INDRADHANUSH GAS GRID LIMITED (IGGL)
(Joint Venture of IOCL, ONGC, GAIL, OIL and NRL)
GUWAHATI, ASSAM

NORTH -EAST GAS GRID PIPELINE PROJECT

BID DOCUMENT FOR

COMPOSITE WORKS (ELECTRICAL & INSTRUMENTATION, CIVIL) FOR NEGDCL PIPELINE CONNECTIVITY UNDER NORTH EAST GAS GRID (NEGG) PROJECT OF M/S INDRADHANUSH GAS GRID LIMITED (IGGL)

OPEN DOMESTIC COMPETITIVE BIDDING

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VOLUME – II OF III

PREPARED AND ISSUED BY

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(A Govt. of India Undertaking)
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STANDARD SPECIFICATIONS (ELECTRICAL SYSTEM)

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Rev.: 1
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SPECIFICATION
FOR
CABLE LAYING

SPECIFICATION NO. - MEC/S/05/E9/01, R-1

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

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MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION ELECTRICAL SECTION, DELHI		
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AMENDMENT STATUS

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1.0 SCOPE

The intent of this standard specification gives recommendation & Board Guideline for selection, transportation, laying, jointing, termination, testing and commissioning of the cabling system. up to 33kV.

2.0 STANDARDS

The work shall be carried out in the best workman like manner in conformity with this specification, the relevant specifications, codes of practice of Indian Standards Institution, approved drawings and instructions of Engineer-in-Charge or his authorised representative issued from time to time. In case of any conflict between the standards, the instruction of Engineer-in-Charge shall be binding.

In general the equipment covered by this specification shall, unless otherwise specified, be in line with the requirement of any of the latest applicable standards of

a) Bureau of Indian Standards
b) British Standard Institution
c) American Standard Institution
d) International Electro Technical Commission

2.2 Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.2 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 GENERAL REQUIREMENTS

3.1 ENVIRONMENTAL CONDITIONS

The cables shall be laid for continuous operation at full load under the climatic and environmental conditions as described in the specification "Design Basis Electrical".

3.2 COMPONENTS AND EQUIPMENT

a) The Contractor has to take care that all components, equipment & cable routes are selected considering easy maintenance, simple and quick diagnosis and long maintenance intervals. All components and equipment shall be designed for continuous duty at rated load and under the given climatic conditions. Standard industrial high performance systems and components shall be used as far as possible. Components and equipment of same kind and type shall be selected for equivalent functions. The interchangeability must be guaranteed.

3.3 TAGGING

All components, equipment, cable route and installations shall receive the respective tagging plates, labels, etc which have to be of extremely durable material resistant against the environmental conditions.

4.0 CABLE SPECIFICATIONS

Refer Specification for LV & MV Cable (Specification No. MEC/TS/05/E9/073A).

5.0 MISCELLANEOUS MATERIALS SPECIFICATIONS

5.1 Connectors

Cable terminations shall be made with Aluminium/tinned copper crimped type solder less lugs of approved make for all Aluminium/Cu conductors cables and stud type terminals and shall be as per IS: 8309.

5.2 Cable Identification

Cable tags shall be of 2 mm thick, 20 mm wide aluminium strap of suitable length to contain cable number, equipment no etc.

5.3 Ferrules

Ferrules shall be of approved type size to suit core size mentioned and shall be employed to designate the various cores of control cable by the terminal numbers to which the cores are connected for case in identification and maintenance. Ferruling shall be done at both end of cables.

5.4 Cable Glands

Cable glands shall be nickel-plated Brass double compression type of approved/ reputed make. Glands for classified hazardous areas shall be certified by CMRS and approved by CCOE, Nagpur.

5.5 Cable trays

This shall be either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron trays as specified elsewhere. Prefabricated hot dip galvanized sheet steel cable trays shall be used for maximum support span of 2000 mm unless design is approved for larger span. For requirements of larger than 750 mm width two trays shall be run side by side. Cable trays shall be suitable for a cable weight of 50 kg/meter running length of tray. Minimum thickness of sheet steel/galvanizing shall be 2mm/86 microns respectively.

Cable trays fabricated from standard rolled sections shall use 50x50x6 /ISMC 100 Sections for runners for supporting spans limited to 2000 mm/more than 2000 mm respectively. Cross support shall be 30 x 6 mm flat/ 25x25x6 angle for width upto 500 mm/ more than 500 mm respectively.

Vertical supports for both the above type of trays shall be fabricated out of ISMC 100 and horizontal supports with 75 x 50 x 6 angle iron/ ISMC 75 as approved by Engineer-in-Charge.

