated secondary current as well as withstand the available short circuit level.

Control buses of two sections shall be connected through sectionalising switch.

Indication lamps shall be connected to 240V AC supply.

Isolation arrangement shall be provided on each panel to facilitate fault location and testing. Separate fuses shall be provided for spring charging motors, for indication lamps and for closing/tripping circuits of each cubicle.

3.4 Inscriptions

Identification labels shall be provided for each PDB as well as for each compartment, control device and other components.

PDB designation at the top of central panel with letters of 25 mm (min.) height.

Anodised Al. Plates (Black background and white lettering) for each feeder inscriptions with letters of mm. 6 mm height for each module on door.

Each component shall be identified as per schematics by good quality polyester film stickers on components and by painting in a conspicuous place on the panel body.

Terminal blocks shall be identified as per schematics with stickers / stenciling by black paint.

Danger boards as per IS on front & rear end of PDB in English, Hindi & local language.

3.5 Earthing

A continuous earth bus shall be provided for the PDB at the bottom with an earthing bolt at each end. Bolted joints with tooth spring washers shall be provided for good earth continuity.

Provision shall be made for connecting 4th core incoming and outgoing cables.

The earth bus shall be of aluminium having the same size as that of neutral bus bar at the top.

Neutral and earth busbars shall be connected through a link.

Electrical equipment shall be interconnected with earth grid using minimum size 50 x 6 GI strip or equivalent.

Earthing shall confirm IS: 3043 - 1987, IE rules and statutory regulations.

Internal earthing network shall be connected at two places minimum to the external-earthing network.

5.0 Feeder Types

The PDB'S shall be generally used to feed all items such as Sockets /starters / MCBs/ Other PDB_ supply panels / mobile sockets / non-UPS supply etc.

The following types of feeders shall be envisaged in PDB.

Type 'A' Incomers

- Draw out design
- Air circuit breaker of 800 / 1200 A / 1600 A rating with Microprocessor based trip release for O/L, S/C& E/F.
- Incomer from transformer or incomers from DG set can be switched on one at a time.
- 415V, 3 Ph, 250/400/630 Amps, rated Moulded case circuit breaker with Microprocessor based trip release for O/L, S/C& E/Fwith AC3 duty contactor.
- Current transformers to read phase currents as per PDB rating.
- Relay as per SLD
- Voltmeter with 3-position selector switch
- Digital Ammeters
- Phase (R, Y, B) Indication lamps with fuses.
- ON/OFF/Trip indication lamps (LED type).
- Current transformers for protection and measurement

Type 'B' Control Section

- Dry type control transformer, 415 / 240V with + 2.5 and + 5% tappings on primary, of required rating (minimum 2.5 kVA).
- MCB on primary side and secondary side of transformer.
- Control supply healthy (lamp) indication.

Type 'C' (Power supply Feeder module)

- Heavy duty fuse switch unit of AC 23 duty or MCCB as per SLD.
- Mechanical ON/OFF indication
- Door interlock ,defeat interlock and padlocking facility.
- Rating 32/63/100/125/250/400 A as specified / as per SLD.

Type 'D' (Spare Feeders)

- Each PMCC shall be provided with atleast 20% spare feeders or minimum of 1 no. of spare feeder of each rating whichever is maximum.

Type 'F' (Capacitor Feeders)

- Heavy duty fuse switch unit of AC 23 duty
- Mechanical ON/OFF indication
- Door interlock, defeat interlock and padlocking facility.
- Rating 32/63/125/250 A as specified / as per SLD.
- APFC relay for PF correction.
- Capacitor Bank as per SLD
- PF meter with lagging and leading indication

6.0 Special tools

A set of special tools required for the normal operation and maintenance shall be supplied with each PDB. The tenderer shall include, along with each PMCC, one height adjustable circuit breaker trolley for removal and replacement of the withdrawable circuit breaker carriage.

7.0 Painting

All sheet metal work shall undergo a process of

- o Degreasing

- Pickling in acid
- Cold rinsing &Phosphating
- Two primer coats of Epoxy based primer suitable for corrosive (seashore) atmosphere.
- Two finish coats of painting of light grey or approved colour shade and quality.
- The interior of panel shall have eggshell white paint.

8.0 Inspection testing

The owner or his authorized representatives may visit the works during manufacture of equipment to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given all assistance to carry out the inspection.

The contractor shall submit Quality Assurance Plan (QAP) for respective equipments within three weeks of award of contract. Owner's representative shall be given minimum two weeks advance notice for witnessing the final testing.

Inspection and testing of equipment shall be carried out by the owner/ consultant at the works of the contractor on final product to ensure conformity of the same with the acceptable criteria of technical specification, approved drawings and reference national/ international standards.

QAP shall be prepared and furnished by the contractor in MECON Form No.11.20 (4.4) F- 10.Test certificates including test records and performance data etc. shall be furnished by the vendor.

Inspection will be carried out on the basis of the purchaser's drawings/ manufacturer's approved drawings and instructions contained in the QAP.

QAP shall generally cover the following tests:

- Visual
- Dimensional
- Fitment & alignment
- Measurement of IR Value – Before HV test & after HV test
- High voltage test/ dielectric test
- Routine test as per relevant IS/other standard
- Type test as per relevant IS/other standard

- Test certificates of bought out items
- Paint shade verification
- Operational & functional check
- Verification of BOM

Tests at works and tests at site shall include the following:

a. One minute PF withstand voltage between phases, phase to earth and between open poles as well as for the auxiliary/control circuit.

b. Insulation resistance test for power, auxiliary and control circuits.

c. Milli volts drop across incoming and outgoing jumper connections with breaker closed and in service position.

d. Physical inspection

e. Operational tests

f. Temperature rise test on main and vertical busbars

g. Tests to prove inter changeability of breakers with same current rating.

h. Calibration of meters (if supplier is to commission the equipment, this can be done at site)

i. Check of control circuits

j. Test to prove operating voltage range of spring charging motor, closing coil, trip coil and relays.

k. Heat run test

10.0 Drawings

The following drawings shall be submitted for approval as per agreed schedule.

a) Dimensional GA drawing of PDB indicating busbar arrangement, foundation details, gland plate location,Front view of PDB indicating component locations.

b) Single line schematic diagram indicating feeder details.

c) Control schemes of feeders.

d) Component specification details.

e) List of inscriptions.

f) Internal wiring diagrams

g) Terminal plan and external connection diagrams.

h) Cross sectional drawings of cubicle indicating details of busbar chamber, cable chamber, breaker chamber etc.

i) Catalogues of relays, breakers.

j) Operation and Maintenance Manual
   - Recommended procedure for routine maintenance
   - Tests for checking of proper functioning
   - Diagnostic trouble shooting/ fault location charts

k) Storage, conservation and re-commissioning Manual

l) Safety Manual

m) List of special tools and tackles

11.0 PACKING

The equipment shall be properly packed. Special notations such as fragile, this side up, centre of gravity, etc. shall be clearly marked on the package.

12.0 COMPLETENESS OF EQUIPMENT

All fittings, accessories or apparatus which may not have been specially mentioned in this specification but which are otherwise necessary for satisfactory working of PDBshall be deemed to have been included in the scope of supply.

Rev.: 0
Edition: 2

SPECIFICATION

FOR

LIGHTING FIXTURES OF

HAZARDOUS AREAS

SPECIFICATION NO. - MEC/TS/05/E9/22

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

C O N T E N T S

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 SCOPE

This specification defines the design, construction, testing and supply of lighting fixtures suitable for installation in classified hazardous locations in Refineries/Petrochemical plants. Unless specified in material requisition all fixtures shall be suitable for Zone-1 & Zone-2 & Gas Groups IIA & IIB as per IS 2148.

a. Tenderer to refer separate Technical specification (TS) / SOR item details for following minimum details / re uirements as part of the pro ect needs

1. Type of Ha ardous areas, its one protection grade and gas group classification for suitability of installation of ade uate flameproof light fittings.

2. Type of Light fittings and its uantities in line with SOR.

3. Conventional type HPMV Well glass luminaire/ industrial grade LED flameproof luminaire

Any other item / component / e uipment / accessories / services as necessary for satisfactory completion of the pro ect shall also be covered in separate Technical specification (TS) / SOR item.

2.0 CODES STANDARDS

2.1 The design, manufacture and performance of equipment covered by this specification shall conform to the relevant Indian / International standards and Codes. In particular, the equipment offered shall conform to the latest revision of the following standards.

IS:1913	:	Electric lighting fittings, general and safety requirements for Luminaries:Tubular fluorescent lamps
IS:2148	:	Specification for flameproof enclosures
IS:2206	:	Flameproof electrical lighting fittings Point I & II (well glass and bulk head type, fittings using glass tubes)
IS:5572	:	Classification of hazardous area for electrical installation
IS:6381	:	Construction and testing of electrical apparatus with type of protection `e'
IS:8224	:	Electric lighting fitting for division 2 areas
IS:8289	:	Electrical equipment with type of protection `n'

IS:10322 : Luminaires – Part – 1 – General Requirements

Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.2 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 ENVIRONMENTAL CONDITIONS

The Lighting fixtures shall be designed for continuous operation under the climatic and environmental conditions as described in the “Design Basis-Electrical/Scope of Work”.

4.0 POWER SUPPLY SYSTEM

Unless until specified in material requisition all lighting fixtures shall be suitable for 220 - 250 volts single phase neutral & 50 Hz power supply.

5.0 DESIGN REQUIREMENTS

Light fittings for use in Hazardous areas have the following characteristics. They are sealed to prevent the ingress of the liquid, gas or dust, lens for lamp, protection of a robust impact resistant material. They have a seal or machined face to ensure resistance to liquid, dust or gas, or a quenching flame path. Light fittings have different grades of protection depending on their construction and intended purpose. Some fittings are classified according to their IP Ingress Protection rating as it is designated.

When Light fittings and other electrical apparatus are to be installed in a Hazardous Area it is essential that the decision maker takes measures to reduce the likelihood of an explosion by the correct selection of the equipment to be installed in that area. As the gases and vapours liable to be present are rated according to ignition temperature, Flash point and lower explosive limit, this information must be on hand when making your light fitting selection.

All flame proof fixtures and accessories shall be tested and certified by CMRI/CCE or independent authorities of country of origin for use in specified gas group location/Hazardous area. Certification number/data and gas group/temperature classification must be indicated on the manufacturer's nameplate on each fixture. Contactor shall furnish the type test data & certificates of approval of fixture for use for hazardous location along with offer.

All lighting Fixtures shall conform to the latest revision of all relevant Indian / International Standards / IS / BS / DIN etc. and statutory requirements of Govt. of India and Indian Electricity Act and statutory requirements of Govt. of Jharkhand, Safety codes & technical rules / norms.

Lighting Fixtures shall be properly packed to avoid any damage during transit. The Luminaries under the scope of supply shall be capable of functioning normally under voltage and frequency fluctuations specified in this specification.

Replacement of damaged lighting fixtures including lamps, ballast etc. during transit shall be done immediately.

Replacement of defective lighting fixtures including lamps/ ballast etc. shall be done immediately.

Energy saving features shall be provided along with the fixtures.

6.0 GENERAL REQUIREMENT

6.1 Construction

All fixtures shall be suitable for use in outdoor open location and shall have degree of protection IP-65 or above.

The body of the lighting fixture shall be of cast aluminium alloy LM-6 and should be free from frictional sparking hazard. Complete fixture body and accessories shall be suitable to withstand corrosive atmosphere. Outer metallic surface shall be treated/ prepared and provided with two coats of epoxy paint. All screws, nuts, studs, clamps, supporting brackets, etc. shall be electro galvanized or zinc passivated.

All fixtures shall be provided with sheet steel vitreous enamelled or approved type of reflector. Glass used for fixtures shall be clean, heat & impact resistant and toughened type suitable for use under conditions involving exceptional risk of mechanical damage and shall be type `A' as per IS 2206 or the requirements stipulated by international standards. All well glass fixtures shall be provided with steel wire protecting cage having mesh dimension not exceeding 50 mm.

The fixing parts of the enclosure which is to be opened for replacement of bulb shall be so fastened that they can only be unfastened with special tools. All fixtures shall carry a special warning inscription in English to "Isolate supply elsewhere before opening". Three sets of special tools required for maintenance of fixtures shall be supplied free of cost along with the fixtures.

