

4.17.2 Measurement for steel: -

The structural steel shall be measured as built. No deduction for holes less than 0.02 sq.m shall be made. Steel as erected and specified shall be paid.

4.18 Rate for Painting: -

Rate for painting shall include all item indicated above inclusive of men, material and equipments.

4.18.2 Measurement for Painting: -

Measurement for painting shall be as of Metric tones of Structural steel erected and completed.

4.19 Galvanising of Structural Steel

4.19.2 Galvanising Plant

Prior approval shall be obtained from Employer / Engineer-in-charge if galvanizing is proposed to be carried out outside Contractor's plant.

4.19.3 Workmanship

After all shop work is complete, all structural materials shall be punched with the erection mark and be hot-dip galvanized. Before galvanizing, the steel shall be thoroughly cleaned of any paint, grease, rust, acid or alkali or such other foreign matters as are likely to interfere with the galvanizing process or with the quality and durability of the zinc coating. Pickling shall be very carefully done and shall be proper.

The weight of the zinc coating shall be at least 0.610 kg/sq.m unless specified otherwise. Stub members and members for grillage type footing shall have heavier zinc coating not less than 0.80 kg/sq.m.

The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth, and shall be free from defects like discolored patches, bare spots, unevenness of coating, spelter that is loosely attached to the steel, globules, spikes, etc. The finish shall be as per IS: 2633 unless specified otherwise.

All galvanized members shall be treated with Sodium dichromate solution or an approved equivalent after galvanizing; so as to prevent white storage stains.

Galvanizing of each member shall be carried out in one complete immersion. Double dipping shall not be permitted. However, in case of members over 7.5 m long, the Contractor shall take prior approval of Engineer-in-charge for double dipping. When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'.

Wherever galvanized bolts, nuts locknuts, washers, accessories etc. are specified, they shall be hot-dip galvanized. Spring washers shall be electro-galvanized. Excess spelter from bolts, nuts, etc. shall be removed by centrifugal spinning. Re-chasing of bolt threads after galvanizing shall not be permitted. Nuts, however, may be tapped, but not to cause appreciable rocking of the nuts on the bolts. Readily available GI nuts, bolts and washers conforming to galvanizing requirements may also be used.

Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications, or lack of quality control in any manner in the galvanizing plant, shall render the entire production in the relevant shift liable to rejection.

Contractor shall ensure that galvanizing is not damaged in transit. In the event of occurrence of any damages Contractor shall at his own cost adopt scraping and regularizing the member to satisfy the specific requirements.

4.20 False Ceiling with Gypboard & G I framework:

4.20.2 Scope of work

The work envisaged under these specifications refer to supplying and fixing in position false ceiling at any floor, any location and at any height.

- a) Providing and fixing suspended G.I frame work
- b) Providing and fixing one layer of 12.5 mm gypboard over this frame work
- c) Jointing the board flush, applying two coats of primer suitable for gypboard and two coats of acrylic emulation matt finish paint of approved shade and make.
- d) Making necessary cut outs for light fitting, A.C grills diffusers and other necessities. The work shall include horizontal, vertical and inclined surfaces depending upon the various requirements

4.20.3 Material:

4.20.4 G.I Frame work: -

The system consists of G.I framework suspended from the soffit of the RCC ceiling. The following G.I components shall be used for grid work:

- a) Ceiling section of 80 x 26 x 0.5 mm
- b) Perimeter channel of 20 x 27 x 30 x 0.5mm
- c) Intermediate channels of 15 x 45 x 0.9 mm
- d) Ceiling angle of 25 x 10 x 0.55 mm
- e) Connecting clips of 2.64 mm dia.
- f) Soffit cleat 22 x 37 mm
- g) Anchor fasteners 6 mm

All the G I components shall be of M/s. India Gypsum Limited make and bear the embossing of “GYPSTEEL’ in each length.

The G.I grid work system shall be suspended from the soffit of RCC ceiling using anchor fasteners of 6 mm of approved type and make and connected to soffit cleats and ceiling angle by means of necessary nuts, bolts and washers etc.

4.20.5 GYP BOARD: -

Gyp. Board of plain series 12.5 mm manufactured by India gypsum shall be used. The Gyp board shall conform to be 2095. The longitudinal edge of the Gyp board shall be of tapered / square edges, so as to have flush joints while fixing.

Handling and transporting of Gyp board shall be done carefully and as recommended by the manufactures. The board should always be kept in a dry and covered place sheltered from rain and to avoid dampness from flow, they should be supported on wooden battens which should not be more than 45 cm apart on a flat surface. The material shall be stacked in piles of smaller heights and should not be stacked on edges. Gyp board, which have deformed due to poor stacking should not be used.

Cutting of board should be made in faced side of the board by means of retractable knife or by using a normal saw and the edges of the boards shall be planned using proper files.

4.20.6 FINISHING MATERIALS: -

All jointing compounds, paper tapes, primer and paints shall be with materials manufactured / recommended by India Gypsum.

4.20.7 INSTALLATION: -

Perimeter channels are leveled at the required position of the finished ceiling line and fixed to the wall at 610 mm center with the screws and nylon plugs. The remaining G.I gird component is installed to form a regular grid suspended from the soffit of RCC slab using soffit cleats ceiling angle and anchor fasteners as specified. Extra frame for various cutouts of different shapes, light fittings, AC grills, diffusers, smoke detectors and other necessities have to be provided wherever required is included in the scope of the work at no extra cost. This

frame work has to be made with perimeter channel of specified size and shall be suitably supported. The line and level of the grid work has to be checked for perfection and prior clearance of the grid work has to be obtained from the Engineer-in-Charge before the placement of Gyp board.

The Gyp board is fixed with bound edges at right angles to ceiling section with all joints staggered. All joints of Gyp board have to be fixed on ceiling section. The Gyp boards are screwed to the ceiling section and perimeter channels with Gyp board dry wall screws with joints staggered. Spotting of screws and jointing are then carried out according to India Gypsum recommendations to give a flush and smooth joint.

Necessary door openings of hinged type of suitable sizes has to be provided with a suitable framework for control valves and for access above false ceiling / AC duct boxing at no extra cost.

Joints at horizontal, vertical and inclined surfaces shall be suitably strengthened with additional G.I framework as required.

Finally the boards are jointed and finished so as to have a flush look which includes filling and finishing the tapered and square edges of the board with a jointing compound, paper tape and two coats of primer suitable for gyp board (all as per recommended practices of Indian Gypsum). Then, the finished Gyp board has to be painted with 2 coats of acrylic emulsion matt finish paint of approved color and make.

The rate shall includes providing all material, erecting, suspending, G.I grid work, jointing the boards, providing required cutouts and open able doors and painting including providing necessary fittings and fixtures etc. complete as per the specifications and all other activities related to the completion of the above job.

Details of A.C grills, diffusers, recessed type electrical fittings to be erected in false ceiling will be as per specifications and as shown in drawings.

The quantities indicated are approximate and is likely to vary depending upon the site conditions.

Samples of light fittings are available with Engineer.

The scope of works includes fixing with screws, fixtures etc. the recessed electrical light fittings in the grid work of false ceiling / boxing. Marine plywood (6 mm thick) / special G.I sections, if required, shall also be provided at no extra cost. The rate quoted shall include all the above-mentioned activities related to the completion of the above job.

4.20.8 MODE OF MEASUREMENT: -

Measurements will be made on flat plan area basis in Sq.M calculated to 3 places of decimal. Length and breadth shall be measured corrected to a cm. No deduction shall be made for cutouts made for a. C grills, diffusers, electrical fittings, smoke detectors etc.

4.20.9 ROOFING, WALL CLADDING SYSTEM USING PRE-COATED GI SHEETS OF TRAPEZOIDAL PROFILE

4.20.10 MATERIAL: -

APPLICATION: ROOFING

BASE METAL: 0.55 mm Thick for roofing (BMT) 550 MPa – G550

PROFILE: Single Skin -TRAPEZOIDAL

SUBSTRATE: Zinc –Aluminum alloy Coating AZ150

PAINT SYSTEM: Super – Polyester XRW

FASTENER: Hex-head, Self-Drilling, Tapping Screw;
(Class 3 screws as per AS3566)

4.20.11 General: -

Supply, fabrication, erection and fixing of colour coated Single Skin Trapezoidal profiled sheeting 720 - 1020mm cover width 28-32 mm crests depth at 186-250 c/c (Above 195 mm c/c crest distance there will be minimum 2 ribs at the centre for stiffning). The feed material is manufactured out of 0.45 mm BMT (Base Metal thickness) Hi-Tensile steel with min. 550Mpa yield strength coated with hot dip metallic zinc-aluminium alloy coating Zinalume AZ-150 or equivalent (as per AS1397) as 150 gms/sq.mt total on both sides of Zinc (

45 %) & Aluminium (55%), with super polyester Colorbond XRW quality paint coat or equivalent as per AS/NZS-2728 (category 3) of approved color. The color shall have a total coating thickness of 35 microns of an super polyester XRW quality paint system or equivalent as per AS/NZS-2728 (category 3), comprising of 20 microns exterior coat on top surface and 5 micron reverse coat on back surface over 5 micron primer coat on both surfaces. The Steel manufacturers test certificate for the chemical and mechanical properties of steel must be submitted for approval by the concerned authority prior to installation. The sheet shall have brand marking of the manufacturer on the back of the sheet at every 1 mt c/c which should have the brand name, product specification and the coil number for confirming genuinity of the material. The profile and length of the sheet shall be commensurate with the site requirements and pre-coated with approved color. The contractor shall prepare the shop drawings based on the drawings supplied by the Engineer – in charge or the concern authority. These shall be submitted in five sets sufficiently in advance to the concern authority for approval.

4.20.12 Steel Sheet Material:-

The Steel base material of sheet shall have minimum 550 MPa Yield Strength made out of cold rolled steel and shall be coated with anti-corrosive layer of zinc-aluminum alloy coating as Zinalume AZ-150 coating or equivalent as per AS-1397 with min. 150 gms/sq.mt zinc-alluminium alloy coating mass (total on both side).

4.20.13 Profile:-

Single skin Trapezoidal profiled sheeting 720 -1020mm cover width 28-32 mm crests depth at 186-250 c/c (Above 195 mm c/c crest distance there will be minimum 2 ribs at the centre for stiffning).

4.20.14 Coating:-

The sheet shall is prepainted with super-polyester Colorbond XRW coat or equivalent as per AS/NZS-2728: 1997 (Category 3) of approved color on Zinalume zinc-alluminium alloy substrate or equivalent (as per AS 1397: 1993). The color shall have a total coating thickness of 35 microns of super polyester Color bond XRW quality paint system or equivalent as per AS/NZS-2728: 1997 (category 3), comprising of 20 microns exterior coat on top surface and 5 micron reverse coat on back surface over 5 micron primer coat on both surfaces

All specials and accessories should also be factory fabricated. All the flashing and ridge cap or any other covering should be made out of the same material as that of roofing.

4.20.15 Erection and Fixing:-

- The product will be fastened using Class 3 screws as per AS3566 (as per design) galvanized hex headed, self drilling fasteners of approved make (Buildex or equivalent) and quality including EPDM / Neoprene washer on each crest (or as per design) of the sheet connecting with purlin.
- The standard practice as specified by the manufacturer and as approved by the concern authority. All sheets and accessories must be stored and finally erected without any damage, dent, scratches, etc.
- The contractor will be required to submit design calculation in support of the proposed profile of the sheet and over all the fixing system for the structural properties, standard loading etc. to the satisfaction of the design consultant and the client. The contractor shall also submit methodology for fixing and also a maintenance manual for routine maintenance.
- Flashing, capping and trims shall be formed out of same color coated substrate and thickness as that of the roofing sheet and shall be supplied in a minimum length of 2.5 mt. in the required shape and girths and fixed with fixtures compatible with the system. Silicon sealant non-hardening, neutral cure type of approved make and grade shall be applied at all end laps.
- The contractor shall ensure that panel erector is familiarized with the erection procedure and all the supporting members are straight, level, plump and true (according to AISC) before starting panel erection. Panels shall be erected according to approved shop drawings.

4.20.16 Measurement: -

The payment will be done on the actual finish / covered surface area of the sheet.

No separate payment will be made for the lap of sheet and accessories, bolts, nuts, washers, adjustable bolts and supports for gutters and other fixtures. These are assumed to be included in the quoted rates.

5.0 STRUCTURAL GLAZING, GLASS DOORS, FIXED GLAZING

5.1 Scope of Works:

The scope of works under this contract includes design, supply installation, protection guarantees, testing and maintenance upto the defects liability period of Structural glazing, openable panels, glass doors and fixed glazing.

The work under the section includes all labour, materials, equipment and services as required for the engineering, preparation of shop drawings, testing, fabrication, assembly, delivery anchorage, installation, installation, protection and waterproofing of the structural glazing openable panels, glass doors and fixed glazing system and all in accordance with the true intent and meaning of the specifications and drawings taken together, regardless of whether the same may or may not be particularly shown on the drawings or described in the specification provided that the same can be reasonably inferred therefrom. Anchorage includes all primary and secondary anchor assemblies and supportive structural framing as required to secure Structural glazing system glass doors and fixed glazing.

5.2 The detailed scope of work is as outlined hereunder-

The Structural glazing system and openable panels described hereafter shall include but will not necessarily be limited to the following:

- (a) Frames
- (b) Openable panels where indicated, inclusive of all accessories, fittings, etc.
- (c) All caulking, sealing and flashing including sealing at junctions with roof waterproofing and exterior wall, raised kerbs and in window surrounds.
- (d) Sealant within and around the perimeter of all work under this section.
- (e) Separators, neoprene / EPDM and silicon gaskets, trims, etc.
- (f) Inserts in concrete, anchor fasteners etc. for the anchorage of all work under this section to the approval of structural consultants.
- (g) Isolation of all dissimilar metal surfaces as well as moving surfaces similar or dissimilar.
- (h) Fire-stops, flashing, sealing of all interfaces with buildings etc.
- (i) Protection during storage and construction unit handing over
- (j) Engineering proposals, drawings and data
- (k) Shop drawings, engineering data and structural calculations of all systems including framing, fasteners.
- (l) Scheduling and monitoring of the work
- (m) All samples, mock-ups and test units
- (n) All final exterior and interior cleaning of the Structural glazing system, doors, etc.
- (o) Hoisting, staging, scaffolding and temporary services

- (p) Specified tests, inclusive of necessary reports
- (q) Maintenance manuals
- (r) Periodic inspection, supervision and advice by tenderer's Principal as well as a back-up guarantee in an acceptance format by the Principal for the quality and performance of works.
- (s) Construction monitoring for regular quality control and technical inspection to ensure the work conforms to the shop drawing details (including any modification made during testing) and acceptable standards of quality.

5.3 REFERENCE AND STANDARDS

Materials and workmanship comply with the latest edition of the following standards as follows:

ANSI Z97.1.84. Safety Glazing Materials used in Buildings

ASTM C1036-90 Specification for Float Glass

ASTM C1048-90 Specification for Heat Treated Float Glass

ASTM C864-90 Specification for Compression Seal Gaskets

ASTM C1115-89 Specification for Silicon Rubber Gaskets

ASTM C920-87 Specification for Sealants

ASTM C509-90 Specification for Sealing Material

GTA Specification No. 89-1-6 Specification for environment durability for heat strengthened Spandrel Glass with Applied Opacifiers

BSCP 118 Structural use of Aluminium

In general the contractor may follow any international Standards subject to his satisfying CLIENT that these specifications are equivalent to latest specifications issued by ASTM, ISO, AAMA, BSS & SSIR.

Copies of all codes proposed to be followed for design, materials, installation and testing shall be submitted to CLIENT within 2 weeks of issue of Works Order.

Building Regulations

Design of the Structural glazing system shall comply with all Government codes and regulations for wind design, all calculations shall comply with the requirements of the relevant National Building Code and Indian Standard Code, unless specified otherwise.

5.4 Guarantee

The Contractor shall be fully responsible for and shall guarantee proper design safety and performance of this installed system for a period of 10 years from handing over of works.

The installation shall be to the best international standards and shall specially take account of wind and seismic loads, storms, air pollution, thermal stresses, building movements and the like:

In addition specific 10 years guarantees in approved formats shall be given for performance of glass, double-glazed units, anodizing and sealants. All the Guarantees shall be submitted before payment and 50% of total security deposit after completion, and shall not in any way limit any other rights to correction which the CLIENT may have under the Contract.

5.5 CONTRACTOR'S RESPONSIBILITIES

The Contractor's responsibilities include but are not necessarily limited to the following items :

- (A) The contractor shall provide and install all supplementary parts necessary to complete all items generally implied in the drawings and in the specifications though not specifically shown or mentioned.

This shall include providing assembly & erection of all sections and anchor assemblies to meet the performance and furnishing and installation of all inserts, fasteners, clips bracing and framework as required for the proper anchorage of the Structural glazing system elements to the structure, unless otherwise noted or specified to be furnish / installed by another contractor. Alternate anchorage proposals will be considered. If in the opinion of CLIENT the general design and intent of the drawings and specifications are maintained.

The Contractor's system therefore must perform satisfactorily as a whole.

- (B) Drawings and specifications indicate the required basic dimensions, profiles and performance criteria. The Contractor shall have the option of modification and addition of details provided the visual concept and performance requirements are fulfilled. Proposed modification shall be clearly shown on shop drawings as "Design Modifications" and acceptance of the same will not relieve the Contractor from sole responsibility for performance of the structural glazing and other system. The contractor shall be solely and fully responsible for due performance of his installation based on his own design and details.
- (C) In-plant and job site inspection: The Contractor shall afford for CLIENT and / or their authorised agent full access to plants, shops and assembly points to view and inspect the processes and methods employed in the fabrication, assembly and finishing of the Structural glazing and other system for this project.

CLIENT will have the right to reject any Structural glazing and other system, components, assemblies during assembly and erection if the workmanship and intent are not in strict conformity with the approved shop drawings, documentation, certifications, samples and mock-up.

- (D) Glass, sealants and other items or materials procured by purchase shall be back to back guaranteed by the manufacturer.

5.6 SHOP DRAWINGS

Within 15 days upon award of contract, the contractor shall prepare shop drawings by necessary modifications to the preliminary drawings and two (2) copies of all shop drawings shall be submitted to CLIENT for review and approval. CLIENT's review of all shop drawings will be limited to their conformity to the concept & specifications. CLIENT's approval of the shop drawings will not relieve the contractor from any of the responsibilities and requirements as stated in Contract documents. No work shall be fabricated until the shop drawings and all other related submission, documentation, certifications, samples and the mock-up for that work have been reviewed and approved by CLIENT. On approval the contractor shall submit 4 copies of drawings to CLIENT for release to site.

Shop drawings shall incorporate scaled and dimensioned plans, elevations, sections and full size details for all work in this section.

Shop drawings shall indicate the desired dimensional profiles and modules function, performance standards and, in general, delineate the scope of work. The contractor shall verify and co-ordinate these items with all applicable and / or related trades, contract drawings and specifications. Since the dimensions and modular references shown on the drawings are for specific and / or typical detail, the shop drawings shall include a full complete layout of all modular and referenced dimensions for all the Structural glazing, openable panels, glass doors and fixed glazing and their related elements. All dimensions / modules, etc. shall be fixed checked as required.

The full size details shall show and specify all metal sections, types of finishes; areas to be sealed and sealant materials, gaskets; direction and magnitude of thermal expansion, direction and magnitude of all applicable construction including fasteners and welds, all anchorage assemblies and components; the fabrication and erection tolerances for the work and applicable related works adjoining, attached to or in some way related to the work covered by these specifications. The location of all static and dynamic anchor assemblies, the direction of thermal and other applicable building movements, coordination with concrete works and the sequence of installation shall be designated on the applicable plans, elevations and / or sections. All details shall be subject to CLIENT's approval.

Shop drawings shall indicate the desired profiles, dimensions, details of metal finish and in general delineate the scope of the work. Profile adjustments in the interest of economy, fabrication, erection, weather-ability to

satisfy the performance requirements may be made only with the written approval of CLIENT, provided that the general design and intent of the drawings and specifications are maintained.

Four (4) copies plus two reproducible sepia print each of all final approved shop drawings shall be submitted to CLIENT.

5.7 SAMPLES AND MANUALS

Within 2 weeks of issue of Work Order, the following samples of actual job site materials together with detailed technical data / catalogues shall be submitted in duplicate, unless otherwise noted, and in the sizes noted, for Engineer-in-charge review and approval. Any omission of an item or items which require the Contractor's compliance with these documents does not relieve him from such responsibility.

- (a) Aluminium Extrusions – one of each section, 300 mm long of specified thickness.
- (b) Glass; Each type and kind, 300 X 250 mm of specified thickness and including frame
- (c) Glazing gaskets, tapes, separators, glass setting blocks, etc. Each section of unit, 300 mm long or unit.
- (d) Fasteners and connecting devices, Each type and size
- (e) Finish samples: after approval of the final finish coating is to be provided with six (6) approved samples.
- (f) Patch fitting door mongery and all accessories, as applicable.
- (g) Flashings and finish samples
- (h) Samples submitted should also include assembly of various components forming a typical fixing detail complete with glazing, extrusion, fastener, sealant, etc.

5.8 Maintenance Manual

Submit three (3) copies each of detailed procedures for the periodic inspection maintenance and cleaning of all the Structural glazing, openable panels, glass doors, windows and fixed glazing, finishes, etc.

Structural Properties

- (a) The design of structural glazing system / other fixing systems and all related components shall comply with the requirements of National Building Code IS-875 and Indian Standard Code IS-456
- (b) No structural glazing / other glazing system including sealants and sealed joint shall sustain permanent deformation or failure under loading equivalent to 1.5 times the design wind pressure herein specified.
- (c) Deflections: The specified deflections must be reduced if they are in any way detrimental to the Structural glazing and sealants.

The maximum deflection shall exceed $1/300$ of span of transom / sill/ head members.

Under 1.5 times design wind pressure there should be no permanent deflection of framing member exceeding $1/1000$ of span length.

Maximum deflection of glass under design wind pressure at centre of any panel shall not exceed 15 mm or as recommended by the manufacturer whichever is less.

General

- (a) All braces, supports and connections for the structural glazing shall be designed, provided and installed complete as required.

- (b) Anchors for curtain wall sections shall be located with a maximum distance of 500 mm above or below the RCC floor slab unless specifically approved otherwise by the Structural Consultant.
- (c) Variations from Schematic layouts indicated on the drawings may be permitted but only if a proposed revision does not, in CLIENT's opinion, deviate from the design intent, cause excessive stress in the structure, cause excessive deflection, inhibit thermal and building movement or conflict with other requirements.
- (d) Member shapes and / or profiles if schematically shown on CLIENT's drawings are not necessarily the exact shapes required or best suited for the particular condition. Final shapes and locations shall be as designed by the contractor and are subject to CLIENT's review and approval.
- (e) The horizontal or lateral load on such transom / railing (where not backed by an RCC concrete) shall be designed in accordance with the following criteria i.e. a horizontal UDL at 0.74 KN/m run, UDL supplied to the infill of 1.0 KN/m² and a part load applied to part of the infill at 0.5 KN.
- (f) No holes shall be burned, filed or drilled in any structural steel members unless expressly approved by the Structural Consultant in writing.
- (g) The Contractor shall provide detailed layouts, alignments jigs etc. for the proper and exact placement of all welded anchor studs, anchorage components without any harmful effect to the structural glazing.
- (h) No field forming, cutting and / or alterations of primary wall elements will be allowed. All framing members shall be shop fabricated and finish coated. No furnished surfaces will be permitted on exposed surfaces.

5.9 Concrete Tolerances

The contractor shall take into account tolerance in concrete and masonry surfaces to which the structural and glazing framework is fixed.

Fire stop and Interface with Building

Joints in the structural glazing system between successive floors shall have the required fire resistance of at least 2 hours and shall comply with requirements of CFO.

A fire-stop-cum-smoke seal shall be provided at each window head level. In addition the Contractor shall provide an aluminium flashing to approved design at the window sill level and on 2 sides of vision panels.

All interfaces with building structure and other elements shall be sealed / flashed provided with expandable gaskets to CLIENT's approval.

5.10 Sound Control

Provisions shall be made (e.g. capping of all ends of mullions) to prevent sound transmission through the system. Provisions shall also be made to prevent metal to metal rubbing noise due to thermal changes and wind pressure.

5.11 SYSTEM DESCRIPTION

The front seal structural glazing system is semi utilized system. In this specially designed extruded aluminium mullions are fixed to the building structure by means of SS brackets of angles 100 X 100 X 12 mm of minimum 300 mm long with necessary aluminium packing for true alignment, suitable chinch anchor bolts of minimum 150 X 10 mm shall be provided for fixing the brackets. On to this mullions, the transoms are fixed by means of pre-positioned angle cleats. After installing the grid work of mullion and transom, the entire frame work is aligned in perfect line, level and plumb. Drainage chamber, pressure equalization system and openable panel shall be provided.

Bonding of glass is not to be done on site. Panels are glazed in the factory under controlled conditions as per silicone manufacturer's recommendation to achieve required bonding result. These pre-glazed panels are brought to the site and fixed on to the preinstalled aluminium gird work. The gap between the adjacent glass panels are thereafter filled with silicone sealant to have complete homogenous surface of glass without any grooves and cavities and this shall depend upon the systems offered. The tenderer will indicate the details of systems offered along with the tender.

5.12 Frame Work

Frame work consists of specially designed mullion of minimum size of 101.6 mm X 57 mm X 3 mm (Alloy 6063-T-5/T-6 temper) B.S. 1474. Selection of mullion will depend upon the floor to floor height, distance between 2. Mullions wind pressure and other required structural stabilities. Transoms of minimum 83 X 57 X 2.25 mm (E 91 WP(IS) 1285) are attached to this mullion by means of aluminium angle cleats.

All aluminium sections shall be anodized to 20 microns minimum. Bolts for connections of frame work shall be high tensile steel minimum 100 mm length and pop rivets shall be used and two samples shall be submitted for approval. Test shall include, DFT, film hardness, dry, cross batch adhesion, boiling water adhesion, test & glass measurements & general appearance and shall meet the following performance requirements.

- i) Salt spray resistance 3000 hrs exposure to 5% salt solution at 95% RH, 37.5⁰C > 125 mm crepe or loss of adhesion from scribed lines or cut edges.
- ii) Humidity resistance
- iii) Abrasion resistance
- iv) Mortar resistance
- v) Detergent resistance
- vi) Color retention

Guarantee for peeling, cracking, checking, blistering, fading, , color change.

Cleats & spigots: 6351 alloy T6 temper and SS screws shall be used for fixing the panels.

5.13 Fasteners :

The type, size, alloy and quantity and spacing of all fasteners and anchoring devices shall be as required for the specified performance standards.

Bolts, anchors and fastening devices shall be self locking, suitable for conditions encountered and shall be torque tightened when required to achieve maximum Torque Tension relationship in fasteners, washers, nuts all ancillary items shall be same material as fasteners.

Fastening devices between aluminium and aluminium shall be AISC type 302 (18-8) stainless steel unless otherwise approved.

Fastening devices between aluminium and dissimilar material shall be 300 series non-magnetic stainless steel unless otherwise approved.

Exposed fasteners shall be of stainless steel.

Self-locking fasteners shall be stainless steel with nylon inserts or patches.

Proper care shall be taken in anodizing process to proper adhesion of the structural silicone to the anodized aluminium substrate. The anodize shall be apprised that the extrusion to be finished will be used for structural glazing application.

After a long period of time, anodised surface may develop an aluminium hydroxide surface film. This film shall be removed by detergent free boiling hot water rinse. Random production samples of anodised extrusions must be tested by silicone sealant manufacturers and certified by them.

5.14 Glazed Panels

These are factory made glazed panels which are brought to site of work and are bolted on the pre-fixed gird work of mullions and transoms. The entire safety and principle of structural glazing depends on these panels, in which the glass is bonded to the aluminium frames by means of structural silicone sealant. This has to be done in perfectly controlled conditions and as per the procedure recommended by sealant manufacturer. The sealant manufacturer shall visit the place of application for on-site testing of bonding by deglazing few panels. Necessary certification by the sealant manufacturer shall be furnished indicating that the glazing has been carried out as per their recommended procedure.

5.15 Sealant

All sealant applications must be clearly designated on the applicable shop drawing details and reference to a master sealant schedule specifying materials special instructions and application procedures.

The compatibility and sequence of installation for all sealants must be carefully considered in all proposals in order to ensure the required cure and optimum performance. Sealants must not degrade and / or fail under all design conditions including, but not limited to thermal movement, water, ultraviolet exposure and / or other adverse environmental conditions. The following sealant materials are specified for performance standards only. All proposals must be equal to or better than the materials herein specified. The designation of sealant types noted on the drawings is intended for general design guidance. Final selection by the contractor for the sealant types shall be based on their conformity with the Performance Requirements herein specified and meet with CLIENT's approval. Maximum precautions shall be taken to prevent failure of sealant.

5.16 Front Sealing

After glass panels are installed, leveled and aligned, the groove between two glasses on all the sides which depends upon the systems adopted shall be as minimum as possible. This groove is then filled with weather grade 789/79B black silicone sealant from outside to give one smooth surface. This silicone filled grooves shall allow for thermal movements in the glass. Sleek grooves are to be provided for esthetical requirement.

5.17 Structural Sealant

Dow Corning silicone sealant 995/GE ultra-glaze 4000. All exposed and concealed metal to metal (including tight or butt type metal to metal assembly prior to assembly), perimeter metal to concrete joints shall be silicone base sealant, preferably 2 component, in approved colour, conforming to the manufacturer's recommendations for the specific uses and performance criteria. The manufacturer shall conduct laboratory test for adhesion for each lot of aluminium sections and glass. Laboratory reports shall be submitted to CLIENT.

5.18 Weather Sealant

Grade of sealants for concealed metal to metal and metal to concrete joints are to be installed or embedded in a full bed sealant and shall be of Dow Corning / GE. Joint fillers and back up materials shall be of neoprene and as per the written recommendation from sealant manufacturer. Shape, size hardness, compatibility and bond breaking requirements are to be considered. All sealants shall be non-staining.

All sealants shall be given 10 years Guarantee for materials, workmanship and performance from the date of completion of Contract.

5.19 Caulking compound

Dow Corning 790, one part gun grade consistency, colour to match adjacent material or approved by shall for use around frame or between frame and floor slab.

5.20 Installation

The GI bracket having three way adjustments are first fixed to the building structure as per approved detailed drawings. On to these brackets, the mullions are bolted. The mullion to mullion joint on each floor is achieved

by special aluminium sliding sleeve. There is an expansion gap between two mullion to allow thermal movements.

5.21 Smoke Seal

The gap between the building structure and the structural glazing frame is closed with perforated aluminium tubes. These smoke seals will stop the smoke, travelling from one floor to other floor as well as will stop the noise, travelling from one floor to other floor and shall be two hour fire resistant.

5.22 GLASS

For structural glazing, minimum 6 mm thick reflective heat strengthened glass shall be used.

Stop sol single reflective heat strengthened glass super-silver Blue colour of approved manufacturer shall be used. The glass edges are to be well protected.

All glass and glazing materials shall be verified and co-ordinate with the applicable performance requirements.

Furnish and install glass and glazing work as indicated on the drawings and as specified herein. All glass shall be cut to required sizes and ready for glazing. Any pane which does not fit any section of the glazing and shop front will be rejected and a replacement made at the Contractor's expense. All glass shall be of accurate sizes with clear undamaged edges and surfaces which are not disfigured.

Glass shall conform to the quality, thickness and dimensional requirements specified in US Federal specifications DD-G0451C or equivalent.

Heat strengthened glass shall not deviate in surface flatness by more than 0.23 mm within 260 mm of leading or trailing edge, or 0.076 mm in centre. Direction of ripples shall be consistent and extent shall be acceptable to shall Distortion of glass shall be controlled as much as possible during heat strengthening. Sag distortion shall be uni-directional as per CLIENT's option. Surface compression stress of heat strengthened glass shall be within 320-450 kg/cm².

Permanent identification marking on glass shall be accomplished by a technique selected by the manufacturer. The location of the marking shall be proposed by the Manufacturer and approved by CLIENT. All glass shall be delivered to site with the manufacturer's label of identification attached.

Submit for CLIENT's approval a complete list of materials to be used, including the sealants proposed and such samples as CLIENT may require. All glass and glazing methods and materials including the design and profile dimensions of glazing pockets shall be as approved and recommended in writing by the applicable glass and sealant manufacturers. A sealant substrate test report shall be submitted for each type of sealant for adhesion and compatibility.

Sealants in factory-glazed panels shall be fully cured prior to shipment to project site and installation.

All glass breakage caused by the Contractor or his sub-contractor because of negligence or caused by the installation of faulty work by him shall be replaced by the Contractor at his own expense without delay to the project completion.

The contractor shall be responsible to deliver to CLIENT without charge replacement for any unit of glass and glazing that fails within the Guarantee period of ten (10) years from date of completion of contract.

The glass glazed panels / structural glazing frames for the structural glazing system shall be designed to withstand lateral imposed loads and comply with requirements of local building codes.

Glass thickness should be selected in accordance with AS 1288-1989 "Glass in Buildings Selection and Installation" to satisfy design performance requirements and local design codes.

Glass shall be free from defects or impurities detrimental to its performance Defects such as bubbles, waves, spots, scratches, spalls, discoloration, visibly imperfect coating, chipping and bubbles or delamination of opacifier film shall be limited in accordance with the Manufacturer's / trader's guidelines. The glass is to be produced in such a way that the rollers will be parallel to what will be the horizontal position of the glass. Glass shall be consistent in colour.

Manufacturers' glazing instructions regarding installation, clearance, dimensional tolerance, bite edge clearance etc. shall be followed.

All solar control glass panels shall be stored with particular care and protected against abrasion, sun and moisture prior to installation.

Precautions specified by glass manufacturers to minimise thermal stress must be followed. A thermal stress analysis shall be obtained from glass manufacturer prior to fabrication and their recommendations shall be followed. Allowances shall be made for thermal movements due to an air temperature range of 600C and a material temperature range of 1000 C.

Glass panels shall be selected / rejected on the basis of product quality standards specified by the manufacturer concerning scratches, pinholes, clusters, distortion, colour variations, flaws in coating and other defects.

Each type of glass shall be obtained from only one manufacturer and in one lot. Adequate spare quantity shall be ordered to cover for breakage and for replacement during maintenance period.

Setting blocks for glass shall be extruded neoprene with minimum 80 urometer hardness.

Gaskets

Gaskets and seals shall be extruded EPDM of approved quality, compatible with substrates, finishes and other components they are in contact with. All gaskets exposed directly on the exterior face shall be silicon gaskets.

Extruded EPDM sections shall have the following properties:

Shore Hardness	:	70 ±5A
Tensile strength	:	Min. 70 kg / cm ²
Elongation	:	300%
Ozone Resistance	:	No crack at 50± 5pphm, test temp of 40±2 ⁰ C, test duration of 96 hours and 20% strain

Extruded neoprene sections if specifically permitted shall have the following properties:

Physical Property	Test Method	Performance
Hardness, Durometer A	ASTM D 2240	601.5 points
Tensile strength	ASTM D 412	1800 psi, minimum
Elongation at break	ASTM D 412	25% min
Brittleness temperature	ASTM D 746	40 ⁰ F
Resistance to heat	ASTM D 573	
Change in original properties after 70 hrs. at 100 ⁰ C		
Hardness	-	+ 10 points, max.
Elongation	-	40%, max.
Tensile strength	-	15% max.
Resistance to permanent set compression set after 70 hrs. at 1000 C	ASTM D 395	25% max.

Expansion joints

Expansion joints shall be with EPDM moulding.

Peripheral Flashing shall be done with aluminium anodized black with extruded 6101 alloy T6 tamper with DC multi seal.

SURFACE PREPARATION

Solvent cleaning

Dirty glass edges shall be cleaned with a solvent such as isopropyl alcohol (IPA), Oily metal surfaces shall be cleaned with degreasing solvent such as toluene, or xylene. Glass and metal finish manufacturers shall ensure compatibility of the solvent used for cleaning.

Primer shall be applied as per the manufacturer's recommendations. Silicon sealant shall be applied as soon as possible to prevent built up of dirt, moisture and other contaminants from affecting adhesion of silicone to substrates.

Silicone used shall be natural curing type. Acetoxy curing sealant which releases acetic acid during the cure process is not recommended for use.

All adjacent surfaces shall be masked prior to sealant application. Backer rods shall be carefully positioned.

Sealant shall be applied in a continuous operation from a caulking gun or pump. Positive pressure, adequate to fill the entire joint cavity shall be applied by pushing the sealant bead ahead of application nozzle. The sealant must fill the entire joint and firmly contact with the glass and metal surfaces. Water, soaps or alcohol solutions shall not be used as tooling aids. After tooling, the masking shall be removed.

SEPARATORS

Separators between steel and aluminium members shall be of rigid type, high impact smooth both side Teflon with minimum thickness of 0.8 mm.

QUALITY & CERTIFICATES

All required certificates shall be furnished against each concerned supply.

1. Certificate of conformance for anodized finishes and thickness along with the test result.
2. Test certificates from sealant manufacturers issued at regular intervals during building process, conforming compatibility of materials and adhesion properties and workmanship of the system, testing of adhesion and chemical compatibility of all elements and design review in accordance with sealant manufacturer.
3. Physical and chemical properties of aluminium sections used.

LEAKAGE TEST

The leakage test shall be conducted through hose pipes with water supplied at a pressure of 5 kg / sq.cm. at his own cost.

ACCESSORIES

All accessories shall conform to the relevant IS standard and shall meet all required functional aspects.

GUARANTEE

The tenderer shall provide full guarantee for structural glazing and other works carried out by them in this contract which shall include:

1. Against non-falling of glasses
2. Sturdiness of the system
3. Against water penetration
4. Against air infiltration
5. Smooth operation of the doors.

The structural glazing, door & fixed glazing systems shall be guaranteed for a period of 10 years and any repairs to the structural, sealant and other items if required shall be carried out without any additional cost. The guarantee shall be furnished in stamped paper in the form to be provided after the award of work.