If unit rate is not included in schedule of rates, then cable trays if required, shall be fabricated and installed at site as per ton rate for electrical structural supports etc.

6.0 CABLE LAYING

6.1 Cable network shall include power, control, lighting and communication/signal cables, which shall be laid in trenches, cable trays or conduits as detailed in the relevant drawings and cable schedules. Erection of cable trays as required shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc and minor adjustments shall be done to suit the field conditions wherever deemed necessary without any extra cost.

6.2 High voltage, medium voltage and other control cables shall be separated from each other by adequate spacing or running through independent pipes, trenches or cables trays, as applicable as per IS 1255.

All communication/signal cables (telephones, P.A.S, Instrument) RTD Cables shall run on instrument trays/ducts/trenches. Wherever these are not available, cables shall be taken in a separate trench with a minimum clearance of 300 mm away from electrical trench as per IS 1255 & direction of Engineer-in-Charge. Communication cables shall cross power cables at right angles.

Clearance –The desired Minimum clearance are as follows-

Power Cable to Power Cable	-	Clearance is not necessary. However, there would be some clearance so that, the current carrying capacity become better.
Power cable to control cable	-	0.2m
Power cable to communication/ Signal cable	-	0.3m
Power cable to Gas/Water Main	-	0.3m

Inductive influence/interference on signal/control/communication cable should be checked.

The Power cable should not be laid above the Communication Cable. While laying of power cables the likely interference to existing communication/signal cable should be avoided by referring to and coordinating to appropriate authority.

6.3 All cable routes shall be carefully measured and cables cut to the required lengths, leaving sufficient lengths for the final connection of the cable to the terminal of the equipment. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. The quantity indicated in the cable schedule is only approximate. The contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works.

Before the start of cable laying, cable drum schedule shall be prepared by contractor and get that approved by Engineer-in-Charge to minimize/avoid straight through joints required. Contractor shall work out the actual number of straight through joints required.

6.4 Cables as far as possible shall be laid in complete, uncut lengths from one termination to the other.

6.5 Cables shall be neatly arranged in the trenches/trays in such a manner so that cross-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the Contractor. Cable routing between lined cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 45° to the trench wall. In case of larger diameter cables, i.e., 50 mm and above, adequately sized pipe with larger bend radius shall be provided for ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Engineer-in-Charge.

6.6 All cables shall be identified close to their termination point by cable numbers as per cable schedule. Cable numbers will be punched on aluminium straps (2 mm thick) securely fastened to the cable and wrapped around it. Alternatively cable tags shall be circular in construction to which cable numbers can be conveniently punched.

Each underground cable shall be provided with identity tags of lead securely fastened every 30 m of its underground length & at turning of power cable with at least one tag at each end before the cable enters or leave the ground. In unpaved areas, cable trenches shall be identified by means of markers as per standard drawing. These posts shall be placed at location of changes in the direction of cables (turnings & crossings) and at intervals of not more than 30 M and at cable joint locations.

6.7 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all XLPE/PVC insulated cables shall be taped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.

6.8 RCC cable trenches with removable covers as shown on the drawings will be provided by the Owner. Cables shall be laid in 3 or 4 tiers in these trenches as indicated on the sectional drawings. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases, RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purpose of cable laying and reinstalling them in their proper positions after the cables are laid shall be done by the electrical Contractor at no extra cost.

6.9 Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving trenches shall be coiled and provided with a protective pipe or cover, until such times the final termination to the equipment is connected.

Minimum bending radii of cable shall be as specified in IS: 1255.

6.10 Directly buried cables shall be laid underground in excavated cable trenches where specified

in layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables correctly spaced and arranged with a view of heat dissipation and economy of design.

Desired Minimum depth of laying from ground surface to top of cable is as follows-

High voltage cables, 3.3kV to 11kV Rating	:	0.9m
High voltage cables, 22kV to 33kV Rating	:	1.05m
Low voltage & control cable	:	0.75m
Cables at Road Crossing	:	1.00m
Cables at railway crossing (Measured from Bottom of sleepers to top of pipe)	:	1.00m

The depth and the width of the trench shall vary depending upon the number of layers of cables.

Cables shall be laid in trenches at depth as shown in the drawing with protective GI earth conductor (runs along the cable). Before cables are placed, the trenches bottom shall be filled with a layer of sand. This sand shall be leveled and cables laid over it. These cables shall be covered with 150 mm of sand on top of the largest diameter cable and sand shall be lightly pressed. A protective covering of 75 mm thick second class red bricks shall then be laid flat. The remainder of the trench shall then be back-filled with soil, rammed and leveled.

6.11 As each row of cables is laid in place and before covering with sand every cable shall be given an insulation test in the presence of Engineer-in-Charge / Owner. Any cable, which proves defective, shall be replaced before the next groups of cables are laid.