The temperature rise of external surface shall not exceed the temperature specified in the standards for the gas group to which fitting shall be suitable.

All junction boxes for looping for SPN Lighting circuits using cables upto 4 mm2 shall be minimum 100 mm dia in size. Junction boxes for looping of large three phase cable and

multiple single phase circuits shall be of minimum 300x250x100 mm. in dimension complete with flameproof cable glands as specified in material requisition.

The top of all well glass lighting fixtures shall be identically drilled/ threaded to facilitate the installation on pole/column or ceiling as per the enclosed sketch using stud/bracket supplied by others.

6.2 FLAME PROOF FITTINGS

Flame proof type fittings will be well glass type luminaries suitable for use with HPMV 80W/ 150W/ 250W/400W (High pressure Mercury Vapour) lamp to be used in gas group IIA/IIB and Zone-1/2 with separate control gear complete with copper ballast, power factor improvement capacitor, terminal block enabling loop-in-loop out connection. Fixture and lamp shall be perfectly matched and from same manufacturer. The fittings shall be supplied complete with all mounting accessories etc. The fitting shall be heavy duty and conform to IP 65 degree of protection

The control gear box and enclosure for fittings will have certification from CMRS, Dhanbad and will be suitable for gas groups IIA & IIB as per IS 2148-1981. The fittings will be designed as per IS 2206 (Part-I) -1987. The material for cable gland will be brass/stainless steel/aluminium alloy LM6 and will be double compression type suitable for indoor/outdoor use. These are must for every flameproof fittings and accessories.

Alternatively, LED flameproof well glass luminaire of 30W/ 40W (in place of 70W/125W HPMV) / 60W (in place of 250W HPMV) / 90W (in place of 400W HPMV), recommended for illuminating hazardous area laden with gases or vapors of group IIA, IIB & IIC & zone 1 & 2, suitable for industrial lighting may also be used as per manufacturer's standards. It shall have High pressure die cast aluminum housing with housing with toughned clear heat resistance well glass is cemented into a retaining ring which is fixed with screws to the main housing and the High power COB/SMD LEDs shall have luminous efficacy greater than 140 lm/W. It shall consist of highly reliable constant current LED driver. The LEDs shall withstand minimum surge protection of 4KV. The fitting shall be heavy duty and conform to IP 66 degree of protection.

7.0 COMPLETENESS OF EQUIPMENT

All fittings, accessories or apparatus which may not have been specially mentioned in this specification but which are otherwise necessary for satisfactory working of installation & working of lighting fixtures shall be deemed to have been included in the scope of supply.

8.0 DRAWINGS DOCUMENTS

Documents to be submitted along with the bid/offer:

- Confirmation of scope of supply. All pages of NIT to be signed.
- Un-priced copy to be submitted stating "quoted" against each item.
- Latest Catalogue.

Submission of Drawings & Documents:

Following drawings/ documents/ data shall be submitted for approval by the tenderer:

- Lighting Fixture Data sheets.
- GA of fixtures including mounting arrangement (Ceiling / wall/ structure / Pole).
- Bill of Materials (BOM).
- Product Catalogue.

9.0 TESTING AND INSPECTION

After completion of manufacturing of Lighting Fixtures and prior to despatch, the Lighting Fixtures shall be subjected to type, routine, acceptance and special tests as per the approved QAP. Purchaser / Consultant reserve the right to witness all tests with sufficient advance notice from vendor.

Inspection call shall be given by the manufacturer for association of purchaser or his representative during inspection. Inspection call shall be given minimum 15 days in advance from the proposed date of inspection. Four sets of relevant manufacturer test certificates, test certificate for major bought out components, internal inspection report of tenderer (if applicable) etc. as per the approved QAP shall be enclosed with each inspection call.

Inspection and testing of equipment shall be carried out by the owner/ consultant at the works of the contractor on final product to ensure conformity of the same with the acceptable criteria of technical specification, approval drags. and reference national/ international standards.
The contractor shall submit Quality Assurance Plan (QAP) for respective equipments within 3 weeks of award of contract.

QAP shall be prepared and furnished by the contractor in MECON Form No. 11.20(4.4) F-10 along with their internal in process quality checks.

Routine test and type test certificate shall be furnished for review.

The following type tests shall be carried out as per applicable Indian Standards and shall form part of acceptance testing

a) Dimensional check up
b) Static hydraulic test
c) Impact test
d) Thermal shock test
e) Durability test
f) Test for temperature rise
g) Test for flameproofness

Acceptance test shall be witnessed by owner/consultant.

The following tests shall constitute acceptance tests:

a) Dimensional check up
b) Static hydraulic test
c) Impact test
d) Thermal shock test
e) Durability test

The following tests shall constitute routine tests:

a) Dimensional check up
b) Static hydraulic test

10.0 PACKING / PROTECTIVE SHIPPING DELIVERY

10.1 Packing And Forwarding

All items shall be covered with water proof plastic packages and then packed in wooden crates. Dehumidifying agents shall be put inside the packing. All heavy items like control panels, etc. shall be properly supported by wooden structures before dispatch to avoid any damage during transit and handling of the packages. Electrical equipment shall be delivered to the consignee site by road transport Lorry receipt, invoices, packing list, etc. shall be sent to the consignee along with dispatch of equipment.

10.2 Match Marking

The sub-assembles/parts shall be properly match marked before dismantling for packing and dispatch. Manufacturer for reference during erection at site shall submit match-marking drawings to the purchaser.

REV 0
Edition 2

SPECIFICATION

FOR

CAPACITOR BANK

SPECIFICATION NO.- MEC/TS/05/E9/14

(ELECTRICAL SECTION)

MECON LIMITED

DELHI 110 092

C O N T E N T S

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 INTENT

a) The intent of this standard specification is to define the general requirements for design, manufacture, assembly and testing at manufacturer's works, packing, transportation and receipt at site with all materials and accessories of Capacitor Bank.

b) Tenderer to refer separate Technical specification (TS) / SOR item details for following minimum details / re uirements as part of the pro ect needs

1. **Re uirement of Capacitor bank and its rating voltage level.**
2. **Number of Steps/Switching Conditions/ Capacitor Units and its corresponding ratings.**
3. **Incoming feeder rating/ switchgear details etc. or other pro ect specific details, if any.**

Any other item / component / e uipment / accessories / services as necessary for satisfactory completion of the pro ect shall also be covered in separateTechnical specification (TS) / SOR item.

2.0 CODES STANDARDS

The Capacitor bank shall comply with the latest edition of the following and other relevant Indian standards. Incase equipment is supplied by foreign manufacturers relevant international standards shall be applicable.

IS: 2834:1986	-	Specification for Shunt Capacitors for power systems.
IS – 13340: 2012	-	Specification for Shunt Power Capacitors of Self-healing type for AC Systemsupto rated voltage of 1100V
IS: -13925:2012	-	Specification of Shunt Capacitors for AC power systems for Voltages above 1000V

IEEE - Recommended practice for electrical power distribution (Std. 141) for industrial plants.

3.0 TECHNICAL FEATURES

AUTOMATIC POWER FACTOR CORRECTION EQUIPMENT

The capacitor banks rating shall be selected in such a way so that the power factor shall be maintained to 0.95 or higher at 415 V at all load conditions.

The actual rating of the capacitor bank shall be finalised during drawing approval stage and it shall be provided without any price variation. The rating of the capacitor feeding cables shall be 30% higher than the normal rating

The capacitor bank shall be sheet steel enclosed, free standing, dust & vermin proof and suitable for indoor service. The banks shall be complete with capacitors, busbars chamber and busbars, suitable discharge resistor and fuse for individual capacitor, arrangement for cable entry and termination, earthing terminal, nameplate etc.

The control panel shall be complete with all relays, contactors, switches, lamps etc. Both manual and automatic correction shall be provided. The panel shall be sheet steel enclosed, free standing, dust & vermin proof and suitable for indoor service. The panel shall be complete with busbars chamber and busbars and arrangement for cable entry and termination, earthing terminal, nameplate etc.

The minimum voltage rating of capacitors shall be 460V (phase to phase). CFS unit and contactors shall be suitable for capacitor switching duty. Capacitor shall have higher voltage rating to account for series reactor and 10% system over voltage.

LT capacitors shall be controlled by contactors. The total bank isolation, from the MCC bus, shall be achieved by suitably rated CFS unit having capacitor switching capability. Current rating of CFS unit shall be 30% higher than the normal rating of capacitor bank.

Capacitor bank shall have generally use of different capacity ratings such as of 12.5KVAr , 25KVAr , 50 KVAr , 100 KVAr and so on , that shall be used such that control of desired power factor by proper selection of capacitor rating switching requirements can be more accurately achieved.

Each capacitor bank shall be of 3 Nos. of each individual capacitor rating units connected in delta & should have external fuses for protection. Each capacitor feeder shall have under voltage and over voltage protection by using relay.

Each capacitor shall have series reactor/ choke inductance to control the inrush current. The tenderer shall furnish the rating of capacitor bank and the series reactor/ choke inductance along with calculations in the offer based on data indicated in SLD.

Necessary CT requirement for automatic power factor correction in the incomer breaker panel shall be provided for automatic intelligent power factor controller. Automatic measurement system of the running load / power factor shall be provided to calculate the desired capacitor bank loading through use of automatic correction / capacitor bank switching command.

3.1 Capacitor units

Each capacitor unit shall be fully enclosed in sheet steel on plastic container of adequate thickness suitable for mounting inside the capacitor cubicle. The unit shall be supplied with necessary accessories for forming bank of specified rating.

Capacitors shall be of polypropylene dielectric with self-healing properties. Each unit shall have built-in discharge resistor, series reactor and unit protection fuses and two terminal bushings. The fuses shall not deteriorate or operate due to repeated switching at rated voltage.

The minimum voltage rating of capacitors shall be 440V (phase to phase). Capacitor shall have higher voltage rating to account for series reactor and 10% system over voltage.

The unit shall conform to IS-2834-1981 / IS-13925 and shall be suitable for an ambient of 50 degrees C.

PARAMETER		SPECIFICATION
Rated voltage	-	460V AC
Rated frequency	-	50 Hz
Max. over-current	-	1.3 times rated current
Max. over-voltage	-	1.1 times rated voltage
Max. over load	-	1.3 times rated output

Fuse (capacitor unit)	-	External fuse connected before capacitor
Mounting	-	IP54 enclosure mounted in a panel / box
Discharge device	-	Directly connected discharge device across the capacitor (in the same enclosure) to limit the residual voltage
Connection	-	By PVC copper / Aluminium cable suitable for bottom entry
Earth connection	-	Distinct earth terminals clearly marked . Specify terminal size
Bank connection	-	Delta connected
Max. permissible withstand capacity	-	As per IS13340
Peak inrush current	-	As per IS13340
Over voltage / long duration voltage withstand capacity	-	As per IS13340
Temperature class	-	Suitable for 45 deg C ambient (as per IS 2834). - Specify class selected.
Capacitance tolerance	-	PI specify
Terminals	-	Specify size with cable gland details
Bushing type	-	PI specify
Insulation level	-	2.5 KV

3.2 Capacitor banks

Each LT switchboard section shall have specified number and rating of capacitor banks. The capacitor banks shall be delta connected using singlephase units rated for 440 V. Where capacitor banks of different ratings are specified, the same shall be built-up from a single standard capacitor unit. The capacitor bank formation inside the cubicle shall be formed

considering easy accessibility for each unit and better air clearances. All bus work shall be adequately supported for maximum fault level specified.

Each bank shall be independently controlled. All the banks shall be controlled automatically based on bus power factor. The control scheme shall be such that maximum numberof steps are achieved for smooth control of power factor.

3.3 Control e uipment

Each capacitor bank shall have independent control equipment comprising fuse switch unit, power contactor with auxiliary contacts, line CTs with taut band ammeter and selector switch to read phase currents of capacitor bank feeder, ON/OFF indicating lamps, auto/manual selector switch, auxiliary relays and any other equipment required for satisfactory operation, maintenance and control. Local/remote selector switches where specified shall be provided for switching ON/OFF capacitor banks from remote location.