If breakage of glass / structural defects occurs due to faculty design and execution within the guarantee period of 10 years, the same shall be replaced without any additional cost and the same shall be replaced within 2 weeks. The decision of the Engineer shall be final.

Complete drainage system in the structural glazing panes. Water leakage and condensation shall be drained or discharged to exterior face of wall and shall be sealed off at every floor and water shall not be retained.

DRAWINGS

On receipt of the order, the tenderer within 15 days shall submit detailed fabrication and erection drawings indicating all fixing details and panel arrangement, door details etc. for approval and fabrication to be taken up after approval of these drawings.

PACKING

Packing shall be made with PVC adhesive tape for anti-scratch requirements.
Transport of glazed units shall be done only after the sealant is cured fully.

PAYMENT

The rate quoted shall be per Sq.m. and the opening area of structural glazing / door opening shall be measured for payment. The rate quoted shall include cost of all materials viz. Aluminium, sections, making frames, erection, glazing sealants, weather strips, fittings and fixtures, all fixing arrangements testing, fabrication at plants and erection at site including labour, machinery, scaffolding, staging, chipping of wall, beams, columns, rectification of plaster, painting if required, for the complete job.

CHAPTER-6-PLUMBING WORKS

WATER SUPPLY INSTALLATIONS - GENERAL REQUIREMENTS

All water supply installation work shall be carried out through licensed plumbers.

It is most important to ensure that wholesome water supply provided for drinking and culinary purposes, is in no way liable to contamination from any less satisfactory water. There shall, therefore, be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting or conveying or containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose. The provision of reflux or non-return valves or closed and sealed valves shall not be constructed a permissible substitute for complete absence of cross-connection.

Where a supply of wholesome water is required as an alternative or standby to supply of less satisfactory water or is required to be mixed with the latter, it shall be delivered only into a cistern, and by a pipe or fitting discharging into the air gap at a height above the top edge of the cistern equal to twice its nominal bore, and in no case less than 15 cm.

No piping shall be laid or fixed so as to pass into through or adjoining any sewer, scour outlet or drain or any manhole connected therewith nor through any ash pit or manure-pit or any material of such nature that would be likely to cause undue deterioration of the pipe

Where the laying of any pipe through fouled soil or previous material is unavoidable, the piping shall be properly protected from contact with such soil or material by being carried through an exterior cast iron tube or by some other suitable means. Any piping or fitting laid or fixed, which does not comply with the above requirements, shall be removed and relaid in conformity with the above requirements.

The design of the pipe work shall be such that there is no possibility of backflow towards the source of supply from any cistern or appliance whether by siphonage or otherwise, the reflux or non-return valves shall not be relied upon to prevent such backflow.

All pipe work shall be such so designed, laid or fixed, and maintained as to be and to remain completely watertight, thereby avoiding waste of water, damage to property and the risk of contamination of the water conveyed.

In designing and planning the layout of the pipe work, due attention shall be given to the maximum rate of discharge, required economy in labour and materials, protection from frost, if required, and to avoidance of airlocks, noise transmission and unsightly arrangement.

To reduce frictional losses, piping shall be as smooth as possible inside. Methods of jointing shall be such as to avoid internal roughness and projection at the joints, whether of the jointing materials or otherwise.

Change in diameter and in direction shall preferably be gradual rather than abrupt to avoid undue loss of head. No bend or curve in piping shall be made so as to materially diminish or alter the cross-section.

Underground piping shall be laid at such a depth that it is unlikely to be damaged by frost or traffic loads and vibrations. It shall not be laid in ground liable to subsidence, but where such ground cannot be avoided, special precautions shall be taken to avoid damage to the piping. Where piping has to be laid across recently disturbed ground, the ground shall be thoroughly consolidated so as to provide a continuous and even support.

Where the service pipe is of diameter less than 50 mm the stop valves shall be of the screw-down type and shall have loose washer plates to act as non-return valves. Other stop valves in the service line may be of the gate type.

Water for drinking or for culinary purposes as far as possible shall be on branch pipes connected directly to the service pipe.

Pumps shall not be allowed on the service pipe as they cause a drop of pressure on the suction side thereby affecting the supply to the adjoining properties. In cases where pumping is required, a properly protected storage tank of adequate capacity shall be provided to feed the pump.

Service pipes shall be so designed and constructed as to avoid air-locks, so that all piping and fittings above ground can be completely emptied of water to facilitate repairs. There shall be draining tapper draw-off taps (not underground) at the lowest points, from which the piping shall rise continuously to draw-off taps, ball valves, cisterns, or vents (where provided at the high points).

Service pipes shall be designed so as to reduce the production and transmission of noise as much as possible. Appliances which create noise shall be installed as far distant as possible living rooms of the house. High velocity of water in piping and fittings shall be avoided.

The rising pipe to the storage cistern if any or any feed cistern shall be taken as possible to the cistern and shall be fixed away from windows or ventilators.

All pipe work shall be planned so that the piping is accessible for inspection, replacement and repair. To avoid its being unsightly, it is usually possible to arrange it in or adjacent to cupboards, recesses, etc. provided there is a sufficient space to work on the piping with the usual tools.

Piping shall not be buried in walls or solid floors. Where unavoidable, piping may be buried for short distances provided that adequate protection is given against damage and that no joints are buried. If piping is laid for in ducts or chases, these shall be roomy enough to facilitate repairs and shall be so constructed as to prevent the entry of vermin. They facilitate removal of pipe casing, floor board covering piping shall be fixed with screws or bolts.

When it is necessary for a pipe to pass through a wall or floor, a sleeve shall be fixed therein for reception of the pipe and to allow expansion and contraction and other movement. Piping laid in wood floors shall, where possible parallel with the joists.

Where storage tanks are provided to meet overall requirements of water connection of service pipe with any distributing pipe shall not be permitted except one direct connection for culinary or drinking requirements.

No service pipe shall be connected to any water closet or urinal. All such supplies shall be from flushing cisterns which shall be supplied from storage tank.

No service or supply pipe shall be connected directly to any hot-water system or to any apparatus used for heating other than through a feed cistern thereof.

MATERIALS

The standard size of brass or gun metal fittings shall be designated by the nominal bore of the pipe outlet to which the fittings are attached. A sample of each kind of fittings shall be got approved from Engineer-in-charge and all supplies made according to the approved samples.

All cast fittings shall be sound and free from laps, blow holes and fittings. Both internal and external surfaces shall be clean, smooth and free from sand, etc. Burning, plugging, stopping or patching of the casting shall not be permissible. The bodies, bonnets, spindles and other parts shall be truly machined so that when assembled the parts shall be axial, parallel and cylindrical with surfaces smoothly finished. The area of the water way of the fittings shall not be less than area of the nominal bore, chromium plating wherever specified shall be of 0.3 micron conforming to IS: 4827.

Ball Valve: The ball valve shall be of Brass or Gunmetal as specified conforming to IS 1703. The ball valve shall be of following two classes:-

a) **High pressure:** Indicated by the abbreviation 'HP' for use on mains having pressure of 1.75 kg/sq.cm. or above. These shall remain closed at a test pressure of 10.5 kg/sq.cm.

TABLE 6.10 - Diameter of spherical float (mm)

Sl No	Item	Nominal size of ball valve					
		15 mm	20 mm	25 mm	32 mm	40 mm	50 mm
1.	Diameter of spherical float (mm)						
	High pressure	127	152	203	229	254	305
	Low pressure	114	127	178	203	203	254
	Minimum weight of ball valve including back nut, body and piston (gms)	283	446	823	1149	1589	1852

b) **Low Pressure:** Indicated by the abbreviation 'LP' for use on mains having a pressure up to 1.75 kg/sq.cm. These shall remain closed at a test pressure of 3.5 kg/sq. cm.

The ball valves shall be of following nominal sizes 15 mm, 20 mm, 25 mm, 32 mm, 40 mm, and 50 mm. The nominal size shall correspond with the nominal bore of the inlet shanks. Polyethylene floats shall conform to IS : 9762.

Bib cock and Stop cock: Brass: A bib cock (bib tap) is a draw off tap with a horizontal inlet and free outlet and a stop cock (stop tap) is a valve with a suitable means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of screw down type and shall conform to IS : 781.

Ferrules: The ferrules for connection with C.I. main shall generally conform to IS: 2692.

Fire Hydrants: The hydrants shall be of spindle type with 65 mm outlet combined with sluice valve, unless otherwise specified. The hydrant shall conform to IS: 909 and shall consist of the following components:

- a) One sluice valve class 1 type, conforming to IS : 780.
- b) A duck foot bend
- c) A 65 mm male coupling instantaneous pattern; and
- d) Cast iron cap permanently secured to the duck foot-bend by means of a chain. Where the fire service requirement of coupling differs from the above, the requisite coupling shall be provided at no extra cost.

The body and cover shall be of good quality cast iron, spindle of bronze and the nut and the valve of leaded tin bronze. The bodies, spindle and other parts shall be truly machined with surface smoothly finished.

Full Way Valve Brass: Full way valve is a valve with suitable means of connection for insertion in a pipe line for controlling or stopping the flow. The valve shall be of brass fitted with a cast iron wheel and shall be of gate valve type conforming to IS: 780 opening full way and of the size as specified.

The valves shall be of best quality as approved by the Engineer-in-charge and shall approximately have the weights specified in the water supply chapter with a tolerance of 5 percent.

Pig Lead: Pig lead shall be of uniform quality, clean and free from foreign materials. It shall be of uniform softness and capable of being easily caulked or driven. It shall conform to IS: 782 caulking lead in all respects.

Lead Wool: Lead wool shall conform to IS: 782 in all respects. Lead wool shall strands or plated ribbons of lead. The cross-section of the individual strands shall be flat, in the sectional plane shall not be less than 0.13mm and not more than 0.90 mm and the rope shall be applied in minimum lengths of two meters and maximum length in any one package shall be such that the package does not weigh more than 50 kg.

TABLE 6.11

Mm	Flanged ends (Kg.)	Screwed ends (Kg)
15	1.021	0.567
20	1.0503	0.680
25	2.495	1.077
32	3.232	1.559
40	4.082	2.268
50	6.691	3.232
65	10.149	6.804
80	13.381	8.845

Non-return valve or check Valve-Brass:

A non-return valve permits water to flow in direction only and is provided on the ascending part of the main to check return flow. The return valve shall be of brass and shall be horizontal or vertical flow type as specified.

The valve shall be of quality approved by the Engineer-in-charge and shall have the weight specified in water supply chapter with a tolerance of 5 percent.

Pipes and Specials: Pipes and specials be of any of the following types as specified

- a) Asbestos cement pressure pipes - IS:1592
- b) Cast iron centrifugally cast (spun) - IS:1536
- c) Galvanised steel - IS:1239 & IS:4736
- d) Plastic unplasticised rigid P.V.C. - IS:4981 & IS:4985.

In choosing the material for piping and fittings, account shall be taken of the character of the water to be conveyed through it, the nature of the ground in which the pipes are to be laid and the relative economics.

Pipes-Asbestos Cement (Pressure Pipes)

These shall be made from a through and homogenous mixture of ordinary Portland cement conforming to IS:269 and asbestos fibre free from loading and from organic fibres. The pipes shall conform to IS:1592. The pipes shall be classified according to the test pressure as detailed in water supply chapter.

The maximum working pressure under which each pipe shall be used, shall not exceed half the test pressure for that class of pipe.

The nominal diameters of pipe shall be 50 mm, 80 mm, 100 mm, 125 mm, 150 mm, 200 mm, 250 mm, 300 mm, 450 mm, 600 mm, 900 mm and 1000 mm. The variation of the internal diameter shall not be more than 10% of the nominal internal diameter.

The interior of pipes shall have a smooth finish and regular surface and regular internal diameter. It shall be straight within tolerance limits.

Specials: Plain ended cast iron specials shall be used to suit the diameter of pipe.

TABLE 6.12

Diameters Mm	Horizontal type Kg	Vertical type Kg.
15	0.30	0.25
20	0.55	0.25
25	0.90	0.75
32	1.25	0.90
40	1.70	1.20
50	2.90	1.45
65	5.25	2.15
80	7.70	4.10

TABLE 6.13

Class	Test Pressure
Class-5	5 Kg/sq. cm (50 m head)
Class-10	10 Kg/sq. cm (100 m head)
Class-15	15 Kg/sq. cm (150 m head)
Class-20	20 Kg/sq. cm (200 m head)
Class-25	25 Kg/sq. cm (250 m head)

Pipes-Cast Iron Centrifugally Cast (Spun)

The spun iron pipes shall conform to IS:1536. The spun iron pipes shall be of cast iron casted centrifugally and vary in diameters from 80 mm to 750 mm. These shall be of class LA, class A and class B, as specified. These pipes shall be used for water pressures upto half the hydraulic test pressure as detailed in Table 8.19

Specials: The specials shall conform to IS: 1538. The hydraulic test pressure of each class shall be as detailed in Table 8.20.

Pipes-Galvanised Iron

The pipes (tubes) shall be galvanised mild steel hot finished seamless (HFS) or welded (ERW) HRIW or HFW screwed and socketed conforming to the requirements of IS: 1239 Part-I for medium grade. They shall be of the diameter (nominal bore) specified in the description of the item, the sockets shall be designated by the respective nominal bores of the pipes for which they are intended.

Galvanising shall conform to IS:4736 :The zinc coating shall be uniform adherent, reasonably smooth and free from such imperfections as flux, ash and dress-inclusions, bare patches, black spots, pimples, lumping runs, rust stains, bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanised in and out and free from cracks, surface flaws laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly, and square with the axis of the tube.

TABLE 6.14

Types of pipes	Test pressure of Kg/sq.cm		
	Class LA	Class A	Class B
Spigot and socket pipe in all diameters	12	18	24
Flanged pipes upto 600 mm dia		18	24

TABLE 6.15

Nominal – Diameter	Test pressure in Kg/sq.cm (metre head)	
	Fitting without branches or with branches not greater than half the principle diameter.	Fitting with branches greater than half the principal diameter
Upto and including 300 mm	25(250)	25(250)
Over 300 mm and upto and including 600 mm	20(200)	20(200)
Over 600 mm and upto and including 1500 mm	15(150)	10(100)

All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS: 554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

All tubes shall withstand a test pressure of 50 Kg/sq.cm without showing defects of any kind.

Fittings: The fittings shall be of mild steel tubular or wrought steel fittings conforming to IS: 1239 (Part-II) or as specified. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended.

Pipes-Plastic

The plastic pipes commercially available in the country are that of (i) low-density polyethylene (LDPE) (h) High-density polyethylene HDPE, and (iii) Rigid (unplasticised) polyvinylchloride (UPVC). These pipes are corrosion resistant and light in weight, and have been found suitable for cold water services. Plastic materials perform on their own merits, and each of these plastic pipes has its own limitations and advantages for a particular application under conditions of use. Relevant Indian standard specifications have been laid down for these pipes.

Low Density Polyethylene is flexible, it is now well established that this material is used for pipes with diameter upto 63 mm, generally recommended for use in long runs e.g. for point to point conveyance of water, because of its flexibility and fact that LDPE pipes require closer spacing of clips for horizontal and vertical runs, their use has not been found practical for installation of internal water supply system.

High Density Polyethylene is rather tougher as compared to low-density polyethylene Pipes upto 1600 mm diameters have been produced out of this material. In India however, HDPE pipes are available from 16 mm to 400 mm dia.. These pipes in small diameters for internal water supplies has not found ready acceptance because of practical problems like on-site jointing, and taking out of various connections in plumbing, in larger diameters for conveyance of water effluents and in long runs from point to point has been found very suitable and has been readily accepted by the Public Health Engineering similar departments, in the country.

Polyethylene pipes are normally available in black colour. These are resistant to most of chemicals except nitric acid, and very strong acids, fats and certain solvents particularly chlorinate ones. There is a phenomenon called environment stress cracking which means that if polyethylene stressed at normal temperatures and comes in contact with certain materials then it will crack and eventually fail. The material includes detergent organic acids, esters, aldehydes, ketone, amides, nitro compounds, and alcohols (but not beer) HDPE is worse than LDPE in this respect.

Rigid (Unplasticised) PVC Pipes widely accepted for applications such as cold was services internal/external water supplies system, water mains, rain water system, soil waste piping system, and underground (sewage piping system. Rigid PVC is three times as rigid polyethylene it is also much stronger and will withstand much higher pressure for given thickness. Joints can. easily be made in rigid PVC pipes by solvent welding, and a whole range injection moulded matching fittings and specials are available for these pipes.

Rigid PVC pipes are normally available in the following shades —

- White/cream.
- Light to dark grey.
- Black.

In general rigid PVC is resistant to most inorganic acids, alkalies and salts, as well as many organic chemicals. It is quite resistant to most effluents, salt water and plating solutions, corrosive fumes, soils and the like which lead to its applications over a wide field. The material is also perfectly safe with water, whether hard or soft, and in the former case it tends to retard the formation of scale. Those materials which do attack it include concentrated oxidizing acids, esters, ketones, aromatic and chlorinated hydrocarbons, organ-nitro compounds, organo-amino compounds, lacquer solvents and acetic anhydride.

The pipes shall be reasonably round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth & clean, free from grooving and other. The end shall be cleanly cut and square with the axis of the pipe. The pipe shall be designated external diameter and shall conform to IS: 4985 Revised in all respects.

Fittings: Fittings used shall be of the same make as that of PVC pipes, injection moulded or made in cast iron and shall conform to Indian Standard wherever available.

Shower Rose Brass: The shower rose shall be of chromium plated brass of specified diameter. It shall have uniform perforations. The inlet size shall be 15 mm or 20 mm as required.

Sluice Valves-Brass/Gun Metal: The sluice valves are used in a pipe line for controlling or stopping flow of water. These shall be of specified size and class and shall be of inside non-raising screw type upto 300 mm size and raising or non-raising screw type above 300 mm with either double flange or double socket ends and cap or hand wheel. These shall in all respects comply with the Indian Standard Specification IS: 780 for valves upto and including 300 mm size and IS:2906 for valves above 300 mm size. Class I sluice valves are used for

maximum working pressure of 10 Kg/ sq.cm (100 metre head) and class II sluice valve for 15 Kg/sq.cm (150 metre head).

The body, domes covers, wedge gate and stuffing box shall be of good quality cast iron, the spindle of bronze, the nut and valve seats of leaded tin bronze. The bodies, spindles and other parts shall be truly machined with surface smoothly finished. The area of the water way of the fittings shall be not less than the area equal to the nominal bore of the pipe.

The valve shall be marked with an arrow to show the direction of turn for closing of the valve.

Water Meter (Domestic Type)

Water meters shall be selected according to flow to be measured and not necessarily to suit a certain size of main. The following points shall govern the selection of meters:

- a) The maximum flow shall not exceed the nominal capacity of the meter.
- b) The continuous flow shall be not greater than the continuous running capacity rating.
- c) The minimum flow to be measured shall be within minimum starting flows.

Inferential water meter has the same accuracy as the semi-positive type at higher flows; it passes unfiltered water better than a semi-positive meter and is lower in cost.

Special care is necessary in selecting the most suitable meter where large rates of flow may exist for short periods. The normal working flow shall be well within the continuous running capacity specified in IS: 779, as high rates of flow over short period may cause excessive wear if the meter chosen is too small for the duty.

TABLE 6.16

<i>Nominal size of meter (mm)</i>	<i>Discharge per hour</i>	
	<i>Semi positive Type (litres)</i>	<i>Inferential Type (litres)</i>
15	2000	2500
20	3400	3500
25	5500	5500
40	10000	16000
50	15000	23000

Owing to the fine clearances in the working parts of meters, they are not suitable for measuring water containing sand or similar foreign matter, and in such cases a filter or dirt box of adequate effective area shall be fitted on the upstream side of the meter. See Fig. 2. It shall be noted that the normal strainer fitted inside a meter is not a filter and does not prevent the entry of small particles, such as sand.

Water meters and their parts, especially parts coming in continuous contact with water shall be of materials resistant to corrosion and shall be non-toxic and non-training. Use of dissimilar metals in contact under water shall be avoided as far as possible in order to minimise electrolytic corrosion.

LAYING AND JOINTING OF PIPES AND FITTINGS

Unloading

The pipes shall be unloaded where they are required.

Unloading (except where mechanical handling facilities are available) - pipes weighing upto 60 kgs shall be handled by two persons by hand. Heavier pipes shall be unloaded from the lorry or wagon by holding them in loops, formed with ropes and sliding over planks set not steeper than 45 degree. The planks shall be sufficiently rigid and ropes shall always be used to roll the pipes down the planks. The ropes should be tied on the side opposite the unloading. Only one pipe shall be unloaded at a time.

Under no circumstances shall be the pipes be thrown down from the carriers or be dragged or rolled along hard surfaces.

The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for reclamation. Any pipe which shows sufficient damages to preclude it from being used shall be discarded.

Storing

The pipes and specials shall be handled with sufficient care to avoid damage to them. These shall be lined up on one side of the alignment of the trench, socket facing upgrade when line runs uphill and upstream when line runs on level ground.

Each stack shall contain pipes of same class and size, consignment or batch number and particulars of suppliers, wherever possible, shall be marked on the stack.

Storage shall be done on firm, level and clean ground. Wedges shall be provided at the bottom layer to keep the stack stable.

Cutting

Cutting of pipes may be necessary when pipes are to be laid in lengths shorter than the lengths supplied, such as while replacing accessories like tees, bends, etc. at fixed position in the pipe lines.

A line shall be marked around the pipe with a chalk piece at the point where it is to be cut. The line shall be so marked that the cut is truly at right angle to the longitudinal axis of the pipe. The pipe shall be rigidly held on two parallel rafters nailed to cross beams, taking care that the portion to be cut does not overhang and the cut mark is between the two rafters. The pipe shall be neatly cut at the chalk mark with carpenter's saw or hacksaw having a long blade, by slowly rotating the pipe around its longitudinal axis so as to have the uncut portion on top for cutting. Cutting of the pipe at the overhang should, as far as possible, be avoided, as an overhanging and is liable to tear off due to its weight before the cutting is complete.

Trenches

The trenches shall be so dug that the pipes be laid to the required alignment and at required depth.

Cover shall be measured from top of pipe the surface of the ground.

The bed of the trench, if in soft or made up earth, shall be well watered and rammed before laying the pipes and the depressions, if any, shall be properly filled with earth and consolidated in 20cm layers.

If the trench bottom is extremely hard or rocky or loose stony soil, the trench shall be excavated at least 150 mm below the trench grade. Rocks, stone or other hard substances from the bottom of the trench shall be removed and the trench brought back to the required grade by filling with selected fine earth or sand (or fine moorum if fine soil or sand is not available locally) and compacted so as to provide a smooth bedding for the pipe

The excavated materials shall not be placed within 1 metre or half of the depth of the trench whichever is greater, from the edge of the trench. The materials excavated shall be separated and stacked so that in refilling they may be relaid and compacted in the same order to the satisfaction of the Engineer-in-charge.

The trench shall be kept free from water. Shoring and timbering shall be provided wherever required. Excavation below water table shall be done after dewatering the trenches.

Where the pipe line or drain crosses an existing road, the road crossing shall be excavated half at a time, the 2nd half being commenced after the pipes have been laid in the first half and the trench refilled. Necessary safety measures for traffic as directed shall be adopted. All types, water mains cables, etc. met within the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the electrical and communication cable met with during course of excavation, removal of which, if necessary, shall be arranged by the Engineer-in-charge.

Laying

The pipes shall be lowered into the trench by means of suitable pulley blocks, sheer legs chains ropes etc. In no case the pipes shall be rolled and dropped into the trench. One end of each rope may be tied to a wooden or steel peg driven into the ground and the other end held by men which when slowly released will lower the pipe into the trench. After lowering, the pipes shall be arranged so that the spigot of one pipe is carefully centered into the socket of the next pipe, and pushed to the full distance that it can go. The pipe line shall be laid to the levels required. Specials shall also be laid in their proper position as stated above wherever safe and sufficient clean cover is not obtained, the pipes shall be protected with a easing pipe or other suitable means.

Where so directed, the pipes and specials may be laid on masonry or concrete pillars. The pipe laid on the level ground, shall be laid with socket facing the direction of flow of water.

The pipes shall rest continuously on the bottom of the trench. The pipes shall not rest on lumps of earth or on the joints. Four metre long wooden templates may be used to check the level of the bed. Clearance of approximately 100 mm in depth and width equal to length of the collar plus 30mm on both sides shall be provided at the joint which shall be refilled from sides after the joint is made.

In unstable soils, such as soft soils and dry lumpy soils it shall be checked whether the soils can support the pipe lines and if required suitable special foundation shall be provided.

Some clayey soils (for example black cotton soil) are drastically affected by extremes of saturation and dryness. In changing from saturated to a dry Condition, these soils are subjected to extraordinary shrinkage which is usually seen in the form of wide and deep cracks in the earth surface and may result damages to under ground structures, including pipe materials. The clay forms a tight gripping bond with the pipe, subjecting it to

excessive stresses as the clay shrinks. It is recommended that in such cases an envelope of a minimum 100 mm of tamped sand shall be made around the pipe line to avoid any bonding.

In places where rock is encountered, cushion of fine earth or sand shall be provided for a depth of 150 mm by excavating extra depth of the trench, if necessary, and the pipes laid over the cushion. Where the gradient of the bed slopes is more than 30 degree it may be necessary to anchor a few pipes against sliding downwards.

Thrust Blocks

Thrust blocks are required to transfer the resulting hydraulic thrust from the fitting of pipe on to a larger load bearing soil section.

Thrust blocks shall be installed wherever there is a change in the direction/size of the pipe line or the pressure line diagram, or when the pipe line ends at a dead end. If necessary, thrust blocks may be constructed at valves also.

Thrust blocks shall be constructed taking into account the pipe size, water pressure, type of fitting, gravity component shell when laid on slopes and the type of soil.

When a fitting is used to make a vertical bend, it shall be anchored to a concrete thrust block designed to have enough weight to resist the upward and outward thrust. Similarly at joints, deflected in vertical plane, it shall be ensured that the weight of the pipe, the water in the pipe and the weight of the soil over the pipe provide resistance to upward movement. If it is not enough, ballast or concrete shall be placed around the pipe in sufficient weight to counteract the thrust.

When the line is under pressure there is an outward thrust at each coupling. Good soil, properly tamped is usually sufficient to hold pipe from side movement. However, if soft soil conditions, are encountered, it may be necessary to provide side thrust blocks of other means of anchoring. In such cases only pipe on each side of the deflected coupling shall be anchored without restricting the coupling.

Pipes on slopes need be anchored only when there is a possibility of the back fill around the pipe sloping down the hill and carrying the pipe with it. Generally for slopes upto 30 degree good well drained soil carefully tamped in layers of 100 mm under and over the pipe, right upto the top of trench will not require anchoring.

For steeper slopes, one out of every three pipes shall be held by straps fastened to vertical supports anchored in concrete.

Back Filling and Tamping

Back filling shall follow pipe installation as closely as possible to protect pipe from falling boulders, eliminating possibility of lifting of the pipe, right upto flooding of open trench and shifting pipe out of line by caved in soil.

The soil under the pipe and coupling shall be solidly tamped to provide firm and continuous support for the pipe line. Tamping shall be done either by tamping bars or by using water to consolidate the back fill materials.

The initial back fill material used shall be free of large stones and dry lumps. In stony areas the material for initial back fill can be shaved from sides of the trenches. In bogs and marshes, the excavated material is usually little more than vegetable matter and this should not be used for bedding purposes. In such cases, gravel or crushed stone shall be hauled in.

The initial back fill shall be placed evenly in a layer of about 100 mm thick. This shall be properly consolidated and this shall be continued till there is a cushion of at least 300 mm of cover over the pipe.

If it is desired to observe the joint or coupling during the testing of mains they shall be left exposed, Sufficient back fill shall be placed on the pipe to resist the movement due to pressure while testing.

Balance of the back fill need not be so carefully selected as the initial material. However, care shall be taken to avoid back filling with large stones which might damage the pipe when spaded into the trench.

Pipes in trenches on a slope shall have extra attention to make certain that the newly placed back fill will not become a blind drain in effect because until back fill becomes completely consolidated there is a tendency for ground or surface water to move along this looser soil resulting in a loss of support to the pipe. In such cases, the back fill shall be tamped with extra care and the tamping continued in 100 mm layers right upto the ground level.

Hydrostatic Tests

Hydrostatic Tests: The portions of the line shall be tested by subjecting to pressure test as the laying progresses before the entire line is completed. In this way any error of workmanship will be found immediately and can be corrected at a minimum cost. Usually the length of the section to be tested shall not exceed 500m.

Where any section of a main is provided with concrete thrust blocks or anchorages, the pressure test shall not be made until at least five days have elapsed after the concrete is cast. If rapid hardening cement has been used in these blocks or anchorages, test shall not be made until atleast two days have elapsed.

Prior to testing, enough back fill shall be placed over the pipe line excluding the joints to resist upward thrust. All thrust blocks forming part of the finished line shall have been sufficiently cured and no temporary bracing shall be used.

The section of the line to be tested shall be filled with water manually or by a low pressure pump. Air shall be vented from all high spots in the before making the pressure strength test because entrapped air gets compressed and causes difficulty in raising the required pressure for the pressure strength test.

The test pressure shall be gradually raised at the rate of approximately one Kg./sq. cm./min. The duration of the test period if not specified shall be sufficient to make a careful check on the pipe line section.

LAYING AND JOINTING OF ASBESTOS CEMENT PRESSURE PIPE (EXTERNAL WORK)

The specifications described in 8.7.4 shall apply, as far as applicable.

Storing

The stack shall be in pyramid shape or the pipes laid lengthwise and crosswise in alternate layers. The pyramid stack is advisable for smaller diameter pipes, for conserving space in storing them. The height of the stack shall not exceed 1.5 metre.

Cast iron detachable joints and fittings shall be stacked under cover and separated from the asbestos cement pipes and fittings.

Rubber rings shall be kept clean, away from grease, oil, heat and light.

Trenches

The width of the trench above pipe level shall be as small as possible but shall provide sufficient space necessary for jointing the pipes. The trench width shall be such as to provide a space of 200 mm on either side of the pipe. Where the depth is more than 45 cms, the minimum width shall be 45 cms.

The pipes, shall have a minimum soil cover of 750 mm, when laid under foot paths and side walks, 900 mm, when laid under roads with light traffic or under cultivated soils and 1.25 m, when laid under roads with heavy traffic when the soil has a poor bearing capacity and is subjected to heavy traffic, the pipes shall be laid on a concrete cradle. An extra trench depth of 100 mm shall be provided for each jointing pit.

Jointing

Before commencing jointing, the pipes, joints and ends of the pipes shall be cleaned, preferably with a hard wire brush to remove loose particles.

Special Cast Iron Fittings and Accessories

Normally when pipe line is laid, a certain number of cast iron fittings such as tees, bends, reducers, etc. and special fittings such as air or sluice valves are required.

Laying of Fittings: All cast iron fittings shall be plain ended to suit the class and diameter of pipe manufactured. Cast iron fittings are jointed by cast iron detachable joints only. Cast iron specials having flanges are jointed in the pipe line with cast iron flange adapters having one end flanged and the other plain ended.

Anchorages: It shall particularly be noted that the cast iron joints do not hold pipe ends within firmly. During working or test pressure, there will be the tendency for the pipe ends or specials ends to slip out of the joint, more so in case of blank end cap used for closure of pipe line and in case of degree bends and tees. In order to keep them firmly in the pipe line, anchoring of these specials are necessary against the direction of thrust.

The anchorage shall consist of either concrete cast-in-situ or masonry built in cement mortar. The anchors shall be extended to the firm soil of the trench side. The shape of the anchors will depend on the kind of specials used. They shall be spread to the full width of trench and carried vertically by the side and over the special to about 15 cm. The bearing area on sides of the trench shall be proportional to the thrust and to the bearing capacity of the sides of the trench.

Hydrostatic Tests

The pipes shall be tested as specified in IS:5913 in the factory and hence the purpose of field testing is to check the quality of workman ship and also to check whether the pipes have been damaged in transit. As such, the test pressure shall be kept as 1.5 times the actual operating pressure unless a higher test pressure is specified. However, it may be noted that the test pressure during the field test shall not exceed the values given in Table 6.17

TABLE 6.17 - TEST PRESSURE FOR PIPES

Class of pipe	Maximum field test pressure kgf.sq.cm
5	3.75
10	7.50
15	11.25
20	15.00
25	18.75

Asbestos cement pipes always absorb a certain amount of water. Therefore, after the line is filled, it shall be allowed to stand for 24 hours, before pressure testing and the line shall be again filled.

Measurements

The net length of pipes as laid or fixed shall be measured in the running metres correct to a cm.

Specials shall be excluded and enumerated and paid for separately. The portion of the pipe within the collar at the joints shall not be included in the length of pipe work.

Excavation refilling, shoring and timbering in trenches, masonry or concrete pillars and thrust blocks, wherever required, shall be measured paid for separately, under relevant items of work.

The join shall be enumerated and paid for separately.

Rates: The rates shall include the cost materials and labour involved in all the operations described above except for the items measured enumerated separately.

LAYING AND JOINTING OF PIPES AND FITTINGS (EXTERNAL WORK)

Specifications described for pipe laying shall apply as far as applicable.

Trenches

The gradient is to be set out by means of bonning rods and the required depth to be excavated at any point of the trench shall be regarded as directed by the Engineer-in-Charge. The the trench shall not be less than 1 metre measurement from the top of the pipe to the surface of the ground under roads and not less than 0.75 metre elsewhere.

The width of the trench shall be the nominal diameter of the pipe plus 40 cm but it shall not be less than 55 cm in case of all kinds of soils excluding rock and not less than 1 metre in case of rock.

Laying : Any deviation either in plan or elevation less than 11.25 degrees shall be effected by laying the straight pipes around a flat curve of such radius that minimum thickness of lead at the face of the socket shall not be reduced below 6 mm or the opening between spigot and socket increased beyond 12 mm at any joint. A deviation of about 2-25 degree can be effected at each joint in this way. At the end of each day's work the last pipe laid shall have its open ends securely closed with a wooden plug to prevent entry of water, soil, rats and any other foreign matter into the pipe.

LAYING AND JOINTING OF G. I. PIPES (EXTERNAL WORK)

Trenches: The galvanised iron pipes and fittings shall be laid in trenches. The widths and depths of the trenches for different diameters of the pipes shall be as in Table 6.18

TABLE 6.18

Dia of pipe (mm)	Width of trench (cm)	Depth of trench (cm)
15 to 50	30	60
65 to 100	45	75

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

Cutting and Threading: Where the pipes have to be out or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The end of the pipes shall then be carefully threaded conforming to the requirements of IS: 554 with pipe dies and tapes in such manner as will not result in slackness of joints when

the two pieces are screwed together. The taps and dies shall not be used for turning of the threads so as to make them slack, as joint. The screw threads of pipes and fitting shall be protected from damage until they are fitted.

Jointing: The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped round the screwed end of the pipe. The end shall then be screwed in the socket, Tee etc. with the pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

Thrust Blocks: In case of bigger diameter pipes where the pressure is very high, thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate of 20 mm nominal size) of adequate size and shape shall be provided on all bends to transmit the hydraulic thrust to the ground, spreading it over a sufficient areas, depending upon the type of soil met with.

Painting: The pipes shall be painted with two coats of anticorrosive bitumastic paint of approved quality.

Testing of Joints: The pipes and fittings after they are laid and jointed shall be tested to hydraulic pressure of 6 Kg/sq.cm (60 meters). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw off taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing. Pipes or fittings which are found leaking shall be replaced and joints found leaking shall be redone, without extra payment.

Trench filling: The pipes shall be laid on a layer of 7.5 cm sand and filled upto 15 cm above the pipes. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be classified according to their diameters, method of jointing and fixing substance quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and wastage. in case of fittings of unequal bore the largest bore shall be measured.

Note: G.I unions shall be paid separately in external work.

Digging and refilling of trenches shall either be measured separately as specified in the appropriate clauses of excavation and earth work or clubbed with main item.

Rate: The rate shall include the cost of labour and materials involved in all operations described above. The rate shall not include excavation in trenches, painting of pipes and sand filling all round the pipes, unless otherwise specified.

LAYING AND JOINTING UNPLASTICISED P.V.C PIPES (EXTERNAL WORK)

Handling and Storage: Unplasticied P.V.C pipes are light in weight material. Reasonable care shall be taken in handling and storage of these to prevent damages. On no account the pipes shall be dragged along the ground. Pipes shall be given adequate support at all times. They shall not be stacked in large piles, especially under warm temperature conditions as the bottom pipes may distort, thus giving rise to difficulty in pipe alignment and jointing.

For temporary storage in the field , where racks are not provided care shall be taken that the ground is level and free from loose stones. Pipes stored thus shall so stacked as to prevent movement, the pipes shall preferably be stored under shade.

For satisfactory service performance of plastic pipes under conditions of use, the following points must be kept in view while undertaking installation of plastic piping system:

- a) The plastic materials are 'thermoplastic' in nature, and must not be used in contact with hot surfaces (or hot water).
- b) They must be supported at regular intervals for above ground installation.
- c) Allowances must be made, during installation for their expansion, particularly by using loose clips / clamps;
- d) A range of specials and matching fittings must be identified and their manufactures / suppliers listed.

Rigid P.V.C. pipes from 16 mm to 315 mm dia have been produced.

In these specifications only the use of rigid (unplasticied) P.V.C pipes for cold water supplies is covered.

Trenches : The trench bottom shall be carefully examined fro the presence of hard objects such as flints, rock projections or tree roots etc. pipes shall be bedded in sand or soft free from rock and gravel. Back fill 15 cm above the pipe shall also be of fine sand or soft soil. Pipes shall not be painted. The width of trench shall be not

les than outside dia meter of pipe plus 30 cm in case of gravel soils. Pipes shall be laid at least 90 cms below the ground to the top of the pipe).