All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/ lined trench.

6.12 Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection upto a minimum of 300 mm above grade or as shown in the standard drawings.

Cable ends shall be carefully pulled through the conduits, to prevent damage to the cable. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

Following grade of the pipe fill shall be used for sizing the pipe size:

a)	1 cable in pipe	-	53% full
b)	2 cables in pipe	-	31% full
c)	3 or more cables	-	43% full
d)	Multiple cables	-	40% full

After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/ `PUTTI' for sealing purpose. The cost for the same shall be deemed to have been included in the installation of G.I. Pipe and

no separate payment shall be allowed.

6.13 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures, the electrical contractor shall determine their location and obtain approval of the Engineer-in-Charge before cutting is done.

6.14 At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.

6.15 Drum number of each cable from which it is taken shall be recorded against the cable number in the cable schedule.

6.16 Cables installed above ground shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel or at right angles to beams, walls or columns.

Cables shall be so routed that they will not be subjected to heat from adjacent hot piping or vessels.

6.17 Individual cables or small groups which run along structures/walls etc. will be clamped by means of 10 SWG GI saddles on 25x6 mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables and no separate payment shall be made on this account. Alternatively small group of cables can be taken through 100 mm slotted channel/ISMC 100.

They shall be rightly supported on structural steel and masonary, individual or in groups as required, if drilling of steel must be resorted to, approval must be secured and steel must be drilled where the minimum weakening of the structure will result.

Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300 mm for cables upto 25 mm diameter and maximum 450 mm for cables larger than 25 mm diameter.

6.18 All G.I. Pipes shall be laid as per layout drawings and site requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the contractor), all the burrs from the pipes shall be removed. GI Pipes with bends shall be buried in soil/concrete in such way that the bends shall be totally concealed. For G.I. Pipes buried in soil, bitumen coating shall be applied on the buried lengths. Installation of G.I. Pipes shall be undertaken well before paving is completed and necessary co-ordination with paving agency shall be the responsibility of Electrical Contractor. The open ends of pipes shall be suitably plugged with G.I. Plugs after they are laid in final position. G.I. Plugs shall be supplied by the Contractor at no extra cost.

6.19 Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable trays shall be suitably clamped by means of G.I. Saddles/Clamps, whereas cable in horizontal run of cable trays shall be tied by means of nylon cords.

6.20 Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint unless otherwise specified.

7.0 TERMINATION

7.1 All PVC cables upto 1.1 KV grade shall be terminated at the equipments by means of double compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.

All Cable entries shall be through bottom only and top entry terminations are made only after getting approval of Engineer-in-Charge.

7.2 Power cables wherever colour coding is not available shall be identified with red, yellow and blue PVC tapes. Where copper to aluminum connections are made, necessary bimetallic washers shall be used for trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.

7.3 In case of control cables, all cables shall be identified at both ends by their terminal numbers by means of PVC ferrules or self-sticking cable markers. Wire numbers shall be as per schematic/ wiring /inter- connection diagram. Bidders shall have the samples of PVC ferrules/cable markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends.

7.4 Where threaded cable gland is screwed into threaded opening of different size, suitable galvanized threaded reducing bushing shall be used of approved type, at no extra cost. All switchgear and control panels shall have un-drilled gland plate.

Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables.

7.5 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom close fit hole should be drilled in the bottom plate for all the cables in one line, then bottom plate should be split in two parts along the center line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.

7.6 Cable leads shall be terminated at the equipment terminals, by means of crimped type solderless connectors.

Crimping shall be done by hand crimping hydraulically operated tool and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before

the crimping. Conductor surface shall be cleaned and shall not be left open.

7.7 Cable accessories for H.V. Systems

7.7.1 The 11, 6.6 and 3.3 KV cables terminations joints shall be done by skilled and experienced jointers duly approved by the Engineer-in-Charge. Termination including supplying of jointing kit shall be in the scope of contractor unless specified otherwise.

7.7.2 The termination and straight through joint kit for use on high voltage system shall be suitable for the type of cables or the type of cables issued by owner for installation. Supply of termination kit shall be in the scope of contractor. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fitting and consumables items. An installation instruction shall be included in each sheet.

7.7.3 The termination kits shall be suitable for termination of the cables to indoor switchgear/panels or outdoor weatherproof cable box or outdoor transformer & motors or Double/Four pole structure. The terminating kits shall preferably be of the following types:

a) Heat-shrinkable power cable termination/joint kit of M/s. Raychem or equivalent.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

7.7.4 The straight throh jointing kits shall be suitable for underground-buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types.

a) Heat-shrinkable sleeve type of M/s. Raychem or equivalent.