Each bus section shall have a multistage (12 stage) microprocessor based PF relay with associated contactors, bus PF meter for group control of the banks connected to respective bus section. The power factor controller shall have LCD display with indication of inductive/capacitive power factor, active outputs, demand for switching on/off of a capacitor step, alarm conditions, overtemperature conditions, phase shift, C/K ratio, type of switching sequence etc.It shall also have optional RS-485 Modbus adaptor for allowing communication with a monitoring system.

All switching equipment shall have capacitor switching rating of 150%of rated current of capacitor bank. All equipment shall be suitable for 240 V AC control supply. Necessary protection through HRC fuses shall be provided for control circuits. Control supply shall be drawn preferably through control transformer. Necessary interlock shall be provided to ensure switching-on of capacitor banks after it is fully discharged.

3.4 Details to be furnished in datasheet of APFC Panel

i) Name of manufacturer
ii) kVAR rating
iii) Rated voltage
iv) Rated Frequency
v) Number of phases
vi) Type of connection
vii) Enclosure details
viii) Material of construction and its thickness
ix) Dimensions
x) IP Protection class
xi) Application

xii) Cable entry details
xiii) Paint shade
xiv) Busbar details – Material,cross section, busbar supports etc.
xv) Capacitor type
xvi) Number of steps
xvii) Configuration details
xviii) Switchgear details – Incomers, outgoing, APFC Relays etc.
xix) Bill of material

4.0 DRAWINGS AND DOCUMENTS

4.1 Vendor shall furnish all data/drawings/documents specified in the vendor data requirement.Approval of the drawing shall not relieve the manufacturer of his responsibility to equipment conforming to the relevant specification and standards or for any mistakes, errors or omissions in the drawing.

4.2 Following Drawings & Documents shall be submitted after award of contract for approval:

i) List of drawings
   a) Overall General arrangement drawing
   b) Capacitor bank details
   c) Capacitor sizing calculation
   d) Technical Datasheet
   e) Bill of material
   f) QAP, Internal Test Certificates and Inspection Certificates

ii) Instruction manuals for erection, testing and commissioning.
   a) Instruction manual shall give step by step procedure for:

   - Erection, testing and commissioning
   - Operation
   - Maintenance and
   - Repair

   b) Operation and Maintenance Manual
   - Recommended procedure for routine maintenance

- Tests for checking of proper functioning

iii) List of special tools and tackles

5.0 TESTS AND ACCEPTANCE

Tests shall be carried out at manufacturer's works under his care and expense.

The manufacturer shall submit a QAP inline with the format enclosed for approval of MECON. All tests and documents of inspection documents shall be shall be done based on this.

All routine tests as specified by the applicable standard code shall be conducted. Type test certificates for the Capacitor bank from a recognized testing organization shall be furnished with the bids. The vendor shall also submit a list of guaranteed technical particulars with the bids.

In addition, specific tests shall be conducted to check mechanical and electrical operation/wiring etc. and panel wiring conforming to the specification and approved schematic drawings.

All routine tests on capacitor banks shall be conducted as per relevant standards (Refer IS: 13118 – latest revision).

Above tests shall be provisionally conducted at manufacturer's works by providing temporary connection to switchgear units in order to simulate the actual conditions.

QAP shall generally cover the following tests:

- Visual
- Dimensional
- Fitment & alignment
- Measurement of IR Value – Before HV test & after HV test
- High voltage test/ dielectric test
- Routine test as per relevant IS/other standard
- Type test as per relevant IS/other standard
- Impulse test HT
- Test certificates of bought out items
- Paint shade verification
- Operational & functional check
- Verification of BOM

Type tests

- Thermal stability test

- Measurement of the tangent of the loss angle (tan δ) of the capacitor at elevated temperature
- Voltage test between terminals
- Voltage test between terminals and container
- Lightning impulse voltage test between terminals and container
- Discharge test
- Ageing test
- Self-healing test
- Destruction test

Routine tests

- Capacitance measurement and output calculation
- Measurement of the tangent of the loss angle (tan δ) of the capacitor at elevated temperature
- Voltage test between terminals
- Voltage test between terminals and container
- Test of the internal discharge device
- Self-healing test

All the capacitor banks shall be subjected to the routine tests as per IS 13340 at manufacturer's works. Type test certificates for similar design have to be submitted for approval. Test procedures as specified in IS-13340 shall be adopted.

6.0 CAPACITOR SIZING CALCULATION (To be submitted by the vendor)

i) Required kVAr = kW [tan $\cos^{-1}$(initial pf) – tan $\cos^{-1}$(final pf)]

ii) kVAr of capacitor bank = $\frac{2 \times \pi \times f \times C}{100}$

iii) kVAr of series reactor = kVAr of capacitor bank x % of reactor

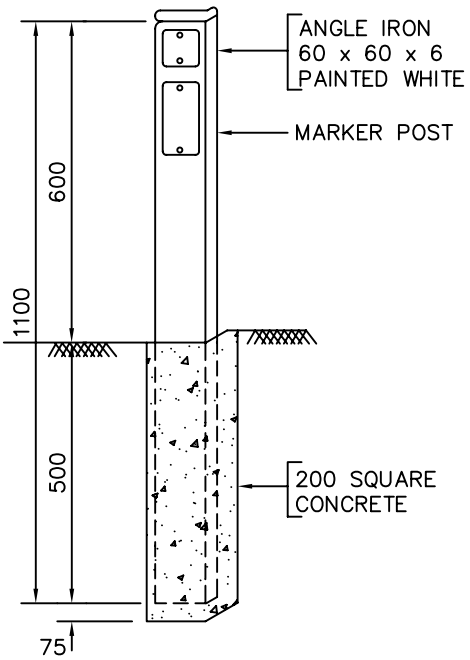
iv) Current of series reactor = $\frac{\text{kVAr of capacitor bank}}{\text{kV} \times \sqrt{3}}$

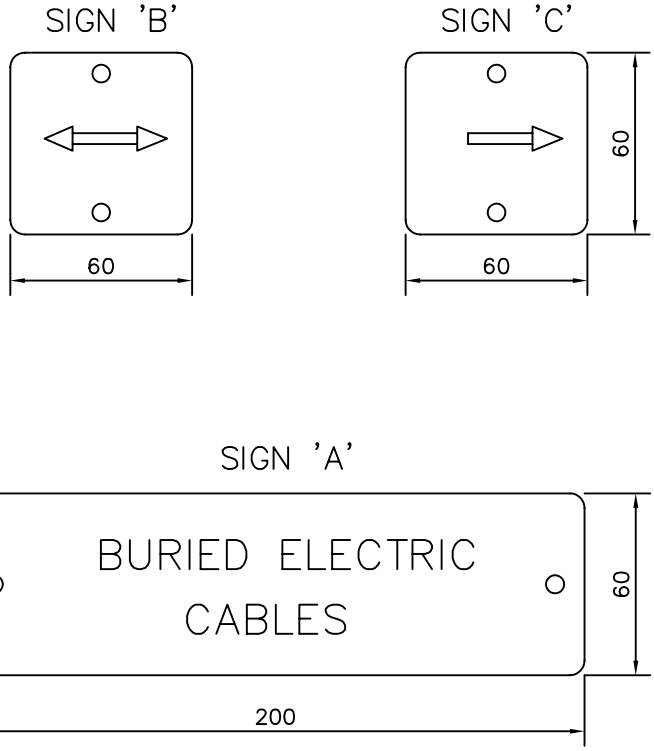
v) Inrush current = $\frac{U\sqrt{2}}{\sqrt{X_C \times X_L}}$

STANDARD DRAWING
(ELECTRICAL SYSTEM)

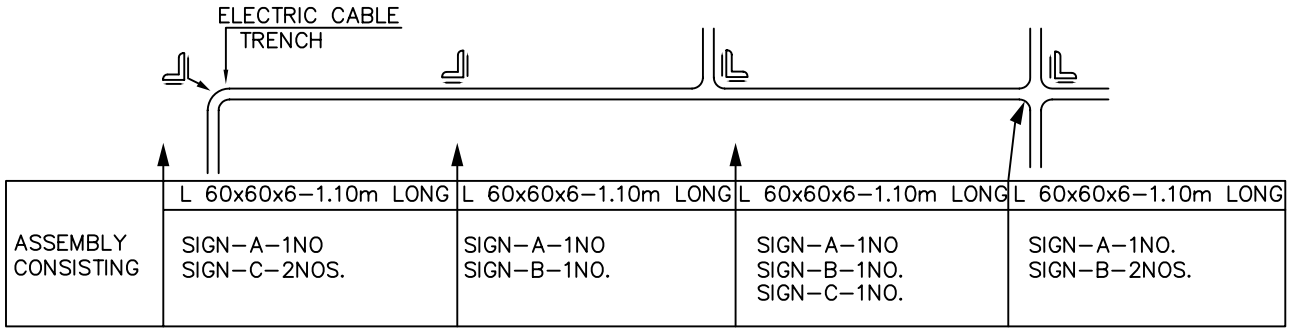
LIST OF STANDARD DRAWINGS (ELECTRICAL)

Sl. No.	Description of Drawings	Drawings No.
1	MARKING OF TRENCHES FOR ELECTRIC CABLES	MEC/SD/05/E9/01/01
2	TYPICAL SECTION OF CABLE TRENCH IN UNPAVED AREAS	MEC/SD/05/E9/01/02
3	EARTH ELECTRODE IN TEST PIT	MEC/SD/05/E9/02/01
4	COPPER PLATE ELECTRODE IN TEST PIT	MEC/SD/05/E9/02/02
5	TYPICAL EARTH CONNECTION FOR STREET LIGHT POLE	MEC/SD/05/E9/02/03
6	EARTHING OF TANKS AND VESSELS	MEC/SD/05/E9/02/04
7	EARTHING METHOD FOR PROCESSING EQUIPMENT	MEC/SD/05/E9/02/05
8	TYPICAL INSTALLATION OF POLE MOUNTED STREET LIGHTING FIXTURE FOR SAFE AREA (WITHOUT RUNGS)	MEC/SD/05/E9/03/01
9	BLOCK DIAGRAM FOR UPS SYSTEM, 3PH. CHARGER AND ACDB	MEC/SD/05/E9/071/01
10	TYPICAL INSTALLATION OF FLOOD LIGHTING POLE (WITH RUNGS)	MEC/SD/05/E9/77/02
11	DIV.2 / FLAME PROOF LIGHTING FIXTURE MOUNTING DETAILS	MEC/SD/05/E9/77/03
12	TYPICAL INSTALLATION OF LIGHTING FIXTURES ON GI OCTOGONAL POLE.	MEC/SD/05/E9/77/04 Sheet 1 of 3
13	TYPICAL INSTALLATION OF LIGHTING FIXTURES ON GI OCTOGONAL POLE.	MEC/SD/05/E9/77/04 Sheet 2 of 3
14	TYPICAL INSTALLATION OF LIGHTING FIXTURES ON GI OCTOGONAL POLE.	MEC/SD/05/E9/77/04 Sheet 3 of 3





TYPICAL ARRANGEMENT OF MARKER



	L 60x60x6–1.10m LONG	L 60x60x6–1.10m LONG	L 60x60x6–1.10m LONG	L 60x60x6–1.10m LONG
ASSEMBLY CONSISTING	SIGN–A–1NO SIGN–C–2NOS.	SIGN–A–1NO SIGN–B–1NO.	SIGN–A–1NO SIGN–B–1NO. SIGN–C–1NO.	SIGN–A–1NO. SIGN–B–2NOS.