Jointing

Solvent welded joints: Non heat application Method:

In this method, instead of forming a socket on one pipe and an injection moulded socket fitting or coupler is used, with a provision to take in the pipes at both ends. The solvent cements are applied on the surfaces to be jointed and the joint is made at ambient temperature. Injection moulded fittings only shall be used in preference to fabricated fittings, only solvent recommended by the manufacturers of pipes shall be used and full load on the joints applied only after 24 hours. The pipe shall be cut perpendicular to the axis of the pipe length with a metal cutting saw or an ordinary hand saw with metal cutting saw or an ordinary hand saw with small teeth. Pipe ends have to be beveled slightly with a beveling tool (Reamer) at an angle of about 30 degree. The total length of insertion socket (injection moulded socket or coupler) shall be marked on the pipe and checked how far the pipe to the the marked distance, if not possible it shall at least be pushed for 2/3 of this distance.

Dust, oil, water grease etc. shall be wiped cut with a dry cloth from the surface. Further the grease should be thoroughly removed with a suitable solvent, such as methylene chloride or as an alternative the outside surface of the pipe and the inside of the fitting may be roughened with emery paper.

Generous coatings of solvent cement shall be evenly applied on the inside of the fitting around the circumference for the full length of insertion and on the outside of the pipe end upto the marked line with non synthetic brush of suitable dimension. The pipe shall be pushed into the fitting socket and held for 1 or 2 minutes as otherwise the pipe surfaces shall be wiped out the solvent cement has dried up too much or the tapering of the socket is too steep, joining will not be proper and pipe will come out of the fitting.

In summer months joints shall be made preferably early in the morning or in the evening when it is cooler. This will prevent joint form pulling apart when the pipe cools off at night. Heat application method for jointing shall not be allowed.

Flanged Joints: For jointing P.V.C pipes particularly of larger sizes to valves and vessels and larger size metal pipes where the tensile strength required the joint is made by the compression of gasket or ring seal set in the face of C.I. flanges. Flanges solvent welded to the P.V.C. pipes shall be supplied by the manufactures.

Rubber Ring joints: Rubber ring joints can provide a water tight seal but do not resist pull. As such these may be used only as repairs collar and for jointing pipes larger than 110 mm. Such joints may be provided on pipes which are buried in the ground and supported throughout on bedding so that they are not subject to movements and longitudinal pull. As such these may be used only as repairs collar and for jointing pipes larger than 110 mm. Such joints may be provided on pipes which are buried in the ground and supported throughout on bedding so that they are not subject to movements and longitudinal pull. The material of rubber ring shall conform to IS : 5382 where aggressive soil are met with, synthetic rubbers perform better for jointing in plastic or metallic housing. The rubber compressed and makes a seal between the pipe and the housing. The ring shape and the method compressing the ring vary considerably in different application of lubricating paste which shall be procured from the manufacturer of P.V.C pipes .Rubber rings shall be supplied by the manufacturer.

The rubber ring joints can be either of:

1. With spigot socket, or
2. With separate collar pieces having two rubber rings, one at either end.

Crossing Road or Drain: Where the line crosses a road or a drain, it shall be through CI or R.C.C. pipe.

Supports for Valve and Hydrant: Valve and hydrant tees shall be supported that the torque applied in operating a valve is not transmitted to the pipe line.

Inspection and Testing Solvent welded pipe shall not be pressure tested until at least 24 hours after the last solvent cemented joint has been done.

All control valves shall be positioned open for duration of the test and open end closed with water tight fittings. The testing pressure on completion of the work shall not be less than one and a half times the working pressure of the pipes..

Pressure shall be applied either by hand pump or power driven pump. Pressure guages shall be correctly positioned and closely observed to ensure that at no time are the test pressure exceeded. The systems shall be slowly and carefully filled with water to avoid surge pressure or water hammer. Air vents shall be open at all high points so that air may be expelled from the system during filling.

When the system has been fully charged with water and air displaced from the line air vent shall be closed and the line initially inspected for seepage at joints and firmness of supports under load, Pressure may then be applied until the required test sure is reached.

Without any additional requirement of make-up-water the test pressure should not fall more than 0.2 kg/sq.cm. at the end of one hour test duration.

Measurements: The length shall be measured in running metre correct to a cm for the finished work which shall include P.V.C. fittings such as bends, tees, elbows, reducer, crosses, plugs, sockets, nipples and nuts, but exclude, taps, valves, etc. All pipes and fittings shall be classified according to their outside diameters and pressure ratings. Fittings of unequal outside diameter shall be measured along with the larger diameter pipe.

Rate: The rate shall include the cost of labour and material in all the operation described above except excavation in trenches, sand filling around the pipes, metal pipe used for encasing P.V.C. pipe and anchor blocks, unless otherwise specified.

LAYING AND JOINTING G.I. PIPES (INTERNAL WORK)

For internal work the galvanised iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts or recess etc., provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage and where so required joints are not buried. Where directed by the Engineer-in-Charge, a M.S. tube sleeve shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion and contraction and other movements. In case the pipe is embedded in walls or floors it should be painted with anticorrosive bitumastic paints of approved quality. The pipe shall not come in contact with lime mortar or lime concrete as the pipe is affected by time. Under the floors the pipes shall be laid in layer of sand filling as done under concrete floors.

All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern holder bat clamps of required shape and size so as to fit tightly on the pipes when tightened with screwed bolts, these clamps shall be embedded in brick work in cement mortar 1:3 (1 cement: 3 coarse sand), and shall be spaced at regular intervals in straight lengths as shown in table 6.19

TABLE 6.19

Dia. of pipe (mm)	Horizontal Length (m)	Vertical length (m)
15	2	2.5
20	2.5	3
25	2.5	3
32	2.5	3
40	3	3.5
50	3	3.5
65	3.5	5
80	3.5	5

The clamps shall be fixed at shorter lengths near the fittings as directed by the Engineer-in-charge.

For G.I. pipes 15 mm diameter, the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick work or concrete. However, for bigger dimension pipes the holes shall be carefully made of the smallest size as directed by the Engineer-in-charge. After fixing the pipes the, holes shall be made good with cement mortar 1:3 (1 cement: 3. coarse sand) and properly finished to match the adjacent surface.

Unions will be provided to facilitate connections additions and alterations as well as for maintenance and for change of pipes. The locations where unions are to be provided will be decided with prior written approval of the Engineer-in-charge.

Measurements :The lengths shall be measured in running metre correct to a cm for the finished work, which shall include G.I pipe and G.I. fittings such as bends, tees elbows, reducers, crosses, plugs, sockets, nipples and nuts, but exclude brass or gun metal taps (cocks), valves, unions, lead-connection pipes and shower rose. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance, quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and waste. In case of fittings of unequal bore, the largest bore shall be measured. Pipes laid in trenches (or without supports) and pipes fixed to walls, ceilings, etc. with supports shall be measured separately.

Rate: The rate shall include the cost of labour and material involved in all the operations described above. The rate shall include the cost of cutting holes in walls and floors and making good the same. This shall not however, include concealed pipe work in which case cutting of chase and making good shall be paid separately.

It shall not include painting of pipes and providing sleeves, unless specified otherwise. It will also not include union, which shall be paid for separately.

TABLE 6.20

LAYING AND JOINTING P.V.C. PIPES (INTERNAL WORK)

Clamping: The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively plastic clamps of suitable designs, wherever manufactured shall be preferred. Provision shall be made for effect of thermal movement by not gripping restricting the pipe at supports between the anchors for suspended pipes. The supports shall allow repeated longitudinal temperature movement take place without abrasion. Line or point contact with the pipe shall be avoided. Heavy components such as metal valves shall be individually supported.

Supports: P.V.C. pipes require supports at close interval. Recommended support spacing unclassified P.V.C. pipes are given in Table-9.20. This spacing may be increased by 50% for vertical runs support.

It is essential that P.V.C pipes shall be aligned properly before fixing them on the wooden plugs are with clamps. Even if the wooden plugs are using a plumb line, P.V.C. pipe shall also for its alignment before clamping. The pipe line be wavy if the clamps are not fixed plumb.

Connection to a Water Tap: Connection of the water tap shall be made by means of an adopter. G.I. adopter preferably be supplied by the same manufacturer as that of P.V.C. pipe. In any threaded coupling between P.V.C. and G.I. is preferable that PVC fitted inside the G.I. fitting. If however greater projection is desired, same shall be achieved joining a short piece of a G.I. pipe

Connection to a shower Rose: Shower connection shall be of G.I. pipes

Connection from Masonry/Concrete Tank: Solvent cement shall be coated on the section of the pipe to be embedded in concrete. Fine dry and cement mixture shall be sprinkled uniformly around the pipe. This shall give a rough surface which can be safely embedded in concrete; water proofing cement shall be used to close the gap properly.

Measurements : The length shall be measured in running metre correct to a cm for the finished work which shall include P.V.C. fittings such as bends, tees, elbows, reducer, crosses plugs, sockets, nipples and nuts, but

Pipe Dia. Mm	Support spacing mm
20	700
25	750
32	825
40	975
50	975

exclude taps, valves, etc. All pipes and fittings shall be

classified according to their outside diameter shall be measured along with the larger diameter pipe.

Rate: The shall include the cost of labour and material in all the operation described above except metal pipes used for encasing P.V.C. pipe and anchor blocks, unless otherwise specified.

POLYETHYLENE WATER STORAGE TANKS

Material: Polyethylene used for manufacture of tanks and manhole lids may be high density (HDPE), low density (LDPE) or linear low density (LLDPE) and shall conform to IS: 10146. Polyethylene shall be compounded with carbon black so as to make the tank resistant to ultra violet rays from the sun. The percentage of carbon black content in polyethylene shall be 2.5 ± 0.5 percent and it shall be uniformly distributed. The material used for the manufacture of tank, manhole lid and fittings shall be such that they neither contaminate the water nor impart any taste, color, odour or toxicity to water.

R.C. STORAGE TANKS

The tanks shall be cast in situ, circular / rectangular in shape and approved capacity. These shall be as per approved drawings and specifications.

Concealing G.I.pipes in walls

Chases shall be cut in walls to house/conceal the pipes. The chases shall have a width of 35 mm + outer diameter for hot water pipes or 30 mm + outer diameter for other pipes. Horizontal chases shall be avoided or reduced to the minimum. The chases shall be vertical, as far as possible. The depth of vertical chases shall not exceed one third of the wall thickness and that for horizontal chases shall in no case exceed one sixth of the wall thickness. Horizontal chases, when unavoidable, should be located in the upper or lower one third of height of storey. No horizontal chase shall exceed one meter in continuous length. Vertical chases should not be closer than 2m. in any stretch of a wall. No chase shall be allowed in half brick load bearing wall. No inclined

chases shall be permitted in walls. In unavoidable cases inclined chases shall be cut with written approval of the Engineer – in – Charge and repaired to his satisfaction. Under no circumstances inclined chases shall be allowed in half brick masonry walls. Chases shall be cut by chiseling out the masonry to correct line, width and depth. Any damage to the adjoining portion or to any other item shall be made good, as decided by the Engineer-in-Charge, for which no extra payment will be made. All dismantled materials shall be removed from the site.

The pipes to be concealed shall be cleaned to remove all dirt from the surface of the pipe and wrapped with good quality compact asbestos fiber for a thickness of 6 mm in the case of hot water pipes without leaving any gap or projection at joint. Wrapping shall be held in position by tying thin plastic wire helically. Cold water pipes shall be wrapped with yarn for a thickness of 3 mm.

After housing the pipes in the chase, leaving minimum 20 mm clear space at the face of the wall, the chases shall be filled with cement concrete 1:2:4 using 20 mm graded metal or cement mortar 1:3, as may be specified or directed by the Engineer-in-Charge and made flush with the wall surface. The concrete surface shall be roughened with wire brushes to provide key for plastering.

Measurement

Concealed pipes shall be measured in running metre correct to a cm.

Rates

The rate shall include the cost of labour, all materials involved, hire of tools etc. complete for the finished work specified above but excluding cost of pipes.

Concealing PVC pipes

The specification shall be as for Concealing GI pipes except as follows:

Cutting chases, filling the chases after housing the pipe, finishing etc. as for concealing G-3 pipes. Width and depth of chases shall be 35 mm + outer diameter of the pipe.

The pipe shall be wrapped with hemp yarn dipped in hot bitumen for a thickness of 6 mm without leaving any gap.

SANITARY INSTALLATIONS

APPLIANCES AND FITTINGS

All vitreous and sanitary appliances (Vitreous china) shall conform to IS: 2556 (part I) general requirements.

The chromium plating shall conform to IS: 4827 and shall be of grade 2 (thickness 10 micron). The chromium plating shall never be deposited on brass unless a heavy coating of nickel is interposed.

Flushing Cisterns

The flushing cisterns shall be automatic or manually operated high level or low level as specified for water closets and urinals. A high level cistern is intended to operate with minimum height of 125 cm and a low level cistern with a maximum height of 30 cm between the top of the pan and underside of the cistern.

Cisterns shall be of Cast Iron, Vitreous China, Pressed steel (IS: 774 for flushing type and IS: 2326 for automatic flushing cistern and plastic (IS: 7231.)

The cistern shall be supported on two Cast Iron brackets of size as approved by the Engineer-in-charge and embedded in cement concrete 1:2:4 block, 100 x 75 x 150 mm. The Cast Iron brackets shall conform to IS: 775. These shall be properly protected by suitable impervious paint.

The cistern shall have a removable cover which shall fit closely on it and be secured against displacement. In designs where the operating mechanism is attached to the cover, this may be made in two sections, but the section supporting the mechanism shall be securely bolted or screwed to the body. The outlet fitting of each cistern shall be securely connected to the cistern. The nominal internal diameter of the cistern outlet shall be not less than 32 mm and 38 mm for high level and low level cisterns respectively and the length of the outlet of the cistern shall be 37 + 2 mm.

Ball valve shall be of screwed type 15 mm in diameter and shall conform to IS 1703. The float shall be made of polyethylene as specified in IS: 9762.

The flush type shall be of (a) medium quality galvanized iron having internal diameter 32+ 1 mm for high level cisterns and 38+ 1 low level cistern. The flush pipe shall be of suitable length with bends etc. as required for fixing it with front or back inlet W.C. Pan (b) Polyethylene pipes low density conforming to IS: 3076 or high density conforming to IS:4984. (c) Unplasticised PVC pipes conforming to IS: 4985. For high density polyethylene and unplasticised PVC pipes, the outside diameter pipes shall be 40 mm. When PVC plumbing

pipes are used, the outside diameter of pipe shall be 40 mm for high level cisterns and 50 mm for low level cisterns.

In case of high level cistern the flush pipe shall be a vertical pipe 125 cm long and having a nominal internal diameter 32+1 mm (except plastic flush pipes) and in case of low level cistern 30 cm long and 38+1 mm diameter (except plastic flush pipes)

Overflow pipe

GI overflow pipe shall be of not less than 20 mm nominal bore and shall incorporate a non corrodible mosquito proof brass cover having 1.25 mm dia perforation, screwed in a manner which will permit it to be readily cleaned or renewed when necessary. No provision shall be made whereby the overflow from the cistern shall discharge directly into the water closet or soil pipe without being detected.

The invert of the overflow pipes in the case of high level and low level cisterns shall be 19 mm minimum above the working water level. In case of overflow due to any reason water should drain out through the overflow pipe and not through the siphon pipe.

The plastic overflow pipes shall be manufactured from high density polyethylene conforming to IS 4984 or unplasticised PVC conforming to IS 4985.

Foot rests: Foot rests shall be of Vitreous China conforming to IS: 2556 (Part-X). Foot rests which are rectangular shall meet the minimum requirements and dimensions and may be of different designs where so specified. Foot rests of different shapes and sizes shall also be allowed subject to approval of Engineer-in-charge.

Mirror: The mirror shall be of superior sheet glass with edges rounded off or beveled, as specified. It shall be free from flaws, specks or bubbles. The size of the mirror shall be 60x45 cm unless specified otherwise and its thickness shall not be less than 5.5mm. It shall be free from silvering defects.

Pillar Taps: Pillar taps shall be chromium plated brass and shall conform to IS: 1795. Every pillar tap, complete with its component parts shall withstand an internally applied hydraulic pressure of 20 Kg/sq.cm maintained for a period of 2 minutes during which periods it shall neither leak nor sweat.

Sinks: Laboratory sinks shall be of white vitreous china with dimensions as specified conforming to IS: 2256 (Pt. V). Kitchen sinks shall be of white glazed fire clay conforming to IS: 771(Part-II) with upto date amendments. The kitchen sink shall be of one piece construction with or without rim, with or without overflow.

Towel rail

The towel rail shall be of:

CP Brass with two CP brass brackets coated with nickel chromium plating of thickness not less than grade no.2 of IS: 4827.

Anodized aluminium fluted surface with two anodized aluminium brackets. The size of the rail shall be 75 cm x 20 mm dia or 60 cm x 20 mm dia, 1.25 mm thick as specified. The fixing screw shall be of CP brass.

Urinals

Bowl type urinals: Urinal basins shall be of flat back or corner wall type lipped in front These shall be of white vitreous china conforming to IS: 2556-(Part VI) Sec.I. The urinals shall of one piece construction. Each urinal shall be provided with not less than two fixing holes of minimum dia 6.5 mm on each side. Each urinal shall have an integral flushing rim of suitable type and inlet of supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self draining type. It shall have a weep hole at the flushing inlet of the urinals.

The following tolerances may be allowed on the dimensions:

On dimension 50 mm and over ± 4 percent

On dimensions less than 50 mm ± 2 mm

On all angles ± 3 degree

Stall Urinals: The stall urinal and its screens shall be of white glazed fire clay conforming to IS: 771 (Pt.3-Sec.2). The stall shall be 1140 mm high and 460 mm wide with 400 mm overall depth at the base. Where specified, screens which shall be 1200 mm high and 15 cm wide (overall) and projecting 50 cm after suitable embedment in the wall shall be provided as directed by the Engineer-in-charge.

Half stall urinals: They shall be of white vitreous China conforming to IS: 2556 (Part VI-Sec.2).

Urinal Partition Slabs: Urinal partition slabs shall be provided, as specified.

Wash Basins: Wash basins shall be of white vitreous china conforming to IS: 2556 (Part-I) and IS: 2556 (Part-IV). Wash basins either of flat back or angle back as specified shall be of one piece construction, including a combined overflow. Stud slots to receive the brackets on the underside of the wash basin shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from back of basin to the centre of the stud. The stud shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess slot type of overflow having an area of not less than 5 sq.cm shall be provided and shall be so designed as to facilitate cleaning of the overflow.

Where oval shape or round shape wash basin are required to be fixed these shall be fixed preferably in RCC platform with local available stone topping either fully sunk in stone top or top flush with stone topping as directed by Engineer-in-charge.

The wash basins shall be one of the following patterns and sizes as specified.

- a) Flat back: 630 x 450 mm
550 x 400 mm
450 x 300 mm
- b) Angle back: 600 x 400 mm
400 x 400 mm

White glazed pedestals for wash basins, where specified shall be provided. The quality of glazing of the pedestal shall be exactly the same as that of the basin along with which it is to be installed. It shall completely recessed at the back to accommodate supply and waste pipes and fittings. It shall be capable of supporting the basin rigidly and adequately and shall be so designed as to make the height from the floor to top of the rim of basin 75 to 80 cm. The waste fittings shall be brass chromium plate or as specified. The following tolerances may be allowed on dimensions specified:

On dimension 75 mm and over	+ 4 percent
On dimensions less than 75 mm	+ 2 mm
Diameter of the waste hole	+ 3 mm

Waste fittings for wash basins and sinks: The waste fittings shall be of nickel chromium plated brass, with thickness of plating not less than service grade 2 of IS: 4827 which is capable of receiving polish and will not easily scale off. The fitting shall conform in all respect to IS: 2963. It shall be sound, free from laps, blow holes and pits and other manufacturing defects. External and internal surfaces shall be clean and smooth. They shall be neatly dressed and be truly machined so that the nut smoothly moves on the body.

Waste fitting from wash basins shall be of nominal size of 32 mm.

Water closet

Squatting pans: Squatting pans shall be of white vitreous china conforming to IS: 2556 Part-I from General Requirements and relevant IS codes for each pattern as described below:

- i) Long pattern-conforming to IS: 2556 (Part-III)
- ii) Orissa pattern-conforming to IS: 2556 (Part-III)
- iii) Integrated type conforming to IS: 2556 (Part-XIV)

Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush pipes. The flushing rim and inlet shall be of the self draining type. It shall have weep hole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise specified or ordered by the Engineer-in-charge. The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and its face shall be uniform and smooth to enable easy and quick disposal while flushing. The exterior surface of the outlet below the flange shall be an unglazed surface which shall have grooves at right angles to the axis of the outlet. In all cases a pan shall be provided with a 100 mm) S.C.I. trap 'P' or 'S' type with approximately 50 mm water seal and 50 mm dia vent horn, here required by the Engineer-in-charge,

The following tolerances may be allowed on the dimensions specified:

Long pattern and Orissa pattern:

- a) On dimension 50 mm and over ± 4 percent
- b) On dimensions less than 50 mm ± 2 mm

- c) On all angles ± 3 deg.
- d) The top surface of long pattern pan shall not at any point vary from its designed plane or contour by more than 6 mm for size 580 mm and by more than 10 mm for sizes 630 mm and measured vertically. This value shall not exceed 10 mm in case of Orissa pattern pans.

Integrated squatting pan:

- e) On dimension 50 mm and over ± 4 percent
- f) On dimensions less than 50 mm ± 2 mm
- g) On all angles ± 3 deg.

Water closet (Wash Down Type): Water closets shall be of white vitreous china conforming to IS: 2556 (Part-I) and 2556 (Part-II), as specified and shall be of “Wash down type”. The closets shall be of one piece construction. Each water closet shall have not less than two holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flushing pipe of dimensions to suit the flushing rim. In the case of box rims adequate number of holes, on each side together with a slot opposite the inlet shall be provided. The flushing rim and inlet shall be of the self draining type. The water closet shall have a weep hole at the flushing inlet. Each water closet shall have an integral with either ‘S’ or ‘P’ outlet with atleast 50 mm water seal. For P trap, the slope of the outlet shall be 14 deg. below the horizontal. Where required the water closet shall have an antisiphonage 50 mm dia vent horn on the outlet side of the trap and on either right or left hand or centre as specified set at an angle of 45 deg. and invert of vent hole not below the central line of the outlet. The inside surface of water closets and traps shall be uniform and smooth in order to enable an efficient flush. The serrated part of the outlet shall not be glazed externally. The water closet when sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 15 litres of water between the normal water level and the highest possible water level of the water closet as installed.

Dimensions and Tolerances

Where tolerances are not given for a specific dimension, the following shall be permissible.

- On dimension 75 mm and over + 4 percent
- On dimensions less than 75 mm + 2 mm
- On all angles + 3 deg.

INSTALLATION OF MIRROR

Fixing: The mirror shall be mounted on backing with environmentally friendly material other than asbestos cement sheet shall be fixed in position by means of 4 C.P brass screws and CP brass washers, over rubber washers and wooden plugs firmly embedded in walls. CP brass clamps with CP brass screws may be an alternative method of fixing, where so directed. Unless specified otherwise the longer side shall be fixed horizontally.

INSTALLATION OF SEAT AND COVER TO WATER CLOSET

Fixing: The sheet shall be fixed to the pan by means of two corrosion resistant hinge bolts with a minimum length of shank of 65mm and threaded to within 25 mm of the flange supplied by the manufacturer along with the seat. Each bolt shall be provided with two suitably shaped washers of rubber or other similar materials for adjusting the level of the seat while fixing it to the pans. In addition, one non-ferrous or stainless steel washer shall be provided with each bolt. The maximum external diameter of the washer fixed on the underside of the pan shall not be greater than 25 mm. Alternative hinging devices as supplied by the manufacturer of the seat can also be used for fixing with the approval of the Engineer-in-Charge.

INSTALLATION OF SINK

The installation shall consist of assembly of sink CI brackets, union and G.I. or P.V.C waste pipe.

Fixing: The sink shall be supported on CI cantilever brackets, embedded in cement concrete (1:2:4) block of size 100x75x150 mm; Brackets shall be fixed in position before the dado work is done. The CP, brass or P.V.C union shall be connected to 40 mm nominal bore GI or PVC waste pipe which shall be suitably bent towards the wall and shall discharge into a floor trap. CP, brass trap and union and waste shall be paid separately. The height of front edge of sink from the floor level shall be 80 cm.

INSTALLATION OF WATER CLOSET

Installation of water closet with seat and cover, flushing cistern and flush bend.

Fixing: The closet shall be fixed to the floor by means of 75 mm long 6.5 mm diameter counter-sunk bolts and bolts embedded in floor concrete.

INSTALLATION OF FOOT RESTS

After laying the floor around the squatting pan as specified a pair of foot rests shall be fixed in cement mortar 1:3 (1 cement: 3 coarse sand).

INSTALLATION OF TOWER RAIL

It shall be fixed in position by means of CP brass screws on wall surface by means of PVC clash fasteners, firmly embedded in wall.

Mosquito proof netting

Mosquito proof netting shall be provided at all ventilation pipe out let openings. A cap type netting made of 2 layers of 100 mesh brass wire gauge at a spacing of 2.5 cms and the space between the two layers filled with uncompacted glass wool shall be provided. The frame of net cap shall be in brass or stainless steel and clamped at the outlet of ventilating pipe.

CHAPTER-7- SANITARY INSTALLATIONS WORKS

APPLIANCES AND FITTINGS

All vitreous and sanitary appliances (Vitreous china) shall conform to IS: 2556 (part I) general requirements.

The chromium plating shall conform to IS: 4827 and shall be of grade 2 (thickness 10 micron). The chromium plating shall never be deposited on brass unless a heavy coating of nickel is interposed.

Flushing Cisterns

The flushing cisterns shall be automatic or manually operated high level or low level as specified for water closets and urinals. A high level cistern is intended to operate with minimum height of 125 cm and a low level cistern with a maximum height of 30 cm between the top of the pan and underside of the cistern.

Cisterns shall be of Cast Iron, Vitreous China, Pressed steel (IS: 774 for flushing type and IS: 2326 for automatic flushing cistern and plastic (IS: 7231.)

The cistern shall be supported on two Cast Iron brackets of size as approved by the Engineer-in-charge and embedded in cement concrete 1:2:4 block, 100 x 75 x 150 mm. The Cast Iron brackets shall conform to IS: 775. These shall be properly protected by suitable impervious paint.

The cistern shall have a removable cover which shall fit closely on it and be secured against displacement. In designs where the operating mechanism is attached to the cover, this may be made in two sections, but the section supporting the mechanism shall be securely bolted or screwed to the body. The outlet fitting of each cistern shall be securely connected to the cistern. The nominal internal diameter of the cistern outlet shall be not less than 32 mm and 38 mm for high level and low level cisterns respectively and the length of the outlet of the cistern shall be 37 + 2 mm.

Ball valve shall be of screwed type 15 mm in diameter and shall conform to IS 1703. The float shall be made of polyethylene as specified in IS: 9762.

The flush type shall be of (a) medium quality galvanized iron having internal diameter 32+ 1 mm for high level cisterns and 38+ 1 low level cistern. The flush pipe shall be of suitable length with bends etc. as required for fixing it with front or back inlet W.C. Pan (b) Polyethylene pipes low density conforming to IS: 3076 or high density conforming to IS:4984. (c) Unplasticised PVC pipes conforming to IS: 4985. For high density polyethylene and unplasticised PVC pipes, the outside diameter pipes shall be 40 mm. When PVC plumbing pipes are used, the outside diameter of pipe shall be 40 mm for high level cisterns and 50 mm for low level cisterns.

In case of high level cistern the flush pipe shall be a vertical pipe 125 cm long and having a nominal internal diameter 32+1 mm (except plastic flush pipes) and in case of low level cistern 30 cm long and 38+1 mm diameter (except plastic flush pipes)

Overflow pipe

GI overflow pipe shall be of not less than 20 mm nominal bore and shall incorporate a non corrodible mosquito proof brass cover having 1.25 mm dia perforation, screwed in a manner which will permit it to be readily cleaned or renewed when necessary. No provision shall be made whereby the overflow from the cistern shall discharge directly into the water closet or soil pipe without being detected.

The invert of the overflow pipes in the case of high level and low level cisterns shall be 19 mm minimum above the working water level. In case of overflow due to any reason water should drain out through the overflow pipe and not through the siphon pipe.

The plastic overflow pipes shall be manufactured from high density polyethylene conforming to Is 4984 or unplasticised PVC conforming to IS 4985.

Foot rests: Foot rests shall be of Vitreous China conforming to IS: 2556 (Part-X). Foot rests which are rectangular shall meet the minimum requirements and dimensions and may be of different designs where so specified. Foot rests of different shapes and sizes shall also be allowed subject to approval of Engineer-in-charge.

Mirror: The mirror shall be of superior sheet glass with edges rounded off or beveled, as specified. It shall be free from flaws, specks or bubbles. The size of the mirror shall be 60x45 cm unless specified otherwise and its thickness shall not be less than 5.5mm. It shall be free from silvering defects.

Pillar Taps: Pillar taps shall be chromium plated brass and shall conform to IS: 1795. Every pillar tap, complete with its component parts shall withstand an internally applied hydraulic pressure of 20 Kg/sq.cm maintained for a period of 2 minutes during which periods it shall neither leak nor sweat.

Sinks: Laboratory sinks shall be of white vitreous china with dimensions as specified conforming to IS: 2256 (Pt. V). Kitchen sinks shall be of white glazed fire clay conforming to IS: 771(Part-II) with upto date amendments. The kitchen sink shall be of one piece construction with or without rim, with or without overflow.

Towel rail

The towel rail shall be of:

CP Brass with two CP brass brackets coated with nickel chromium plating of thickness not less than grade no.2 of IS: 4827.

Anodized aluminium fluted surface with two anodized aluminium brackets. The size of the rail shall be 75 cm x 20 mm dia or 60 cm x 20 mm dia, 1.25 mm thick as specified. The fixing screw shall be of CP brass.

Urinals

Bowl type urinals: Urinal basins shall be of flat back or corner wall type lipped in front These shall be of white vitreous china conforming to IS: 2556-(Part VI) Sec.I. The urinals shall of one piece construction. Each urinal shall be provided with not less than two fixing holes of minimum dia 6.5 mm on each side. Each urinal shall have an integral flushing rim of suitable type and inlet of supply horn fro connecting the flush pipe. The flushing rim and inlet shall be of the self draining type. It shall have a weep hole at the flushing inlet of the urinals.

The following tolerances may be allowed on the dimensions:

On dimension 50 mm and over ± 4 percent

On dimensions less than 50 mm ± 2 mm

On all angles ± 3 degree

Stall Urinals: The stall urinal and its screens shall be of white glazed fire clay conforming to IS: 771 (Pt.3-Sec.2). The stall shall be 1140 mm high and 460 mm wide with 400 mm overall depth at the base. Where specified, screens which shall be 1200 mm high and 15 cm wide (overall) and projecting 50 cm after suitable embedment in the wall shall be provided as directed by the Engineer-in-charge.

Half stall urinals: They shall be of white vitreous China conforming to IS: 2556 (Part VI-Sec.2).

Urinal Partition Slabs: Urinal partition slabs shall be provided, as specified.

Wash Basins: Wash basins shall be of white vitreous china conforming to IS: 2556 (Part-I) and IS: 2556 (Part-IV). Wash basins either of flat back or angle back as specified shall be of one piece construction, including a combined overflow. Stud slots to receive the brackets on the underside of the wash basin shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from back of basin to the centre of the stud. The stud shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess slot type of overflow having an area of not less than 5 sq.cm shall be provided and shall be so designed as to facilitate cleaning of the overflow.

Where oval shape or round shape wash basin are required to be fixed these shall be fixed preferably in RCC platform with local available stone topping either fully sunk in stone top or top flush with stone topping as directed by Engineer-in-charge.

The wash basins shall be one of the following patterns and sizes as specified.

c) Flat back: 630 x 450 mm

550 x 400 mm

450 x 300 mm

d) Angle back: 600 x 400 mm

400 x 400 mm

White glazed pedestals for wash basins, where specified shall be provided. The quality of glazing of the pedestal shall be exactly the same as that of the basin along with which it is to be installed. It shall completely recessed at the back to accommodate supply and waste pipes and fittings. It shall be capable of supporting the basin rigidly and adequately and shall be so designed as to make the height from the floor to top of the rim of basin 75 to 80 cm. The waste fittings shall be brass chromium plate or as specified. The following tolerances may be allowed on dimensions specified:

On dimension 75 mm and over + 4 percent

On dimensions less than 75 mm + 2 mm

Diameter of the waste hole + 3 mm

Waste fittings for wash basins and sinks: The waste fittings shall be of nickel chromium plated brass, with thickness of plating not less than service grade 2 of IS: 4827 which is capable of receiving polish and will not easily scale off. The fitting shall conform in all respect to IS: 2963. It shall be sound, free from laps, blow holes and pits and other manufacturing defects. External and internal surfaces shall be clean and smooth. They shall be neatly dressed and be truly machined so that the nut smoothly moves on the body.

Waste fitting from wash basins shall be of nominal size of 32 mm.

Water closet

Squatting pans: Squatting pans shall be of white vitreous china conforming to IS: 2556 Part-I from General Requirements and relevant IS codes for each pattern as described below:

- i) Long pattern-conforming to IS: 2556 (Part-III)
- ii) Orissa pattern-conforming to IS: 2556 (Part-III)
- iii) Integrated type conforming to IS: 2556 (Part-XIV)

Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush pipes. The flushing rim and inlet shall be of the self draining type. It shall have weep hole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise specified or ordered by the Engineer-in-charge. The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and its face shall be uniform and smooth to enable easy and quick disposal while flushing. The exterior surface of the outlet below the flange shall be an unglazed surface which shall have grooves at right angles to the axis of the outlet. In all cases a pan shall be provided with a 100 mm S.C.I. trap 'P' or 'S' type with approximately 50 mm water seal and 50 mm dia vent horn, here required by the Engineer-in-charge,

The following tolerances may be allowed on the dimensions specified:

Long pattern and Orissa pattern:

- h) On dimension 50 mm and over ± 4 percent
- i) On dimensions less than 50 mm ± 2 mm
- j) On all angles ± 3 deg.
- k) The top surface of long pattern pan shall not at any point vary from its designed plane or contour by more than 6 mm for size 580 mm and by more than 10 mm for sizes 630 mm and measured vertically. This value shall not exceed 10 mm in case of Orissa pattern pans.

Integrated squatting pan:

- l) On dimension 50 mm and over ± 4 percent
- m) On dimensions less than 50 mm ± 2 mm
- n) On all angles ± 3 deg.

Water closet (Wash Down Type): Water closets shall be of white vitreous china conforming to IS: 2556 (Part-I) and 2556 (Part-II), as specified and shall be of "Wash down type". The closets shall be of one piece construction. Each water closet shall have not less than two holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flushing pipe of dimensions to suit the flushing rim. In the case of box rims adequate number of holes, on each side together with a slot opposite the inlet shall be provided. The flushing rim and inlet shall be of the self draining type. The water closet shall have a weep hole at the flushing inlet. Each water closet shall have an integral with either 'S' or 'P' outlet with atleast 50 mm water seal. For P trap, the slope of the outlet shall be 14 deg. below the horizontal. Where required the water closet shall have an antisiphonage 50 mm dia vent horn on the outlet side of the trap and on either right or left hand or centre as specified set at an angle of 45 deg. and invert of vent hole not below the central line of the outlet. The inside surface of water closets and traps shall be uniform and smooth in order to enable an efficient flush. The serrated part of the outlet shall not be glazed externally. The water closet when sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 15 litres of water between the normal water level and the highest possible water level of the water closet as installed.

Dimensions and Tolerances

Where tolerances are not given for a specific dimension, the following shall be permissible.

On dimension 75 mm and over	+ 4 percent
On dimensions less than 75 mm	+ 2 mm
On all angles	+ 3 deg.

INSTALLATION OF MIRROR

Fixing: The mirror shall be mounted on backing with environmentally friendly material other than asbestos cement sheet shall be fixed in position by means of 4 C.P brass screws and CP brass washers, over rubber washers and wooden plugs firmly embedded in walls. CP brass clamps with CP brass screws may be an alternative method of fixing, where so directed. Unless specified otherwise the longer side shall be fixed horizontally.

INSTALLATION OF SEAT AND COVER TO WATER CLOSET

Fixing: The sheet shall be fixed to the pan by means of two corrosion resistant hinge bolts with a minimum length of shank of 65mm and threaded to within 25 mm of the flange supplied by the manufacturer along with the seat. Each bolt shall be provided with two suitably shaped washers of rubber or other similar materials for adjusting the level of the seat while fixing it to the pans. In addition, one non-ferrous or stainless steel washer shall be provided with each bolt. The maximum external diameter of the washer fixed on the underside of the pan shall not be greater than 25 mm. Alternative hinging devices as supplied by the manufacturer of the seat can also be used for fixing with the approval of the Engineer-in-Charge.

INSTALLATION OF SINK

The installation shall consist of assembly of sink CI brackets, union and G.I. or P.V.C waste pipe.

Fixing: The sink shall be supported on CI cantilever brackets, embedded in cement concrete (1:2:4) block of size 100x75x150 mm; Brackets shall be fixed in position before the dado work is done. The CP. brass or P.V.C union shall be connected to 40 mm nominal bore GI or PVC waste pipe which shall be suitably bent towards the wall and shall discharge into a floor trap. CP. brass trap and union and waste shall be paid separately. The height of front edge of sink from the floor level shall be 80 cm.

INSTALLATION OF WATER CLOSET

Installation of water closet with seat and cover, flushing cistern and flush bend.

Fixing: The closet shall be fixed to the floor by means of 75 mm long 6.5 mm diameter counter-sunk bolts and bolts embedded in floor concrete.

INSTALLATION OF FOOT RESTS

After laying the floor around the squatting pan as specified a pair of foot rests shall be fixed in cement mortar 1:3 (1 cement: 3 coarse sand).

INSTALLATION OF TOWER RAIL

It shall be fixed in position by means of CP brass screws on wall surface by means of PVC clash fasteners, firmly embedded in wall.

Mosquito proof netting

Mosquito proof netting shall be provided at all ventilation pipe out let openings. A cap type netting made of 2 layers of 100 mesh brass wire gauge at a spacing of 2.5 cms and the space between the two layers filled with uncompacted glass wool shall be provided. The frame of net cap shall be in brass or stainless steel and clamped at the outlet of ventilating pipe.