7.7.5 Makes of kits other than those specified above may be considered, provided the Contractor furnishes type test certificates, along with the offer for approval of the same.

7.7.6 Type tests are to be carried out at manufacturer's works to prove the general qualities and design of a given type of termination/jointing system. The type tests shall include the following tests conforming to the latest IEC 502.2, 466 and VDE 0278 specifications. The type test certificates shall be submitted by the Contractor along with the offer for indicating the jointing system considered.

a. A.C. Voltage withstand dry test for 1 minute
b. Partial discharge test - Discharge magnitude shall be less than 20 p.c.
c. Impulse voltage withstand test with 10 impulses of each polarity.
d. A.C. high voltage test following load cycling test with conductor temperature at 95°C.
e. Thermal short circuit test of 250°C for 1 second.

f. DC Voltage withstand test for 30 minutes.

g. Humidity test.

h. Dynamic short circuit test.

i. Salt log test

j. Impact test

8.0 TESTING

8.1 Before energizing, the insulation resistance of every circuit shall be measured from phase to phase and from phase to ground.

8.2 Where splices or termination are required in circuits rated above 600 volts, measure insulation resistance of each length of cable before splicing and or/ terminating. Repeat measurement after splices and/or terminations are completed.

8.3 Measure the insulation resistance of directly buried cable circuits before cable trenches are back-filled. Repeat measurement after back- filling.

Rating of IR tester for cables of different voltage rating as follows-

Cable Voltage grade	IR Tester Voltage Rating
1.1kV	500V
3.3kV	1000V
6.6kV	1000V
11kV	1000V

8.4 Cables after jointing & termination are subjected to DC high voltage test. The recommended values of test voltage are given below.

	Test Voltage Between		
Uo/U	Any conductor and metallic Sheath/ Screen /Armour	Conductor to Conductor (For Unscreened Cable)	Duration (Min.)
0.65/1.1	3	3	
1.9/3.3	5	9	
3.3/3.3	9	9	
3.8/6.6	10.5	18	15
6.6/6.6	18	18	
6.35/11	18	30	
11/11	30	30	

8.5 All cables shall be tested as per standard test Performa available with site engineer.

8.6 Cable schedule and layout drawings must be marked for AS BUILT conditions during the installation work and shall be approved by Site Engineer.

9.0 DOCUMENTATION

After commissioning & testing of all power & control cables, contractor shall submit the following document to Client/MECON for As-Built status in hard copy (5 set) plus one soft copy.

i) Complete commissioning report of cables
ii) Drawing showing Cable rout of all laid cables in trenches/trays including respective cable numbers.

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Rev.: 1
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SPECIFICATION
FOR
EARTHING AND LIGHTNING PROTECTION

SPECIFICATION NO: - MEC/S/05/E9/02, R-1

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

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MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION OIL & GAS SBU, DELHI		
TITLE	EARTHING & LIGHTNING PROTECTION	DOCUMENT NO. MEC/S/05/E9/02	Page 1 of 1 REVISION : 1 EDITION : 1

AMENDMENT STATUS

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1.0 SCOPE

The intent of this specification is to define the requirements for the supply, installation, testing, and commissioning of the complete Earthing & lightning protection System.

2.0 STANDARDS

The work shall be carried out in the best workmanlike manner in conformity with this specification, the relevant specifications/codes of practice of Indian Standard Institution, approved drawings and instructions of the Engineer-in-Charge or his authorized representative issued from time to time. In case of any conflict between the standards, the instructions of Engineer-in-Charge shall be binding.

IEC 60364 Electrical installations of buildings

IEC 61024 Protection of structures against lightning

IEC 61312 Protection against lightning electromagnetic impulse

IS 2309 Protection of building and allied structure against lightning

IS 3043 Code of practice for earthing

2.1 Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.2 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 TAGGING

All components, equipment and installations shall receive the respective tagging plates, labels, etc., which have to be of extremely durable material resistant against the environmental conditions. For further requirements, reference is made to the specification "Design Basis-Electrical".

4.0 EARTHING SYSTEM

General

The stations shall be equipped with an equipotentially meshed grounding network. All exposed conductive parts or elements of the station systems will be connected to this

network. The earthing systems of the various stations are part of the protection systems for electrical power supply, instrumentation, control and supervisory system. The earthing system consists of the main grounding grid, the grounding rods, the building foundation grounding and the equipment grounding.

Supply of all other erection/consumable required to complete the installation shall be the responsibility of the contractor. All hardware used for earthing shall be hot dip galvanized.

Any other items not specifically mentioned here but necessary for completeness of job shall be in the scope of contractor & shall be supplied by contractor without any extra cost.