NOET:– 1. TRENCHES SHALL BE MARKED AT ALL DIRECTION CHANGES, INTERSECTIONS AND STRAIGHT RUNS.
2. SIGN MADE OF 14 ENAMELLED SHEET PLATE WHITE LETTRING MADE ON GREEN BACKGROUND.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
			REVISIONS				

SECTION: ELECTRICAL

	NAME	DATE	CHKD	DATE
DSGN				
DRWN				

APPROVED

MARKING OF TRENCHES FOR ELECTRIC CABLES

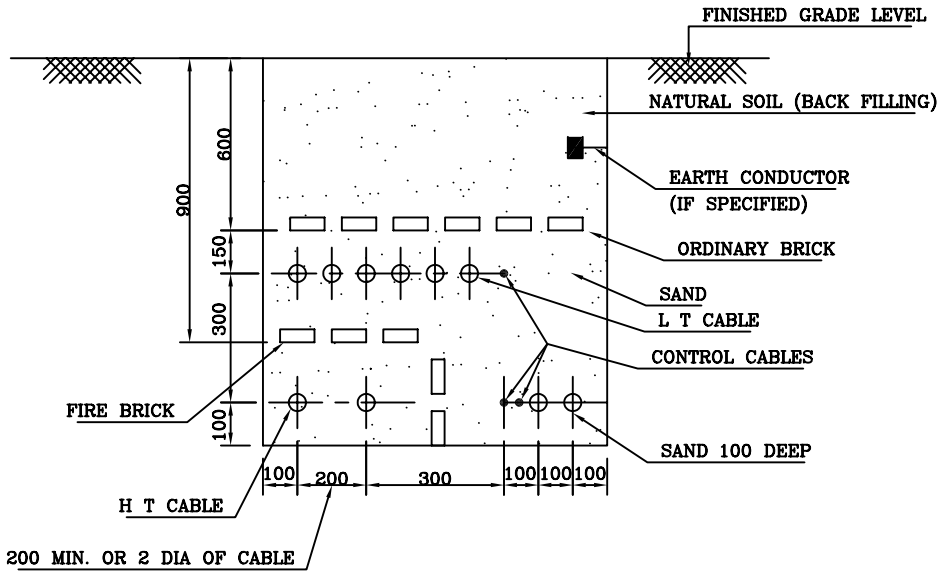
मेकॉन लिमिटेड
MECON LIMITED

SCALE : N.T.S.

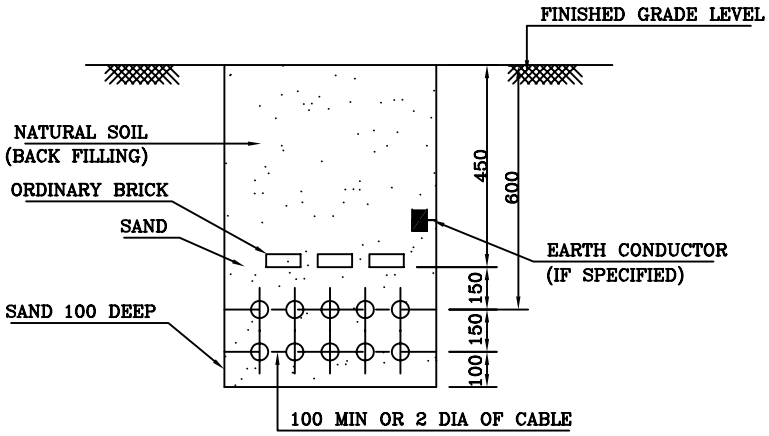
DRG.NO MEC/SD/05/E9/01/01

REV 0

TYPICAL SECTION WITH H. T. CABLES AND L T CABLES



TYPICAL SECTION WITH L T CABLES ONLY



NOTES:–

1. LEAVE SPACE FOR LATER ADDITION OF AT LEAST 2 CABLES OR 15% AVERAGE SPARE SPACE REGARDLESS OF FUTURE EXPANSION.
2. IF TELEPHONE CABLES ARE LAID IN THE SAME TRENCH A CLEARANCE OF 300mm SHALL BE BE PROVIDED BETWEEN POWER AND TELEPHONE CABLES .

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
			REVISIONS				

SECTION: ELECTRICAL				
	NAME	DATE	CHKD	DATE
DSGN				
DRWN				
APPROVED				

TYPICAL SECTION OF CABLE TRENCH IN UNPAVED AREAS

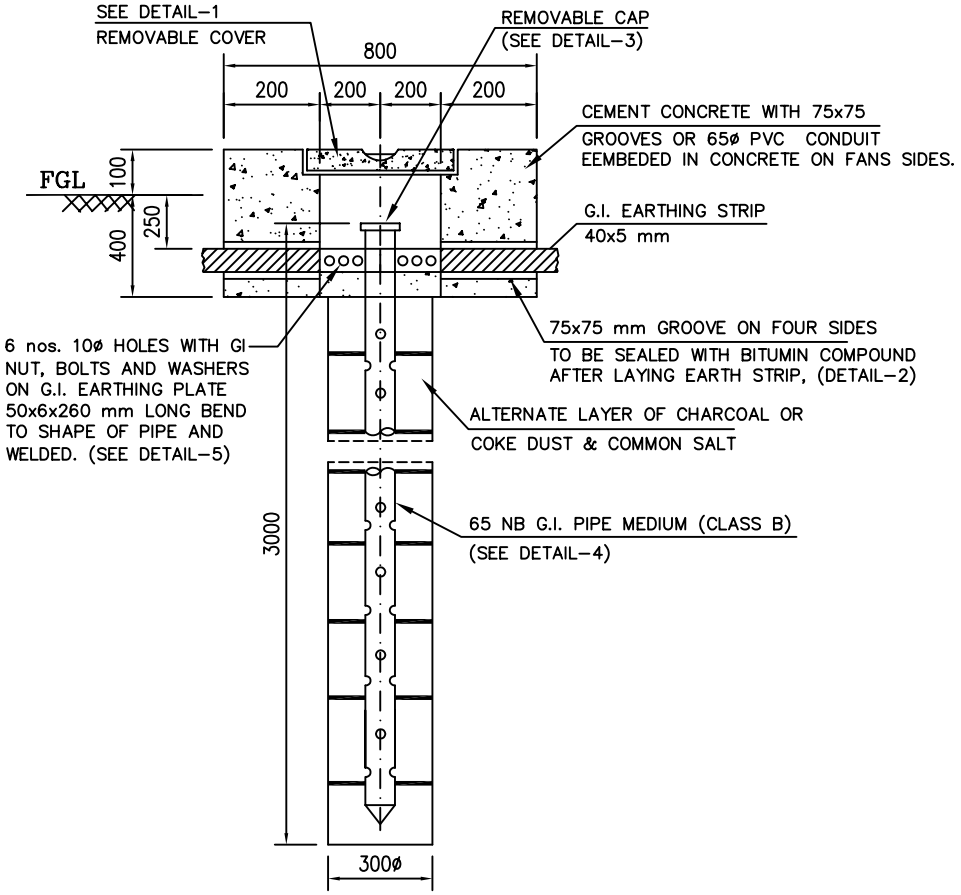
मेकॉन लिमिटेड

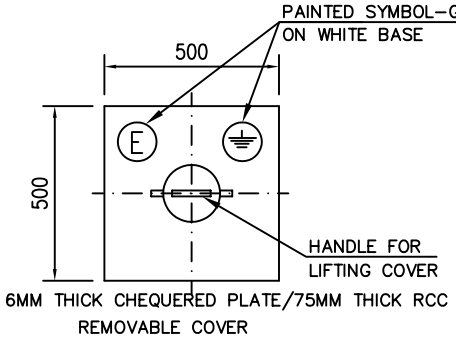
MECON LIMITED

SCALE : N.T.S.

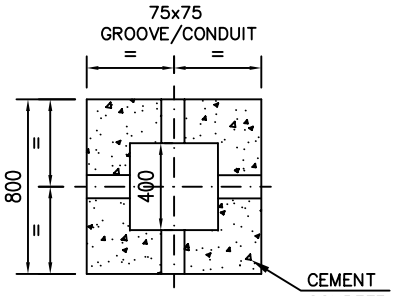
DRG.NO MEC/SD/05/E9/01/02

REV 0

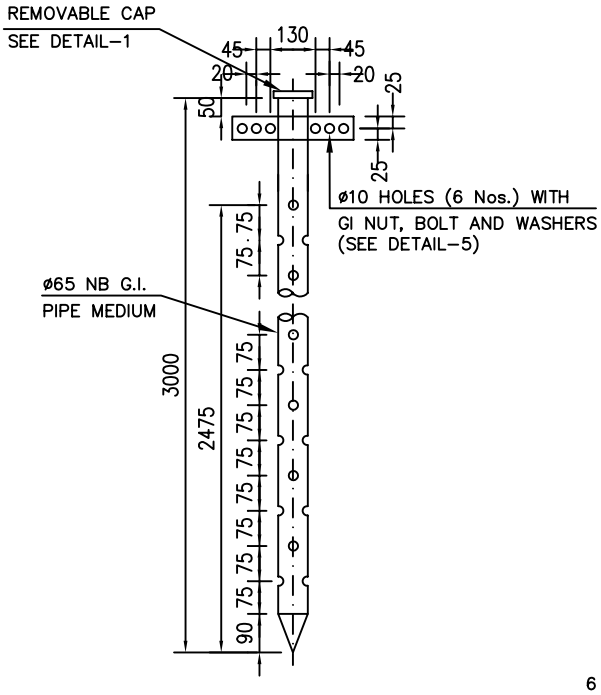




DETAIL–1 R3



DETAIL–2



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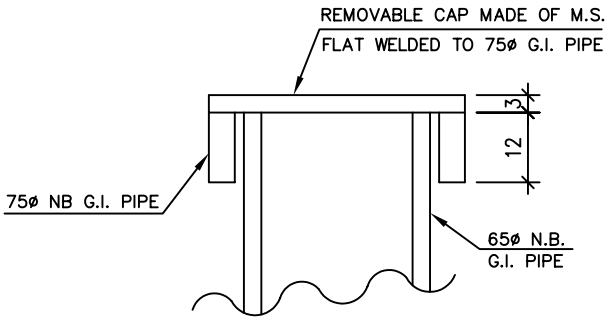
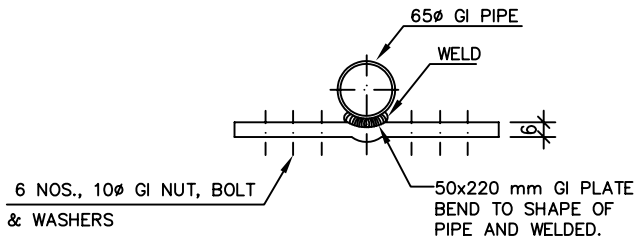


DETAIL–3



DETAIL–5

NOTE:–

1.) THE PIPE SHALL BE HOT DIP GALVANISED AFTER FABRICATION.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
3	30.04.07	G2	CHEQUERED PLATE COVER ADDED	QA	DKP		

REVISIONS

SECTION: ELECTRICAL				
	NAME	DATE	CHKD	DATE
DSGN	QUASIM			
DRWN	IRFAN	23.07.04		

APPROVED

EARTH ELECTRODE IN TEST PIT

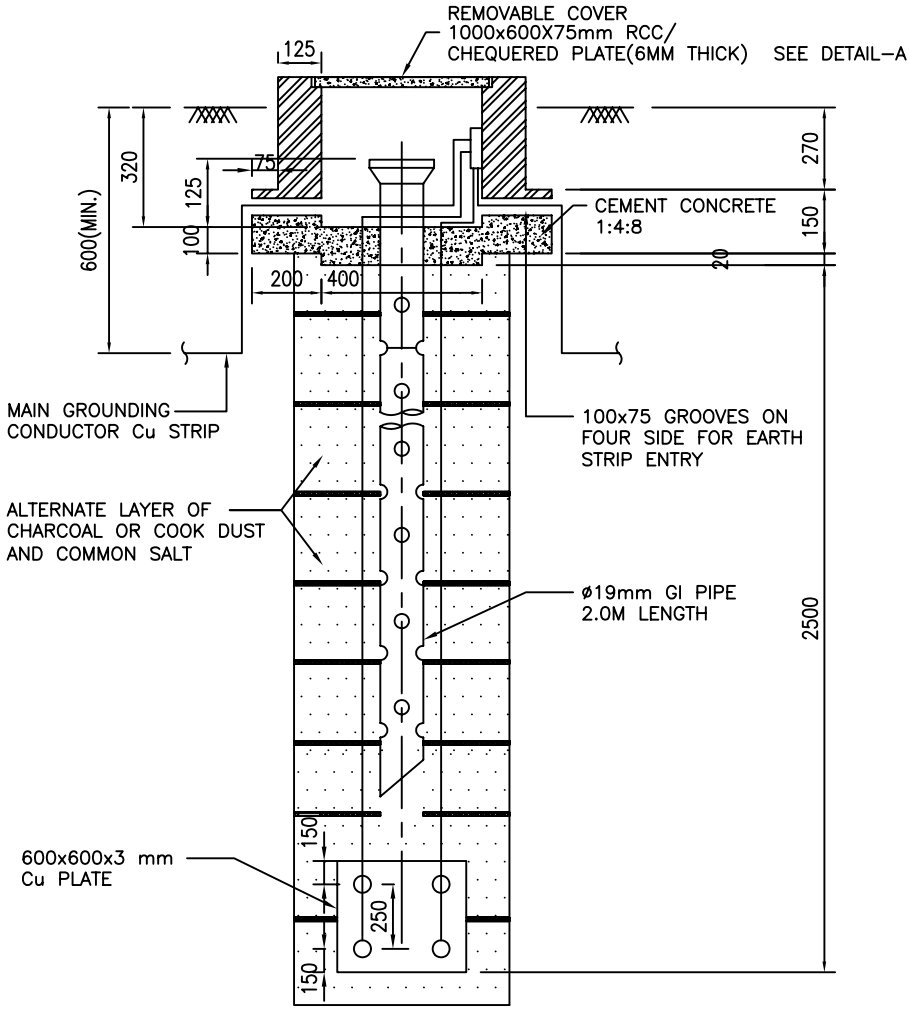
मेकॉन लिमिटेड

MECON LIMITED

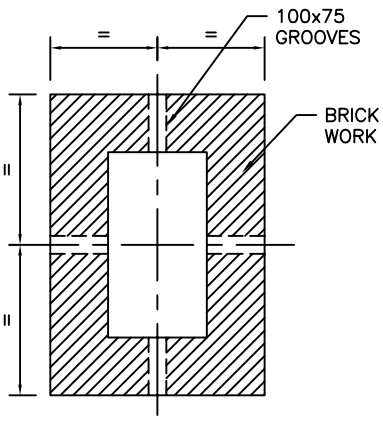
SCALE : N.T.S.