CHAPTER 8-WATER SUPPLY

- 8.0** Terminology
- 8.1 Pipes
- 8.2 Transporting and Handling Pipes
- 8.3 Laying, Jointing and Field Testing of Pipes
- 8.4 Quality Control
- 8.5 Installation of Underground Services Warning Tape
- 8.6 Concrete around Pipelines
- 8.7 Cleanliness
- 8.8 Valves
- 8.9 Flow Meter
- 8.10 Valve Chamber and Meter House
- 8.11 Supplying and Fixing Vents
- 8.12 Rubber Packing
- 8.13 MS Bolts and Nuts
- 8.14 Pig Lead
- 8.15 Water Level Indicator
- 8.16 Lightning Arrestor
- 8.17 Fire Hydrants
- 8.18 Ball Valves/Float Valves
- 8.19 Scour Valve/Washout Valve
- 8.20 ELSR and Sump
- 8.21 List of Mandatory Tests
- 8.22 Trial Run

CHAPTER 8: WATER SUPPLY

List of Relevant Bureau of Indian Standard codes to be followed.

1	IS. 8329	Centrifugally cast ductile iron pressure pipes for water, gas and sewage.
2	IS. 9523	Ductile iron fittings for pressure pipes for water, gas and sewage.
3	IS 11906	Recommendations for cement mortar lining cast iron, mild steel and ductile iron pipes and fittings for transportation of water.
4	IS 12288	Code of practice for laying of ductile iron pipes.
5	IS 5531	Cast iron specials for asbestos cement pressure pipes for water, gas and sewage.
6	IS 4984	High Density Polyethylene (HDPE) pipes for potable water supply, sewage and industrial effluent
7	IS 4985	uPVC pipes for potable water supply.
8	IS 7634	Code of practice for plastic pipe work for potable water supply. Part. 2 - Laying and jointing of polyethylene pipes Part. 3 – Laying and jointing PVC pipes.
9	IS 7834	Injection moulded PVC fittings with solvent cement joints for water supply.
10	IS 8008	Injection moulded HDPE fittings for potable water supplies.
11	IS 8360	Fabricated HDPE fittings for potable water supplies.
12	IS 10124	Fabricated PVC fittings for potable water supplies.
13	IS 12235	Methods of test for unplasticised PVC pipes for potable water supplies.
14	IS 2373	Water meter (bulk type)
15	IS 780	Sluice valves for water works purposes (50 to 300 mm size)
16	IS 2906	Sluice valves for water works purposes (350 to 1200mm size)

8.0 TERMINOLOGY

Ductile Iron

Product by a metallurgical process, which involves addition of magnesium into molten iron of low sulphur content.

Asbestos Cement Pipes:

Pipes made of a mixture of asbestos paste and Cement.

Cast Iron Detachable Joint

A jointing unit of AC pipes comprising two cast iron flanges, a central cast iron collar, two rubber rings and a set of bolts and nuts.

A.C. Coupling Joint

An A.C. Coupling having inside grooves to hold rubber rings and three rubber rings.

8.1 PIPES

Pipes of many materials are available for use in Water Supply works

8.1.1 Cast Iron Pipes (CI Pipes)

The advantages of CI Pipes are good durability, good strength, low cost of maintenance and easy tapping facility for house connections by drilling and inserting a ferrule. The disadvantages are heavy weight, high transport cost and high laying and jointing cost.

8.1.1.1 Types of CI Pipes

Based on the method of manufacture, CI Pipes are of two types – (i) Vertically cast or pit-cast pipes and (ii) Centrifugally cast or spun pipes. Vertically cast pipes are cast using vertical moulds as specified in IS 1537. Spun pipes are cast in accordance with IS 1536. Spun pipes are more compact, free from blow holes, of lesser weight and of smooth inner surface

compared to centrifugally cast pipes. Standard lengths of CI spun pipes are 3.66m, 4.0m, 4.5m, 5.0m and 5.5m. Common sizes available are 80mm, 100mm, 125mm, 150mm, 200mm, 250mm, 300mm, 350mm, 400mm, 450mm, 500mm, 600mm, 700mm, 750mm, 800mm, 900mm and 1000mm. Longer sizes can be obtained against special manufacturing. Size referred to is the internal diameters.

Based on the thickness of pipe shell, that provides capacity to withstand working pressure, CI pipes are classified as class LA, A and B. Class LA is taken as the base for evolving the series. Class A and B allow 10% and 20% increases in thickness respectively.

8.1.1.2 Pressure rating of CI pipes

The pressure and working pressure of class LA, A and B pipes are given in the tables below

TABLE 8.1: Test and working pressure of spigot and socket ended spun pipes

Class of Pipe	Test Pressure at works, kg/sq.cm		Test Pressure at site, kg/sq.cm		Maximum working Pressure inclusive of surge pressure, kg/sq.cm	
	Upto 600mm	Above 600mm	Upto 600mm	Above 600mm	Upto 600mm	Above 600mm
LA	35	15	16	15	10	10
A	35	20	20	20	12.5	12.5
B	35	25	25	25	16.0	15.0

TABLE 8.2: Test and working pressure of Flanged spun pipes

Class of Pipe	Test Pressure at works, kg/sq.cm		Test Pressure at site, kg/sq.cm		Maximum working Pressure inclusive of surge pressure, kg/sq.cm	
	Upto 300mm	350 to 600mm	Upto 300mm	350 to 600mm	Upto 300mm	350 to 600mm
B	25	16	25	20	16	16

8.1.1.3 Cast Iron fittings

All cast iron fittings for all types of jointing, the fittings shall conform to IS: 1538. Only one type of fittings shall be used for all classes (LA, A, B etc.) of pipes.

Except otherwise required, all fittings shall be coated externally and internally. Each fitting shall be marked with trade mark of manufacturer, nominal diameter, weight, last two digits of the year of manufacture and ISI certification mark.

8.1.2 Ductile Iron Pipes (DI Pipes)

DI Pipes are centrifugally cast (spun) in accordance with IS 8329. DI Pipes are also called spheroidal graphite iron pipes or nodular pipes. Advantages of DI Pipes over cast iron pipes are greater tensile strength, significant elongation at break, high resistance against breakage due to impact and lighter in mass as compared to cast iron pipes.

DI fittings shall conform to IS 9523. CI fittings in accordance with IS 13382 can also be used in DI pipe lines.

DI pipes are available in standard lengths of 4m, 5m, 5.5m and 6m. Common sizes available are from 80mm to 2000mm. Size referred to is the internal diameter.

8.1.2.1 Classification of DI Pipes

DI Pipes are classified as K7, K8, K9, K10 and K12 depending upon the service conditions and manufacturing process. Test and working pressure of different classes of DI pipes are furnished in **Table 8.3.**

Diameter of Pipe	Test Pressure at works Kg/cm ² (Mpa)
------------------	---

Mm	K7	K8	K9	K10	K12
80 - 300	32 (3.2)	40 (4.0)	50 (5.0)		
350 - 600	25 (2.5)	32 (3.2)	40 (4.0)		
700 - 1000	18 (1.8)	25 (2.5)	32 (3.2)		
1100 - 2000	12 (1.2)	18 (1.8)	25 (2.5)		

Note: Maximum working pressure including surge pressure is 50% of the works pressure.

For screwed or welded flanged pipes, the minimum classes based on working pressure criteria are as follows.

TABLE 8.4: Minimum class for DI flanged pipes

Nominal Dia., mm	Screwed on flange minimum				Welded on flange minimum			
	PN-10	PN-16	PN-25	PN-40	PN-10	PN-16	PN-25	PN-40
80-450	K ₉	K ₉	K ₉	K ₉	K ₉	K ₉	K ₉	K ₉
500-600	K ₁₀	K ₁₀	K ₁₀	K ₁₀	K ₉	K ₉	K ₉	K ₁₀
700-1200	K ₁₀	K ₁₀	K ₁₀	-	K ₉	K ₉	K ₉	-
1400-2000	K ₁₀	K ₁₀	-	-	K ₉	K ₉	-	-

8.1.2.2 Coating.

Pipes shall be protected internally and externally with lining and coating respectively.

8.1.2.2.1 External Coating.

External coating shall be with metallic zinc rich paint not less than 130 grams per square metre with a local minimum of 110 grams per square metre or bitumen coating with mean thickness not less than 70 micro metres or polythene sleeving of density between 910 and 930 kg/cubic metre.

When specified, cement lining with a seal coat of bituminous material shall be given.

8.1.2.2.2 Internal Lining.

By agreement between the manufacturer and the purchaser, the following lining shall be provided to suit the conditions of use.

- Portland cement lining (IS. 8112 or IS. 45)
- Sulphate resisting cement mortar lining (IS. 12330 or IS. 6909)
- High alumina cement mortar lining (IS. 6452)
- Bituminous paint

8.1.2.2.3 Cement Mortar Lining.

Portland cement mortar lining performs well and expected life is about 50 years in soft water with moderate amount of aggressive carbon dioxide and when pH is in the range of 6 to 9. When mortar lining is exposed to sulphate attack, sulphate resisting cement mortar shall be used. When the water is aggressive (pH between 4 and 6) high alumina cement mortar shall be used. High alumina cement lining also offers excellent resistance to abrasion.

8.1.2.2.4 Method of Lining.

Cement mortar lining is done in the factory by centrifugal process to ensure uniform thickness. With lining 'C' value will be 140 for pipes diameter less than 1200mm and 145 for pipes of diameter greater than 1200mm.

8.1.2.3 Marking

Each pipe shall be marked with manufacturer, nominal diameter, class, last 2 digits of the year of manufacture and a short white line at the spigot end of pipe with push button joints.

8.1.2.4 Ductile Iron Fittings

Ductile iron fittings shall conform to IS. 9523.

8.1.3 Steel Pipes

Steel pipes shall be welded pipes, seamless pipes or spiral weld pipes.

8.1.3.1 Mild Steel Pipes

Mild steel tubes and specials shall conform to IS. 1239 for sizes upto 150mm. These are made from tested quality of steel by hot finished seamless, electric resistance welded, high frequency induction welded or hot finished welded. Steel pipes (tubes and sockets) of smaller diameter can be made from solid bar sections by hot or cold drawing process, referred to as seamless pipes. Larger sizes are manufactured by open hearth, electric or basic oxygen welding process. Pipes shall be in random lengths from 4 to 7 metres. Larger pipes shall conform to IS. 3589. Standard Mild Steel pipes are available in sizes 15mm to 500mm and in random lengths 4 metres to 7 metres. The size referred to is the internal diameter. High Test Line Mild Steel Pipes are referred to in terms of outside diameter.

8.1.3.2 Classes of Pipes

Steel pipes are classed as light, medium and heavy, based on the thickness of pipes.

8.1.3.3 Hydraulic Tests at Factory

Each tube of smaller size (upto 150mm) shall be hydraulically tested at manufacturer's works to withstand a pressure of 5MPa ($1\text{MPa}=10.2\text{ kg/square centimetre}=0.102\text{ kg/mm}^2=1\text{N/mm}^2$). Larger pipes shall be tested using the formula $P=2St/D$ where P=Test Pressure in MPa, S=Stress in MPa which shall be taken as 40% of the specified minimum tensile strength, t=Thickness in mm, D=Outside diameter in mm.

8.1.3.4 Galvanising

When tubes are to be galvanized, the zinc coating shall conform to IS. 4736. (Hot dip zinc coatings on steel tubes.)

8.1.3.5 Nominal Diameter

Nominal diameter or nominal bore of steel pipe is the inner diameter of the pipe.

8.1.3.6 Markings

Each pipe shall be marked with manufacturer's name or trade mark, nominal diameter, pipe designation/wall thickness and ISI certification mark.

8.1.3.7 Fittings for Steel Pipes

8.1.3.7.1 Screwed fittings

Malleable iron fittings for steel pipes shall conform to IS 1879. Wrought steel fittings shall conform to IS 1239. Threads to these fittings shall be as per IS 554. Galvanising of the special shall be done as stipulated in IS 1239. The specials are manufactured in three grades – light, medium and heavy. After being screwed, the specials should withstand an internal water pressure of 5MPa without any sign of leakage.

8.1.3.7.2 Plane Ended Specials

In case of plain end fittings, wrought steel butt welding fittings are used.

Flanges may be screwed or welded type. The contact surface may be plain, serrated and grooved for ring joints. The serrated finish shall be of spiral or concentric grooves, usually about 0.4mm deep with 12 serrations per centimetre. The flanges shall conform to IS 6392. The bolts and nuts shall be in accordance with IS 1364.

8.1.3.8 Protection against corrosion

Against internal corrosion, steel pipes shall be given epoxy lining or hot applied coal tar/asphalt lining or rich cement mortar lining at works or in field by centrifuging. Outer coating for underground pipe line shall be in cement – sand guniting or hot applied coal tar asphaltic enamel reinforced with fibre-glass fabric yarn. The protective coating shall be in accordance with IS. 10221.

8.1.4 Asbestos Cement Pipes (A.C. Pipes)

Asbestos Cement Pipes are manufactured from a mixture of asbestos paste and cement pressed by steel rollers. They can be drilled and tapped for connections using saddle piece and ferrule. A.C. Pipes are available in sizes 80mm, 100mm, 125mm, 150mm, 200mm, 250mm, 300mm, 350mm, 400mm, 450mm, 500mm and 600mm. Standard length of pipe is 4 metres.

Advantages of A.C. pipes are non- corrosiveness to most natural soil conditions, good flow characteristics, light weight, easy in cutting, drilling and fitting with C.I. Specials, greater deflection with joints, ease of handling and quick laying. Disadvantages are poor capacity to withstand high superimposed load, corrosion by acids and highly septic sewage, erosion by grit particles on steep gradients and high velocities.

8.1.4.1 Classification of pipes

A.C. pipes are classified according to their test pressures as given below.

TABLE 8.5: Class, Test pressure and working pressure of A.C. pipes.

Class of pipe	Test Pressure at works, kg/sq.cm	Working Pressure, kg/sq.cm	
		Pumping	Gravity
Class 5	5.0	2.5	3.3
Class 10	10.0	5.0	6.7
Class 15	15.0	7.5	10.0
Class 20	20.0	10.0	13.3
Class 25	25.0	12.5	16.7

8.1.4.2 Specials

Plain ended cast iron specials conforming to IS.5531 shall be used as specials.

8.1.5 Concrete Pipes

Concrete pipes are manufactured conforming to IS.458, by centrifugal (spun) process. Concrete pipes shall be manufactured with or without reinforcement. These pipes are available in lengths 2, 2.5 and 3metres. Size referred to is the internal diameter.

8.1.5.1 Classification of pipes

Concrete pipes are classified as non–pressure pipes and pressure pipes. Non pressure pipes are referred to as NP and pressure pipes as P. There are 4 classes of non-pressure pipes, used for different purposes, as shown below.

TABLE 8.6: Classification and use of non-pressure concrete pipes.

Class	Description	Use
NP1	Unreinforced	For drainage and irrigation
NP2	Reinforced, light duty	For culverts carrying light traffic
NP3	Reinforced, medium duty	For culverts carrying medium traffic
NP4	Reinforced, heavy duty	For drainage and irrigation use, for culverts carrying heavy traffic

There are 3 classes of pressure pipes used for water supply.

TABLE 8.7: Classification of pressure concrete pipes used for water supply.

Class	Description	Use
P1	Reinforced concrete pipes tested to hydrostatic pressure 0.2 mpa	For use on gravity mains. Working pressure not to exceed 2/3 test pressure. Usable for sewers where water tight joints are required.
P2	Reinforced concrete pipes tested to 0.4 mpa	For use on gravity lines with working pressure 2/3 test pressure and pumping main with working pressure ½ the test

		pressure.
P3	Reinforced concrete pipes tested to 0.6 mpa	For use on gravity lines with working pressure 2/3 test pressure and pumping main with working pressure ½ the test pressure.

8.1.5.2 Sizes available

Class P1 pipes are available in sizes 80, 100, 150, 250, 300, 350, 400, 450, 500, 600, 700, 800, 900, 1000, 1100 and 1200mm. Class P2 available in 80, 100, 150, 200, 250, 300, 350, 400, 450, 500 and 600mm sizes while class P3 are available in 80, 100, 150, 200, 250, 300, 350 and 400mm sizes.

8.1.6 Pre-stressed Concrete Pipes

Reinforced pre-stressed concrete pressure pipes are manufactured in accordance with IS.784. These pipes can be economically used for intermediate pressure in the range 6kg/cm² to 20 kg/cm² for factory test. Size referred to is the internal diameter.

Pipes are available in lengths given below. Size is referred to the internal diameter.

TABLE 8.8: Internal Diameter and length of pipe.

Internal diameter in mm.	Length in meter
80 to 400	4, 5 and 6
450 to 1700	4, 5 and 6

8.1.6.1 Classification of Pipes

No specific classification is available since the pipes can be designed to take care of the desired pressure, by appropriate pre-stressing. Field test pressure shall be 1.5 times the working pressure. Factory testing shall be field test pressure + 2.0 kg/cm².

8.1.7 Unplasticised Polyvinyl Chloride (uPVC) Pipes

PVC and Polyethylene pipes fall under the general title of Plastic pipes. uPVC pipes are manufactured in accordance with IS:4985. The pipes are produced by extrusion process. The compound for extrusion comprises PVC resin, colouring pigments, opacifiers and heat stabilizers. Advantages of uPVC pipes are resistance to corrosion, light weight, toughness, rigidity, ease of fabrication, economical in laying, jointing and maintenance. Sizes available are 16mm, 20mm, 25mm, 32mm, 40mm, 50mm, 63mm, 75mm, 90mm, 110mm, 125mm, 140mm, 160mm, 180mm, 200mm, 225mm and 250mm. uPVC pipes are referred to the outer diameter.

8.1.7.1 Classification of pipes

uPVC pipes are available in working pressure ranges of 2.5, 4, 6, 8 and 10 kg/cm² at 27°C and classified under the same working pressure.

8.1.7.2 Length of pipe.

U PVC pipes are available in standard length of 6 metres.

8.1.8 High Density Polyethylene Pipes (HDPE pipes)

HDPE pipes shall conform to IS 4984. The pipes are manufactured by extrusion technique.

HDPE pipes are classified on pressure ratings as PN 2 for 0.2 MPa, PN 4 for 0.4 Mpa, PN 6 for 0.6 Mpa, PN 8 for 0.8 Mpa, PN 10 for 1 MPa. The pipes shall be used for a temperature range upto 45°C. The recommended maximum working stress for the material at 27°C in a pipe is 50 kg/sq.cm. The pipes are referred to in terms of outer diameter.

HDPE pipes are flexible and tough, at the same time they are resilient and conform to the topography of the land/trench when laid. They are coilable. The diameter of the coil shall not

be less than 25 times the outside nominal diameter of the pipe without any kinks. These pipes can be easily bent in installations reducing the specials like bend and elbow. They are lighter in weight and easy to carry. They can withstand movement of heavy traffic. They have non-adherent surface, which reject any material that would impede the flow. HDPE pipes are anti-corrosive and have smooth inner surface.

These pipes are commonly available in sizes 20mm, 25mm, 32mm, 40mm, 50mm, 63mm, 75mm, 90mm, 110mm, 125mm, 140mm, 160mm, 180mm, 200mm, 225mm, 250mm, 280mm, 315mm and 355mm. The sizes indicate outer diameter. Pipes will be supplied in coils or straight lengths of 5 to 20 metres. Longer length reduces the number of joints.

Colour of pipes shall be black with 3 blue stripes. Depth of stripes shall not be more than 0.2mm.

The pipes shall be marked with white paint on either side of the pipes. For coils, marking shall be made at both ends and at spacing not exceeding 5 metres in between.

Alternatively marking shall be done hot embossed on white base, every metre throughout the length of the pipe or coil. Marking shall contain the following information.

- Manufacturer's name/ Trade name
- Designation of pipe (Grade of raw material, class of pipe, nominal outside diameter)
- Lot/batch number
- ISI certification mark and
- Raw material manufacturers

The colour used for marking shall be as given below.

TABLE 8.9: Class of pipes and colour of marking

Class of pipe	Class 1 (2 kg/cm ²)	Class 2 (2.5 kg/cm ²)	Class 3 (4 kg/cm ²)	Class 4 (6 kg/cm ²)	Class 5 (10 kg/cm ²)
Colour	Orange	Red	Blue	Green	Yellow

HDPE pipes cannot be located with conventional electronic pipe locators. Therefore proper record of pipe location shall be maintained. Residual chlorine has no/negligible effect on HDPE pipe. These pipes are susceptible to rodent attack. Polyethylene may continue to burn, once ignited.

8.1.8.1 Verification of Dimensions

- i) Method of measurement of diameter, thickness and ovality: Outside diameter shall be taken as the average of two measurements taken at right angles for pipes upto 110 mm dia. As an alternative, diameter shall be measured preferably by using a flexible Pi tape or circometer, having an accuracy of not less than 0.1mm.
- ii) Thickness shall be measured by a dial vernier or ball ended micrometer. Resulting dimension shall be rounded to 0.1mm. Outside diameter shall be measured at a distance of at least 300 mm from the end of the pipe. In case of dispute, the dimension of pipes shall be measured after conditioning at room temperature for 4 hours.
- iii) Ovality: It is the difference between maximum outside diameter and minimum outside diameter at the same cross section at 300mm away from the cut end. For coiled pipes, it shall be measured prior to coiling (or after re-rounding of pipes).

8.1.8.2 Performance requirements

- i) Visual appearance: Internal and external surfaces shall be smooth, clean and free from grooving and other defects. Ends shall be square with the axis of pipe. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be

permissible provided that the wall thickness remains within the permissible limits. The outside diameter, thickness, tolerance in thickness and ovality shall be as per relevant IS.

- ii) Hydraulic characteristics: When subjected to internal pressure creep rupture test, the pipes shall not show signs of localised swelling, leakage or weeping and shall not burst during the test duration. The temperature, duration of test and induced stress for the test shall be as per details given in the table below:

TABLE 8.10: Type of Test, Temperature, Duration of Test and Induced Stress for Test

Sl. No	Test	Test temp (°C)	Test duration (min holding time) Seconds	Induced Stress (MPa)		
				PE 63	PE 90	PE 110
1	Type test	80	165	3.5	4.6	5.5
2	Acceptance test	80	48	3.8	4.9	5.7

The internal test pressure for the above test shall be calculated by adopting the formula given below

$$P = \frac{2 \times p \times s}{(d-s)}$$

where
 p=test pressure in MPa
 s=minimum wall thickness in mm
 d=outside diameter in mm
 P=induced stress in MPa as given in the table above

- iii) Reversion test: Longitudinal reversion shall not be greater than 3%
- iv) Overall migration test: When tested from a composite sample of minimum of 3 pipes as per IS 9845, the overall migration of constituents shall be within the limits specified in IS 10146.
- v) Density: Composite sample of minimum of 3 pipes as per IS 7328 shall have a density of 940.3-946.4 kg/ cu m at 27 deg C. The value of density shall not differ from the nominal value by more than 3 kg/cu.m as per clause 5.2.1.1 of IS 7328.
- vi) Melt flow rate (MFR): Composite sample of minimum of 3 pipes as per IS 2530 at 190 deg C with nominal load of 5 kgf, MFR shall be 0.4 -1.1 g/ 10 minutes and also shall not differ by more than 30% of the material used in manufacturing of pipes. The MFR of the material shall be 0.41-1.10g/10 minutes when tested at 190deg C with nominal load of 5kgpf as determined by method prescribed in 7 of IS 2530. The MFR of the material shall be within +20% of the value declared by the manufacturer.
- vii) Carbon black content and dispersion: For composite sample of minimum of 3 samples in accordance with IS 2530, the carbon black content shall be within 2.5+ 0.5% and the dispersion of carbon black shall be satisfactory.

8.1.8.3 Sampling, frequency of tests and criteria for conformity for acceptance tests:

- i) Lot: It shall consist of same size, same pressure rating, same grade and manufactured essentially under similar conditions.

The number of samples to be collected for various tests based on the size of lot shall be as per the table given below. The pipes shall be selected at random for sampling. Starting from any pipe in the lot, count them as 1,2,3,4 etc upto 'r' and so on where 'r' is the integral part of N/n, N being the number of pipes in the lot and 'n' is the number of pipes in the sample. Every Rth pipe so counted shall be drawn as to constitute the required sample size.

TABLE 8.11: Sample Size, Acceptance Criteria

Number of pipes in lot	Sample number	Sample size	Cumulative sample size	Acceptance number	Rejection number
1	2	3	4	5	6
Upto 150	First	13	13	0	2
Do	Second	13	26	1	2
151-280	First	20	20	0	3
Do	Second	20	40	3	4
281-500	First	32	32	1	4
Do	Second	32	64	4	5
501-1200	First	50	50	2	5
Do	Second	50	100	6	7
1201-3200	First	80	80	3	7
Do	Second	80	160	8	9
3201-10,000	First	125	125	5	9
Do	Second	125	250	12	13
10,000-35000	First	200	200	7	11
Do	Second	200	400	18	19

- ii) Visual and dimensions: They shall be checked from the first sample size. Pipes failing to satisfying any of the requirements shall be considered as defective. The lot is satisfied if the number of defectives found in the first sample are less than or equal to the corresponding number given in column 6 of the table .The lot is defective if the number of defectives is greater than the number in rejection number. If the defectives number is between columns ‘5’and ‘6’, the second sample of sizes shall be taken and examined .The lot is considered satisfactory, if the number of defectives found in the cumulative sample is less than or equal to the corresponding acceptance number. Otherwise it is considered not satisfactory.

- iii) Hydraulic characteristics, reversion, overall migration, MFR and carbon black / dispersion tests:

The lot having satisfied visual and dimensional requirements only shall be taken up for further testing.

A separate sample size for each of the tests shall be taken as stipulated below and selected at random from the sample already examined for visual and dimensional inspection.

No of pipes	Sample size
Upto 150 pipes	3
151-1200	5

All the pipes in the sample shall be tested for requirements .The lot shall be considered satisfactory if none of the samples tested fails.

8.1.9 Medium Density Polyethylene Pipes (MDPE Pipes)

(NOT USED)

8.1.10 Low Density Polyethylene Pipes (LDPE Pipes)

LDPE Pipes shall conform to IS 3076. Manufacturing process is same as that for HDPE pipes.

Classification under pressure ratings and referring to sizes are same as those for HDPE pipes. LDPE pipes are available in sizes ranging from 12mm to 140mm.

Features of LDPE pipes are similar to HDPE pipes.

8.1.11 Glass Reinforced Plastic Pipes (GRP Pipes)

(NOT USED)

8.1.12 Fibre Reinforced Plastic Pipes (FRP Pipes)

(NOT USED)

8.2 TRANSPORTING AND HANDLING PIPES, SPECIALS AND APPURTENANCES

8.2.1 Transporting and handling:

Pipes and fittings must not be dropped, indented, crushed or impacted. Particular care should be taken to avoid scoring, scrapping and abrasion damage. During transportation, loading and unloading, pipes and fittings shall not be allowed to come into contact with any sharp projections, which may cause damage. During transit, pipes and fittings shall be well secured and adequately supported along their length. Pipes and fittings of plastic materials shall be covered during transportation. Scores or scratches to a depth of 10% or more of wall thickness are sufficient to require rejection of the pipes and fittings. Pipes must not be stored or transported where they are exposed to heat sources likely to exceed 700 C e.g., vehicle exhaust gases.

8.2.2 Safety Precautions:

- i) PE particles can be abrasive if they enter eyes
- ii) Molten PE produced by welding operation will adhere strongly to the skin in the event of accidental contact. Should this occur, the affected part should be flooded with cold water. The molten or solidified material should not be removed from the skin and medical assistance should be obtained even for small burns.

8.3 LAYING, JOINTING AND FIELD TESTING OF PIPES

8.3.1 Handling and Storage Of Pipes- General

8.3.1.1 Pipes and fittings shall be handled and stored in accordance with the manufacturer's recommendations and subject to the approval of the Engineer. Handling operations shall be carried out with care.

8.3.1.2 Pipes and fittings shall be stored on a flat level area and raised above the ground on timber bearers so that the lowest point of any pipe or fitting is not less than 150 mm above the ground. Pipes and fittings supplied either on pallets or crated shall remain on the pallets or in their crates until required.

8.3.1.3 Non-crated pipes shall be stacked to the approval of the Engineer. Spigot and socket pipes shall be stacked so that successive pipe layers have sockets protruding at opposite ends of the stack. Pipe of different sizes and thickness shall be stacked separately.

8.3.1.4 Each pipe and fitting shall be subjected to a visual inspection after off-loading at site and prior to installation.

8.3.1.5 Pipes and fittings damaged during transportation, handling and storage shall be set aside and the damage brought to the attention of the Engineer. Proposals for repair shall be submitted in writing for the Engineer's approval. If in the Engineer's opinion the nature of any damage is such that the condition of a pipe has been impaired and cannot be repaired the pipe concerned shall not be incorporated in the Works

8.3.2 Laying Jointing and Testing

8.3.2.1 General

Setting Out: Before any excavation for water pipeline/chambers is commenced the Contractor shall define the centre line or other agreed reference line of the Works and erect the necessary profiles throughout their full length if so required by the Engineer.

Pipes and fittings shall be examined for damage and carefully brushed out immediately before laying.

The formation of excavations for pipelines shall be dry, even and free of stones and other protrusions. Where exceptionally poor ground conditions are encountered at the trench formation the Contractor shall, at the direction of the Engineer, excavate down to firm ground or 300mm below formation, whichever is the less. The extra-excavation shall be backfilled with either concrete or selected granular material as directed by the Engineer.

Where pipelines are to be laid in trench, the Contractor shall provide, fix and maintain at such points as may be directed by the Engineer properly painted sight rails and boning rods of predetermined measurement for the boning in of individual pipes to correct alignment. The sight rails shall be at a suitable height vertically above the line of pipes or immediately adjacent thereto and there shall at no time be less than three sight rails in position on each length of pipeline under construction to any one gradient.

Pipelines shall be temporarily capped when pipe laying ceases, to prevent the ingress of foreign matter. The Contractor shall ensure that the pipes remain clean and free from dirt and deposits and if required by the Engineer the pipelines shall be cleaned out using approved methods and equipment, which do not damage to the internal lining of the pipes and valve chambers.

Colour coded plastic marker tapes shall be placed over the pipeline even when not separately specified.

Where pipelines are to be constructed in any tunnel heading or duct provided by the Contractor, the minimum clearance between the inside face of the tunnel heading or duct and the pipe shall be 200 mm unless otherwise shown on the Drawings.

The Contractor shall adopt a suitable method of controlling the alignment of a pipeline installed in a tunnel heading or duct to the approval of the Engineer.

Testing: The line of pipes after laying and jointing shall be tested to a pressure at least double that of working pressure, provided that in no case shall the pipes be tested to a less pressure than that equivalent to a head of 40 meters of water and the pipes and joints shall be absolutely watertight. The contractor shall provide the water, appliances and labour for testing the pipes at his own expense.

Regime of testing: The following regime of testing shall be followed through out the period of Contract.

Tests at the start of the Contract.

In house tests shall be conducted as per relevant IS code and the test results submitted together with the request for material approval.

Tests during the Contract Period

Type tests and acceptance tests as stipulated in relevant IS shall be strictly carried out at the factory and acceptability of pipes ascertained before dispatch to site. In addition, field hydrostatic test shall be done and quality of pipes ensured.

8.3.2.2 Cast Iron Pipes

Pipes shall not be thrown from the trucks on hard roads

All pipes, fittings, valves and hydrants shall be carefully lowered into the trench, piece by piece by means of ropes or other tools to prevent damage to them. Pipes of diameter more than 300mm shall be lowered into trenches using chain-pulley blocks.

The pipes shall be inspected for defects by ringing with a light hammer while suspended to detect cracks. If doubt persists, further confirmation may be obtained by passing a little kerosene, which seeps through and shown on the outer surface. Any pipe found unsuitable after inspection and before laying shall be rejected.

The outside of the spigot and inside of the socket shall be wire brushed and wiped clean and dry to make them free from oil and grease before laying. The inner face shall be wiped clean with cloth or cotton waste.

During laying operation, no foreign material like debris, tools, clothes or any other material shall be placed in the pipe.

After placing a length of pipe in the trench, the spigot shall be centered in the socket and the pipe forced home and aligned to the gradient.

Wherever cutting of pipe becomes necessary, like for inserting valves, fittings etc., it shall be done in a neat manner at right angles to the axis of the pipe so as to leave a smooth cut face. Machine cutting shall be adopted. With prior approval of the Engineer, electric arc cutting method may be permitted using a carbon or steel rod, flame cutting shall not be allowed.

On level ground, the socket ends should face upstream, when runs uphill the socket ends shall face the upgrade.

Deflection allowed at any joint shall not exceed the following values.

Lead Joint	2.5 deg
Rubber Joint - (80 to 300mm dia)	5 deg
- (350 to 750mm dia)	4 deg
- (> 750mm dia)	3 deg

Thrust and Anchor blocks shall be designed and suitably provided wherever necessary.

Jointing CI Pipes

CI pipe joints shall be broadly classified into two – (i) Flanged joints and (ii) Socket and Spigot joints

Flanges will be cast monolithically with body in the case of centrifugally cast pipes and screwed on the ends in the case of spun pipes and bolt holes drilled, as per IS 1538. The pipes and/ or specials shall be manufactured with ends to suit the predetermined method of jointing

Flanged Joints

Holes in flanges will be drilled as per IS 1538 for jointing with bolts and nuts, unless specified otherwise. Compressed fibre board or rubber sheet of thickness 1.5mm to 3mm will be used in between flanges, conforming to IS 1638. The fibre board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight shall not be less than 112 grams/ mm thickness/ square metre.

Each bolt shall be tightened a little bit at a time taking care to tighten diametrically opposite bolts alternatively. No spanner other than the standard pattern shall be allowed. Any appliance for lengthening the leverage of any spanner shall be permitted. All flanges with their bolts shall be painted with two coats of tar. The gasket shall be of such width as to fit inside the circle of bolts.

For fitting flanged sluice valves, air valves, hydrants, meters, bends and other specials same type of jointing shall be adopted.

Spigot and socket joints

Spigot and socket joints shall be provided as laid down in IS 3114. Common types of Spigot and socket joints are (i) Molten lead joint, (ii) Lead wool joint, (iii) Tyton joint, (iv) Push-tite joint and (v) Cement joint.

Lead joint (Molten lead)

Lead used for jointing shall conform to IS: 782. Lead is extremely resistant to atmospheric corrosion and is not affected by soil or liquid flowing inside the pipe.

The spigot end of one pipe shall be forced into the socket end of the preceding pipe. Hemp yarn shall be placed around the spigot and driven tightly against the inside base of the socket with suitable yarning tools, layer by layer until tight hemp fills annular space for specified depth. The lead is melted in an iron pan of suitable size in easy reach of the joints to be filled so that the molten lead remain in proper temperature while carrying from melting pan to the joint. The outer end of the socket is closed by means of well kneaded clay leaving the space to be filled with lead as hollow. At the summit of the clay mould through a small opening the molten lead is poured so that the joint is completely filled with molten lead. After the lead has solidified, the clay gasket is removed and the joint caulked with hammer of weight not less than 2kg by hammering up the face of the lead uniformly in series with at least three special caulking tools. Lead run joint shall be finished 3mm behind the socket face.

Advantages of lead joints are that minor repairs could be carried out without putting the pipe line out of service. The disadvantage is that it has a tendency to loosen under vibration due to

lack of elasticity and creeps under high pressure creating leaky joints which require periodic caulking.

Lead and spun yarn required for different sizes of pipes are given below.

TABLE 8.12: Lead and spun yarn for different sizes of pipes

Nominal size of joint, -mm	Lead per joint, kg	Depth of lead joint, mm	Yarn per joint, kg
80	1.8	45	0.10
100	2.2	45	0.18
125	2.6	45	0.20
150	3.4	50	0.20
200	5.0	50	0.30
250	6.1	50	0.35
300	7.2	55	0.48
350	8.4	55	0.60
400	9.5	55	0.75
450	14.0	55	0.95
500	15.0	55	1.00
600	19.0	55	1.20
700	22.0	55	1.35
750	25.0	55	1.45

Lead Wool Joint

Lead wool or lead yarn jointing is adopted when it is inconvenient or dangerous to use molten lead. Lead wool consisting of finely spun lead in continuous strands can be used without heating to fill socket and spigot joints. Hemp yarn shall first be inserted and caulked into the socket and above that the lead wool shall be introduced in strings not less than 6mm thick and caulking repeated with each turn of lead wool. The whole of the lead wool shall be compressed into a dense mass and joint finished flush with the face of the socket. Approximate weight and depth of lead wool for various pipes are given in the table below.

TABLE 8.13: Weight and depth of lead wool for various sizes

Dia. of pipe (mm)	Weight of lead wool (kg)	Depth of lead wool (mm)
80	0.80	19
100	0.90	19
125	1.25	20
150	1.60	23
200	2.05	23
250	2.95	25
300	3.50	25
350	4.65	29
400	5.70	31
450	6.70	32
500	8.30	33
600	10.00	35
700	11.80	36
750	13.60	38
800	15.40	40
900	16.80	40

Tyton Joints

Tyton joints are push on type. The sockets of the pipes to receive tyton joints are specially designed to contain elongated grooved gasket. The inside contour of the socket provides a seat for the circular rubber ring in a modified bulb shaped gasket. An internal ridge in the socket fits into the groove assembly. The socket and spigot ends of the pipes are cleaned and then a thin film of lubricant is applied to the bulb seating inside the socket. The gasket is placed inside the socket with the bulb towards the back of the socket so that the hard rubber heel engages in the retaining groove. If any loop is left, it shall be pressed flat for proper fit of gasket in the groove.

After centering, the spigot shall be inserted far enough into the socket to make contact with the gasket. The spigot end is forced into the socket carefully, compressing the gasket till the spigot end reaches the inner end of the socket using fork tool or pull jack.

Push-tite Joint

Push-tite is specially devised moulded rubber ring gasket to fit the socket configuration suitable for conventional pour joints. The flange shaped mouth of the gasket is made of harder rubber. It provides a strong shoulder for self-centering of the spigot end at the time of assembly. Push-tite will function effectively under all normal working conditions.