For stations, which are to be extended, the existing earthing system shall be considered. The layout of new earthing system shall match to the existing installations. The new and the existing grounding network must be interconnected at two (2) locations, at least.

The grounding network system will be installed in different locations have different soil characteristics according to the location of the stations. Before design and installation of the grounding network the actual soil conditions in the station areas must be determined by adequate soil resistance measurements by the contractor & submit for review & approval.

Station earthing should have low earth resistance, low touch & step potential.

5.0 EARTHING CONDUCTOR

The main grid conductor shall be hot dip galvanized G.I. Flat or PVC insulated copper conductor. Size & type of conductor shall be as marked on the drawings. Thickness of hot dip galvanizing shall not be less than 75 microns.

6.0 DESIGN REQUIREMENTS

6.1 The earth resistance of the overall interconnected station grounding network shall not exceed 1 Ω.

6.2 All exposed metal part such as HT/LT switchgear, DP/FP structure, distribution board, metal clad switchgear enclosure, lamp brackets, lamp holder, plug sockets, lighting poles, junction boxes, high mast etc shall be properly earthed by connecting these to the earth electrode by means of GI wire/Flat or PVC insulated Cu conductor of approved size to pass the fault current safely to earth in case of any fault.

6.3 For the UPS, the SCADA and telecommunication systems with their equipment a separate grounding network with sufficient cross-section to avoid interference shall be installed. This grounding network shall be connected to the common station grounding network on one (1) separable and indicated connection point, within the electrical building or equipment container/enclosure.

6.4 Before design and installation of the grounding network the actual soil conditions in the station areas must be determined by adequate soil resistance measurements.

6.5 The required conductor spacing, the total length of the grounding grid and the required grounding material cross-section shall be calculated under consideration of the maximum earth fault current, to maintain touch and step voltages within reasonable limits. The impedance of the fault current path and protective devices shall be chosen that the faulted circuit will be disconnected from the supply within the required time. A respective grounding calculation with report shall be performed for each station and is to be submitted to the Client/MECON for approval.

6.6 Multiple connections of grounding conductors shall only be carried out above ground. For these connections the respective grounding bars are to be installed. Extensions of single grounding conductors can be permitted below ground under use of compression connectors or welding connections, with repair painting and coating of the connection point.

6.7 All connections of conductors on equipment shall be performed with pressure type lugs or connectors and threaded bolts, screws, spring-washers and washers. Special care must be taken to avoid the arising of a chemical element. Connections between bare copper and iron parts must be protected in a special manner and shall only be executed on above-ground connection points (grounding bars) or inside of pits.

7.0 EARTHING NETWORK

7.1 The earthing installation shall be done in accordance with the earthing drawings and the standard drawings of reference attached with this document. The entire earthing system shall fully comply with the Indian Electricity Act and Rules. The contractor shall carry out any changes desired by the Electrical Inspector or the owner, in order to make the installation conform to the Indian Electricity Rules at no extra cost. The exact location on the equipment shall be determined in field, in consultation with the Engineer-in-Charge or his authorized representative. Any changes in the methods, routing, size of conductors etc shall be subject to approval of the Owner/ Engineer-in-Charge before execution.

7.2 Excavation and refilling of earth, necessary for laying underground earth bus loops shall be the responsibility of the contractor.

7.3 The main earth grid shall be laid at a depth of minimum 700 mm below grade level. Wherever RCC cable trenches are available, the earth lead shall be laid in the trenches and shall be firmly cleared to the walls of concrete lined trenches. The earthing strip shall be protected against mechanical damage.

7.4 A common grounding system network (Main earthing grid) will be made underground by using 50 mm x 6 mm GI earthing strip connected to earth electrodes in loop-in & loop-out system and connecting the electrical equipment to network. In RCC cable trench one number earth strip of size 50 x 6 mm shall be run throughout the length of the trench.

7.5 Earthing system around each building shall be laid at distance approximately 1.5 meter from the building & at a depth of approximately 0.8m. The ring shall be bonded at intervals to the building steel structure, reinforcement of building columns & pipes wherever they are crossing. The earth ring shall further be connected to deep earthing

electrodes to achieve a combined earth resistance of less than One or Two ohm as specified earlier.

7.6 In process unit areas, the earthing cable shall be run along cable trays wherever specified in the layout drawings. The earthing cable shall be suitably cleated and electrically bonded to the cable tray at regular intervals.