DRG.NO MEC/SD/05/E9/02/01

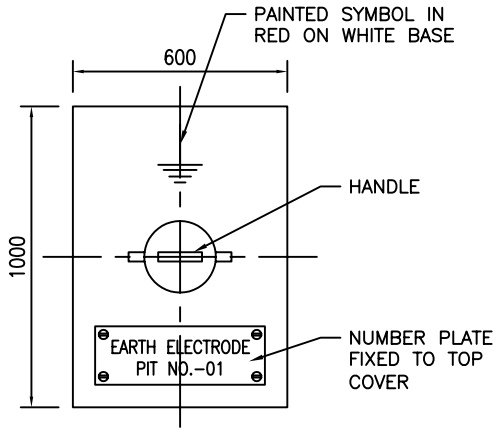
REV 3



COPPER PLATE ELECTRODE WITH TREATED EARTH PIT



DETAIL-B



DETAIL-A

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD		
REVISIONS				REFERENCES		DRG. NO.	

SECTION: ELECTRICAL					
	NAME	DATE	CHKD	DATE	
DSGN	Q.A.		QA		
DRWN	IRFAN	05.01.07			
APPROVED	(DK PANDE)				

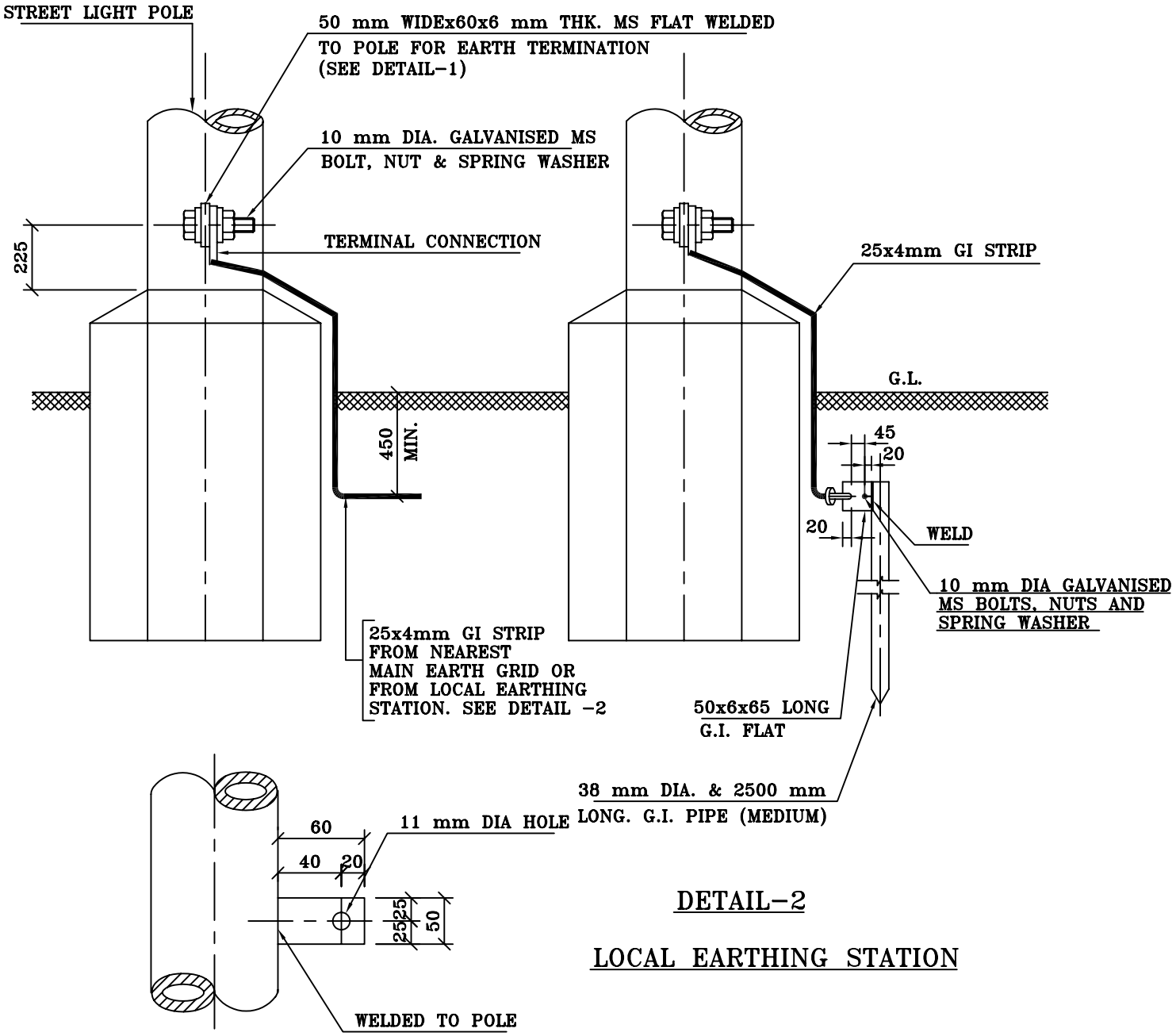
COPPER PLATE ELECTRODE IN TEST PIT

मेकॉन लिमिटेड

MECON LIMITED

SCALE : N.T.S. (SH. 1 OF 1) REV

DRG.NO MEC/SD/05/E9/02/02 0



DETAIL-1

DETAIL-2

LOCAL EARTHING STATION

NOTES:-

1. USE TWO EARTHINGS IF VOLTAGE IN POLE JUCTION BOX IS 415 V

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS				REFERENCES	DRG. NO.

SECTION: ELECTRICAL				
	NAME	DATE	CHKD	DATE
DSGN	QUASIM			
DRWN	IRFAN	29.07.04		
APPROVED				

TYPICAL EARTH CONNECTION FOR STREET LIGHT POLE

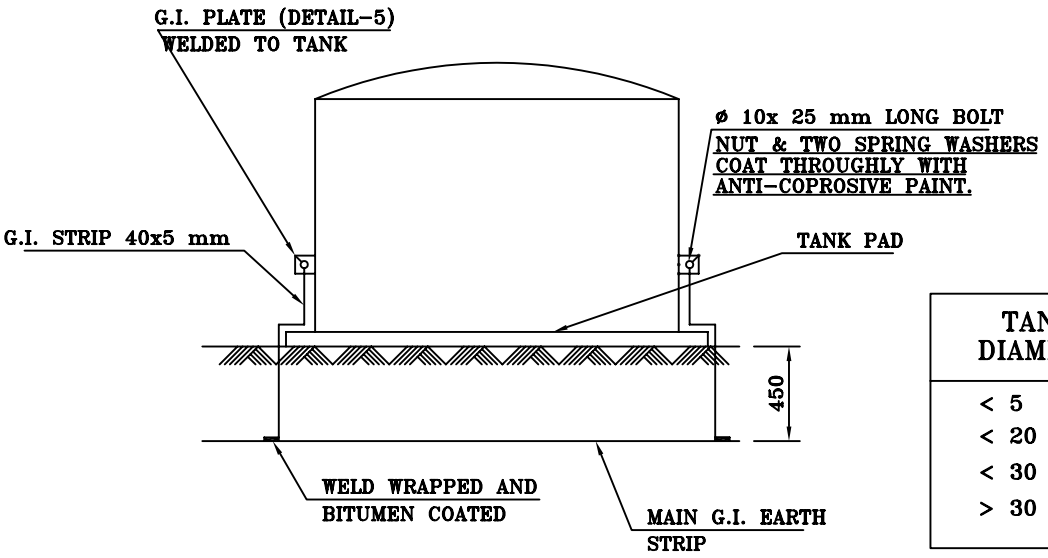
मेकॉन लिमिटेड

MECON LIMITED

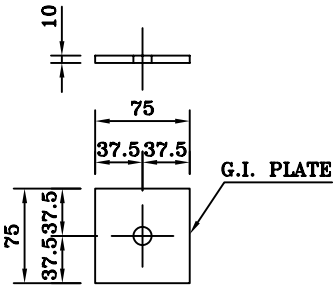
SCALE : N.T.S.

DRG.NO MEC/SD/05/E9/02/03

REV 2



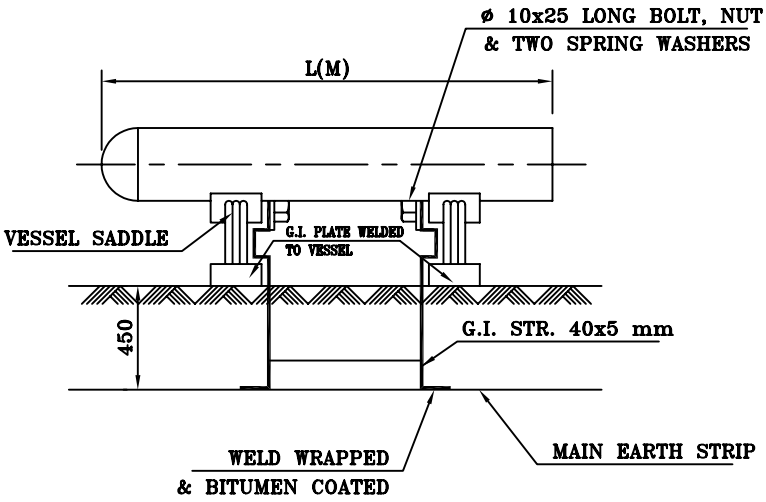
DETAIL-1



DETAIL-5

TANK DIAMETER	GROUNDIG CONNECTION
< 5	1
< 20	2 AT 180°
< 30	3 AT 120°
> 30	4 AT 90°

DETAIL-2



DETAIL-3

TANK DIAMETER	GROUNDIG CONNECTION
< 5	1
< 20	2
< 30	3
> 30	4

DETAIL-4

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS				REFERENCES	DRG. NO.