Cement Joints

Cement Joints are used for low pressure flows, as in sewers. A closely twisted spun yarn gasket of required diameter in one piece of sufficient length to pass around the pipe and lap at the top shall be thoroughly saturated in cement paste. The gasket shall be laid in the socket circumferentially for the lower third of the socket and covered with cement mortar. The spigot end shall be thoroughly cleaned, inserted and carefully driven home after which a small amount of mortar shall be inserted in the annular space around the entire circumference of the pipe and solidly rammed into the joint with a caulking tool. The remainder of the joint shall then be completely filled with mortar and beveled off at an angle of 45 degree with the outside of the pipe. The joint shall be kept wet with neat gunny bags for 24 hours after making.

Field Testing of pipeline

After laying and jointing, pipe line must be pressure tested to ensure that pipe line joints are sound enough to withstand maximum pressure likely to be developed under working conditions. The test pressure should not be less than the highest pressure of the following:

- (i) For gravity pipelines
 - a) 1.5 times the maximum sustained operating pressure
 - b) 1.5 times the maximum pipe line static pressure
- (ii) For pumping mains
 - a) Sum of the maximum sustained operating pressure and the maximum surge pressure.
 - b) Sum of the maximum pipe line static pressure and the maximum surge pressure.

Under testing, the leakage should not exceed 0.1 litre per millimeter of pipe diameter per kilometer of pipe line per day for each 30 metres pressure head applied. When a pressure drop occurs water shall be pumped to maintain the pressure constant and the quantity of water thus pumped shall be carefully measured. This quantity amounts to leakage.

The test shall be taken as passed if the pipe line withstands the pressure specified above and the leakage is within the specified limit.

8.3.2.3 Ductile Iron Pipes (DI Pipes)

Laying:

Laying procedure for DI pipes is same as that for CI pipes.

Types of Joints

Joints shall be flanged type or push on type.

Flanged Joints

Flanged Joints shall be screwed to the barrel or welded. Flanges shall be fixed at right angles to the axis of the pipes and shall have machined face. For both types, flange drilling shall be as per IS 1538. Screwed on flanges shall be sealed at threaded joint between the pipe and the flange with a suitable sealing compound. Rubber gaskets for flanged joints shall conform to IS 638.

Push-on-Joints

For push on joints, the spigot end shall be suitably chamfered or rounded off for smooth entry of pipe in the socket fitted with gasket. Rubber gasket for push on type shall conform to IS 5382.

Hydrostatic Test

All pipes shall be tested at works at pressure as stipulated in IS. 8329. The pressure shall be applied internally and steadily maintained for a minimum period of 10 seconds. The pipe should not show any sign of leakage, sweating or any other defect.

TABLE 8.14: Test Pressure at works in MPa

Nominal Dia., mm	Screwed on flange minimum			Welded on flange minimum			
	Class K ₇	Class K ₈	Class K ₉ , K ₁₀ , K ₁₂	PN- 10	PN-16	PN-25	PN-40
80-300	3.2	4.0	5.0	1.6	2.5	3.2	4.0
350-600	2.5	3.2	4.0	1.6	2.5	3.2	4.0
700-1000	1.8	2.5	3.2	1.6	2.5	3.2	-
1100-2000	1.2	1.8	2.5	1.6	2.5	2.5	

8.3.2.4 Steel Pipes

Laying

Steel pipes shall be laid as specified in IS. 5822. Pipes shall be inspected for defects such as protrusion, grooves, dents, notches etc and if found they shall be rectified. Defect free pipes shall be lowered in the trenches. The procedure for lowering varies with the method adopted for coating the pipes. Care shall be taken to see that longitudinal welded joints of consecutive pipes are staggered by at least 30° and shall be kept in upper third of the pipe line. Pipes laid above ground may be allowed to rest on the ground if the soil is not aggressive. The ground should however be dressed to match the curvature of the pipe shell for an arch length subtending an angle of 120° at the centre of the pipe.

For all pipe lines laid above ground provision shall be made to contain expansion and contraction on account of temperature variation. Expansion joints or loops shall be provided at pre-determined points.

Testing

The pipes in test length shall be slowly filled with water and air shall be expelled. The field test pressure shall not be less than the greatest of the following.

- Maximum sustained operating pressure
- Maximum static pressure
- Sum of the maximum of (a) and (b) and surge pressure.

Where the working pressure is less than two-third of the test pressure in the case of gravity main or half the test pressure in the case of pumping main, the test pressure shall be maintained at least for 24 hours.

Further the leakage during the test shall also be within the prescribed limit. If the pressure drops, water shall be pumped in to maintain the test pressure and the quantity of water thus pumped shall be carefully measured. The quantity should not exceed 0.1 lit / millimeter of pipe diameter per kilometer of pipe line length for each 30 metres of head applied.

Jointing.

Following are the types of joints provided in steel pipes.

- Threaded joints (Screwed joints)
- Sleeved pipes by fillet weld
- Plain end pipe by butt weld
- Flanged joint (Bolted joints)

Threaded joints are given to the smaller pipes. Threads of all screwed ends and socket (coupling) shall conform to IS. 554. Each screwed joint pipe shall be supplied with one socket as an integral part of the supply. Larger pipes shall have welded joints.

Sleeved pipes with fillet weld shall be as specified in IS. 3589.

Plain end but welding shall be as per IS. 3589.

Flanged joints are used wherever required. The flanges shall conform to IS. 1538.

When tubes are required to be galvanized the zinc coating shall be in accordance with IS. 4736.

8.3.2.5 Not used

8.3.2.6 Concrete Pipes

Jointing

All non-pressure pipes shall have flexible rubber ring joints in accordance with IS.783.

Pressure pipes shall have rigid collar joints, rigid spigot and socket joints or semi flexible spigot and socket joints.

Collar Joints: Collars are 15 to 20 cm wide. A mixture of cement and sand in the ratio 1:1.5 is rammed along with caulking iron to form the joint. The joint shall be kept wet for 10 days for maturing.

8.3.2.7 Prestressed Concrete Pipes (PSC Pipes)

Jointing

Pipes are jointed with rubber gaskets to provide flexible joints as per IS.784. Pipes are provided with spigot and socket ends to enable jointing with rubber gaskets. The rubber gaskets shall conform to IS.5382.

8.3.2.8 Polyethylene Pipes

Storage

Polyethylene pipe packs should be placed on timber bearers approximately 2m c/c. Avoid long term stacking of pipes. Providing proper regard is given to sideways stability (ex: wind forces), packs which are usually 1.2 meters wide may be stacked up to 3m in height for straight pipes. Coils stacked horizontally shall be placed on pallets for convenient lifting or slinging and the height of coils shall be limited to 1.0m in height.

Lifting and unloading

Metal hooks, chains or slings must not be used without padding for lifting coils or pipes. Care shall be taken to avoid injury to personnel when cutting the steel restraining bands on coils.

8.3.2.8.1 Laying

1. In sufficient time before commencement of the Works, the Contractor shall submit for the Engineer's approval the pipe manufacturer's complete and detailed specification for the handling and installation of pipes and fittings in open trench and such other methods of construction of pipeline specified or proposed by the Contractor, irrespective of whether the data was submitted with the tender.
2. The Contractor shall lay pipes in accordance with the approved manufacturer's installation specification as approved by the Engineer after submission and acceptance of appropriate quality control test results.
3. The Contractor shall use a suitable mechanised device to the approval of the Engineer for gauging pipe deflections both before and after laying, in the stages specified.
4. For pipes of less than 600mm diameter, a deflectometer of a form that can be drawn through the pipeline and capable of measuring diametric dimensions both vertically and horizontally shall be provided by the Contractor. It shall be calibrated for each diameter

regularly in the presence of the Engineer to maintain the accuracy of the instrument. The device shall also provide a means of identifying where each deflection measurement was taken along the length of the pipeline. This shall be either in the form of a continuous print out or in the form of a visual display or a remote monitor.

5. When instructed by the Engineer, the Contractor shall also provide pipe deflection measuring equipment in full working order for use of the Engineer or the Employer.
6. The pipes shall be laid and bedded in a granular material as specified elsewhere except where concrete protection is required. Trenches shall be excavated to depth 150 mm below the underside of the pipe.
7. The granular material shall be placed over the full width of the bottom of the trench to the level of the underside of the pipe and shall be compacted as required for that class of bedding material. Suitable depressions shall be made in the bed to accommodate the pipe joints and shall be of minimum width and depth practicable. The trench shall be carefully filled to 300 mm above the crown of the pipe in layers not exceeding 150mm. Particular care shall be taken to ensure that the depressions for the joints are completely filled and that the bedding material is well compacted under the haunches of the pipe over the full length of the pipeline.
8. The Engineer may, from time to time, require that tests are carried out on the bedding to determine the degree of compaction being achieved by the Contractor. Where the Contractor is consistently unable to achieve the required degree of compaction or proves unable to keep pipe deflections to within the acceptable limit then he shall change his method of compaction or use a better class bedding material. The trench shall then be backfilled and compacted to a level 300 mm above the crown of the pipe with selected excavated material free from large stones etc. All filling shall be carefully compacted by a method approved by the Engineer, which shall avoid disturbing the pipes or the joints.
9. Polyethylene pipeline may be laid along the side of the trench and jointed there. Thereafter the jointed pipeline shall be lowered into the trench carefully without causing undue bending. The pipe line shall be laid inside the trench with a slope of about 0.5 m per 100 m of pipe line (pipe line to be laid in a sinuous alignment).

Permissible radius at changes in direction:

- i) Changes in direction shall be achieved by 'cold bending' at ambient temperature so long as the radius of curvature is not less than the values indicated below.
 - SDR = Ratio of outside diameter and wall thickness
 - Ambient temperature shall be 20 degree C or more

Standard dimension ratio (SDR)	Radius
41	40 Dia
42	40 X Dia
33	30 X Dia
26	25 X Dia
<21	20 X Dia

- ii) Fittings shall not be located on bent pipe and kept at least 1 m away from the tangent point
- iii) Thrust blocks shall be provided near connections made from PE to other pipe materials
- iv) Compressible material must be used around the pipe in the concrete surround

8.3.2.8.2 Jointing

1. Pipe jointing surfaces and components shall be kept clean and free from extraneous matter until the joints have been made or assembled.
2. Flexible joints of spigot and socket type with a single sealing ring shall be laid with a gap between the spigot end and the shoulder of the socket. The gap, referred to as the initial

jointing allowance, measured parallel to the pipeline shall not be less than 6 mm or greater than 13 mm or as recommended by the pipe manufacturer.

3. In flexible joints incorporating a sleeve coupling with two sealing rings the initial gap between the spigot ends of the pipes shall be as recommended by the manufacturer.
4. For uPVC pipes solvent welded joints with parallel sockets will not be permitted unless made in the manufacturer's workshop.
5. Rubber joint rings which are not locked in position in pipe sockets shall be stored, until needed, in a cool place free from direct sunlight.
6. Spigot and socket flexible joints shall have the annular space between the pipe and socket sealed with an approved joint sealant to prevent the ingress of loose material or concrete.
7. The annular space shall be sealed immediately on completion of a satisfactory initial hydraulic test prior to concreting or backfilling but not prior to the test.
8. Flanged pipes shall incorporate an annular gasket at the joints. In horizontal lengths or pipelines the gaskets shall cover the full face of the flange and shall have holes cut in them corresponding to the bolt holes in the flanges. In pipes laid vertically, a plain ring covering the flange between the bolt circle and the bore of the pipe may be used if desired. Gaskets shall be 3 mm thick and shall be made of first quality rubber incorporating two layers of cotton fabric insertion evenly spaced in the gasket. When flanged joints are to be made the bolts shall be inserted and the nuts turned to finger tightness. Thereafter the final tightening of the nuts shall be effected by spanners in such sequence that diametrically opposite nuts are tightened together.
9. The Contractor shall ensure the patent joints are made strictly in accordance with the manufacturer's Instruction.
10. Butt fusion welding

Jointing the Polyethylene pipes can be done with Butt-welding equipment with the temperature and pressure recording arrangements. The pipeline may be laid along side the trench and jointed there. Thereafter the jointed pipe line shall be lowered into the trench carefully without causing undue bending. The pipeline shall be laid inside the trench with a slack of about 0.5 m per 100 m of pipeline (pipe line to be laid in a sinuous alignment).

Pipe to be jointed must be of the same wall thickness and the ends must be cut square. Unmatched wall thickness will require machining by chamfering of the greater thickness at an angle of 5 deg or less to give the same thickness. The success of each weld is extremely dependent on cleanliness, temperature control and good equipment, which have been properly maintained. The pipe ends should be dry and free of dust. Mating surfaces must be planed immediately before welding to remove surface material as polyethylene (PE) oxidises on exposure to air. If these prepared surfaces are touched, there is a risk of contamination.

The timing of the welding sequence is most important if consistent quality of weld is to be obtained. Times for the simultaneous heating of the pipe ends against the hot plate (mirror), mirror removal, the pressing of the melted pipe ends together to give the required amount and shape of bead material and finally the cooling time whilst maintaining pressure are all of critical importance.

If the pipe temperature is not uniform (e.g.: when welding is carried out in direct sunlight), an uneven pipe wall temperature will exist which could affect the uniformity of the weld. This temperature difference must be equalized by shielding the weld zone well in advance of making the joint. Covers on the ends of pipes remote from the weld will prevent cooling air from passing through the pipe interior and assist in keeping weld zone temperatures uniform.

The temperature of the hot plate will be in the range 200+ 10 deg C (takes about 30 minutes for electrical heating and more for blow torch) with the higher temperature recommended for PE80 to PE 100 welds. When welding is being performed in windy conditions, the temperature may need to be raised slightly to compensate for air-cooling. If the temperature is too high, there is a risk of thermal degradation of the PE resulting in a weak joint. If it is too low, it causes a weak joint due to insufficient melted material. The temperature of the hot plate must therefore be checked regularly. For detecting the correct temperature, crayon chalk shall be used. Around 200 deg C, the colour of crayon dot on the mirror changes within 2 seconds. The dot made shall be thin and if not, time taken will be more indicating a wrong temperature. It is important that the correct heating, jointing and cooling times be used. Excessive heating time

will have the same effect as a temperature which is too high and possibly cause thermal degradation. Too short a heating time will result in insufficient melted material. The heating, jointing and cooling time should not vary significantly from the times shown in the table below. Otherwise the joint will not develop full strength. Longer cooling times are however permissible. Excessive pressure will squeeze the melted PE out of the joint and weaken it. However the jointing procedure to be adopted and equipment to be used shall be submitted by the Contractor to the Engineer for approval and shall conduct jointing on the approved method.

TABLE 8.15: Heating, Jointing And Cooling Times

Wall thickness (mm)	Initial bead width (mm)	Soak time t2 (sec)	Max t3&t4 (sec)			Min t 5 (min utes)	Final bead width (mm)		Min T6 (Min utes)
			SDR				Min	Max	
			41	17	9				
2	1	30	4	3	3	5	4	6	11
4	1	60	5	4	3	7	5	8	12
6	1	90	5	4	4	9	6	9	13
8	1	120	6	4	4	11	7	10	14
10	1	150	7	5	4	13	8	12	15
12	1	180	8	5	4	15	9	13	16

NOTE:

1. t3 must be as short as possible eg: a delay of only 3 sec can cause a temperature drop of 15deg C or more
2. t2: time of contact between the plate and pipe ends after relieving the pressure p2.
3. Excessive pressure will squeeze the melted PE out of the joint and weaken it

Butt fusion procedure:

- i. Clamp the pipes in the butt fusion machine
- ii. If practicable keep the brand markings in line
- iii. Wipe the pipe ends, inside and out, with a clean cloth to remove water, dirt, muck etc.
- iv. Align the pipe ends and clamp in place
- v. Plane both ends until they are perfectly square
- vi. Remove the plastic shavings from the vicinity of pipe ends without touching the prepared surface as any contamination at this stage will be detrimental to the welding process
- vii. Bring together the two pipe ends and ensure they are aligned
- viii. Check the hot plate (mirror) temperature (range 200-240deg C) and make certain the surfaces are clean. It is good practice to make `dummy` welds daily, prior to welding sessions as a means of cleaning the mirror. That is, the weld procedure should be taken to the heat soak stage, when the process can be aborted. The hot plate surfaces must not be touched with metal implements or tools. A damaged or dirty mirror will result in a poor joint.
- ix. Move the pipe ends into contact with the hot plate and a steady pressure of about 2kg / sq cm (P1) while a uniform bead forms around the circumference of both pipe ends. This procedure is to ensure that the entire face of the pipe heats uniformly through positive contact with the mirror.

- x. When a satisfactory bead height has formed, relieve the pressure but maintain contact pressure between the plate and pipe ends of 0.5 kg/ sq cm (P2) until the recommended time t2 (heat soak time) has elapsed
- xi. Back the pipe ends away from the mirror. When removing the mirror, make sure it is not wiped across the molten pipe ends
- xii. Bring the melted pipe ends together within the period t3 and allow the recommended pressure of 2-3 kg/ sq cm (P3) to build up within a time period of t4. This pressure should be applied by building up gradually to avoid squeezing out too much of the melt and held for a time of t5 .Do not disturb the joint during the required cooling time of at least t6.
- xiii. Relax the contact pressure and carefully remove the clamps only after ensuring the joint has fully solidified. Do not stress the joint or debeat until the required cooling time has elapsed

8.4 QUALITY CONTROL

Visual inspection of joints

- i) The beads should be uniform and symmetrical without any sharp notches. Refer the butt fusion weld section profiles given below which are useful to check the quality of joints.
- ii) Inspection of Bead after removal: Use an approved bead removal tool to remove the bead. Do not remove bead by chipping or chiselling. Examine the underside of bead. It shall be solid and rounded with a broad root. Hollow beads with a thin root or curled edges should be rejected. When the bead is bent to reverse the curvature, there should be no sign of any slits or fissures (given below)

Melt area assessment

The joint being tested is cut transversely into a strip approximately 20 mm wide and 150mm long. A small flame played on the exposed cut edge of the weld will cause differential shrinkage of the fusion melt and the parent pipe .The pattern thus created will illustrate whether too much pressure has been applied and thus squeezed out most of the melt

Tensile Strength

The test specimens are to be prepared as given in Indian standards.

Condition the specimens in air at 20+2 deg C for < 12 hours for pipes of wall thickness upto and including 12.7mm or < 24 hours for pipes of wall thickness over 12.7mm

Test specimen containing the weld zone shall not fail to a stress which must not be less than 0.8 of that of the virgin parent pipe .The test is performed with the bead removed.

A normal pressure test on a welded pipe sample at 80 deg C should meet the requirements for pipe which does not contain weld material

The grip separation rate should be 50 mm/min +10%

Note the failure stress and mode of failure (ductile, tearing or brittle failure)

Acceptance criteria

If all specimens are visually sound and separate in a ductile manner, the welding can be judged as satisfactory. If the specimens exhibit brittle separation modes, the welds of the batch require further investigation. Number of samples to be tested is given below

Pipe size(mm)	Min number of samples
> 90 <110	2
> 110 <180	4
>180 < 315	6
>315	7

Field Testing Of Pipe Line

- a) The normal procedure of testing is not applicable to PE pipes because they exhibit strain creep and stress relaxation. When PE pipes are sealed for testing, there will be reduction in pressure over time (or pressure decay) even in a leak free system, as a

result of the creep characteristics of the material. If air is in the pipe line, it would be compressed as the test pressure built up, and then later expanded with very little pressure loss. Hence attention shall be paid to eliminate air pockets.

- b) It is desirable to cover the joints before testing. The pipe line shall be filled and pressure tested from the lowest point. After filling, the pipe line shall be left to stabilise at its temperature for a minimum period of 3 hours (preferably delay testing until the following day)

The test pressure shall be 1.3 times the rated pressure of pipes. Apply the pressure by continuously pumping at a constant rate. If the relation between pressure and time is not linear, it indicates presence of considerable amount of air in the pipe line. Then terminate the test and take action to remove air. If there is no air entrapped, continue pumping till the pressure reaches the test pressure (P₂). Isolate the pipe line and allow the pressure to reduce. Use the pressure loading time (T_L) to achieve test pressure as a reference. Record the pressure at predetermined times from the moment of valve closure. As PE relaxes, apply a correction factor of 0.4 t L.

Take a first reading of pressure P₁ at t₁ where t₁ = T_L

Take a second reading of pressure P₂ at t₂ = 7T_L (approx)

Correct times as follows

$$T_{1c} = t_1 + 0.4T_L$$

$$T_{2c} = t_2 + 0.4T_L$$

Calculate the slope $n_1 = \frac{\log P_1 - \log P_2}{\log T_{2c} - \log T_{1c}}$

For a good water tight pipe line, $n_1 < 0.04$ — 0.05 for buried pipe line
 < 0.08 — 0.10 for above ground pipe line

If the value of n_1 is less than the above values, remove air and take a third reading of pressure of P₃ at t₃ = 15 T_L. Correct the time as t_{3c} = t₃ + 0.4 T_L

Calculate $n_2 = \frac{\log P_2 - \log P_3}{\log T_{3c} - \log T_{2c}}$

Calculate the predicted pressure by adopting the following formula

$$P = P_L \left[\frac{2.5T}{t_l} + 1 \right]^{-n}$$

where, P = predicted pressure after time t

P L = test pressure (at start of test when the test pressure is first reached)

T = time (from reaching the test pressure)

T L = loading time

N = 0.04—0.05 for buried pipe

0.08—0.10 for above ground pipe

If the actual pressure recorded is found to vary significantly from the predicted value, draw a graph showing the relationship between log pressure (on Y axis) and log time (on X axis). If the graph shows an increasing slope with time i.e. the actual recorded pressures are less than the predicted pressures, leakage is probable. If the graph shows a decreasing slope with time, ie the actual recorded pressures are greater than the predicted pressures; air entrapment is the likely cause. If the slope is linear but between the slopes identified (0.04-0.05 and 0.08-0.10) it indicates poor backfill compaction but not a failed test.

In the event of a retest being required on the pipeline, this shall be done not earlier than 5 times the previous total test period.

Suitable metal plates shall be used to support the PE flanges to enable them to be bolted together. In most cases, sealing is improved by incorporating a natural or synthetic rubber gasket between PE pipes. HDPE stub ends shall be used at the joint.

- c) Each test length shall be a maximum of 200 meters

8.5 INSTALLATION OF UNDERGROUND SERVICES WARNING TAPE

- 8.5.1** Services protection tapes shall be installed above all water pipeline mains constructed or exposed under this Contract excluding individual service connections.
- 8.5.2** For pipeline with top of the pipe barrel more than 900mm below finished surface level the tape shall be placed over the centerline of the pipe line at 600mm below finished surface level during backfilling and compaction operation. For pipelines with less than 900mm cover to the top of the pipe barrel the tape shall be placed over the centerline of the pipe at 300mm above the top of the pipe barrel during backfilling, compaction and reinstatement operations.
- 8.5.3** The tape shall be continuous over pipelines and at joints between tapes from separate rolls the joint shall be lapped a minimum of one metre.

8.6 CONCRETING AROUND PIPELINES

8.6.1 Concrete Bed Or Bed And Surround

- 8.6.1.1** Pipes may be encased in concrete wherever necessary with provision for a mechanical key such as a welded thrust flange. Compressible material at least 3mm thick and at approximately 150mm from the face of concrete into the concrete shall be provided around pipes at the entry point and exit point to eliminate any potential sharp edges from rubbing against the pipe wall. Pipeline shall not be filled with water until the concrete has developed sufficient strength. Where concreting to pipelines is specified a blinding layer of concrete Class 10 shall be placed over the full width of the trench or heading to comply with the following requirements.

TABLE 8.16: Requirement for Blinding Layer of Concrete

	PIPE NOMINAL BORE mm			
	Up to			Above
	900	700 to 1200	1000	1200
Minimum thickness of blinding layer (mm)	75	75	75	100
Minimum extent of blinding each side of pipe barrel (mm)	150	150	230	300
Minimum clearance between blinding and pipe barrel (mm)	80	150	230	300
Minimum clearance between blinding and underside of pipe socket (mm)	25	25	25	25

- 8.6.1.2** Concreting to the pipeline shall be either bed or bed and surround as shown on the drawings and shall be of concrete M 20 along such lengths as are shown on the Drawings or ordered by the Engineer.
- 8.6.1.3** When support of excavations is provided building paper shall be placed against that support before concreting to facilitate withdrawal of support.
- 8.6.1.4** In the case of spigot and socket pipes with flexible joints the concrete at each joint shall be interrupted in a vertical plane at the edge of the socket by a strip of fibreboard or other material approved by the Engineer and of the following thickness:-
- 8.6.1.5** The protection and filling of headings shall be of concrete Class 25 for a thickness of 13 mm for pipes upto 300 mm nominal bore 25 mm for nominal bore from 300 mm to 600 mm, 38 mm for 600 to 1200 mm and 50 mm for nominal bore 1200 mm to 2000 mm.
- 8.6.1.6** The annulus of the pipe socket shall be sealed with an approved sealant, clay or tape to prevent the ingress of concrete in the joint.

8.6.2 Concrete Slab Protection - uPVC AND GRP Pipes

Where concrete slab protection to uPVC and GRP pipelines is specified such protection shall extend a minimum of 200mm either side of the pipe trench as dug. The slab shall be of reinforced concrete M25 as shown in the drawings or ordered by the Engineer.

8.6.3 Pipes Through Structures

- 8.6.3.1 Unless otherwise shown on the Drawings where pipes pass through a concrete wall or structure they shall be protected with a surround of concrete class 30 integral with the external face (s) of the structure. For pipes of less than 500 mm diameter the surround shall extend from the wall or structure by 300 mm and the width and depth of the surround beyond the outside face of the pipe at its horizontal and vertical diameters shall be a minimum of 300 mm or as otherwise indicated on the Drawings. For pipes of 500 mm diameter or greater the surround shall extend from the wall or structure by 500 mm and the width and depth of the surround beyond the outside face of the pipe at its horizontal and vertical diameters shall be 500 mm or as otherwise indicated on the Drawings.
- 8.6.3.2 Where the Engineer permits openings to be left in concrete wall for the subsequent fitting and concreting of pipework and fittings, the soffit of the openings shall be inclined away from the packing face at not less than one in four to the horizontal. The periphery of the openings shall be formed as specified for the construction joints. After placing the pipe or fitting the remaining void shall be carefully packed with concrete of appropriate class, every care being taken to produce a watertight joint. The concrete shall be retained by formwork, which shall be built up as concrete filling proceeds. The Contractor shall ascertain from the suppliers of prefabricated or manufactured goods any special fixing instructions and shall refer them to the Engineer for approval.
- 8.6.3.3 Where fixing bolts are positioned by means of a template they shall be supported and braced to remain in perfect alignment during the setting of the concrete or grout. Where it is necessary to drill for fixing the holes shall be to the minimum size necessary and they shall be grouted solid with a free-flowing non-shrink grout approved by the Engineer. Where boxing out for horizontal bolts or fittings is provided the boxing out - and refilling shall be as specified above for pipes and fittings through walls.
- 8.6.3.4 In fixing penstocks or flanges to concrete or blockwork the gate or door shall be in the closed position. The frame shall be supported against the face of the concrete or blockwork and the nuts tightened by hand. The space between the wall and the frame shall be filled solid with a non-shrink grout or a hard setting butyl mastic not in strip form.
- After the hardening of the mortar or mastic the nuts shall be properly tightened in a sequence to prevent any distortion of the frame and ensure equal bearing against the wall. Aluminium penstocks or fittings shall be bedded in a hard setting mastic.
- 8.6.3.5 Care must be taken to protect faces and other working parts from mortar and other droppings.
- 8.6.3.6 Except where otherwise specified when a metal is fixed to a metal or any other surface the metal surfaces in contact shall be painted on site with two coats of bituminous paint immediately prior to fixing. Where it is necessary to joint dissimilar metal such as aluminium to steel or cast iron the two surfaces shall be separated by an approved insulation not less than 1.5 mm thick.
- 8.6.3.7 Under no circumstances shall aluminium be built into wet concrete or be fixed to fresh concrete. Where aluminium or ferrous structural members are built into block work or concrete the contact surfaces shall be first painted with two coats of bituminous paint.
- 8.6.3.8 HDPE pipes passing through a water retaining concrete wall or structure shall have a grit-bonded key formed with silica sand on the external surfaces of the pipes along the entire embedded length. All excess sand shall be removed.
- 8.6.3.9 On spigot and socket pipelines a socket or coupler shall be installed flush with the outside face of the concrete surround unless otherwise shown on the Drawings.
- 8.6.3.10 The first pipe that is clear of concrete surround beyond the external face of a concrete wall or structure shall be a short length of either spigot and socket or double spigot to suit the flow direction and pipe material. The effective length of this pipe shall be 1.5 times the nominal bore or 600mm whichever is the greater.
- 8.6.3.11 Any over excavation adjacent to a structure and beneath the formation level of a pipe trench to be constructed by the contractor or to be constructed by others to make connection to a plugged or capped pipe laid by the contractor shall be backfilled to the formation level of the pipe trench with concrete Class 20. This concrete shall extend to the limit of the over excavation along the line of the pipe trench and across the full width of the pipe trench shown on the Drawings or to the limit of the excavation whichever is least.

8.6.4 Thrust Blocks

8.6.4.1 At every bend and junction on pressure pipelines the Contractor shall construct a thrust block in concrete M20. The contractor shall prepare the thrust block drawings and shall get approval of the **Engineer**.

8.6.4.2 The additional excavation required to obtain a firm thrust face against undisturbed ground shall be made after the thrust block is cured. The concrete backfill to the excavation shall be placed the same day as the additional excavation is carried out.

8.6.4.3 No pressure is to be applied to thrust blocks until concrete has matured.

8.6.5 Anchorage at Valves

Near valves, anchorage shall be provided to minimise the turning movement during operating of valves.

8.6.6 Granular Material For Bedding To Pipelines

Granular bedding material for pipe, unless otherwise specified, shall consist of free-draining hard, clean, chemically suitable sand of grain size between 1.00mm and 4.5mm.

8.7 CLEANLINESS

The interior of the pipes must be carefully freed from all dust as the work proceeds, for which purpose a disc plate or brush sufficiently long to pass two or more joints from the end of pipe last laid shall be continuously drawn forward as the pipes are laid. The ends of the pipes must be securely protected during the progress of the work. The pipes laid shall not be made receptacle either for tools, hookahs, clothes or of any other matter during the progress of works.

8.8 VALVES

8.8.1 General

8.8.1.1 Flanges of valves shall be drilled to IS. 1538. A complete set of bolts and nuts and one gasket shall be supplied to each flange.

8.8.1.2 The valves shall be capable of withstanding the specified test pressures of the pipeline and be suitable for the conveyance of water of specified quality.

8.8.1.3 All valves shall be protected for corrosive environment.

8.8.2 Sluice Valves

8.8.2.1 Sluice valves shall comply with IS 14846 and be flanged unless otherwise stated and be tested to the requirements of Class 1.

8.8.2.2 Maximum Differential Pressure and Maximum Working Pressure shall be as per relevant IS standards.

8.8.2.3 Sluice valves shall be of the double-flanged cast iron wedge-gate type and shall have non-rising spindles unless otherwise specified or shown on the Drawings. They shall have a cast iron body with renewable gunmetal faces on body and wedge and bolt-on cast iron bonnet. Rising stem valves shall also incorporate a combined yoke.

8.8.2.4 Where sluice valves above 350 mm bore are mounted with the spindle in the horizontal place the valve body shall be fitted with renewable gunmetal machined gage slides and the gates with renewable hard bronze shoes accurately machined to reduce sliding friction.

8.8.2.5 A sluice valve above 500 mm bore (300 mm if power actuated) shall be provided with jacking screws and valves above 350 mm bore where mounted in a horizontal pipeline shall be provided with feet.

- 8.8.2.6 Unless otherwise specified each valve shall be provided with a suitable hand wheel of adequate diameter for the duty required and gearing shall be supplied where necessary to ensure that the required operating force applied by hand to the rim of the wheel does not exceed 25Kgf.
- 8.8.2.7 Hand wheels shall have smooth rims and the direction of closing which shall be clockwise shall be cast on them. Vandal and weatherproof clear polycarbonate tube covers shall be securely fitted to protect the threads of rising stems and spindles and tubes shall be clearly and permanently engraved to indicate the position of the valve.
- 8.8.2.8 Valve stems shall be of forged aluminium bronze or stainless steel machined all over and with a machine cut robust trapezoidal or square form thread operating in a gunmetal nut.
- 8.8.2.9 Stem seals shall be of the stuffing box and gland form arranged for easy replacement of packing and shall be accessible for maintenance without removal of the valve from service.
- 8.8.2.10 Extension spindles headstocks and foot brackets shall be provided where specified. Where possible providing the valve is not subject to submergence. The extension spindle shall be of the non-rising type and a cast iron bridle piece or similar shall be incorporated on valves of the rising spindle type for this purpose. Where rising stem valves are subject to submergence the extension spindle shall also be of the rising type with the threaded portion positioned above top water level. Extended spindle installations shall include all necessary brackets intermediate supports etc.
- 8.8.2.11 Headstocks for non-rising spindle installations shall incorporate a valve position indicator.
- 8.8.2.12 Extension spindles shall be of stainless steel or manganese steel and shall conform with the requirements of valve stems with the exception of non-threaded sections which may be of mild steel. Extension spindle couplings shall be of the muff type and shall be drilled and provided with a nut and bolt for securing the spindle to the valve stem, which shall likewise be drilled to accept the bolt.
- 8.8.2.13 Extended spindle installations of the rising type shall be provided with thrust tubes between valve and headstock in order to absorb the thrust in both directions of operation for valves of 300 mm bore and above and for all motorised/actuator operated valves. Thrust tubes shall incorporate all necessary fixing brackets and spindle guide plates.
- 8.8.2.14 Where valves are required to be operated by the keys spindle caps shall be fitted. The caps shall be drilled and each provided with nut and bolt for securing to the spindle which shall likewise be drilled to accept the bolt. Where caps are fitted they shall be supplied complete with operating key.
- 8.8.2.15 All hand wheels, headstocks, foot brackets, guide brackets and thrust tubes shall be of cast iron.
- 8.8.2.16 Fixing nuts and bolts supplied by the manufacturer shall be as specified in the appropriate clauses of relevant IS.
- 8.8.2.17 Valves shall carry identification marks and/or plates in accordance with the Indian Standard and those for use on process plant shall carry additional brass plate carrying valve identification and a brief description of its function.
- 8.8.2.18 Valves shall be sized such that the velocity through the valve when fully open does not exceed 2.25 metres per second at the rated flow. They shall have flanges to IS. 1538 and shall be capable of withstanding the same test pressures as the pipeline on which they operate. All nuts and studs subject to vibration shall be fitted with spring washers or locking tabs.
- 8.8.2.19 All valves shall be coated with solvent free coal tar epoxy resistant to mineral acid which has pH $\leq$ 2.

8.8.2.20 All materials used in the manufacture of the valves shall conform to the following minimum standards: -

Cast Iron*	BS 1452	Grade 220
Gunmetal	BS 1400	Grade LG2
Aluminium Bronze	BS 2872	Grade Ca104
Stainless Steel	BS 970: Part 1	Grade 316S31
Manganese Steel	BS 970: Part 1	Grade 150 M19

*Spheroidal Graphite Iron to ISO 1083 may be used as an alternative to Cast Iron for waterworks standard valves to BS 5163.

8.8.3 Reflux Valves (Non-Return Valves)

8.8.3.1 Reflux valves shall comply with IS 5312 and be double flanged cast iron unless otherwise specified. They shall be resilient seated and be of the quick acting single door type designed to minimise slam on closure by means of heavy gunmetal faced doors weighted as necessary. The valves shall be fitted with renewable gunmetal door sealing faces which shall be positively fixed. The door hinge pin/shaft shall extend through a sealing gland on the side of the body and be fitted with an external lever to permit back flushing. Glands shall be of the stuffing-box type with the exception that for valves below 450mm bore they may be of the O ring type. The valve door shall be weighed to suite the application and the lever shall be of heavy duty type designed for the additional of external weights should these be required at some future date.

8.8.3.2 All reflux valves shall be suitable for operating in the horizontal plane unless otherwise specified.

8.8.3.3 Covers shall be provided to allow ample access for cleaning and service and shall be supplied complete with tapped bosses fitted with air release cocks. Valves above 350mm bore shall be provided with feet.

8.8.3.4 The design of the valve body shall be such that there is adequate clearance around and the back of the door to minimise jamming by rags and debris. Stops shall be provided to limit the back lift of the door and shall be positioned to prevent fouling.

8.8.3.5 The hinge pin/shaft shall be stainless steel and preferably square in section to ensure positive location of the door. If circular shafts are utilised the back flushing lever shall be located on squared section the diagonal dimension of which shall be equivalent to the full diameter of the shaft. Both door and lever shall be positively and securely fixed to the hinge pin/shaft. Grub screws pins (parallel or taper) or clamps will not be acceptable. All internal fixing devices shall be of stainless steel.

8.8.3.6 Valves shall carry identification marks and/or plates.

8.8.3.7 Valves shall be sized such that the velocity through the valve when fully open does not exceed 2.25 m/sec at the rated flow. All nuts and studs subject to vibration shall be fitted with spring washers or locking tabs.

8.8.3.8 All valves shall be prepared and painted in accordance with Engineers instructions.

8.8.4 Air Release Valves

8.8.4.1 Air release, or Air valves as they are usually known, shall be of double orifice pattern with grey or ductile cast iron bodies. The inlet flange shall be faced and drilled in accordance with IS.1538.

8.8.4.2 The valves shall be adequately sized for the release of gas from the pipeline (or other container) without restriction of rate of fillings or flow due to back pressure and also to allow admission of air during pipeline emptying at a rate sufficient to prevent excessive depression of pressure in the pipe.

- 8.8.4.3 Valves shall be designed to prevent the operating elements being in contact with the pipeline liquid by approved means such as the provision of an auxiliary float and chamber sufficiently large to isolate the orifice valves and seats throughout the rated operational range.

In applications where the pipeline characteristics may lead to liquid column separation with consequent possibility of surge a vented non-return valve shall be provided which allows air to enter freely on separation by controls and expulsion of air/gas as the liquid column rejoins.