7.7 Joints and tapping in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below ground shall be welded and suitably protected by giving two coats of bitumen and covering with Hessian tape. All joints above ground shall be by means of connectors/ lugs as far as practicable. Tee connectors shall be used for tapping, earth leads from the main earth loop wherever it is installed above ground. Earthing plates shall be provided for earthing of two or more equipment at a place from earth grid. Where aluminium cable risers are to be connected to the underground GI earth bus, the aluminium cable riser shall be taken to the nearest earth pit and terminated through a bolted joint. If this is not practicable, then G.I. risers shall be brought above grade and a bolted joint shall be made between this GI riser and the aluminium cable termination. This G.I. Riser shall be protected applying two coats of bituminous paint/bitumen on the exposed portion.

7.8 Conduits in which cables have been installed shall be effectively bonded and earthed. Cable armours shall be earthed at both ends.

8.0 INSTALLATION OF EARTH ELECTRODES

8.1 Earth pipe electrodes shall be installed as shown in the earthing layout drawings shall be in accordance with the standard drawings, specification and IS: 3043. Their location shall be marked to enable accurate location by permanent markers.

8.2 All earth electrodes shall preferably be driven to sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. Wherever practicable, the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes.

8.3 All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months. If necessary, a number of electrodes shall be connected in parallel to reduce the earth resistance, shall be in the scope of contractor. The distance between two electrodes shall not be less than twice the length of electrode.

8.4 The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.

8.5 Tentative no of earth pits shown in drawing are only for reference to the contractor. The exact location and number of earth electrodes required at each location shall be determined in the field in consultation with the owner/Engineer-in- Charge, depending on the soil strata and resistivity, to meet the ohmic values prescribed in clause 6.1. The contactor shall design the earthing system accordingly & submit for review & approval.

8.6 Earth Electrodes shall be located avoiding interference with road, building foundation, column etc. Individual earth electrode shall be provided for each lightning arrestor and lightning mast. The electrodes shall be so placed that all lightning protective earths may be brought to earth electrode by a short and straight a path as possible to minimize surge impedance.

8.7 The disconnect facility shall be provided for the individual earth pits to check their earth resistance periodically. All the earth electrodes shall be suitably numbered and this should be indicated in as built drawings.

9.0 CONNECTION

9.1 All electrical equipment is to be doubly earthed by connecting two points on equipment to a main earthing ring. The earthing ring will be connected via links to several earth electrodes. The earth grid formed shall be a closed loop as shown in the drawing with earth electrodes connected to the grid with double strip connection. The cable armour will be earthed through the cable glands.

9.2 In hazardous areas all major process equipments shall be connected to the earthing ring by means of anti- loosening connections and all pipelines will be bonded and earthed on entering the battery limit of the process area.

9.3 The following shall be earthed.

1. Transformer neutrals & body
2. Double Pole & Four Pole structures
3. CT/PT neutrals
4. Neutral Grounding Resistors
5. Lightning Arrestors
6. All switchgear and their earth buses, bus duct
7. Motor Frames
8. UPS, Telecommunication system, RTU's, Control panels & other instruments etc.
9. Non-current carrying metallic parts of electrical equipment such as switchgear, switch racks, panel boards, motor control centres, lighting, power and instrument panels, push button stations, cable trays, pipes, conduits, terminal boxes, etc.
10. All fences, gates/enclosures, housing electrical equipment
11. All steel structures, rails etc. including bonding between sections
12. Shield Wire
13. Structural steel and Columns
14. Loading racks
15. Lighting Mast, poles
16. Lighting rods (Mast)
17. Tanks and vessels containing flammable materials.
18. Rotating parts of the agitators, pumps etc. through spring loaded brushes of suitable grade.
19. Earth continuity conductor shall be provided for flanges.

Conductor size for connection to various equipments shall be as indicated on Earthing Layout Drawings.

9.4 Two distinct conductors directly connected to independent earth electrodes, which in turn shall be connected to the earth and earth system. The earth connection shall be properly made. A small flexible aluminium cable loops to bridge the top cover of the transformer and the tank shall be provided to avoid earth fault current passing through fastening bolts when there is a Lightning surge, high voltage surge or failure of the bushings.

9.5 Each Lightning Arrestor shall be connected to a separate electrode located as close as possible to it and within the fenced area for each set of arrestors. The two nos. electrodes for each set of arrestors shall be spaced about 5 meters apart so that they are all within the enclosing fence. Each of these electrodes shall be connected to the main earth grid.