SECTION: ELECTRICAL

	NAME	DATE	CHKD	DATE
DSGN				
DRWN				

APPROVED

EARTHING OF TANKS AND VESSELS

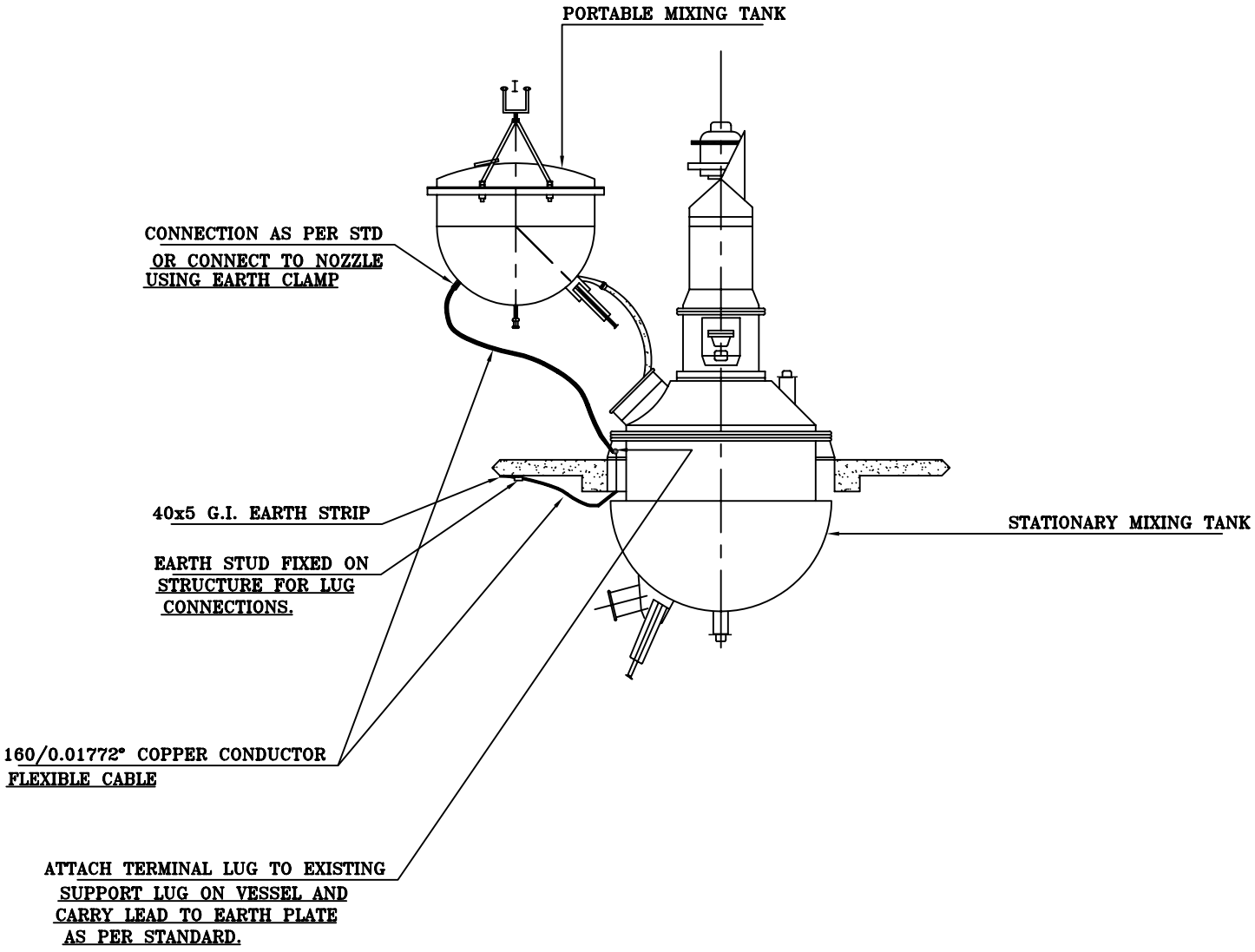
मेकॉन लिमिटेड

MECON LIMITED

SCALE : N.T.S.

DRG.NO MEC/SD/05/E9/02/04

REV 0



NOTE:

1. ALL PROCESSING EQUIPMENT INCLUDING MIXERS, CHURNS, AUTOCLAVES, COLUMNS, CENTRIFUGES, FILTER PRESS,PUMPS ETC. SHALL BE ELECTRICALLY EARTHED EXCEPT WHERE IN DIRECT CONTACT WITH PROPERLY EARTHED STEEL MEMBERS.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
			REVISIONS				

SECTION: ELECTRICAL				
	NAME	DATE	CHKD	DATE
DSGN				
DRWN				
APPROVED				

EARTHING METHOD FOR PROCESSING EQUIPMENT

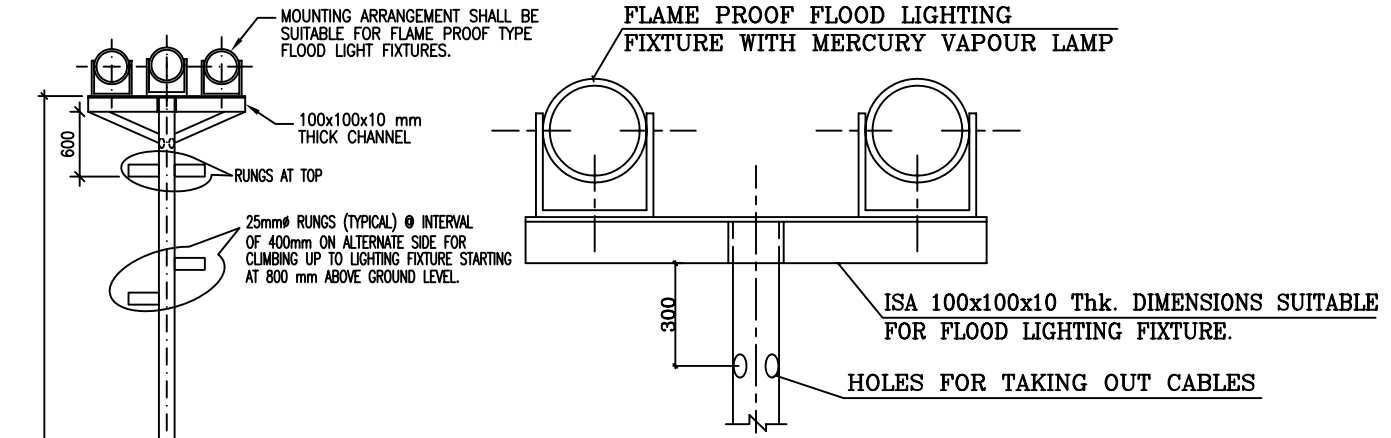
मेकॉन लिमिटेड

MECON LIMITED

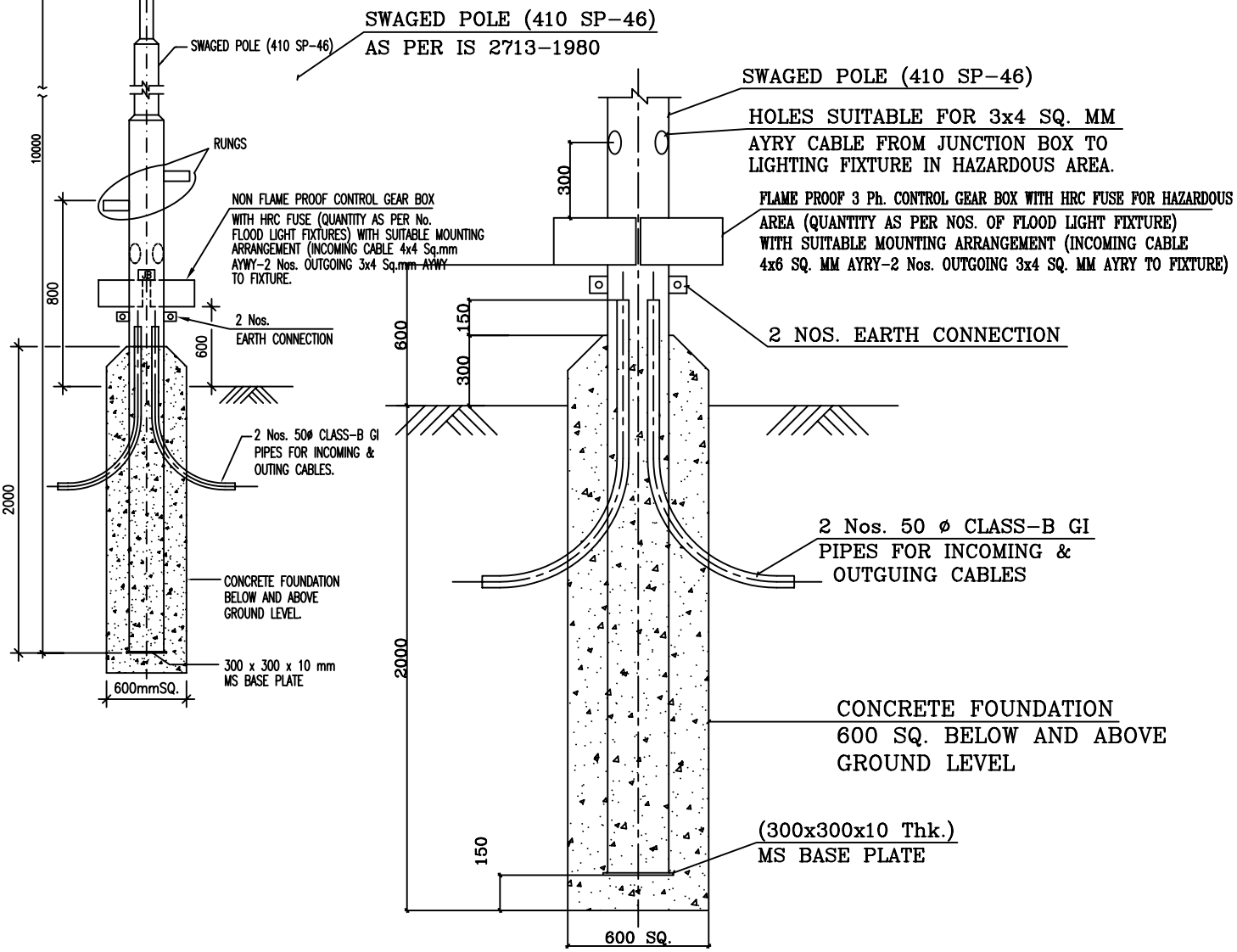
SCALE : N.T.S.

DRG.NO MEC/SD/05/E9/02/05

REV 0



MOUNTING ARRANGEMENT AT TOP



BOTTOM DETAIL

NOTE :-

1. MARSHALLING BOX / JUNCTION BOX & G.I. PIPES FOR CABLES SHALL BE PROVIDED ON THE CABLE TRENCH SIDE.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD
			REVISIONS		REFERENCES

DRG. NO.

SECTION	ELECTRICAL			
	NAME	DATE	CHKD	DATE
DSGN				
DRWN	DAYA	12.04.2001		
APPROVED				

TYPICAL INSTALLATION OF FLOOD LIGHTING POLE (WITH RUNGS)