In applications where the hydraulic conditions are such that pressures fall below atmospheric pressure during normal operation and where air inflow at that time could induce surge conditions an air inflow check valve shall be incorporated.

Fixing nuts and bolts supplied by the manufacturer shall be as specified in the appropriate clauses herein.

- 8.8.4.4 All air and gas relief valves and associated isolating valves shall be works tested and capable of withstanding the same test pressures as the pipeline or vessel on which they operate.

- 8.8.4.5 All valves and operating linkage shall be prepared and painted in accordance with Engineers instructions.

- 8.8.4.6 All materials used in the manufacture of the valves shall conform to the following minimum standards.

Float chamber	Grey Cast Iron to BS 1452
Flange and Cover	Grade 220 or Spheroidal Graphite Iron to BS 2789
Liquid Float	Copper, polycarbonate and approved equivalent
Air valve Float and Guide	Polycarbonate or approved equivalent
Orifices Guides and Mechanisms	Stainless steel to BS 970: Part 1

- 8.8.4.7 Testing

All valves supplied shall be tested at factory and all tests passed in the presence of the Engineer nominated by the client, as per relevant IS code. Requests for acceptance of materials shall be enclosed with a copy of such test results.

8.9 FLOWMETER

8.9.1 General

The flow meter shall be of Electromagnetic type complete with primary head and signal converter cum flow indicator as integral. Also a remote indicator for flow rate and totalization shall be provided at the pump house. The detailed specifications of the flow meter shall be as follows:

8.9.2 Material of Construction and other features:

Measuring tube: SS

Liner: Hard Rubber/Neoprene/Polyurethane

Electrode: Has

telloy C4

Connecting Flanges: Carbon Steel

Earthing Ring: SS316

Coil housing: Sheet metal with epoxy coat.

Insulation class of field coils shall be of 'F' class. The electrodes shall be of self cleaning, surface polished type.

Type of Protection: IP67, NEMA6

Accuracy: 0.5% of measured value

Power supply: 230V AC, 50Hz

Output: 4-20mA Analog isolated.

Coil supply: Pulsed DC supply from the converter

Cable connection: ½” NPT of SS 304, Double compression

8.9.3 Flow range

Flow meters installed should be having a flow range upto 25% excess over the calculated flow rate at each concerned location.

Note:

1. The contractor shall install the flow meter appropriately as per manufacturers recommendations and as directed by the Engineer in the rising main close to the Pump House.
2. Scope of the work shall include cutting the pipe, providing and welding suitable size flanges on the existing pipe at suitable locations. Power supply connections to the Flow meter shall be made using proper size cables in suitable length. Separate indicator shall be provided in the Pump House for monitoring the flow.
3. The flow meter shall be provided with grounding rings.
4. Additional flow indicator shall be provided inside the pump house at a suitable position as directed by the Engineer in charge. Suitable size and length of cable and accessories shall be included in the scope.

8.9.4 Testing

The meter shall be calibrated and tested as per relevant Codes and certificates shall be submitted for approval. The manufacturer's Test certificate shall be provided for approval of the Engineer. The flow meter shall be subjected to inspection.

8.10 VALVE CHAMBERS AND METER HOUSES

All the sluice valves, air valves and scour valves shall be protected by valve chambers constructed as specified in relevant drawings. The chambers shall be provided with an access hole and the hole covered with manhole covers of size 600mm x 600mm. The manhole covers shall be of heavy duty for the chambers located on roads over which vehicular traffic can be anticipated and for others the covers shall be of medium duty. Ladder or foot rests shall be provided so that access into the valve chamber through the access hole is easy. Outside of the valve chamber shall be coated with 2 coats of bituminous paint. Inside of the valve chamber shall be protected with cement colour first quality emulsion paint. The price quoted should be inclusive of all works including earthwork excavation, backfilling, construction of RCC chamber, formwork, manhole cover, etc all complete as specified in specifications and drawings.

8.10.1 Protection to Water Meters

Bulk water meters shall be protected in a meter house or concrete chamber with adequate protection to the water meter, but enabling easy reading of the meter, as directed by the Engineer

8.10.2 Protection against Corrosion

All corrosive parts such as specials and valves shall be protected against corrosion with 3 coats of anticorrosive paint. Wherever salt content is present in soil, such corrosive parts shall be protected with 3 layers of bituminous coating and leak proof wrapping with polythene sheets

8.11 SUPPLYING AND FIXING VENTS

Vents of diameter 150 mm or as specified / directed by the Engineer shall be provided in the roof of all storage reservoirs. If more than one compartment is available, each compartment shall be provided with vents. One vent pipe of minimum 150 mm diameter shall be provided for every 50 sq. metre plan area, or part there of in any compartment. The vents shall be of cast iron and shall have wall casting base so that it can be fixed in cover slab. The vents shall be fixed vertically and shall have double out lets each forming a semi circle with the stem. Each out let shall be curved in opposite direction of the other out let. Vents fitted at ground level shall have sufficient stem length so and the out let will have clearance of at least 50 cms between the out let opening of the vent top of reservoir cover slab to prevent entry of frogs and worms. In other cases the clearance shall be 30 cms. The vents shall be painted with two coats of black paint or tar. The outlets of the vents shall be fitted with brass mosquito proof netting.

Measurement:

The vents shall be measured in numbers.

Rate:

Rate shall include labour, cost and conveyance of all materials, fixing in concrete slab at the time of casting, painting, etc. complete for the finished work. The brass mosquito proof netting will be measured separately.

8.12**RUBBER PACKING**

Flanged joints shall be provided with rubber packing sheet in between flanges and tightening with bolts and nuts. Rubber packing used for jointing flanges shall conform to IS 1638. The packing used shall be of such width that the sheet fits exactly with the flange width.

Measurement:

Measured in Kg. correct to 10 grams. This will be covered under items concerned unless specified otherwise.

Rate:

Rate includes labour for cutting, cost and conveyance, placing in position etc. complete for the finished work.

8.13**M S BOLTS AND NUTS**

M S bolts and nuts used for flanged joints in pipelines shall conform to IS-1363 with ends of bolts threaded to required length. Inside of nut shall be threaded to suit bolt threads.

The bolts should be provided with steel washers, tapered or otherwise, of suitable shape to give the head and nut of the bolt a satisfactory bearing. The thread portion of each bolt shall project through the nut at least for 10 mm.

Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. No bolt shall be stressed beyond elastic limit and no spanner other than the standard pattern shall be allowed nor shall any appliance for lengthening the leverage of any spanner be permitted. The flanges and bolts and nuts shall be painted with two coats of paint or tar, as directed by the Engineer.

Measurement:

Bolts and nuts will be measured in Kg, correct to 10 grams. Washers will not be measured.

Rate :

Rate will be inclusive of cost, conveyance and 2 coats of painting, labour and required number of steel washers for the finished work.

8.14**PIG LEAD**

Pig lead shall be 99.99% pure conforming to IS.782.

Measurement :

Pig lead will include cost, conveyance to store, storage, conveyance from store to site etc. complete.

8.15**WATER LEVEL INDICATOR**

A water level indicator shall be provided and fixed, reading depth of water in metre in intervals of 10 cm. The system shall consist of noncorrodable materials and shall be simple and easy to maintain. The water level shall be provided and fixed as approved by the Engineer. The indicator shall be full scale up to 4.00 meter and ratio type above 4.00 m height. Alternatively mono metric gauge or electronic water level indicator can be offered. The reading shall give precision of 1 cm.

Measurement:

Level Indicator will be measured in numbers.

Rate:

Rate will include cost, conveyance and erection for the finished work.

8.16**LIGHTNING ARRESTOR**

Copper Lightning Arrestor shall be provided at the highest level on the roof of the tank as specified in IS.2309. Position and height of the lightning arrestor shall be such that the whole structure shall be enclosed within a cone having its apex at top of the arrestor and generated by a line inclined at 60° to the vertical. The copper lightning conductor shall be of copper tape 20 mm x 3 mm size. It shall be fixed on side and top of the structures using porcelain cleats at an interval of one metre in such a way that it will not have any contact with the structure. The copper rod used for supporting the conical spike at the top shall be of 1.50 m long and 20 mm dia. The earth pit shall be provided with copper plate of 3 mm thick and 0.81 sq. metre surface area clamped with G.I. Pipes of 40 mm dia and 3 meter long. The top end of the pipe will be fitted with a funnel and projected above the ground.

Measurement:

Lightning arrestor shall be measured in numbers.

Cost:

Cost shall include labour, cost and conveyance of all components, erection etc. complete for the finished work.

8.17

FIRE HYDRANTS

Fire hydrants shall be of “Pillar or Post Hydrant” type. It will stand above ground like a post 1.00 m high and connected to the water main underground. It shall consist of a sluice valve, a duck foot bend, 65 mm dia post with one or more outlets at the top of the post, in addition to the branching from the water main. Multiple outlets may be provided on mains of diameter 300 mm and above as directed by the Engineer. The posts shall be painted in red. The hydrant shall comprise a flanged sluice valve (conforming to IS.780, a flanged socket tail piece (conforming to IS.1538), one double flanged duck foot bend, a 63 mm screwed out let, a loose cap and a wrought iron chain. Fire Hydrants shall be provided at all round junctions and street crossings in locations convenient for fire fighting, as directed by the Engineer and at intervals of about 100 meters.

Measurement:

Fire Hydrants will be measured in numbers.

Cost:

The cost of Fire Hydrants will include labour for installation Cost and conveyance all components concrete pedestal for duck foot bend etc. complete for the finished work.

8.18

BALL VALVES / FLOAT VALVES

The Ball valves shall be of cast iron body with bronze liner and gun metal seat ring. It shall conform to IS.1703.

Measurement:

Ball Valves will be measured in number.

Cost:

Cost of Ball Valve will include labour, cost and conveyance of the valve and positioning the ball so that the valve will be closed fully when the tank is full for the finished work.

8.19

SCOUR VALVE / WASH OUT VALVE

Scour Valves are installed on branching from the water pipe line with a tangential Tee. A sluice valve of branch size will be fitted. Scour water shall be discharged into a clean open drain or a natural water body. A duck foot bend shall be used on the out let side. The duck foot bend shall be anchored to a concrete pedestal. Discharge of scoured water shall be through a goose neck or inverted ‘J’ the out let point shall be about 30 cms above the high water level in the receiving drain or water body. The water should never be let out into a sewer manhole directly. If there is any chance for erosion near the discharge point due to large quantity of water at high velocity, protection shall be provided by way of gabion mattresses. Size of the scour valve shall be half the diameter of main pipe plus 25mm.

Measurement:

Scouring arrangements will be measured in numbers.

Cost:

Cost of Scour Valves will include labour for installation, cost and conveyance of double flanged sluice valve, tangential tee on the main pipeline, duck foot bend, extension pipes, goose neck, protection against scouring at out let point, anchoring duck foot bend etc. complete, for the finished work. Manhole housing the valve will be measured separately.

8.20 ELSR and Sump

The execution work of ELSR and Sump shall conform to the following standards specifications and codes of practice of I.S.I.

IS: 456	Code of practice for plain and reinforced concrete (latest edition)
IS: 875	Code of practice for structural safety of building, loading standards (latest edition)
IS: 3370 Part I to IV	Code of practice for concrete structures for storage of liquids (latest edition)
IS: 1893	Criteria for Earth quake resistant Design of structures (latest edition)

10% the payment of ELSR /Sump shall not be payable till satisfactory water tightness test is given for all water retaining structures and till that work shall be treated as complete.

8.21 LIST OF MANDATORY TESTS

Following are the mandatory tests to be conducted at appropriate stages of the work

TABLE 8.17

Item	Test	Field / Laboratory test	Sample size
Pipes	Type tests and Acceptance tests	Laboratory Tests	As per relevant IS
Jointing materials	Acceptance tests	Laboratory Tests	- do -
Pipe lines	Pressure tests	Field hydraulic pressure Tests	- do -
Valves	Acceptance tests	Laboratory Tests	- do -
Water meters	Acceptance tests	Laboratory Tests	- do -

8.22 TRIAL RUN

The trial run shall consist of a period of three month of operation for complete jobs of water supply scheme. The contractor shall provide the skilled plant operator/pump operators, supervisors along with other service staffs for this duration of trial run after completion of the total work. The contractor's staffs shall train the staffs/persons nominated by the Engineer during this period. The contractor shall run the plant round the clock during this period and shall maintain a logbook to ascertain the quality and quantity of water, consumption of power and chemicals if any. Any shortcomings in quality quantity of water shall be corrected by the contractor adopting proper correction measures and as per direction of Engineer.

CHAPTER 9-ELECTRICAL WORKS
TECHNICAL SPECIFICATIONS-ELECTRICAL WORKS.

1.0 GENERAL

- 1.1. The Electrical work will be carried out generally in accordance with the General Specifications for Electrical works Part – I, 2005 in Central Government buildings (CPWD) while complying in all respects with the requirement of the latest Indian Electricity Rules in force from time to time.
- 1.2. The Electrical work will be carried out simultaneously with the building work and will be continued till it is completed satisfactorily along with the completion of essential portions of Building work.
- 1.3. If any minor alterations are found necessary, the Contractor will have to do the same within the Tendered rates.
- 1.4. The work will be carried out in the best workmanlike manner and any defect in the work or changes in the design etc., if pointed out, shall be carried out by the contractor without any extra charge.
- 1.5. The contractor shall employ adequate labour to complete the work within the stipulated time and will make his own arrangement for housing labour and storage of materials &etc. A whole time Electrical Supervisor/Engineer shall be employed by the Contractor who will remain at site of work to receive orders or any other instructions from the Engineer-in- charge.
- 1.6. Any material supplied by the Employer if damaged, in any way during cartage or execution of work or otherwise, shall be made good by the contractor at his own cost.
- 1.7. During the progress of work, completed portions of the building may be occupied and put to use by the Employer but contractor will remain fully responsible for maintenance of the Electrical installations till the entire work covered by this contract is satisfactorily completed by him and taken over by the Employer.

1.1.1 SAMPLES

Samples will be submitted by the contractor according to the specifications / list of approve make. Any deviations from the specifications will have the written consent of the Client/Construction Manager and Engineer-in-charge.

1.1.2 PROGRESS AND TIME OF COMPLETION:

- a) The work will commence immediately after the contractor receives instructions to proceed.
- b) The contractor will work in cooperation with the building contractor and other contractors and shall arrange to place his conduits in the masonry and concrete work as the building or other work, Because of delay in laying of conduits or otherwise shall be the responsibility of the Electrical contractor and will make him liable for damages, if any, by the Employer.
- c) The contractor shall in consultation with the Engineer-in-charge/ Consultants draw up a time schedule on commencement of the work. This time schedule will be strictly adhered to.

1.1.3 COMPLETION TESTS:

On completion of the installations the following tests shall be carried out:-

1. Insulation resistance test.
2. Polarity test of switch.
3. Earth continuity test.

1. Insulation Resistance:

The insulation resistance will be measured by applying between earth and the whole system of conductors or any section thereof with all fuses in place and all switches closed, and except in earthed concentric wiring all lamps in position or both poles of the installation otherwise electrically connected together, a direct current pressure provided that it need not exceed 500 volts for medium voltage circuit. Where the supply is derived from the three wire D.C. or a poly phase A.C. system, the neutral pole of which is connected to earth either direct or through added resistance, the working pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.

The insulation resistance shall also be measured between all conductors connected to one pole or phase conductor of the supply and all connectors connected to the neutral or to the other pole or phase conductors of the supply with all lamps in position and its value shall be not less than that specified in sub-clause below:

The insulation resistance in Mega ohms measured as above shall not be less than 50 Mega ohms divided by the number of outlets or when FR PVC insulated cables are used for wiring 12.5 Mega ohms divided by number of outlets.

Where a whole installation is being tested, a lower value than that given by the formula, subject to a minimum of Mega ohms is acceptable.

A preliminary and similar test may be made before lamps etc. are installed in this event the insulation resistance to earth should not be less than 100 Mega ohms divided by the number of outlets or when FR PVC insulated cables are used for wiring 25 Mega ohms divided by the number of outlets.

The term "OUTLET" includes every point along with every switch except that a switch combined with a socket outlet, appliance of light fitting is regarded as one outlet. Control rheostat, heating and power appliances and electric signs may, if required, be disconnected from the circuit during the test, but in that event the insulation resistance between the case or framework, and all live parts of each rheostat, appliance and sign, shall be not less than half a mega ohms.

2. Polarity test of switch:

a) In a two wire installation a test shall be made to verify that all switches in every circuit have been fitted in the same conductor throughout & such conductor shall be labeled or marked for connection to the phase conductor or to the non-earthed conductor of the supply.

b) In a three wire or four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted in a conductor which is labeled or marked for connection to one of the phase conductor of the supply.

c) The installation shall be connected to the supply for testing. A test lamp, one lead of which is connected to earth, shall test the terminals of all switches. Glowing of test lamp to its full brilliance when the switch is in "ON" position irrespective of appliance in position or not shall indicate that the switch is connected to the right polarity.

3. Testing of earth continuity Path:

The earth continuity conductor including metal conduits and metallic envelopes of cable in all cases shall be tested for electric continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance of earth leakage circuit breaker measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one Ohm.

The contractor shall notify in writing to the Employer about the completion of the work, within 7 days from the date of this notification, the Engineer-in-charge shall send their representative to remain present at the time of carrying out of the tests by the Contractor. The contractor will fix up this date in consultation with the Employer/Client/Construction Manager s for such tests.

Should the above tests not comply with the limits & requirements as above the contractor shall rectify the faults until the required results are obtained.

The contractor shall be responsible for providing the necessary instruments and subsidiary earths for carrying out the tests. The Contractor without any extra charge will carry out the above tests.

1.1.4 DEFECTS LIABILITY PERIOD & MAINTENANCE:

The completed installation inclusive of wiring, light fittings, and fan shall not be final until the expiry of the defects liability period stated from taking over of Installations by the clients. During the period, the Contractor shall be liable for:-

- a) The replacements of any defective parts that may develop in goods/items of his own manufacture or supplied by him.
- b) The rectification of all the defects arising out of defective workmanship of the contractor.
- c) Bringing to the notice of the Employer any defect arising in materials supplied by the Employer. The employer shall provide replacement of such materials.
- d) Until the installation is finally taken over, the Contractor shall have the right of entry to the premises, at his own risk and expenses, for maintaining the installation in proper order. To facilitate maintenance the contractor should clearly indicate the detail distribution diagram on every switchgear, D.B., SDB, MBs, and Feeder Pillars etc.

1.1.5 POSITION OF LIGHTING & DISTRIBUTION BOARDS & SWITCHGEARS

- a) The recommended positions of the lighting points control switches, distribution boards and switchgears etc., as shown on the layout drawings will be generally adhered to.
- b) Should there be any discrepancy or incomplete description, ambiguity or omission in the drawings and other documents whether original or supplementary, forming the contract, completion or maintenance of the installation, the contractor shall immediately on discovering the same draw attention of the Employer.
- c) Prior to the installation of lighting, fan and plug points and the distribution boards, switches etc., final positions shall be ascertained by the Contractor with the Employer.
- d) The dimensions and other details of the electrical drawings shall be compared with the civil drawings at site before executions of the work.

1.1.6 PAINTING & MARKING

All exposed steel work not actually embedded in building construction (viz. conduits, junction boxes, switchboards DBs, MBs etc.) will be painted with one coat of primer and two coats of synthetic enamel paint to shades approved by the Employer/Client/Construction Manager. The paint will match the existing shades of walls wherever instructed. The contractor without extra charge will do this work. All switchgears, MBs, SDBs and final DBs etc. shall be properly painted labeled and numbered as required by the Employer/Client/Construction Manager.

1.1.7 Wherever recessed fittings are required to be provided the Electrical Contractor shall be responsible for informing the building contractor to keep necessary recesses in the slab/false ceiling.

2.0 PANEL MAIN DISTRIBUTION BOARDS/ SUB DISTRIBUTION BOARDS

2.01 GENERAL

Main Distribution Board/ Sub Distribution Boards shall be metal clad totally enclosed, rigid floor mounted air insulated. Cubicle type for use on 415 volts, 3 phase, 50 cycle system. System shall be suitable for fault withstand capacity of 50KA RMS or as specified / Indicated in BOQ symmetrical Equipment shall be designed for operation in high ambient temperature and high humidity tropical atmospheric conditions.

2.02 STANDARDS

2.02.1 The equipment shall be designed to conform to the requirements of:-

- I. IS: 8623 -Factory Built Assemblies of switchgear and control gear
- ii. IS: 4237 - General requirements for switchgear and control gear for voltages not exceeding 1000 volts.
- iii. IS: 2147 - Degree of protection provided by enclosures for low voltage switchgear and control gear.
- iv. IS: 375 - Marking and arrangement of bus bars.

2.02.2 Individual equipment housed in the Main Sub Distribution Board shall conform to the following IS Specifications.

I. Moulded case circuit breaker - IS 13947/I E-947.

ii. H.RC Fuse links	- IS 2208-1962 or IS 9224-1979
iii. Current Transformers	- IS 2705
iv. Voltage Transformers	- IS 3156
v. Relays	- IS 3231
vi. Indicating Instruments	- IS 1248
vii. Integrating Instruments	- IS 722
viii. Control switches & Push Buttons	- IS 6875
ix. Auxiliary Contractors	- IS 2959

2.03 CONSTRUCTION

All panels and Main Distribution / Sub Distribution Board shall be metal enclosed, indoor, floor mounted free standing type made up of the required vertical section, which when coupled together shall form continuous dead front Distribution Board. Main Distribution Board/ Sub Distribution Board shall be dust and damp protected. Panels & Main Distribution Board shall be extensible on both sides by the addition of side section after removal of end covers. Panels Main Distribution Board/ Sub Distribution Board shall be fabricated with a framed structure with rolled/ folded sheet steel channel section of minimum 3mm thickness, doors and covers shall be of minimum 2mm thick sheet steel shroud and partitions shall be of exterior of Main Distribution Board/ Sub Distribution shall be smoothly finished, leveled and free from flaws. The corners are to be rounded. Front and rear doors to be fitted with dust excluding neoprene gasket with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be ensured Between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

Following minimum clearances to be maintained after taking into account connecting bolts, clamps etc.

I. Between phases	- 32 mm
ii. Between phases and neutral	- 26 mm
iii. Between phases and earth	- 26 mm
iv. Between neutral and earth	- 26 mm

All insulating materials used in the construction of the equipment shall be of non-hygroscopic material, duly treated to withstand the effects of the high humidity, high temperature tropical ambient service conditions.

Functional units such as fuse switch/ fuse switch unit/ moulded case circuit breakers shall be arranged in multi-tier formation. The design of the Main Distribution Board/ Sub Distribution shall be such that each fuse switch/ switch fuse units/ MCCB shall be fully compartmentalised.

Insulated barriers shall be provided with in a vertical section and between adjacent sections to ensure prevention of accidental contact with main bus bars and vertical risers during operation, inspection or maintenance of functional units. All doors/ covers providing access to live power equipment/ circuits shall be provided with tool operated fasteners to prevent unauthorized access. The panel shall be so constructed that the cable alley shall be sufficient enough to accommodate all the outgoing and incoming cables. For each cable there shall be separate cable gland plate of detachable type at the bottom and/ or top of the panel as required. Gland plate shall be 3mm thick.

2.03 METAL TREATMENT & FINISH

All metal work used in the construction of the panels and main Distribution Board/ Sub

Distribution Board should have undergone a rigorous metal treatment process as follows:-

i. Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.

ii. Pickling in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.

iii. A recognized phosphate process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.

iv. Passivating in de-oxalite solution to retain and augment the effects of phosphating. v. Drying with compressed air in a dust free atmosphere.

vi. Primer coating with two coats of a highly corrosion resistant primer, applied wet on wet and stove dried under strictly controlled conditions of temperature and time.

vii. A finishing coat of stoving synthetic enamel paint of gray colour.

2.04 BUSBARS.

The bus bars shall be air insulated and made of high conductivity, high strength aluminum alloy complying with the requirement of grade E-91E of IS-5082.

The bus bars shall be suitable braced with non-hygroscopic SMC supports to provide a through 50KA RMS symmetrical for one second and a peak short circuit withstand capacity of 105KA. The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent bus bars. Large clearances and creep age distances shall be provided on the bus bar system to minimize possibilities of fault. The main phase bus bars shall have continuous current rating throughout the length of the panel. The cross section of neutral bus bars shall be same as that of the phase bus bar for bus bars of capacity upto 200Amp. For higher capacities the neutral bus bar shall not be less than half (50%) the cross section of that of the phase bus bars. Connections from the main bus bars to functional circuits shall be so arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Bus bars shall be colour coded with FR PVC sleeves.

The Main Distribution Board /Sub Distribution Board shall be designed that the cables are not directly terminated on the terminals of switch fuse/ fuse switch/MCCB. but are terminated on cable termination links. Capacity of aluminum bus bars shall be considered as 1.0 Amp per sq.mm of cross section area of the bus bar.

2.06 MOULDED CASE CIRCUIT BREAKERS

2.06.1 GENERAL

Moulded Case Circuit Breaker shall be incorporated in the Main/ sub distribution board wherever specified. MCCBs shall be suitable either for single phase AC 230 volts or there phase 415 volts.

2.06.2 FRAME SIZES

The MCCBs shall have the following frame sizes subject to meeting the fault level:

- | | |
|----------------------|-------------------|
| a. Up to 100A rating | 100A frame. |
| b. From 125 to 225 |225A frame. |
| c. From 225 to 400 |400A frame. |
| d. Above 400A |600A frame. |

2.06.3 CONSTRUCTIONS

The MCCB's cover and case shall be made of high strength heat treatment and flame retardant thermo-setting insulating material. Operating handle shall be quick make/ quick break, trip-free type. The operating handle shall have suitable 'ON', 'OFF' and 'tripped' indicators. Three phase MCCBs shall have common operating handle for simultaneous operation and tripping of all the three phases.

Suitable extinguishing device shall be provided for each contact. Tripping unit shall be of thermal magnetic or static type provided in each pole and connected by a common trip bars such that tripping of any one pole operates all three poles to open simultaneously. Thermal magnetic or static tripping device shall have IDMT characteristics for sustained over loads and short circuits.

Contact tips shall be made of suitable air resistant, sintered alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

2.06.4 TESTING

- a) Original test certificate of the MCCB as per Indian Standard (IS) 315-C-8370 shall be furnished.
- b) Pre-commissioning tests on the MV panel incorporating the MCCB shall be done as per standard.

2.07 MEASURING INSTRUMENTS FOR METERING

2.07.1 GENERAL

Direct reading electrical instruments shall be in conformity with IS 1248. The accuracy of direct reading shall be 1.0 for voltmeter and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The errors due to variations in temperature shall be limited to a minimum. The meter shall be suitable for continuous operation between -10°C to +50°C. All meters shall be of flush mounting type of 96mm square pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The design and manufacture of the meters shall ensure the prevention of fogging of instruments glass. Instruments meters shall be sealed in such a way that access to the measuring element and to the accessories within the case shall not be possible without removal of the seal. The meters shall be provided with white dials and black scale markings.

The pointer shall be black in colour and shall have zero position adjustment device which could be operated from outside. The direction of deflection shall be from left to right.

Suitable selector switches shall be provided for all ammeters and voltmeters intended to be used on three-phase supply.

The specifications herein after laid down shall also cover all the meters, instrument and protective devices required for the electrical work. The ratings type and quantity of meters, instruments and protective devices shall be as per the schedule of quantities.

2.07.2. AMMETERS.

Ammeters shall be moving iron or moving coil type. The moving part assembly shall be with jewel bearing. The jewel bearing shall be mounted on a spring to prevent damage to pivot due to vibrations and shocks, the ammeters shall be manufactured and calibrated as per the latest edition of IS: 1248. Ammeters shall be instrument transformer operated, and shall be suitable for 5A secondary of instrument transformer. The scales shall be calibrated to indicate primary current, unless otherwise specified. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy.

2.07.3 VOLTMETERS

Voltmeter shall be of moving iron or moving coil type. The range for 415 volts, 3 phase voltmeters shall be 0 to 500 volts. Suitable selector switch shall be provided for each voltmeter to read voltage between any two lines of the system. The voltmeter shall be provided with protection fuse of suitable capacity.

2.07.4 -Deleted

2.07.5. MISCELLANEOUS

Control switches shall be of the heavy-duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

Indicating lamps shall be of the filament type of low watt, consumption, provided with series resistor where necessary, and with translucent lamps covers, bulbs & lenses shall be easily replaced from the front.

Push buttons shall be of the momentary contact, push to actuate type fitted with self-reset contacts & provided with integral escutcheon plates marked with its functions.

2.07.6 CABLE TERMINATION.

Cable entries and terminals shall be provided in the Main/Sub distribution board to suit the number; type and size of aluminum conductor power cables and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated.

Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

2.07.7 CONTROL WIRING

All control wiring shall be carried out with 110/660 V grade single core FR PVC cable conforming to IS:694/ IS: 8130 potential standard copper conductors of minimum 1.5 sq.mm for potential circuits and 2.5 sq.mm for current transformer circuits. Wiring shall be neatly bunched, adequately by numbering ferrules at end. All control fuses shall be mounted in front of the panel and shall be easily accessible.

2.07.8 TERMINAL BLOCKS

Terminal blocks shall be 500 Volts grade of the stud type. Insulating barriers shall be provided between adjacent terminal. Terminal blocks shall have a minimum current rating of 10 Amps and shall be shrouded. Provisions shall be made for label inscriptions.

2.08 LABELS

Labels shall be anodized aluminum, with white engraving on black background. They shall be properly secured with fasteners.

2.09. TEST AT MANUFACTURES WORK

All routine tests specified in IS: 8623-1977 shall be carried out and test certificates submitted to the Project Manager.

2.10 TESTING AND COMMISSIONING

Commissioning checks and tests shall be including all wiring checks and checking up of connections. Primary/secondary injection tests for the relays adjustment/ setting shall be done before commissioning in addition to routine meggar test. Checks and tests shall include the following.

- a) Operation checks and lubrication of all moving parts.
- b) Interlocking function check.
- c) Insulation test: when measured with 500V meggar, the insulation Resistance shall not be less than 100 mega ohms.
- d) Trip tests & protection gear test.

3.00 DISTRIBUTION BOARDS

Distribution Board shall be double door type with extended loose wire box at the top and suitable for flush installation. All distribution boards shall be of three phase (415 Volts) or single phase (240 Volts) type with incoming isolator or MCB and / or ELCB as in Schedule of quantities. Distribution boards shall contain plug in or bolted type miniature circuit breaker mounted on bus bars. Miniature circuit breakers shall be quick make & quick break type with trip free mechanism. MCB shall have thermal & magnetic

short circuit protection. MCB shall conform with IS: 8828-1978. Neutral bus bars shall be provided with the same number of terminals as there are single ways on the board in addition to the terminals for incoming mains. An earth bar of similar size as the neutral bar shall also be provided. Phase barrier shall be fitted and all live parts shall be screened from the front. Simple clearance shall be provided between all live metal and the earth case and adequate space for all incoming and outgoing cables. All distribution board enclosures shall have an etched zinc base stove painted followed by synthetic stoved enamel, colour light grey. A circuit identification card in clear plastic cover shall be provided for each distribution board.

3.01 Miniature Circuit Breakers for lighting circuits shall be of "B" series where as 'C' series MCB's shall be invariably used for motor loads, halogen lamps fitting, sodium/ mercury discharge lamps and for all power circuits. All miniature circuit breakers shall be of 9KA rated rupturing capacity.

3.01 EARTH LEAKAGE CIRCUIT BREAKER/ RESIDUAL CURRENT CIRCUIT BREAKERS.

Earth leakage circuit breaker shall be current operated type and of 100 mA sensitivity unless otherwise stated. For single phase distribution, ELCB shall be housed within the DB box. For three phase distribution board, either the ELCB shall be housed in the same box or in a separate box & shall be width & depth of D.B. box. ELCB box shall be of same finish. Height of ELCB box shall be sufficient to accommodate ELCB & termination of incoming & outgoing wires.

4.00 FR PVC/GALVANISED CONDUIT AND WIRING SYSTEM

4.01 TYPE AND SIZE OF CONDUIT

All conduit pipes shall be ISI marked to medium grade./ solid drawn or reamed by welding finished with stove enameled surface (where called for Galvanized conduits shall be used for data cables etc, as per Schedule of quantities. All conduit accessories shall be of threaded type and under no circumstances pin grip type accessories shall be used. The maximum number of FR PVC insulated 650/1100 volts grade copper conductor cable that can be drawn in conduit of various sizes shall be as per IS code. No steel conduit less than 20mm in diameter shall be used. FR PVC conduits shall conform to ISI marked to medium grade. And all accessories and cementing etc. shall be as per manufacturers specification.

4.02 CONDUIT JOINTS

Conduit pipes shall be joined by means of threaded couplers and threaded accessories only. In long distance straight run of conduits, inspection type couplers at reasonable intervals shall be provided or running threads with couplers and jam nuts shall be provided. In the later case the bare threaded portion shall be treated with anti-corrosive preservative. Threads on conduit pipes in all cases shall be between 13mm to 19mm long sufficient to accommodate pipes to full threaded portion of couplers or accessories.

Cut ends of conduit pipe shall have no sharp edges nor any burrs left to avoid damage to the insulation of conductor while pulling them through such pipes.

4.03 PROTECTION AGAINST CONDENSATION

The layout of conduit should be such that any condensation or seeping inside the conduit is drained out. Suitable precaution should also be taken to prevent entry of insects inside the conduit.

4.04 PAINTING OF CONDUIT AND ACCESSORIES

After installation, all accessible surface of conduit pipes, fittings, switch and regulator boxes etc. shall be painted with two coats of approved enameled paint or aluminum paint as required to match the finish of surrounding wall, trusses etc.

4.05 FIXING OF CONDUITS

4.05.1 SURFACE CONDUIT

Conduit pipes shall be fixed by heavy gauge saddles, secured to suitable wood plugs or other approved plugs with screws in an approved manner at an interval of not more than one meter but on either side of the couplers or bends, similar fittings, saddles shall be fixed at a distance of 30cm from the centre of such fittings. The saddles should not be less than 24 gauge for conduits upto

25mm and not less than 20 gauge for larger diameter conduits. The corresponding widths shall be 19mmx25mm. Where conduit pipes are to be laid along the trusses, steel joint etc. The same shall be secured by means of special clamps made of MS. Where it is not possible to drill holes in the trusses members suitable clamps with bolts and nuts shall be used.

For 25mm diameter conduit width of clip shall be 19mm and of 20 SWQG. For conduit of 32mm and above, width of clip shall be 25mm and of 18 SWG.

Where conduit pipes are to be laid above false ceiling, either conduit pipes shall be clamp to false ceiling framework or suspended with suitable supports from the soffit of slab. For conduit pipe run along with wall the conduit pipe shall be clamped to wall above false ceiling in uniform pattern with special clamps if required to be approved by the Engineer-in-charge.

4.05.2 RECESS/ CONCEALED CONDUIT

The chase in the wall shall be neatly made and of ample dimension to permit the conduit to be fixed in the manner desired. In the case of building under construction, conduit shall be buried in the wall before plastering and shall be finished neatly after creation of conduit. In case of exposed brick/ rubble masonry work special care shall be taken to fix the conduit and accessories in the position along with the building work. Work of chasing the wall, fixing the conduit in chases and burying the conduit in mortar before plastering shall form part of point wiring work. The conduit pipe shall be fixed by means of staples or by means of saddles not more than

60cm apart or by any other approved means of fixing. Fixing of standard bends and elbows shall be avoided as far as practicable and all curves maintained by bending the conduit pipe itself with treated with some approved preservative compound to secure protection against rust. Suitable periodical inspection boxes to the barest minimum requirements shall be provided to permit periodical inspection and to facilitate replacement of wires, if necessary. These shall be mounted flush with the wall. Suitable ventilating holes shall be provided in the inspection box covers. Where the length of conduit run is more than 10 meters, then circular junction box shall be provided.

4.06 OUTLET BOXES & COVERS

The switch box shall be made of metal on all sides except on the front. Boxes shall be hot dip galvanized mild steel. Up to 20x30cm size M.S. box shall have wall thickness of 18 SWG and MS boxes above 20x30cm size shall be of 16 SWG. The metallic boxes shall be painted with anti-corrosive paint before erection. Clear depth of the box shall not be less than 60mm. All fitting shall be fitted in flush pattern. Phenolic laminated sheet of approved shade shall be used for switch box covers. These shall be of 3mm thick synthetic phenolic resin bonded laminated sheet as base material and conform to grade P-1 OF IS 2036-1994.

4.07 SWITCHES

All 5/6 and 15/16 Amp switches shall be modular type of 240 volts A.C. grade. All switches shall be fixed on suitable modular plate cover. All 5/6 Amp socket shall be 3-pin type. All 15/16 Amp socket shall be 6-pin type suitable for 15/16Amp. All switches sockets, telephone and TV outlets controlling the lights or fans shall be connected to the phase wire of the circuit.

4.08 FLUSH COVER PLATE

All switches, sockets, telephone and TV outlets etc. shall be fixed on deluxe plate cover suitable modular plate cover unless otherwise called for in drawings or BOQ. Flush cover plate shall be secured to the box with counter sunk brass screws & cup washers.

4.09 WALL SOCKET PLATE

All 6 and 16amp socket outlet shall be 3 and 6 pin respectively. Each outlet shall have a switch located beside the socket preferable on the same flush cover plate. The earth terminal of the socket shall be connected to the earth wire.

4.10 WIRING

All internal wiring shall be carried out with FR PVC insulated wires of 650/1100 volts grade. The circuit wiring for points shall be carried out in looping in system and no joint shall be allowed in the length of the conductors. Circuit wiring shall be laid in separate conduit originating from distribution board to switch board for light/ fan. A light/ fan switchboard may have more than one on a circuit but shall have to be of same phase. Looping circuit wiring shall be drawn in same conduit as for point wiring. Each circuit shall have a separate neutral wire. Neutral looping shall be carried out from point to point of in light/ fan switchboards. A separate earth wire shall be point wiring, Red colour wire shall be used for phase and black colour wire for neutral. Circuit wiring shall be carried out with red, yellow or blue colour FR PVC insulated wire for RYB phase wire respectively and black colour FR PVC insulated wire for the neutral wires. FR PVC insulated copper wire shall be used as Earth continuity conductor and shall be drawn along with other wires. No wire shall be drawn into any conduit until all work of any nature, that may cause injury to wire is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire.

Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust and dirt. Drawing & jointing of copper conductor wires & cables shall be as per CPWD specifications mentioned above.

4.11 JOINTS

All joints shall be made at main switches, distribution board socket and switch boxes only. No joint shall be made in conduits & junction boxes. Conductors shall be continuous from outlet to outlet.

4.12 MAINS AND SUBMAINS

Mains and sub mains cable where called for shall be of the rated capacity and approved make. Every main and sub main shall be drawn into an independent adequate size conduit. Adequate size draw boxes shall be provided at convenient locations to facilitate easy drawings of the submain & main cables. Cost of junction box/ drawn box is deemed to be included in the rates of submain wiring. A independent earth wire of proper rating shall be provided for every submain. Three-phase submain shall be provided with two-earth wire.

Where mains and Sub-mains cables are connected to the switchgear, sufficient extra lengths of submain and mains cable shall be provided to facilitate easy connections and maintenance for termination of cables crimping type cable socket/lugs shall be provided. Same colour code as for circuit wiring shall be followed. The submain wiring shall be inclusive of the termination with crimped cable sockets at both ends.

4.13 LOAD BALANCING

Balancing of circuits in three-phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

4.14 COLOUR CODE FOR CIRCUIT & SUBMAIN WIRING

Colour code for circuit & submain installation shall be Red, Yellow, Blue for three phases. Black for neutral and green only for earth in case of insulated earth wire.

4.15 CLASSIFICATION OF POINTS

Wiring shall be carried out with following sizes of FR PVC insulated stranded single core copper conductor wire /cable.

i.	Light point	-	1.5 sq.mm
ii.	Ceiling/Cabin/Exhaust fan point	-	1.5 sq.mm
iii.	Call bell point	-	1.5 sq.mm
iv.	Plug Point (5 A.S.S. outlet)	-	4.0 sq.mm
v.	Circuit Wiring	-	2.5 sq.mm
vi.	General Power point	-	4.0 sq.mm
vii.	Power Point for A.C. Unit	-	6.0 sq.mm
viii.	Power point for Geyser, Drinking		

Water coolers & hand dryers - 4.0 sq.mm

4.16 TELEPHONE WIRE/ CABLES

Separate conduits shall be provided for internal telephone wiring of telephone system commencing from tag block. Each telephone outlet shall be wired with 2 pair telephone cable from the tag block. All telephone wires shall be of 0.5mm dia or as specified in BOQ annealed tinned high conductivity copper conductor FR PVC insulated & FR PVC sheathed grey conforming to ITD specification SWS 113 B & C. Multiplier FR PVC insulated cables laid in conduit shall be provided for connecting various tag blocks. Telephone cables used for external connections shall be armored. These cables shall be laid directly in ground or in pipe etc. as called for else where.

Following number of 2 pair wires/cables shall be drawn in various sizes of conduits as listed below.

20mm conduit - Upto 3 cables

25mm conduit - more than 3 upto 6 cable

4.17 Maximum number of wires that can be taken in any conduit shall be as per the Table given below:-

FR PVC INSULATED 650/110V GRADE ALUMINIUM/COPPER CONDUCTOR CABLE
CONFORMING TO IS 694-1990

The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25m between draw in boxes and which do not deflect from the straight by an angle or more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.

Conduit sizes are the nominal external diameters.

5.00 LIGHTING FIXTURE AND FANS

5.01 General

- a) All Light fittings, Fans & Fixtures shall be subject to approval prior to its procurement. The contractor shall supply and install lighting fixtures including lamps, tubes starters, accessories fixing hardware necessary for installations, as shown on the Drawings as required and as herein specified.
- b) All fixtures shall be delivered to the building complete with suspension accessories, canopies, hickies casing, sockets, holders, reflectors, ballasts, diffusing material, louvers, plaster frames, recessing boxes etc. all wired and assembled as indicated.
- c) Full size shop detail drawings of special fixture or lighting equipment, where called for in the fixtures schedule shall be submitted to the Engineer for approval.
- d) Fixtures, housing, frame or canopy, shall provide a suitable cover for fixture outlet box or fixture opening.
- e) Fixtures shall comply with all applicable requirements as herein outlined unless otherwise specified or shown on the drawings.
- f) Fixtures shall bear manufacture's name and the factory inspection label.
- g) Fixtures shall be complete wired and constructed to comply with the IEE wiring regulations requirements for lighting fixtures, unless otherwise specified.
- h) Relamping the fixture shall be possible without having to remove the fixture from its place. i) Lamps of the proper type, wattage and voltage rating shall be furnished and installed in each fixture.

5.02 CONSTRUCTION

- a) Fixtures shall be constructed of 0.5 mm thick steel minimum. If other metals are used they shall be of the required thickness to have at least the same mechanical strength. Cast portions of fixtures shall be not less than 1.5 mm thick.
- b) Metal parts of the fixture, shall be completely free from burrs and tool marks. Solder shall not be used as a mechanical fastening device on any part of the fixture. Fixture joints shall be welded and ground smooth.
- c) Fixtures with visible frame shall have concealed hinges and catches.
- d) Recessed fixtures shall be constructed so as to fit into ceiling without distorting either the fixture or the ceiling. Plaster rings shall be provided for plaster ceilings. The Contractor shall coordinate the dimensions with the false ceiling tile dimensions.
- e) Fixtures with hinged diffuser doors shall be provided with spring clips or other retaining devices to prevent the diffuser from moving.
- f) All plastic diffusers shall be of acrylic, unless otherwise noted.
- g) Incandescent fixtures shall be equipped with porcelain medium base with nickel-plated shells.
- h) Fluorescent fixtures shall be provided with white lamp holders.
- i) Industrial type fluorescent fixtures shall have type lamp holders.

5.03 FINISH

- a) All hardware shall be bonderised, cadmium plated, given a corrosion-resistant phosphate treatment of other approved rust inhibiting prime coat, to provided a rust proof base before application of finish. Finish shall be baked enamel.
- b) Non-reflecting surfaces such as fixtures frames and trims, shall be finished with baked enamel paint, unless other-wise specified. The colour of the paint shall be as indicated on the Drawings or as directed later by the Engineer-in charge.
- c) Light reflecting surfaces shall be finished with baked white enamel paint having 3 reflection factor of not less than 855.
- d) All parts of the reflector shall be completely covered by the finish and free from irregularities.
- e) Unpainted surfaces shall be finished with a clear lacquer except for anodized of "Azac" surfaces.
- f) After finish has been applied and cured, it shall be capable of withstanding 1cm radius bend without showing sings of cracking, peeling or loosening from the base metal.
- g) Finish shall be capable of withstanding 72 hours exposure to an ultra-violet RS sun lamp placed 10cm from the surface without discoloration, hardening, or warping and shall retain the same reflection characteristics after exposure.

5.04 WIRING

- a) Fluorescent fixtures shall be wired with not smaller than 1.5 sq.mm asbestos- covered wire. No splice or tap shall be located within an arm, stem or chain. ire shall be continuous from splice in outlet box of the building wiring system to lamp socket or to ballast terminals.
- b) Wiring within incandescent fixtures and for connection to the branch circuit wiring up to the outlet box of lighting point shall not be less than 1.5 sq.mm silicone rubber insulated wire. (150 Deg C temperature).

5.05 INSTALLATION

Fixtures shall be installed at mounting heights as detailed on the Drawings or as instructed on site by the Engineer.

Pendent fixtures within the same room or area shall be installed plumb and at uniform height from the finished floor. Adjustment of height shall be made during installation. Flush mounted recessed fixtures shall be installed so as to completely eliminate leakage of light within the fixtures and between the fixture and adjacent finish.

Fixtures mounted outlet boxes shall be rigidly secured to a fixture stud I the outlet box. Hickeys or extension pieces shall be installed where required to facilitate proper installation.

Fixtures located on the exterior of the building shall be installed with no-ferrous metal screws finished to match the fixtures.

5.06 LAMPS-GENERAL

Lamp shall be supplied and installed in all lighting fixtures listed in the Schedule of lighting Fixtures on the drawings.

Lamps used for temporary lighting service shall not be used in the final lamping of fixture units. Lamps for permanent installation shall not be placed in the fixtures, until so directed by the Engineer-in-charge and this shall be accomplished directly before the building areas are ready for occupancy by the Client.

5.07 LAMPS-FLUORESCENT

Lamps shall be of hot electrodes, preheated, normal start type. Lamps shall have bi-pin bases and a minimum specified rated life.

Unless otherwise indicated on the Drawings, Lamps shall have the colour rendering features and lumens/ watt output of lamps with WHITE colour designation as manufactured by OEM

5.08 LAMPS –INCANDESCENT

Incandescent lamps shall be inside frosted type. Lamps shall have minimum approximate rated life of 750 hours

5.09 BALLAST-FLUORESCENT

- Only single and / or two-lamp ballast shall used in any one fixture. Ballast shall conform to IS 1534 (Part-I) 1977.
- Ballasts shall be high power factor type.
- Ballasts shall have manufacturers lowest sound level and case temperature rise rating. Ballasts shall be special cool operated type.
- Ballasts for indoor fixtures shall be protected by an integral thermal automatic resettling protective unit which shall disconnect the ballast in the event of overheating.
- Ballasts shall be of the same manufacture as the lamps.

5.10 TESTING

After all lighting fixtures are installed and are connected their respective switches, test all fixtures to ensure operation on their correct switch in the presence of the Engineer. All un- operating fixtures or ones connected to the wrong or inconveniently located switch shall be correctly connected as directed by the Engineer.

5.11 CEILING FANS

All ceiling fans shall be provided with suspension arrangement in the concrete/slab/ roof member. Contractor to ensure that provision are kept at appropriate stage all locations shown on the drawing. Fan box with MS hook is to be provided by electrical contractor. Ceiling fan shall be double ball bearing type, copper wound motor complete with canopy, down rod, blades etc. and shall conform to relevant IS standards ceiling fan shall be white in colour. Ceiling fan shall be provided with standard regulator. Regulator shall be suitable for 240 volts A.c. volts A.C supply 50 Hz and shall be of continuous duty type.

5.12 EXHAUST FANS

Exhaust fans shall be heavy-duty type with double ball bearing & conforming to IS 23412-11967. Exhaust fan shall be complete with copper wound motor, capacitor, louvers/ shutter, frame & mounting bracket. Exhaust fan shall be suitable for operation on 240 volts single phase

A.C. supply.

6.00 L.T. CABLES

6.01 GENERAL

LT Cables shall be supplied, inspected laid tested and commissioned in accordance with drawings specifications, relevant Indian Standards specifications and cable manufacturer's instructions. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drums. The recommendations of the cable manufacturer with regard to jointing and sealing be strictly followed.

6.02 MATERIAL

The L.T.Cables shall be XLPE insulated FR PVC sheathed aluminium conductor armored cable conforming to IS: 7098 (part II) 1985. The cable shall be laid directly in ground, pipes, masonry ducts, cable tray surface of wall etc. as shown on drawings.

6.03 INSPECTION

All cables shall be inspected at site and checked for any damage during transit.

6.04 JOINTS IN CABLES

The Contractor shall take care to see that the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoiding of cable joints. The apportioning shall be got approved from Engineer-in-Charge before the cables are cut to lengths.

7.0 RISING MAINS

7.1 The rising mains shall be supplied in convenient sections to suit the building to form a vertical straight run. Each section shall be provided with a number of wall straps preferably one meter apart for fixing the trunking to the wall. It should be provided with front and rear sheet steel cover plates so that it forms a totally enclosed vermin and dust proof metal clad construction of 1.6/2mm thick absolutely flat sheet steel, vermin proof breathers shall be provided in each section to dissipate heat, and to prevent any possibility of an electrical fault due to the presence of vermin.

i). Construction: The bus bars shall be made from rectangular section of high conductivity electrolytic grade aluminum. The current density in the bus bars shall not exceed 1.0 ampere / mm². Neutral bar shall have cross section equal to phase bars. In each vertical run the bus bars shall rest rigidly on a thrust pad at the bottom thereby allowing expansion of the bars upwards. Suitable expansion joints shall be provided. Top of the mains shall be closed by a suitable blank end cover. It must be possible to extend the mains at a later date.

ii). Adapter boxes and tap off boxes shall be provided on rising main enclosure to tap TPN connections of ratings specified in schedule. These shall be without MCCB fitting and shall be provided with detachable end plates with provision of rectangular holes for solid aluminum strip connections (insulated with colored insulating tape or strip to distinguish each strip) to I/C MCCBS fixed on rising mains.

iii). Wherever rising mains pass through floors, a fireproof barrier shall be provided.

Iv). Provision shall be made to ensure earth continuity between adjacent sections and for earthing the complete run of each rising main.

V). Ratings: The rising mains shall be of 400 amp standard ratings for normal supply Bus bars shall be individually insulated with red, yellow, blue and black insulating sleeves to indicate phased and neutral.

vi). Metal Treatment : The sheet steel parts shall be given a rigorous rust proofing treatment which shall comprise alkaline degreasing, descaling in dilute sulphuric acid and a phosphating process followed by two coats of filler oxide primer and one coat of paint of approved shade. Final coat of paint shall be applied just before erection.

7.2 ERECTION OF RISING MAINS

i). The rising main sections shall be thoroughly examined and cleaned before erection. The rising mains shall be erected in straight vertical line. Position of anchoring points on the wall shall be accurately marked and 10mm dia G.I rag bolts shall be grouted to a depth of 75mm into the wall. All nuts shall be G.I and hexagonal. Spring steel washer shall be fixed under each nut.

ii).All sections of the rising main shall be so fixed that there is no mechanical strain on them. Electric connection between bars and earth continuity of the enclosure shall be ensured between sections.

iii).Any damage to the bars or the enclosure / chamber of a section shall be made good to the entire satisfaction of consultant before such section is re-erected.

iv).The upper end of the rising mains shall be fixed with blanking off cap.

v).The adapter boxes to tap the rising mains shall be fixed so that contacts on the adapter make a sound connection with the bars, and adapter cover is intimately connected to the rising mains chamber to ensure earth continuity. The height at which adapters are fixed on the rising mains above the floor level shall be such that solid strip connections from adapters to I/C switch fuse units fixed on the rising mains are as direct and as short as possible subject to approval of the consultant.

vi).All steelwork shall be made rust free anti painted with two coats of oxide paint followed by two coats of enamel paint of approved shade.

8.0 UNDER GROUND L.T CABLES

8.1 GENERAL

MV cables shall be supplied inspected laid tested and commissioned in accordance With drawings, specifications, relevant Indian Standards Specifications and cable Manufacturer's instructions. The cable shall be delivered at site in original drums with Manufacturers name clearly written on the drum. The recommendation of the cable manufacturer with regard to joining and sealing shall be strictly followed.

8.2 MATERIAL

The MV cable shall be FR PVC insulated Aluminum conductor armored cable conforming to IS:1554-1988(Part-I) laid in trenches/ ducts as shown on drawings.

8.3 All cables shall be inspected upon receipt at site and checked for any damage during transit.

8.4 JOINTS IN CABLES

The contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoidance of joining cables. This apportioning shall be got approved by the Client/Construction Manager before the cables are cut to lengths strait joints are prohibited.

8.5 LAYING CABLES

Cables shall be laid by skilled and experience workmen using adequate rollers to minimize stretching of the cables. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks the drums shall be unrolled and cables run over wooden rollers in trenches at intervals no exceeding 2 meters. Cables shall be laid at depth of 0.7 meters below ground level. A cushion of sand, not less than 80mm shall be provided both above and below the cable and joint boxes and other accessories. Cable shall not be laid in the same trench or along side a water main. The cable shall first be laid in excavated trench

80mm layer of sand and shall be spread over the cable. The cable then shall be lifted and placed over the sand bed. The second layer of 80mm sand shall then be sprayed over the cable. The relative position of the cables, laid in the same trench shall be preserved and the cables shall not cross each other as far as possible at all changes in directions in horizontal and vertical planes, the cable shall be bent smooth with a radius of bend not less than 12 times the diameter of cable, minimum 3 meters long loop shall be provided at both sides of every straight joint and 3 meters at each end of cable. Distinguishing marks shall be made on the cable ends for identification. Insulation tapes of appropriate voltage and in red, yellow and blue colour shall be wrapped just below the sockets for phase identification.

8.6 PROTECTION OF CABLES

The cables shall be protected by bricks on the top layer of the sand for the full length of underground cable. Where more than one cable is running in the same trench, the bricks shall cover all the cables and shall project a minimum of approximately 80mm on either side of the cables. Running them through Hume Pipes of suitable size shall protect Cables under road crossings and any other places subject to heavy traffic. The depth of the Hume Pipe shall be 1 meter below the finished floor level

8.7 EXCAVATION AND BACK FILL

All excavation and back fill including timbering, shoring and pumping required for the installation of the cables shall be carried out by the Contractor in accordance with the drawings and requirements laid down

elsewhere. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layer not exceed 150mm. Each layer shall be properly rammed and consolidated before laying the next layer. The contractor shall restore all surface, road ways, side walks, curbs, walls of other works cut by excavation to their original condition, satisfactory to the owner's representative.

8.8 TESTING OF CABLES

Prior of burying of cables, following tests shall be carried out :

- a). Insulation test between phases and phase and earth for each length of cable before and after jointing. On completion of cable laying work, the following test shall be conducted in the presence of the owner's representative.
- a). Insulation resistance test (sectional and overall)
- b). Continuity Resistance Test c). Sheathing continuity test
- d). Earth test

All tests shall be carried out in accordance with relevant Indian Standard Code of Practice and Indian Electricity Rules. the contractor shall provide necessary instruments, equipment and labour for conducting the above test and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Client/Construction Manager / Consultant.

9.0 EARTHING

9.1 GENERAL

All the concurrent metal parts of electrical installation shall be earthed properly. All material conduits trunking, switchgear, distribution boards, switch boxes, outlet boxes, and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. Earthing work shall conform to CPWD General Specifications for Earthing work shall conform to internal –

2005 and Indian Electricity Rules 1956 amended upto date and in the regulations of the local Electricity supply authority.

9.2 Earthing Conductor

Earth continuity conductor along with submain wiring from Main/Sub Distribution boards to various distribution boards shall be of copper. Earth continuity conductor from distribution board onward upto outlet points shall also be of bare copper. Earth continuity conductor connecting Main and Sub Distribution boards to earth electrode shall be with galvanized MS strip.

9.3 Sizing of earthing conductor

All fan regulator, 5 and 15 Amp outlet points, switch boxes shall be earthed with earth wire as specified in bills of quantities. Separate earth wire shall be drawn along with each circuit. From main/sub distribution board to distribution board, earth continuity conductor shall be as mentioned in bills of quantities. Single phase distribution boards shall have one earth continuity conductor while three phase distribution board shall be provided with two earth continuity conductors. Earthing of main switch board and sub-switch boards shall be earthed with two independent earth electrodes or as indicated elsewhere. Earth conductor laid in ground shall be protected for mechanical injury and corrosion by providing GI pipe.

GI pipe shall be of medium class 40mm dia and 4.5 meter in length or as specified in bills of quantities. Galvanizing of the pipe shall conform to relevant Indian Standards.

GI pipe electrode shall be cut tapered at the bottom and provided with bores of 12mm dia drilled not less than 7.5cm from each other upto 2 meter of length from bottom. The electrode shall be buried in the ground vertical with its top not less than 20cm below ground level as per detail enclosed. Earth electrode shall not be situated less than 2 metres from the building. The location of the earth electrode will be such that the soil

has reasonable chance of remaining moist as far as possible. Masonry chamber of size 300 x 300 x 300mm shall be provided with water funnel arrangement a cast iron or MS frame and cover having locking arrangement at the top.

9.4 Plate Earth electrode

Earthing shall be provided with either GI plate electrode or copper plate electrode of following minimum dimension.

- i). GI Plate electrode : 600mm x 600mm x 6mm thick
- ii). Copper plate electrode : 600mmx600mmx 3mm thick

The electrode shall be made buried in ground with its faces vertical and not less Than 3 meters below ground level. 20mm dia medium class GI pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided on the top of this pipe for watering and earth electrode. Earth electrode the Watering funnel attachment shall be housed in masonry enclosure of not less than 300x 300x300mm deep. A

cast iron or MS frame with cover having locking arrangement shall be provided at top of meters from the building care shall be taken that the excavation for earth electrode may not affect the column footing or foundation of the building. In such cases electrode may be further away from the building. In such cases electrode may be further away from the building.

9.5 Artificial Treatment of Soil

If the earth resistance is too high and the multiple electrode earthing does not give adequate low resistance of earth, then the soil resistivity immediately surrounding the earth electrodes shall be reduced by addition of sodium chloride calcium chloride, sodium carbonates copper sulfate, salt and soft coke or charcoal in suitable proportions.

9.6 Resistance to earth

The resistance to earthing system shall not exceed 2 ohm

10.0 Drawing / Procurement & Inspection of Equipment

10.1 Based on the tender drawings and the equipment / scheme finally selected, the contractor shall supply layout, cable line diagrams etc. required for the satisfactory and complete installation of the total electrical power supply and distribution system as envisaged in the tender. Some of the important drawings / details to be submitted for approval are given below:

- a). General arrangement drawings of switchgear, panels ducts etc.
- b). Wiring diagram, schematic diagram and control diagrams for equipment, Switchgear, PCC and the whole system. Schedule and termination details Shall also be provided.
- c). Building plan, elevation / section and details including the layout of plant, equipment, switchgear, bus-ducts and related services like chimney, cooling systems, fuel handling system etc. with dimensions based on the equipment finally selected.
- d). Details of all foundations, cable ducts, cable protections pipes and other civil works e). Complete schedule of LT cables and instrument/ control cables
- f). Layout plan showing the co-ordinates routing for power cables, control / instrument cables and other cables as required, co-ordinated with other services like water supply line, drainage / sewerage line, fire lines, mechanical service pipe line etc. The sectional details, road-crossing details etc. shall also be given at different locations.
- g). Technical catalogue for all equipment, switchgear, cables & material including a complete write up/details of operation, interlocks & controls etc.
- i). Operation and maintenance manuals along with list of spare parts for all equipment. Switchgear cables and materials etc.
- k). A detailed explanatory note giving the details of operational sequence, time period and safety aspects etc,

10.2 Procurement & Inspection of Equipment

Approved list of makes and vendors are given at Annexure 'A'. The ENC reserves the right to check and verify makes of equipment/materials supplied shall be strictly as mentioned therein. For items not specially mentioned, prior approval shall be taken before procurement of the same all equipment's materials supplied shall be brand new and shall be procured directly from the manufacturers dealers or authorized agents. Engineer- In-charge shall have access to the manufacturer's premises for stage inspection/final inspection of any item during its design, manufacturing, assembly testing. After carrying out the necessary factory tests and routine tests as per IS Standards, a copy of the routine test certificate shall be forwarded alongwith the call for carrying out the inspection at the manufacturer's work.

Based on the inspection certificate, Engineer- In-charge reserves the right to carry out the inspection at mutually agreed date and/or give inspection waiver. A minimum of two weeks will be needed after receipt of complete shop inspection report and other details to depute our inspector for inspection.

CHAPTER-10- ROAD WORKS

- A. Work shall be carried out as per the Ministry of Road Transport and Highways (MORT & H) Specification. Specification for Road and Bridges works (5th revision).
- B. For items whose specifications are not given in MORT&H specifications for road and bridge works, then State PWD Specification, BIS specification or sound Engineering practice, as determined by the Engineer in that order should be followed.
- C. Technical and General conditions given in document shall also be followed as particular specification certain conditions regarding street lighting shall also be followed.

TECHNICAL CONDITIONS

- 1. A register in prescribed form showing day to day receipt, consumption and balance of cement at site of work will be maintained at the work/test site by the department, which shall invariably be signed by the contractor or his authorized representative in token of its correctness.
- 2. A field lab, at his own cost will be established by the contractor at site of work and all the required equipment including cube testing machine of suitable quality **and consumable** shall be provided by the contractor as required for various quality control tests subject to approval of Engineer-in-charge. Nothing shall be payable to the contractor towards equipment/day to day expenditure. Technical staff will belong to the Deptt. and ministerial staff shall be supplied by him
- 3. Strict control on all operations of work shall be exercised to ensure that the work is of the proper as envisaged in the specifications and design. Although the tests to be performed for quality control and their minimum frequency will be in accordance with accepted norms, in which respect the MORT & H specifications for road and bridge works latest Edition will be referred to.
- 4. For testing of materials for bridge construction, relevant I.S specification shall be referred to and department will have the discretion to get the sample tested from the reputed testing Laboratory. Testing charges shall be borne by the agency.
- 5. For testing the strength of the finished products like cement concrete, masonry, bearing and also the workmanship to be ensured in the various construction works of bridges, reference shall be made to the relevant clauses of IRC bridges codes.
- 6. The frequency of testing shall generally conform to what has been stipulated in the codes, but this shall be increased beyond the stipulated minimum frequency, if frequent deficiencies in quality of works are noticed in particular location by the Engineer.
- 7. Proper and pucca reference pillars for fixing the longitudinal center line of the bridge and transverse center lines of the piers shall be made before starting the work. The main point about these reference pillars is that they shall be so located as not to be disturbed during construction or during floods and shall last till the work is completed.
- 8. To have proper control on the proportion of various aggregates of cement concrete mix, weight batching instead of volumetric batching shall be adopted.
- 9. Where the concrete has been specified in terms of strength, the concrete mix shall be specifically designed and contractor shall satisfy Engineer-in-charge through laboratory test results that the concrete is of specified strength and quality, ensuring at the same time that the concrete mix so designed is no leaner than a nominal mix, if same has been specified.
 - a. The job mix formula/Mix designed for CC work, etc. will be done from IIT/NIT/NABL Accredited Labs
- 10. The following basic records, in addition to what might be considered necessary, shall be kept at site and be made available to the inspecting officers.
 - a. Record of placement of concrete and test cubes shall be maintained in the following form:

Date	Time of Start	Time of Completion	Unit/Member concreted	Bulking of sand if any	Extra sand used to take care of bulking
1.	2.	3.	4.	5.	6.
Water Cement Ratio Mix 7.					
Water content of coarse aggregate	Water contents of fine aggregate	Extra water added	Total water content	Water cement ratio	
(i)	(ii)	(iii)	(iv)	(v)	
Slump of concrete	Sources of supply of cement and batch No.	Whether the batch of cement tested or not	Identification number of concrete cube taken	7 days cube Strength as specified as per actual test	
8.	9.	10.	11.	12.	
28 days cube Strength as specified / as per actual test	Sign of J.E.	Sign of SDE	Sign of Contractor	Remarks of Engineer-in-Charge.	
13.	14.	15.	16.	17.	

- b. Record of test for controlling the quality of concrete such as grading, analysis of Aggregates, silt content of fine aggregates, water content of fine aggregates, water content of coarse aggregate etc.
- c. Record of test results on samples of mild steel. For steel, high tensile steel.
- d. Record of cement tests for different consignment/batches/sources of supply. e. CPM/PERT chart, original and as revised/updated.

MATERIALS AND WORKS TEST REGISTER.

1. A register on prescribed proforma showing test results of materials and work tests will be maintained at the site of work by the department and every entry there of, shall invariably be signed by the contractor or his authorized representatives in token of its correctness.
2. Concrete of any mix ordinary or controlled shall be regularly tested as per Indian Roads Congress (IRC) standard and only such concrete will be accepted which conforms to the standards laid down in IRC 21-2000 standard specifications and code of practice for roads and bridges. The concrete declared below standard by the Engineer shall be replaced by the contractor simultaneously taking care of safety and soundness of other members or adjoining part of the same member entirely at his own risk and cost.
3. Whenever test cubes are taken these should be suitably numbered and there should be corresponding markings on the individual components, or portions of the components to enable the identification of the unit from which the sample for test cubes was obtained. In this respect, for all the bridge works on the National Highways, a new register should be regularly entered. A span should be designate by mark 'S' and the number below it shall indicate the number of span and the beams should be designated by mark 'B' and should be numbered as 1,2,3 from the up-stream end. Thus the marking as S4, B3 will indicate that this pertains to the span No. 4 from left side while facing downstream side and beam No. 3 from the up-stream side. The cubes should also be serially numbered in the register.
4. The sampling of the concrete and testing of cubes should be done with the full knowledge of the contractor and the signatures of contractor or contractor's representative should be taken in the space specified for it.

5. Whenever the result of the cube tests carried out after three or seven days show a strength, which is not satisfactory, the Engineer of the bridge work should draw the attention of the contractor in writing to the possibility of the concrete not attaining the prescribed standards at the end of 28 days. He may also be warned not to proceed further with the work as the 28 days strength of concrete may show sub- standard results. Another notice should be given to the contractor if the prescribed standard strength has not been attained. The unit of which the sub-standard work forms part becomes liable to rejection.
6. When the cube tests persistently point to a concrete strength lower than that specified, a change in the proportions of concrete for subsequent batches must be given serious thought.
7. In case, however, the concrete strength falls below the required designed strength but its use can be permitted under IRC-21 -2000 of the IRC Bridge code section-iii, the unit may be accepted at the discretion of the Engineer and the information that it complies with the code should be placed on record in the remarks column of the register after obtaining the approval of the Superintending Engineer.
8. For all works concrete shall be mixed in a mechanical mixer which along with other accessories shall be kept in first class working conditions and so maintained throughout the construction, Mixing shall be continued till materials are uniformly distributed & uniform colour of the entire mass is obtained and each individual particle of the course aggregates shows complete coating of mortar containing its proportionate amount of cement. In no case shall mixing be done for less than two minutes after all ingredients have been put into the mixer.
9. Works strength tests shall be made in accordance with IS-516. Each test shall be conducted on ten specimens, five of which shall be tested at seven days and the remaining five at 28 days. The samples of concrete shall be taken on each day of concreting and cubes shall be made at the rate of one for every 5 cubic meters of concrete or a part thereof, however, If concreting done in a day is less than 15 cubic meters the minimum numbers of cubes can be reduced to 6 with specific permission of the Engineer.
10. Similar works tests shall be carried out whenever the quality and grading of materials is changed irrespective of the quantity of concrete poured. The number of specimen may be suitably increased as deemed necessary by the Engineer when procedure of tests given above reveals a poor quality of the concrete and in other special cases.
11. Acceptance criteria of the concrete will be as per the provisions of IRC 21-2000.
12. Design mix concrete shall be designed on the basis of preliminary test, in accordance with IRC
13. 21-2000. The proportions for ingredients chosen shall be such that concrete has adequate workability for the conditions prevailing of the work in question and can be shown to the satisfaction of the Engineer that supply of properly graded aggregate of uniform quality can be maintained till the completion of the work. Grading of aggregates in different sizes and blending them in the right proportions, as required **should be carried out**.
14. Steel reinforcement shall be protected at all times from injury when placed in work. It should be free from scale, paints, oil or other substance. All rust and scale, should be removed and cleaned by a satisfactory method to the approval of the Engineer. All steel reinforcement shall be accurately placed in position as shown in the drawings and firmly held during the placing and setting of the concrete. When splicing of reinforcement is necessary, the splices shall be staggered as far as possible subject to approval of Engineer-in-charge. The bars shall be lapped accurately in accordance with the codal provisions. Welding of reinforcement steel shall not be resorted to unless approved by the Engineer, in exceptional cases.
15. All material brought by the contractor to the site of work shall be open to suitable tests by the Engineer in accordance with the approved method. The contractor shall afford all such facilities as the Engineer may require for collecting and forwarding all such samples and shall hold the material represented by the sample until tests have been made and material found as per standard. The contractor will supply the material approved by the Engineer and the cost of testing charges will be borne by the agency.
16. The contractor shall supply to the Engineer concrete cubes free of cost and in sizes and quantity as provided for in IRC-21-2000 during the execution of the work. All expenses incurred in respect of preparation and testing of specimen, whether at the work site in the laboratory including carriage

to and from etc shall be borne by the contractor. The samples will be taken by contractor in the presence of an authorized representative of the Engineer.

17. 43 grade O.P.C ISI marked cement approved by Engineer shall be used confirming to IS:8002
18. For reinforcement steel Fe-500 grade TMT Bars conforming to relevant IS code shall be used.
19. Agency will produce to the Engineer, the originals bills of cement and steel etc. in token of proof purchase of material along with quality control test certificate of manufactures.
20. Agency will get the material tested from any laboratory (approved) as directed and whenever required by Engineer and all liability of testing shall be borne by the agency.
21. Bitumen, Cement and steel shall be arranged by the agency.

ADDITIONAL CONDITIONS

1. Before laying any construction layer of GSB, sub grade or base course, earth work on berms, if it is to be done by the agency against this agreement, should be completed in all respect simultaneously. Before taking work of any next layer, earth work on berms should be completed. Payment of any layer will be released only when earth work on berms are completed.
2. No compensation for any damages caused to the earthwork by rains, floods or any other natural calamities shall be paid to the contractor. The contractor shall have to make good all such damages at his own cost as per direction of Engineer.
3. The final payment of the tenderer will not be paid until and unless he furnishes to the satisfaction of the Engineer, proof from revenue authority that the price of earth used for the work having been fully paid to the owner of the land from which the earth was removed by the contractor from his (owner) land for the work and to indemnify against all the losses, damages, cost of land expenses which the Govt. suffer or incur as a result of such claim.
4. The earthwork has to be carried out in continuous stretches according to the directions of the Engineer.
5. Level should be taken and entered in measurement book before commencing the work at an interval not exceeding 15 meters and after finishing the work complete in all respect as per MORT&H specification. The finished work will be checked longitudinally as well as in cross section for computing the quantity of earth work as per Clause No. 113.3 of MORT&H (road wing) specification (4th revision) or 2001/latest edition
6. The contractor shall make arrangement at his own cost for at least two numbers of modern leveling instruments (wild type) for the purpose of carrying out leveling operation failing which the same shall be arranged by the Engineer at his risk and cost.
7. The agency to whom the work is allotted will have to produce original vouchers for all quantities in lieu of purchase of bitumen from refinery, steel, cement and bricks from the original manufacturer or other authorized dealers / distributors to the entire satisfaction of the Engineer for ascertaining the genuineness of material. Attested copy of voucher will have to be submitted along with bills.
8. In case of embankment with Fly Ash, the contractor shall take special care to keep the surface wet at all times so that the Fly Ash does not get mixed up with the atmosphere thus causing poor visibility besides health hazards. If the contractor does not comply with this provision, the Engineer shall make necessary arrangement after giving appropriate notice to the contractor, for keeping the fly ash surface wet and the contractor shall pay the expenses incurred on demand or otherwise the same shall be recovered by Engineer from bills due to the contractor.

ADDITIONAL CONDITIONS FOR BITUMINOUS WORK

1. The contractor will quote the rate of Bitumen Macadam item with 3.4% of Bitumen contents for upto 75mm thick and 3.3% for 80mm to 100mm thick by weight of total mixture. Nothing extra will be paid if Job Mix formula warrants more bitumen contents. If density as per Job Mix formula comes out to be less than 2.2gm/CC, rate will reduce accordingly & if is more than 2.2gm/CC nothing extra will be paid.
2. The contract unit rate for SDBC item shall be as specified in Clause 507.9 of MoRT&H specification (4th revision), except that the rate shall include the provision of bitumen @ 5.0 percent, by weight of total mixture. Nothing extra will be paid if job mix formula warrants more bitumen contents. If density was per Job Mix formula comes out to be less than 2.29gm/CC, rate will reduced accordingly & if is more than 2.29gm/CC nothing extra will be paid.
3. The contract unit rate for DBM item shall be as specified in Clause 505.9 except that the rate shall include the provision of bitumen content @ 4% for 75mm to 100mm thick DBM and 4.5% upto 75mm thick by weight of total mixture. Nothing extra will be paid if job mix formula warrants more bitumen contents. If density as per job mix formula comes out to be less than 2.30 gm/CC, rate will be reduced accordingly and if it is more than 2.30 gm/CC nothing extra will be paid.
4. The contract unit rate for BC item shall be as specified in Clause 507.9 of MoRT&H specification (5th revision), except that the rate shall include the provision of bitumen @ 5.4 percent for 30-40mm thick and 5.2% for 50mm thick, by weight of total mixture Nothing extra will be paid if job mix formula warrants more bitumen contents. If density as per job mix formula comes out to be less 2.30 gm/CC, rate will be reduced accordingly and if it is more than 2.30 gm/CC nothing extra will be paid.
5. The agency to whom the work is allotted will have to produce original vouchers for all quantities in lieu of purchase of bitumen from refinery steel, cement, and bricks from the original manufacturer or other authorized dealers/distributors to the entire satisfaction of the Engineer for ascertaining the genuineness of material. Attested copy of voucher will have to be submitted along with bills.
6. The documentary proof of procurement of bitumen from refinery as per requirement prescribed in the MORT&H specification/technical note of MORT&H and IRC special publication No. 53 from the reputed source and test result from CRRI will be produced by the agency.
7. The Job mix formula will be got tested IIT/NIT/NABL Accredited Testing Labs and testing charges will be borne by the agency. Nothing shall be paid on this account.
8. After filling the depression of the existing road surface and before applying tack coat, the existing levels of the road, surface and after construction shall be taken jointly by the authorized representative of the contractor and Engineer at grid of point at 10 mtrs. Centre to centre longitudinally in straight reaches but 5 meter at curves as per Clause No. 113.3 of MORT&H specification. The cubic contents of the mix laid compacted and finished shall be computed on the basis of the initial and final levels as per formula approved by the Engineer.

The contractor shall provide, install, maintain and operate at his own cost in good working condition a weigh bridge of suitable capacity at site of the hot mix plant under the direction of Engineer or his representative.

Each truck before loading of the mix shall be weighted on the weigh bridge and its weight shall be recorded in the measurement book under the signature of authorized representative of the contractor and of the Engineer. The truck shall be again be weighed on the weight bridge after loading of the mix and its weight recorded as per prescribed proforma.