9.6 The shield wire shall be connected with the main grid solidly and not through supporting steel structures.

9.7 All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.

9.8 All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground. In case of G.I. Earth Loop all underground "T" connections shall be of the same size as main loop however in case of PVC insulated aluminium conductor loops underground joints shall be completely avoided. Connections to motors from earth plate or main loop conductor brought above ground shall not be less than following:

Equipments	**Earthing Conductor size**
Grid & equipment such as: Main Electrical Distribution Board Silent D. G. Set	50 x 6 mm GI Flat
Utility building PDB, MLDB, Switch Socket DB, UPSDB, Lighting DB etc	25 x 5 mm GI/16 sq. mm GI rope
FLP – WP lights/control station	6 sq mm solid GI Wire
Product pipe line	16 sq mm flexible copper wires
Mechanical equipment / Vessels, Tanks, Pipe/cable racks, structure, fencing	50 x 6 mm GI Flat
RTU, Telecom, UPS	25 x 5 mm copper
Field Instruments	2.5 sq mm PVC Cu Wire

Jumper for flanges 50 x 2 mm Copper Strip

Anchor bolts or fixing bolts shall not be used for earthing connection.

9.9 All hardware used for earthing installations shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections of equipment.

9.10 Lighting fixtures shall be earthed through the extra core provided in the lighting cable for this purpose.

10.0 TESTING OF EARTHING SYSTEM

Earthing systems/connections shall be tested as follows:

10.1 Resistance of individual electrodes shall be measured after disconnecting it from the grid.

10.2 Earthing resistance of the grid shall be measured after connecting all the electrodes to the grid. The resistance between any point on the metallic earth grid and the general mass of earth shall not exceed 1 ohm.

10.3 The resistance to earth shall be measured at the following:

1) At each electrical system earth or system neutral earth.
2) At each earth provided for structure lightning protections.
3) At one point on each earthing system used to earth electrical equipment enclosure.
4) At one point on each earthing system used to earth wiring system enclosures such as metal conduits and cable sheaths or armour.
5) At one point on each fence enclosing electrical equipment.

Measurement shall be made before connection is made between the ground and the object to be grounded.

11.0 LIGHTNING PROTECTION

11.1 Lightning protection system shall generally comprise lightning finials (air terminals or collector rods), roof conductors or collector lines, down conductors, test links, and earth electrodes. The number, types, materials and sizes shall be in accordance with the drawings.

11.2 Air terminals shall be mounted on top of buildings or structure as required. All air terminals shall be inter-connected with roof conductors, pipes, hands rails or any other metallic projection above the roofs shall also be bonded to the roof conductors.

11.3 Down conductors from air terminals or from roof conductors shall be routed as directly as possible to the test links on earth buses, with minimum bends.

11.4 All provisions regarding connections of conductors for equipment earthing system shall also apply to lightning protection system.

11.5 In corrosive atmospheres, plumbing metal for corrosion protection shall cover lightning finials or air terminals.

11.6 The layout and design of lightning protection systems for building extensions or new buildings and structures provided within existing station areas shall match the existing design.

11.7 All connections between the different parts of lightning protection systems and the connections to the earthing system must be performed in a manner such that the arising of chemical elements will be avoided.

12.0 COLLECTORS

Collectors shall be determined in accordance with the lightning ball method. Collectors may comprise a combination of the following components:

- Collector lines
- Collector rods

12.1 Natural Components Of Collectors

Metal cladding, metal roof structures, metal components of roof Structures, gutters and railings may be considered as natural components of collectors.

The requirements of the standards, such as the following, have to be considered:

- Parts must be permanently conductively connected,
- Minimum thickness of the metal involved,
- Cross-sections of the parts.

Installations with metal casings need not to be fitted with collectors taking into consideration the above-mentioned minimum requirements.

Protective coatings or insulation between metal parts shall be electrically bridged.

12.2 Mesh Type Collectors

Buildings shall be provided with mesh-type collector lines. The collectors have to be configured in a way such that no point of the roof is at a distance of more than 5 m from a collector.

The maximum permitted mesh size is as follows:

- Buildings with telecommunication or control rooms 10 x 10 m
- Other buildings 10 x 20 m

Protruding roof superstructures, such as ladders, chimney stacks, pipes, antenna mounting brackets, etc. and other metallic parts of buildings which are located near the roof (e.g. louvers of ventilation openings) must be directly connected to the collector lines.

12.3 Collector Rods

Collector rods shall be used for roof superstructures featuring mechanically or electrically operated equipment, such as ventilators and non-conductive parts projecting from the mesh plane by 0.3 m. The angle of protection and a certain minimum distance have to be observed.

Outdoor electrical facilities for HVAC or other purposes not located in the protective area of earthed structures, installations or buildings, including exposed electrical equipment shall be protected by collectors.

Buildings with sheet metal roofs where the thickness of the sheet is smaller as the required value, the collector mesh must be equipped with collector rods of sufficient quantity and length to avoid lightning strokes in the sheet metal.