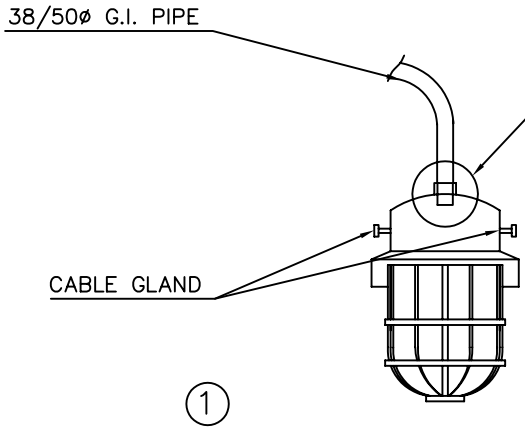
मेकन लिमिटेड

MECON LIMITED

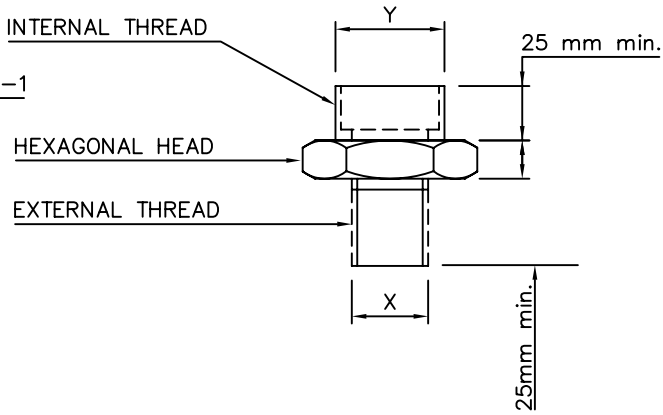
SCALE : 1:50

DRG.NO. MEC/SD/05/E9/77/02

REV 0

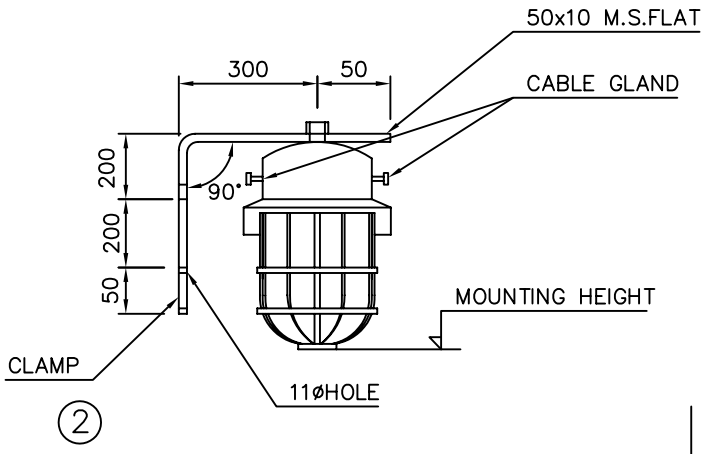


DIV. 2/FLAME PROOF WELL GLASS
LIGHTING FIXTURE–POLE MOUNTED

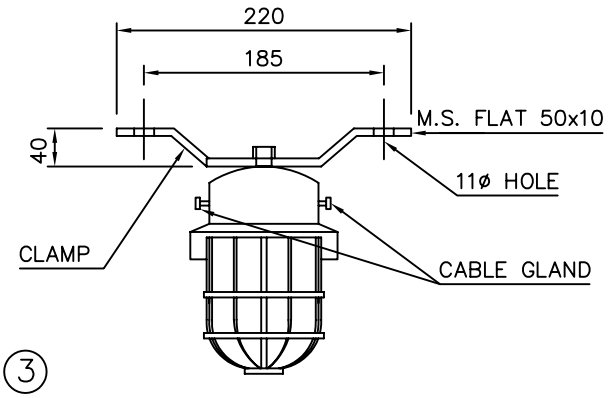


DETAIL – 1
(ADAPTOR)

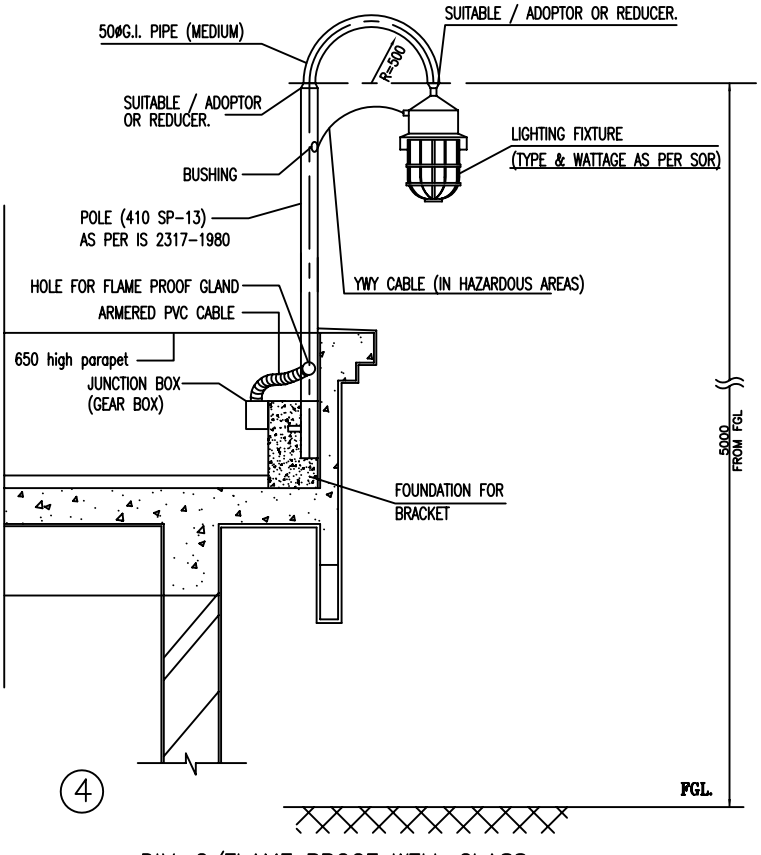
DESCRIPTION	DIMENSIONS	
	X	Y
PLATFORM MOUNTED POLE	TO SUIT 19ø B.S. PIPE	TO SUIT 38ø B.S. PIPE
FLOOR MOUNTED POLE	TO SUIT 19ø B.S. PIPE	TO SUIT 50ø B.S.PIPE



DIV. 2/FLAME PROOF WELL GLASS
LIGHTING FIXTURE–BRACKET MOUNTED



DIV. 2/FLAME PROOF WELL GLASS
LIGHTING FIXTURE–CEILING MOUNTED



DIV. 2/FLAME PROOF WELL GLASS
LIGHTING FIXTURE–BRACKET MOUNTED ON BUILDING.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS				REFERENCES	DRG. NO.

SECTION: ELECTRICAL

	NAME	DATE	CHKD	DATE
DSGN				
DRWN				

APPROVED

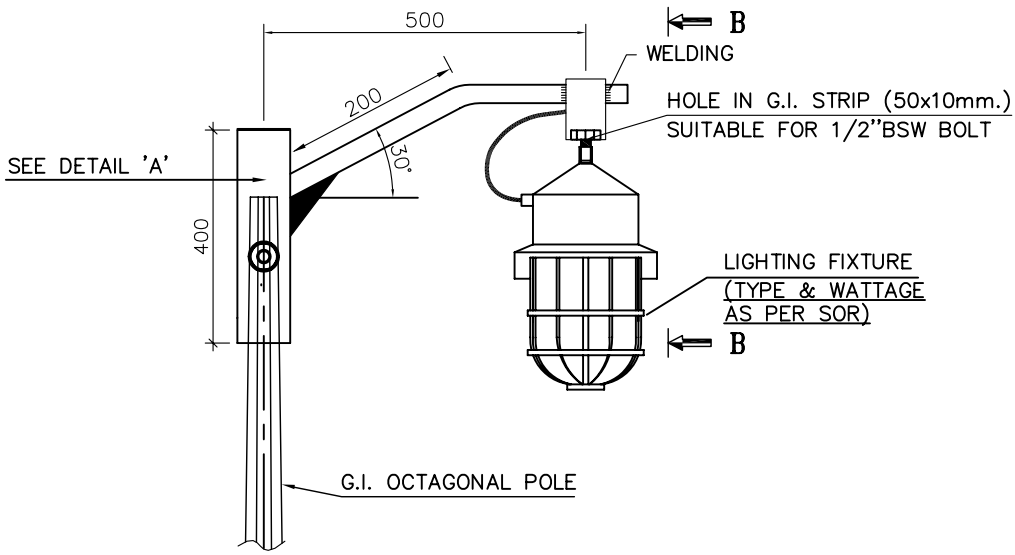
FLAME PROOF LIGHTING FIXTURE MOUNTING DETAILS (TYPICAL)

मेकॉन लिमिटेड
MECON LIMITED

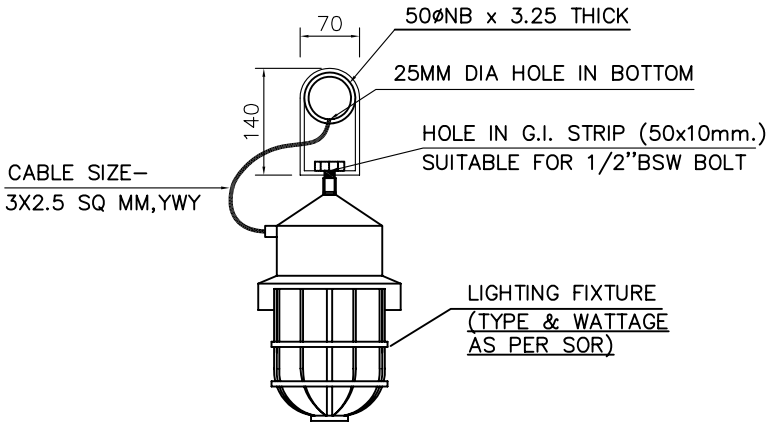
SCALE : N.T.S.

DRG.NO MEC/SD/05/E9/77/03

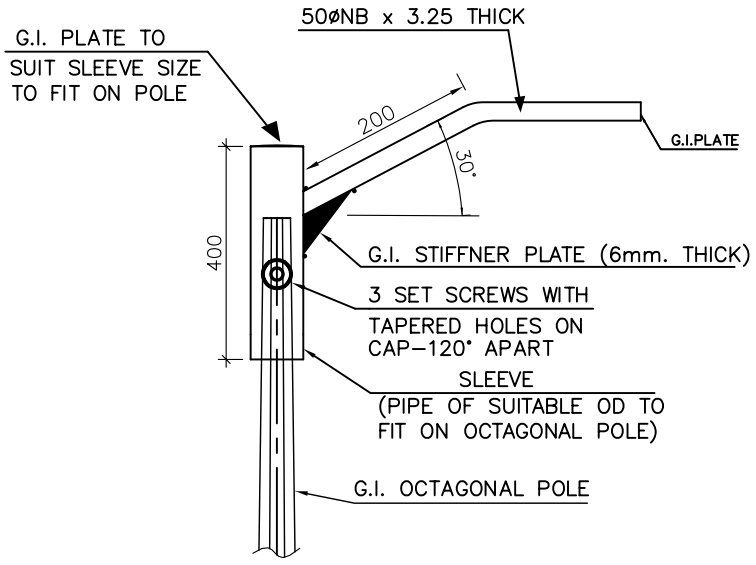
REV 0



DETAIL OF BRACKET/ARM



VIEW B–B



DETAIL–A

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD	REFERENCES	DRG. NO.
			REVISIONS				

SECTION: ELECTRICAL

	NAME	DATE	CHKD	DATE
DSGN	QUASIM			
DRWN	SUNIL	13.01.10		

APPROVED

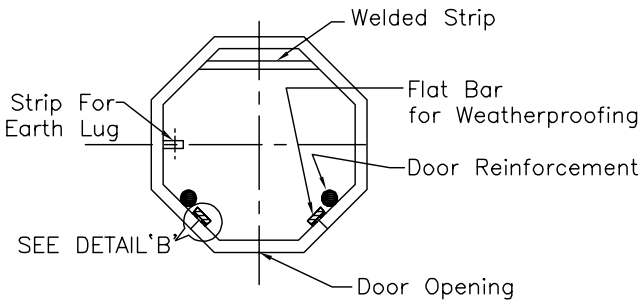
TYPICAL INSTALLATION OF LIGHTING FIXTURE ON OCTAGONAL POLE

मेकॉन लिमिटेड

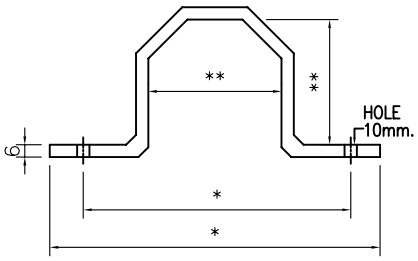
MECON LIMITED

SCALE : N.T.S. | SHEET 2 OF 3 | REV 0

DRG.NO MEC/SD/05/E9/77/04



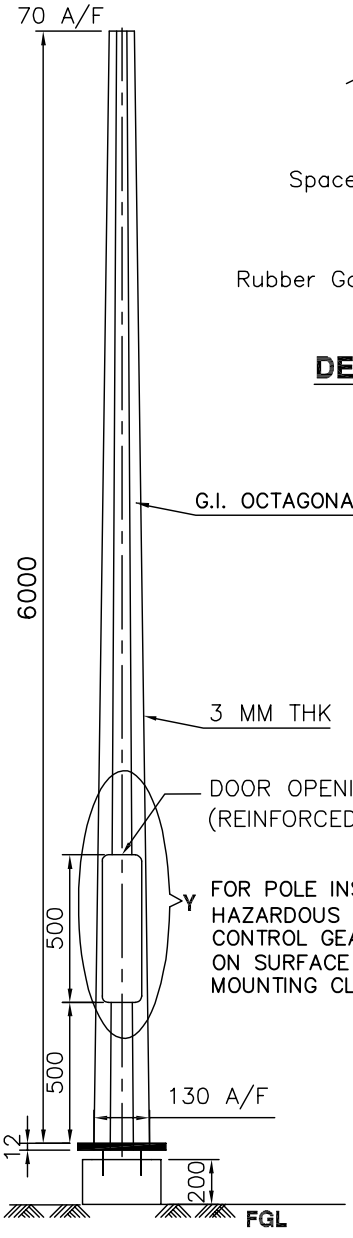
SECTION A-A (FOR SAFE AREA)