The volume shall then be worked out by dividing the weight of the mix laid on particular stretch of the road with average field density of the very particular stretch. For this purpose the average density for the stretch shall be determined by the actual determination of field density by core cutter method. The test will be carried out at the rate of minimum of one test per 700 sqm area as prescribed in MORT&H specification.

For purpose of payment, volume worked out by actual levels as laid down in para 8 (a) and determination of volume by density methods as per Para (b) and theoretical volume with designated thickness and area will be considered and the lowest value of the three shall be adopted.

In case the contractor/Engineer feels that there are substantial undulation at site and additional material is to be consumed on account of this and if there is a provision in the estimate undulation/leveling course, the contractor will submit a case/claim to the Engineer with for full justification along with supporting data i.e. leveling/surveying done at site etc. before execution and Engineer will get the same approved from Employer before execution.

9. Unloading of bitumen at plant site will be done in the presence of representative of Engineer. The day to day receipt and issue account of bitumen shall be maintained by the representative of Engineer and signed daily by the contractor or his authorized representative on the performa appearing on subsequent pages.
10. The Hot Mix Plant will be so located subject to the approval of the Engineer involving such lead in transportation of the mix so as to avoid its segregation and temperature drop beyond specified limits. The maximum lead should not be more than 25 km.
11. The contractor shall carry out the survey of existing road and submit the proposal for improvement of riding quality including the existing level and final level at his own cost and shall get it approved from the concerned Superintending Engineer in writing before commencing the work.
12. When the work under one agreement is being executed, the contractor shall not undertake any other work from same hot mix plant without written permission of the Engineer and shall also make separate arrangement of bitumen for that work.

PEB WORK

BASIC BUILDINGS DESCRIPTION :

Sr. No.	Primary Processing Centre	
1	Frame type	Clear –rigid frame
2	Width	As per Drawing
3	Length	As per Drawing
4	Eave height	As per Drawing
5	Bay spacing	As per Tender Drawing
6	Bracing	CROSS ROD BRACING + PORTAL BRACING
7	Roof Sheeting	Supply, fabricate and erect roofing with galvanized sheet(pre-painted AL-Zn alloy colour coated steel)(0.5mmTCT) flashing with profiled support system including fixtures and fastenings as per drawing and specifications
8	Wall cladding	Supply, fabricate and erect roofing with galvanized sheet(pre-painted AL-Zn alloy colour coated steel)(0.5mmTCT) flashing with profiled support system including fixtures and fastenings as per drawing and specifications
9	Insulation	Fibreglass insulation having thickness 50 mm with MS wire mesh facing reinforced aluminium foil having density 16 Kg/Cu.m
11	Turbo Ventilators	600mm. Dia, stainless steel with ball bearing
13	Cage ladder	2 No.
14	Roll up door Manual	As per Drawing
15	Load Considerations	The load considerations of the Refrigeration components, hanging loads, docks, all other applicable loads are also to be considered.
16	Minimum Structural Steel	40 MT (Bidder must design the PEB with all applicable, vet and submit the PEB design after successful vetting)

*For further detail kindly refer the Tender drawings.

- Profiled Eaves Gutters shall be Considered
- Downspouts shall be Considered, up to FFL
- Column & roofing structure so designed shall not allow pigeon sitting (to avoid Pigeon / Birds habitation.)
- Painting Includes Two coats of synthetic enamel on site & one coat red oxide at factory to all primary & secondary members.
- Cage ladder with a small platform at top to go up to the roof for maintenance.
- All structural steel members shall be made free from rust, grease / grime, welding wastes, sharp edges using polishing & shot blasting and immediately spray painted using one coat of zinc chromites antirust primer and Two coats of synthetic enamel oil paint It shall be the responsibility of the contractor to get the shade of paint approved from employer at appropriate time.
- Spacing of purlins to support Roofing sheets shall not be more than 1.2m c/c
- Gutters, gable ,corner flashing shall be profiled and adequately sized, box shaped and shall be made out of 26 G profiled colour coated galvanized steel.
- Bidders to provide option of using screw less, continuous, joint less, crimping type sheeting.

- **SPECIFICATION OF MATERIALS**

- Built Up Members: Grade 50 confirming to ASTM A572 materials having min. yield stress of 345N/mm².
- HOT ROLLED Members: IS 2062 Grade A.
- Web to flange welds of Built Up members are Single side fillet welds by continuous automatic
- SAW process, unless noted otherwise except for crane beams(Double side weld)
- All primary members shall have at least one welded splice.
- Secondary: Light gauge cold formed sections having min. yield stress of 345 N/mm² .
- Anchor bolts, Brace or Sag Rods: Material having min. yield stress of 240 N/mm²..
- Bolts and Nuts : High tensile conforming to ASTM A-325M for primaries and ordinary ASTM A307M for Secondary.
- Sheeting conforming to ASTM A792M (or) AS1397, Coating AZ150.For Trapezoidal Y.S 550 N/MM²,
- **Primary Built up members :**
- Cleaning: Sweep Blasting
- Primer: 1 coat of Red Oxide DFT 30 microns
- The Anchor Bolts shall be Black Steel.
- Secondary Cold Formed members shall be 120GSM
- **ROOF SHEETING**
single skin Galvalume 26g painted Galvalume
- **WALL SHEETING**
single skin Galvalume 26g painted (STD Color)
- Insulation Fibreglass 50mm thk. 16 Kg/m³ density with Aluminium facing for roof area.

1. BUILDING ADDITIONS: NA

2. STANDARD PRODUCT SPECIFICATIONS

A Standard System shall be made up of primary members, secondary members, connections, roof sheeting, wall sheeting, sheeting fasteners, sealer, closures, ridge caps, flashing and trim, gutters and downspouts.

PRIMARY MEMBERS:

Primary structural framing shall include the transverse rigid frames, lean-to-rafters and columns, canopy rafters, interior columns (beam and column frames), bearing frame rafters and corner columns and end wall wind columns.

SECONDARY MEMBERS:

Secondary structural framing shall include the purlins, girts, eave struts, wind bracing, flange bracing, base angles, clips and other miscellaneous structural parts.

PAINT OF STRUCTURAL MEMBERS:

All structural members shall be cleaned by wire brushing to remove dirt, grease, oil and loose mill scale and given one shop coat of red oxide, air drying & two coats of synthetic enamel on site.

CONNECTIONS:

All field connections shall be bolted (Unless otherwise noted). Primary bolted connections shall be furnished with high strength bolts conforming to the physical specifications of ASTM A325 (or equivalent). Secondary bolted connections shall be furnished with machine bolts

PHYSICAL SPECIFICATIONS OF STRUCTURAL MEMBERS:

Members fabricated from plate or bar stock shall have flanges and webs joined on one side of the web by a continuous welding process and will conform to the physical specifications of ASTM A 570 (Grade 50) or equivalent and having a minimum yield strength of 50,000 P.S.I. (345 MPa). Members fabricated by cold forming process shall conform to the physical specifications of ASTM A570 (Grade 50) or equivalent and having a minimum yield strength of 50,000 P.S.I. (345 MPa). Members fabricated from hot rolled structural shapes shall conform to the physical specifications of ASTM A572 (Grade 36) or equivalent and having a minimum yield strength of 36,000 P.S.I. (250 MPa). Rod and angle bracing shall conform to the physical specifications of ASTM A36 (or equivalent) and having a minimum yield strength of 36,000 P.S.I. (250 MPa). Roof and wall cladding shall conform to the physical specifications of ASTM A 653 (or equivalent) and having a minimum yield strength of 50,000 P.S.I. (345 MPa). All other miscellaneous secondary members shall have minimum yield strength of 36,000 P.S.I. (250 MPa).

ROOF SHEETING / WALL SHEETING :

BASE METAL:

Providing and fixing trapezoidal profile sheeting having high crest height of 28mm at 196mm c/c with a cover width of 980mm. In between the two crests there are two additional small ribs to provide extra strength to the sheet. The side lap is provided with anti-siphoning flute for perfect water tightness.

The base steel shall be Bare / Colour coated Galvalume / Zinalume steel, made out of 0.50mm TCT (Total Coated Thickness) having tensile strength of 550mpa. The steel will have a metallurgical coating of 150gsm of aluminium and zinc alloy (both sides inclusive) comprising of 55% aluminium + 43.5% zinc + 1.5% silicon as per ASTM A-446 Grade E / ASTM A-792 OR AS: 397.

The profiled sheets shall be supplied up to 12 Mt long in single sheet to minimize the longitudinal joints.

COLOUR COATING :

The organic coating will consist of 20 - 25 microns of Silicon Modified Polyester / Super polyester paint inclusive of 5 - 7 microns of corrosion inhibiting primer. The reverse side will be as per manufacturer's standard backer coat.

SHEETING FASTENERS :

Standard fasteners shall be No. 14, Type A, self tapping sheet metal screws with metal and neoprene washers. All screws shall have hexagonal heads and made of zinc plated steel. Fasteners to be used will be self-drilling self- tapping type of the best quality as per AS-3566 Class 3 approved, which should compatible to be used with Galvalume / Zinalume steel sheets.

SEALER / ROPE SEAL :

This is to be applied around Skylights and self flashing windows. Sealer shall be 6mm wide x 5mm thick, asbestos fiber filled pressure sensitive Butyl tape. The sealer shall be non asphaltic, non shrinking non drying and non toxic and shall have superior adhesion to metals, plastics and painted surfaces at temperatures from - 51 deg. 'C' to + 104 deg. 'C'.

CLOSURES / FILLER STRIPS :

Solid or closed cell E.T.P. (Ethylene Polypropylene Terpolymer) closures matching the profile of the panel shall be installed along the eaves, rake and other locations specified on LCPL drawings.

RIDGE CAP:

A formed panel matching the material color, slope and profile of adjoining Kolor Metal roof panels.

FLASHING AND TRIM :

Flashing and/or trim shall be furnished at the rake, corners, and eaves, framed openings and wherever necessary to provide weather tightness and finished appearance. Color shall be white for rake and eave flashings and color of wall for corner flashings unless otherwise specified by client. Material shall be 26 G thick conforming to the physical specifications of ASTM A446 Grade C or equivalent and having minimum yield strength of 36,000 P.S.I. (265 MPa). These shall be formed out of the same substrate and corresponding thickness as that of the roofing / cladding sheets and shall be supplied in standard lengths of 2.5mm or as directed in the required shapes and girths and fixed by means of hex-head mechanically galvanized stitching screws with EPDM washers.

EAVE GUTTERS AND DOWNSPOUTS:

Eave gutters shall be box shaped, color coated, and 0.5mm nominal thickness (26 gauges) galvanized steel. The outside face of the gutter shall be supported with color coated 0.5mm nominal thickness (26 gauges) galvanized straps to the eave member at a maximum spacing of 3m. Downspouts shall be rectangular shaped, color coated 0.5mm nominal thickness (26 gauges) galvanized steel. Downspouts shall have a 45 degree elbow at the bottom and shall be supported by attachment to the wall covering at 3.0m maximum spacing.

STRUCTURAL FASTENERS:

Primary structural connections are made with electro galvanized (silver) high strength bolts Gr. 8.8 steel conforming to IS 3757. Purlins & girts are connected to their supporting members by machine bolts Gr. 4.6 steel conforming to IS 1363 electro-galvanized (yellow). Anchor bolts are made of rods conforming to ASTM F1554 with minimum yield strength of 250 MPa. Roof & wall panels are fastened by No. 12 carbon steel self-drilling screws hot-dip galvanized with polymer coated finish with an integral washer head to which an EPDM Elastomeric layer is bonded.

POLYCARBONATE SHEET.

- **Impact Strength**

The impact strength of solid PC sheet is 200 times that of glass.

- **Light Weight**

the weight of solid PC sheet is only about half of glass, and the weight of hollow PC sheet is only about one twelfth at the same thickness.

- **Transparency**

The light transmission of 3mm solid PC sheet is 88%, and the light transmission of 6mm hollow PC sheet is 80%.

- **UV-Protection**

PC sheet is co-extruded with a high-density ultra violet ray absorbent to fight against ultra violet ray, while keeping the PC sheet from decoloring.

- **Resistance to weather**

PC sheet have good weather ability, it can maintain excellent properties in a wide temperature range from -40°C to +120°C.

- **Inhibiting Condensation**

When outdoor temperature is 0°C, indoor temperature is 23°C, PC sheet will not get condensation even with relative humidity as high as 80%.

- **Thermal Insulation.**

The K-value of glass is 1.2 times that of solid PC sheet and is 1.7 times that of hollow pc sheet. So PC sheet can prevent heat loss and save more energy.

- **Sound insulation.**

The hollow from and polycarbonate resin offer significant advantage to the sound insulation.

- **Flame Resistance.**

Through testing by National Center for Quality Supervision & Testing of Fire Building Materials, each behavior of the material conforms to the standard of difficult-flammability material. PC sheet is rated Class B1 according to QB8624-1997.

- **Easy Installation**

PC sheet can be bent while hot or cold. It is possible to construct curved roofs and windows. The minimum radius of curvature of PC sheet is 175 times of its thickness.

- **Technical data:**

Impact strength (J/m): 850
Light transmission (%): 88
Specific gravity (g/cm³): 1.2
Coefficient of thermal expansion (mm/moC): 0.065
Serve temperature (°C): -40°C to +120°C
Heat conductivity (W/m²oC): 2.3-3.9
Tensile strength (N/mm²): ≥60
Flexural strength (N/mm²): 100
Modulus of elasticity (Mpa): 2400
Tensile street at break (Mpa): ≥65
Elongation at break (%): >100
Specific heat (KJ/kg•K): 1.17
Heat deflection temperature (°C): 140
Effect of soundproof (10mm hollow): decay 20db

3. List of Approved Makes

A Structural

Steel Authority of India.
Essar Steel
TISCO
Jindal

B Paint

Asian Paints
Berger Paints
ICI Paints/ICI India Ltd.
Shalimar Paints
Nerolac Paints

C Welding Consumable

Advani Oerlikon Ltd
Essab
D&H

D Polycarbonate sheet

GE
Jindal

E Galvalume sheet

JSW Steel
TATA Bluescope
Bhushan Steel Ltd.
Steel Authority of India Ltd.

Manufacturers Test Reports for Structural Steel, Radiographic/Ultrasonic Test reports for welded joints, Paint Quality Test, Roofing & Cladding Galvalume Sheets, Turbo ventilators to be submitted along with the materials while procuring on construction site.

SPECIAL SPECIFICATIONS

CONTENTS

1.1	SITE OFFICE FOR THE ENGINEER	1
1.2	LABORATORY AND LABORATORY TESTING.....	2
1.3	SITE SURVEYS, SETTING OUT AND DESIGN DETAILING.....	4
1.4	SOIL INVESTIGATION AND REPORT.....	7
1.5	PROGRESS PHOTOGRAPHS.....	7
1.6	NOTICE BOARDS.....	7
1.7	ADVERTISING.....	8
1.8	SITE SAFETY.....	8
1.9	SERVICES.....	11
1.10	AS BUILT RECORDS.....	11
1.11	PROGRAMME OF WORKS.....	11
1.12	CONTRACTOR'S OFFICES, YARD, STORES AND PLANT AREA.....	12
2.1	SITE PREPARATION.....	13
3.0	APPROVED MAKES.....	19

1.1 SITE OFFICE FOR THE ENGINEER

1.1.1 Provision of Site Office

The successful Tenderer is to provide and maintain a site office at a location approved by the Engineer / Construction Manager in consultation with the Employer, within 15 days from the date of issue of Notice to Proceed.

1.1.2 Furnishing of the Site Office for the Engineer

A separate Engineers office as specified in the contract data shall be provided. This Engineers office shall be of standard quality and furnished. The maintenance of this Engineers office is also the responsibility of contractor. If the same is not handed over a penalty amount of Rs. 5000 may be deducted from Contractor's Bill.

1.1.3 Surveying Equipment

1.1.3.1 The Contractor shall provide at the site, at his own expense, set of surveying and measuring equipments as specified in the contract data. The set shall be used by the Contractor for requirement at site and also shall be made available from the commencement of contract for the use of the Engineer's Representative. The set shall consist of the following instruments:

1.1.3.2 All equipment shall be supplied with their tripods, staff and such other equipment/item as the Engineer's Representative may require for the measuring, or setting -out of the work.

1.1.3.3 The Contractor shall be solely responsible for the maintenance of all such instruments and equipment and shall ensure they are, at all times, in good repair and adjustment. All equipment other than expendable items shall revert to the Contractor upon completion of the works.

1.1.3.4 The Contractor shall provide the Engineer, throughout the Contract period, with all necessary assistants and chainmen to assist with surveying work. The assistant shall keep the survey equipment in good order.

1.2 LABORATORY AND LABORATORY TESTING

1.2.1 Description

1.2.1.1 Testing of materials and completed work shall be carried out by a site laboratory established and allocated exclusively for that purpose, all testing shall be carried out under the direction and supervision of the Engineer's staff. All tests shall be performed in strict accordance with the appropriate Indian Standards or other standards as approved by the Engineer.

1.2.1.2 Any testing relating to the Works as required by the Engineer which cannot be carried out in the site laboratory shall be carried out at the Contractor's expense, at an independent laboratory approved by the Engineer.

1.2.1.3 The provision of laboratory facilities on site, as specified, shall in no way relieve Contractor of the responsibility for providing additional laboratory space and testing equipment as necessary in order to control materials at mixing plants and elsewhere and enable him to fulfil his obligations under the Contract.

1.2.1.4 If for any reason a laboratory cannot be setup at site, all the tests shall be got done in a laboratory approved by the Engineer.

1.2.2 Laboratory Building

1.2.2.1 The Contractor shall provide, furnish, equip, keep clean and maintain to the satisfaction of the Engineer a laboratory building of a floor area not less than 30sq.m. The building shall be provided with electrical power, potable water, drainage, and shall have adequate daylight and artificial lighting.

1.2.2.2 The Laboratory shall be adequately staffed by the contractor with materials technicians and assistants in the numbers deemed necessary by the Engineer so that no interruption of unnecessary delay shall occur to construction activities due to delays in sampling or testing, in-site or in the laboratory, as

required by the Contract. The testing equipment provided in the laboratory shall be sufficient but not limited to carry out the following tests;

- (a) modified Proctor compaction tests
- (b) Field Density tests using core cutter and sand replacement methods
- (c) Crushing strength of 150mm size concrete cubes.
- (d) Sieve analysis
- (e) Slump tests

The Contractor shall, at the Commencement of the Contract, submit a detailed list of the equipment he is proposing to provide showing for each item its type and model, serial number, manufacturer's name and year of manufacture for the Engineer's approval.

The testing of the works by the Engineer, in no way, absolves the Contractor from his responsibilities to carry out his own testing of the quality of his works and the materials used.

1.2.2.3 The laboratory building and equipment shall be used exclusively for the purposes for which they are intended and shall, together with all equipment, all samples and records, be open to inspection by the Engineer during all working hours.

1.2.2.4 The laboratory shall be fully operational within 15 days of commencement of Contract and remain so until all work in the opinion of the Engineer is complete. A sum of Rs. 5000/ day will be deducted from the money due to the Contractor for each day over the 15 day limit, for failure on the part of the Contractor to provide the laboratory to the Engineer's satisfaction. At the end of Construction the laboratory building with furniture and equipment shall revert to the Contractor. The laboratory shall not, however, be removed from site without the prior consent of the Engineer.

1.2.2.5 If in case the tests are to be done in an approved laboratory, such an approval shall be obtained from the Engineer within 15 days of commencement of Contract; in such cases the Clause 1.2.2.4 will not apply.

1.2.2.6 2 Vernier Callipers and 2 Screw Gauges having 0.01 mm least count shall be made always available at site by the Contractor

1.2.2.7 After removal of the laboratory the Contractor shall clean and level the site removing all foundations, drain water pipes and other services installed for the laboratory and return the ground to its original condition.

1.2.3 Contractor's Senior Materials Technician

1.2.3.1 The Contractor shall provide a full-time senior materials technician to be responsible for the day-to-day activities of the laboratory and for site testing. He shall be directly and solely responsible to the Engineer or designated members of his staff. The senior materials technician shall have not less than ten years experience of the testing of earthworks and pavement materials and their construction, including asphalt concrete, and of concrete for structures, and shall be fully converse with the testing of materials as per latest Indian Standards. The experience and qualifications of the senior materials technician shall be to the approval of the Engineer.

1.2.4 Sample

1.2.4.1 The Contractor shall submit samples of all materials and goods for inclusion in the works to the Engineer and only those approved by the Engineer and to the standards specified elsewhere in the Contract may be ordered for supply. Samples shall be submitted promptly in order not to delay the works.

All work executed shall be of equal standard in all respects to the approved samples and the Engineer may reject any work which, in his opinion, does not comply with the approved samples.

1.3 SITE SURVEYS, SETTING OUT AND DESIGN DETAILING

1.3.1 Description

The Contractor shall be responsible for the true and proper setting-out of the works in relation to the lines and levels of reference given by the Engineer or shown on the Drawings and for the correctness of the position, levels, dimensions and alignment of all parts of the works and for the provision of all necessary instruments, appliances and labour used in connection therewith.

He shall carry out a detailed survey of the site in advance of his commencement of Construction work, and shall supply full details to the Engineer as specified in the following sub clauses.

All setting out and levelling shall be based on permanent Benchmarks obtained from the Local Authority.

1.3.2 Existing levels and Layouts

1.3.2.1 Before commencing operations of any section of the works, the Contractor shall survey all existing detail in that section, in plan and in level and shall plot the results in such detail and to such scales as shall be to the satisfaction of the Engineer. These survey plots shall be supplied to the Engineer at least two weeks in advance of the start for services specified in the specification and, in any event, at least four weeks before the intended commencement of construction on the section. Unless otherwise instructed by the Engineer the detailed survey plots will be supplied in 1:200 scale and printed on high quality transparent draughting medium as approved by the Engineer.

1.3.2.2 In addition to the requirements of Sub - clause 1.3.2.1 above, horizontal control lines shall be marked out by pegs at intervals of not more than 20m and the lines traversed with theodolite by steel band or by any other method acceptable to the Engineer. The alignments established shall be referenced by pegs offset at suitable distance on each side of the horizontal control lines. These offset pegs shall be painted in a conspicuous colour.

1.3.2.3 Cross sections of the existing ground and of the ground after completion of earthworks shall be taken at intervals not exceeding 20m along the horizontal control lines in an approved and acceptable manner.

1.3.3 Bench Marks and Survey Points

1.3.3.1 As the work proceeds, the contractor shall establish, at suitable location, substantial permanent benchmarks, clear of the works, from which, all subsequent setting out and levelling shall be carried out. The location of the benchmarks shall be agreed with the Engineer before they are established.

1.3.3.2 Benchmarks shall be constructed in class 20/20 concrete, with minimum dimensions of 0.3m x 0.3m, the upper surface being approximately 50mm above ground level. A 20mm diameter mild steel rod, not less than 300mm in length, shall be cast into the concrete so that it projects about 10mm above the centre of the surface of the concrete. The concrete surface shall be clearly engraved with the reference number of the benchmark. The co-ordinates and level of each benchmark shall be determined in metres to 3 decimal places.

1.3.3.3 The Contractor shall check co-ordinates and levels of benchmarks at monthly intervals and immediately notify the Engineer of any discrepancies.

1.3.4 Survey, Design, Working and Shop Drawings

1.3.4.1 The Contractor should note that the Drawings and Quantities in the Tender Documents, whilst detailed, have to be considered as preliminary, and only provide an indication of the locations, layouts and scope of works. The locations, layout and scope of works may be altered and in such cases the Contractor shall not be entitled to any claim whatsoever for such alterations over and above the measured works or measured variations at the tendered rates except in accordance with the provisions of relevant Clauses of the Conditions of Contract.

1.3.4.2 Subject to the above limitation, design detail will be provided by the Engineer in advance of the Contractor's intended commencement of construction as indicated in his approved construction programme or as otherwise agreed with the Engineer.

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- 1.3.4.3 Should any Contractor's proposals for the any specialised items differ in entirely or substantially from that of the Engineer's or should it affect another component of the element or item of work beyond permissible variations from it, then the Contractor shall, at his own cost, be responsible for redesign to provide a complete acceptable system before approval of any part thereof. For such works, the Contractor shall furnish, at his own expense, the Engineer with copies of all design calculation, sketches, working drawings and similar information in as much detail as the Engineer may reasonable require for his full information and subsequent approval.
- Such approval of the Contractor's design shall not relieve the Contractor from any of his duties, responsibilities or obligations under the Contract.
- The above design work to be undertaken by the Contractor or his approved subcontractor shall be in accordance with f current practice generally using accepted design techniques in accordance to international standards or as specified in the relevant Tender Document all to the approval of the Engineer.
- 1.3.4.4 Contractor shall prepare the working drawings/shop drawings and documents, including diagrams and schedules shall show the details of proposals for the execution of the works and shall include everything necessary for the following purposes :
- To illustrate in detail the arrangement of the various section of the works and to identify the various components.
- To integrate the various sections of the works.
- The shop drawings required shall include but not be limited to the following
- General layout drawings for equipment and like items as deemed necessary by the Engineer.
- a) Detailed layout drawings all lift stations and pumping stations, showing the connection of mechanical and electrical services, ducting, paper work, conduit, cable tray and trunking together with earthing system
 - b) Detailed layout drawings showing sections such as through ceiling voids and vertical shafts.
 - c) System diagrams, circuit diagrams and wiring diagrams for all installations and equipment.
 - d) The drawings, specifications and technical information for materials and equipment of building components such as doors, windows etc.
- 1.3.4.5 Working drawings and documents shall be made available in sufficient time in order to maintain the Programme of Work on site.
- The Contractor shall liase with the Engineer for the period required for any approval, which shall be a maximum of two weeks.
- The Contractor shall ensure that all items to be ordered by him can be accommodated in the positions shown on the drawings and for taking all necessary dimensions on site together with any supporting information which may be necessary for preparing working drawings.
- Materials or equipment shall be ordered nor construction of the associated works be commenced until such approval has been obtained from the Engineer.
- The Contractor shall be deemed to have obtained a full and proper understanding of the Engineer's design and design intents and to have satisfied himself with their accuracy and suitability. In this respect, the Engineer will meet all reasonable requests made by the Contractor in furnishing design information and the like to he Contractor. No claim in respect of lack of knowledge will be admissible.

Before commencement of construction, the Contractor shall conduct a detailed topographic survey of each road in the project and submit to the Engineer, for approval, the following:

- (a) Tabulated control levels to which the works are to be referred to. Co-ordinates of each salient point shall be determined in metres to 3 decimal places.
- (b) Plan of the proposed road showing the location of the asphalt carriageway. The drawing shall clearly indicate the location of the boundary walls wherever available. Where boundary walls are not available the survey should show the extent of the right of way of the road. The existing services, as determined by site excavation, should also be marked up on these plans.
- (c) Profile of the existing road as directed by the Engineer
- (d) In the dual carriageway, profile shall be drawn for both carriageways.

1.4 SOIL INVESTIGATION AND REPORT

- 1.4.1** A soil investigation has been undertaken during the Design phase. However in case additional investigations are required during the course of construction the Contractor shall be advised of such requirement and the Contractor shall promptly carry out such investigations as advised by the Engineer.

1.5 PROGRESS PHOTOGRAPHS

- 1.5.1** The Contractor shall submit to the Engineer each month, throughout the period of the Contract, progress photographs as mentioned in the General conditions of the contract, taken at the direction of the Engineer. The camera used for this purpose shall be such that the date is printed out.
- 1.5.2** In addition copies of previously selected progress photographs and mounted in three separate and suitable albums shall also be delivered to the Engineer on the Preliminary Handing-over of the works. The arrangements for the progress photographs are subject to the approval of the Engineer and shall be discussed at as early a date as possible so that complete coverage can be assured.

1.6 NOTICE BOARDS

The Contractor shall provide, erect and maintain for the duration of the contract, two steel framed timber notice boards for the works, in location approved by SPV and the Engineer's Representative.

Notice Boards shall have a block board panel size of around 3m as detailed on the Drawings or equally approved. Prior to sign writing, the board shall be painted with two coats of white oil based paint back and front. The board shall be supported above the ground on steel struts painted matt black and fixed into concrete foundations, all to the approval of the Engineer. The sign shall be painted by a skilled sign writer to show the details described in the Contract. The Contractor is responsible for obtaining all necessary approvals for the erection of these notice boards.

Under no circumstances, shall sub-contractor's or supplier's name boards be fixed on hoarding or elsewhere on site.

1.7 ADVERTISING

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- 1.7.1** Neither the Contractor nor any of those in his employment shall give information concerning the works for publication in any form without the written approval of the Engineer.
- 1.7.2** Neither the Contractor nor any of his sub-contractors shall erect placards or advertisements within the site other than the notice boards permitted under the relevant Clauses.
- 1.8 SITE SAFETY**
- 1.8.1 Site Safety**
- In order to improve the general vehicular traffic condition and to guarantee public safety from and around the work the Contractor shall provide all labour, and materials, and construct and maintain temporary traffic diversions through out the construction activities, to the directive and approval of the Engineer. It is therefore recognised that there is a particular responsibility placed upon the Contractor to take special precautions for public safety and to minimise the scale and extent of disruption. Plans for diversion shall always be submitted to the Engineer for prior approval.
- 1.8.2 Safety on Site**
- 1.8.2.1** The Contractor shall ensure that the works are carried out in a safe manner. According to internationally accepted guidelines on safe working procedures and to the satisfaction of the Engineer.
- 1.8.2.2** The following requirements shall be complied with by the Contractor:
- a) Excavation - All excavations shall be adequately supported to avoid collapses and effective safety barriers shall be erected with warning signs and devices around all open excavations to the satisfaction of the Engineer.

Struts and walling shall not be used as ladders and for the purpose of access to the base of excavation the Contractor shall provide proper ladders which shall be suitably secured.

Reflective wearing shall be worn by all workmen on or close to a highway and, where necessary, temporary road signs and cones shall be provided to ensure a safe working area.
 - b) Protective Clothing - The Contractor shall ensure that all personnel on site are supplied with the necessary protective clothing such as safety helmets, goggles, face masks, ear muffs, gloves, boots, etc. which are required for the operations being performed.
 - c) Scaffolding - Suitable and sufficient scaffolds shall be provided and properly maintained for all work that cannot safely be carried out from the ground or from part of the structure or from a ladder.

Every scaffold shall be of good construction, of suitable and sound material and of adequate strength for the purpose for which it is used. Unless designed as an independent structure, every scaffold shall be rigidly connected to a part of the structure which is of sufficient strength to afford safe support. Protective headgear shall always be worn.
 - d) Lifting Device - Every rope, chain, pulley, bloc, hook, winch, crane or other lifting gear used for raising or lowering loads or as a means of suspending them shall be of good construction, sound material, adequate strength and free from defects. They shall be properly maintained and tested at regular intervals by a competent person, who shall be to the approval of the Engineer.
 - e) Working in existing manholes etc. , - Checks shall be carried out before entry to ensure that the atmosphere is fit for respiration and no smoking naked lights or flames are to be permitted in any sewer, manhole or chambers or adjacent to them when these are open

The equipment which shall be made available shall include but not limited to:

- a) Gas detector lamps with lead acetate papers.
- b) Lifting harness with ropes
- c) Handlamps with spare batteries
- d) First aid kit.
- e) Protective head gear.
- f) Rubber Gloves.
- g) Breathing apparatus.

1.8.2.3 Throughout the period of the Contract, the Contractor shall provide safety helmets and high reflectivity jackets to all Consultant's staff and visitors. Barriers must be provided to all excavations for the safety of the public and flagmen must be used for all items of plant for the safety of the operatives, supervision staff and members of the public.

1.8.3 Vehicular Movement

1.8.3.1 Before commencing the works, the Contractor shall consult with and obtain from the Employer and the Engineer their requirements for temporary safety signs, road markings, lighting and other measures necessary to ensure the safety of the public, and shall comply with these requirements will not relieve the Contractor of his obligations under the Contract. The Contractor shall also take a No Objection Certificate from Consultants supervising other Contracts in the area, get details of newly installed and temporary services and obtain access requirements for other contractors.

1.8.3.2 The Contractor shall deploy, as a full time member of his site staff for the duration of the contract, whose duties shall include the production and implementation of safety management schemes. Qualification and experience of the safety management staff shall be subject to the approval of the Engineer.

1.8.3.3 Throughout the Contract, the Contractor shall maintain vehicular and personnel access to all parts within the site at all time.

Adequate warning and direction signs are to be erected wherever necessary and diversions are to be maintained in good condition to the satisfaction of the Engineer.

1.8.3.4 Temporary diversions shall be constructed and maintained to the standards approved by the Engineer. Upon completion of the Permanent works, the temporary diversions shall be removed and the site restored to the satisfaction of the Engineer.

1.8.3.5 All diversions and safety sign boards must be constructed and maintained to the highest standards with regular washing of cones and daily maintenance of flashing lights. The signs and cones should be self-stabilising, and if extra stability is required only small sandbags should be used.

1.8.3.6 All stockpiles of material to be used in the works must be fenced off and all unsuitable material must be removed from site on a daily basis and not stockpiled on site.

- 1.8.3.7 Payment for safety management shall be considered as included in the various pay items of B.O.Q. deductions to be made, from moneys due to the Contractor, for failure on the part of the Contractor to provide adequately for safety and for the accommodation of safety management plan.
- 1.9 SERVICES
- 1.9.1 Contractor to establish location of Services**
- Before the Contractor may proceed with the Works in any given area he is required to establish the precise location of all services in that area as executed by other contractors.
- 1.10 AS BUILT RECORDS
- 1.10.1 On or before the completion of the works, at the direction of the Engineer, the Contractor shall prepare detailed drawings and other records, as required, of the works executed. The Contractor is required to submit the soft copy as well as two hard copies of the as built records to the scale advised by the Engineer.
- 1.11 PROGRAMME OF WORKS
- 1.11.1 In respect of the programme of works required under Clause 17 of the General Conditions of Contract the following specific requirements shall apply: -
- The works shall be programmed in such a way as to minimise disruption to other works
 - Works shall not be carried out simultaneously over large areas of the site but shall be sequenced so that all operations likely to cause disruption to other works shall be undertaken and completed in discrete area before commencement of operations in other areas.
 - Works, which, by their nature, will create disruption and / or obstructions to other works, shall be programmed to be undertaken in a continuous sequence of events from the initial disruption until the restoration of access without and significant delay between operations.
- 1.11.2 The Contractor's Programme of Works, submitted in accordance with Clause 17 of the Conditions of Contract, shall be subject to the approval of the Engineer and of Employer, the Contractor has not properly achieved the objectives of the programme, then they may require the Contractor to revise his Programme and the Contractor shall do so forth, for this reason the Contractor is advised to liaise closely with the Engineer during the production of his Programme.
- 1.11.3 The Contractor should note that when a phase or phases of the works is/are programmed to be completed before commencement of another phase, the Contractor may not commence work on the later phase until the former phase is completed, even if the former phase overruns its allocated construction time, without the specific permission of the Engineer's Representative.
- 1.11.4 In addition to the Works Programme required under Clause 17 of the Conditions of Contract, the Contractor shall produce individual programmes for each element of the works likely to cause significant disruption to other works, for the approval of the Engineer and prior to commencement of the element of the works, clearly showing the sequencing of construction operations in such a manner as to minimise the duration of the disruption.
- 1.11.5 The Contractor shall note that different work in various parts of site by other contractors may be in progress or may commence during the Contract Period. It will be the Contractor's responsibility to liaise with contractors on adjacent sites in order to ensure the detail progress. The Contractor's Programme will be phased and will make full allowance for the need for a co-operative timing with adjacent contractors.

1.12 CONTRACTOR'S OFFICES, YARD, STORES AND PLANT AREA

- 1.12.1 The Contractor's main office shall be located in the general vicinity of the Engineer's office, on land to be provided, by the Contractor, for the duration of the project. The Contractor's main office shall be used for the purposes of administering the Project but may not be used for the storage of construction materials nor for storage or maintenance of plant and shall not be allowed to become unsightly.
- 1.12.2 The Contractor's other offices, yard, stores and plant area shall be provided, by the Contractor, at location(s) to the approval of the Employer. The Contractor shall be responsible for all associated expenses including rents, assessments or temporary occupation license fees, establishment, running and maintenance costs, the supply of all services, as well as the obtaining of any appropriate No Objection Certificates.
- 1.12.3 Within 7 days of the Commencement date of the Contract, the Contractor shall submit, for the approval of the Engineer, a drawing showing detailed plans for his offices, yard, stores and plant area, together with all sanitary arrangements, and for the supply of water and electricity. Until the Engineer has given his approval in writing, no construction of any of the Contractor's facilities shall commence. The area shall be fenced in accordance with the Engineer's approval.
- 1.12.4 The Contractor shall not be permitted to erect temporary building or structures elsewhere without the specific permission in writing of the Engineer, including approval of the dimensions and specifications of such buildings or structures and their location.
- 1.12.5 The Contractor shall take all steps necessary as directed by the Engineer to minimise or eliminate dust, noise or any other nuisance, which may occur. Plant emitting dust, smoke, excessive noise or other nuisance shall not be permitted to be sited at any location which shall cause nuisance to any building or other installation, whether complete or under construction, site offices, camps, or other similar buildings.
- 1.12.6 Under no circumstances shall overnight accommodation be permitted on site except for Site watchman in carrying out their duties.
- 1.12.7 Throughout the period of the Contract, the Contractor shall maintain the area of his operation within the limits of the site in a clean, tidy and safe condition by arranging materials and the like in an orderly manner. All rubbish, debris, waste materials and the like shall be systematically cleared from the site as it accumulates.
- 1.12.8 The Contractor shall satisfy himself as to the means of access to the site and other relative items affecting him, his sub-contractors and suppliers.
- 1.12.9 Upon completion of the Contract, or, in the case of facilities required by the Contractor during the Period of Maintenance, on completion of the period of maintenance the Contractor shall remove all buildings and other facilities from the site including all foundations and services, clean and level the site and restore the ground to its original condition.

2.1 SITE PREPARATION

2.1.1 General

The Contractor shall maintain close liaison with the Engineer and the Employer and shall obtain their approval prior to removal of any service installation. Where external Service Authority installations are to be removed, they shall be removed after the existing facilities have been