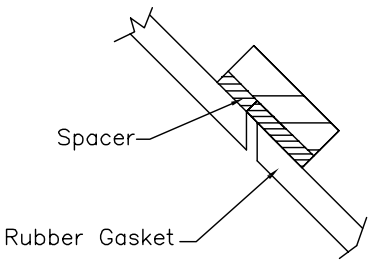
G.I. MOUNTING CLAMPS FOR CONTROL GEAR BOX

NOTE:-

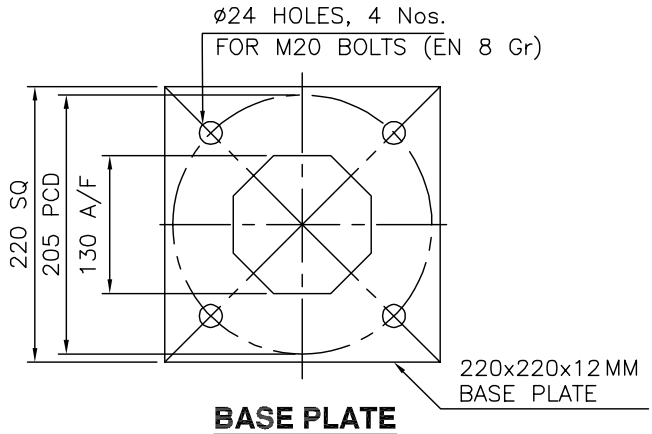
* DIMENSOIN TO FIT THE MOUNTING HOLE OF CONTROL GEAR BOX.
** TO SUIT POLE DIMENSION



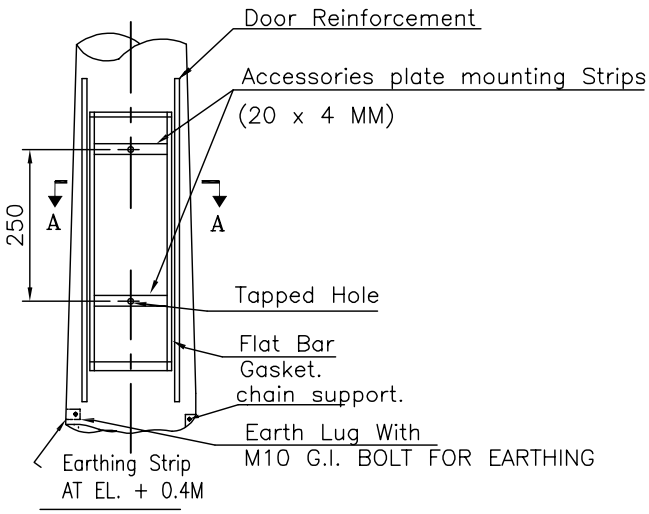
ELEVATION



DETAIL`B'



BASE PLATE



DETAIL`Y'

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS				REFERENCES	DRG. NO.

SECTION: ELECTRICAL				
	NAME	DATE	CHKD	DATE
DSGN	QUASIM			
DRWN	SUNIL	13.01.10		
APPROVED				

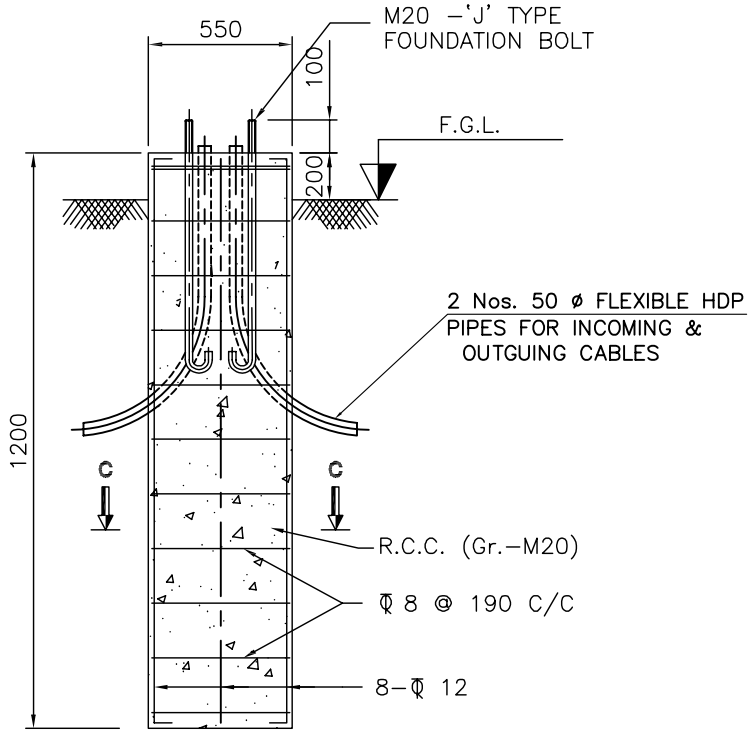
TYPICAL INSTALLATION OF LIGHTING FIXTURE ON OCTAGONAL POLE

मेकॉन लिमिटेड

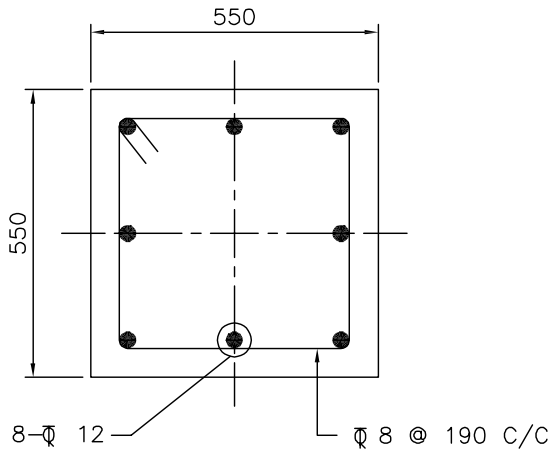
MECON LIMITED

SCALE : N.T.S. | SHEET 1 OF 3 | REV 0

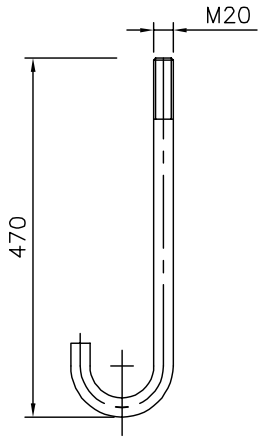
DRG.NO MEC/SD/05/E9/77/04



DETAIL OF CIVIL FOUNDATION



SECTION C-C



ANCHOR BOLT DETAIL
(TOTAL LENGTH–600 mm)

NOTES:

1. Grade of steel reinforcement (for R.C.C.) – Fe 415
2. Clear cover to reinforcement – 50 mm
3. Assumed S.B.C. – 10 T/Sq.mtr. (minimum)

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS				REFERENCES	DRG. NO.

SECTION: ELECTRICAL				
	NAME	DATE	CHKD	DATE
DSGN	QUASIM			
DRWN	SUNIL	13.01.10		

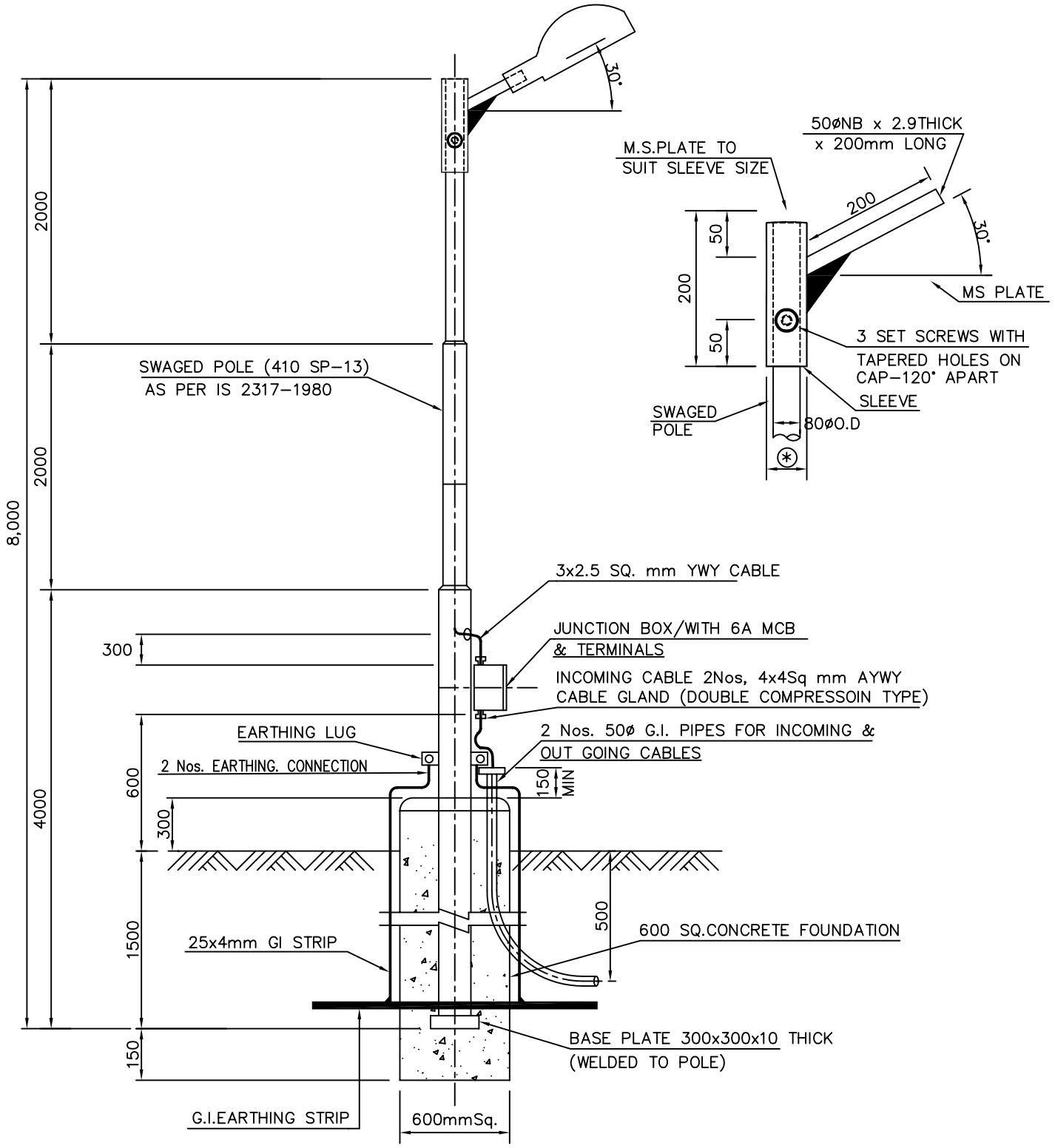
APPROVED

TYPICAL INSTALLATION OF LIGHTING FIXTURE ON OCTAGONAL POLE

मेकॉन लिमिटेड
MECON LIMITED

SCALE : N.T.S. | SHEET 3 OF 3 | REV 0

DRG.NO MEC/SD/05/E9/77/04



NOTES:-

1.) ⊛TO SUIT 80mmø OD (TOP SECTION).

2.) MARSHALLING BOX,JUNCTION BOX & G.I. PIPES FOR CABLES SHALL BE PROVIDED ON THE CABLE TRENCH SIDE.

REV NO	DATE	ZONE	DESCRIPTIONS	BY	APPRD
REVISIONS				REFERENCES	DRG. NO.

SECTION: ELECTRICAL

	NAME	DATE	CHKD	DATE
DSGN	QUASIM			
DRWN	IRFAN	30.07.04		

APPROVED

TYPICAL INSTALLATION OF STREET LIGHTING FIXTURE (BRACKET MOUNTED) ON POLE FOR SAFE AREA

मेकॉन लिमिटेड

MECON LIMITED

SCALE : N.T.S.

DRG.NO MEC/SD/05/E9/03/01

REV 0