12.4 Down Conductors

Down conductors shall be selected in a manner such that there are several parallel current paths between the collector and the earthing system. The length of each down conductor is to be kept as short as possible.

Steel structures and steel columns of buildings may be used as down conductor, if the minimum sizes according to the standards are guaranteed. In each case the connections with the earthing system and collectors respectively must be visible and removable.

Starting from the corners of the structure involved, conductors should be distributed around the exterior as evenly as possible. They must be configured in such a way as to constitute the direct continuation of the collector. The minimum distance between conductors and doors, windows and other apertures must be 0.5 m.

If not already connected with the collectors or with the internal potential equalisation, larger metal parts mounted in/on the building outer walls (e.g. frames of doors, ventilation louvers) shall be terminated on the down conductors. The number of down conductors and the minimum distance between the conductors is given as follows:

a) Buildings containing telecommunication and control systems
- Minimum number of conductors: 4
- Maximum distance between conductors: 10 m

b) Other buildings
- Minimum number of conductors: 2
- Maximum distance between conductors: 20 m

All down conductors which are connected to the earthing system must be provided with an accessible isolating point for measuring purposes. For termination the grounding bars of grounding loops shall be used, preferably. No conductors are required for outdoor

metal structures of adequate size.

12.5 Inadmissibly Short Distances

Inadmissibly short distances between the lightning protection system and metal installations or electrical equipment shall be prevented. In the event of potential hazard due to flash-over or disruptive discharge caused by lightning, appropriate measures shall be taken.

Admissible distances between lightning protection systems and metal installations, electrical wiring and equipment shall be determined in compliance with the standards. This also applies to the use of special roof-mounted collectors.

13.0 TESTS OF LIGHTNING PROTECTION SYSTEM

After erection of the earthing and lightning protection system all installations shall be tested in accordance with applicable regulations

The following tests shall be carried out, at least:

- Measures against corrosion protection and arising of chemical elements,
- Check of all connections,
- Measurements of earthing system resistance,
- Measurements of lightning protection system conductivity,
- Check of mechanical details,
- Compliance with specifications.

The aim of the tests is to ensure the proper function of the complete scope. The measuring results and the locations of the measuring points have to be indicated in respective drawings as a basis for future measurements.

14.0 DOCUMENTATION

Complete documentation shall be provided for the design, construction, testing, maintenance and repair of the earthing and lightning protection systems and their components.

The documentation shall be in English language.

The following drawings/documents shall be submitted for approval within 3 weeks of award of contract.

a) Soil resistivity survey report
b) Technical data sheets
c) Earthing design calculations
d) Lightning protection design calculations
e) Earthing grid layouts
f) Construction drawings
g) Spare parts list

h) Operation and maintenance manuals
i) Test reports

The documents listed above shall be handed over for approval. Special attention has to be given to the fact, that documentation must be submitted with sufficient time allocated for approval prior to manufacturing / assembly. The documentation has to be prepared in accordance with the relevant ISO standards. The final documentation shall be delivered on paper in sufficient number and with exception of the signed protocols in electronic form, also. The type of the electronic files and the number of copies shall be agreed with the Client.

After commissioning & testing of earthing system contractor shall submit the following document to Client/MECON for As-Built status in hard copy (5 set) plus one soft copy.

a) Soil resistivity survey report
b) As built earthing grid layouts & earth electrode installations
c) Construction drawings

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Rev.: 0
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SPECIFICATION
FOR
ELECTRICAL INSTALLATION IN BUILDINGS

SPECIFICATION NO.- MEC/TS/05/E9/03, R-0

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

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AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)
1.	LED Lights included	-	-	Oct'15	AM	MKJ

1.0 SCOPE

The intent of this specification is to define the requirements for the design, testing at manufacturer works, supply, erection, testing and commissioning of the electrical installation inside buildings, shelters, sheds etc.

2.0 STANDARDS

2.1 The work shall be carried out in the best workmanlike manner, in conformity with this specification, the relevant specifications/ codes of practice of the Indian Standard Institution, approved drawings and instructions of the Engineer-in-Charge or his authorized representative issued from time to time.

2.2 In addition to the standards mentioned in 2.1, all work shall also conform to the requirements of the following:

i) Indian Electricity Act and Rules

ii) Fire Insurance Regulations

iii) Regulations laid down by the Chief Electrical Inspector of the State, State Electricity Board.

iv) Regulations laid down by the Factory Inspector of the State.

v) Any other regulations laid down by the local authorities.

IS: 732 / IEC 60364	Code of Practice for Electrical Wiring Installations
IS: 10492	General requirements and testing of anchor cable stoppers
IS: 12459	Code of Practice for Fire Safety in Cable Runs
IS: 14927	Cable Trunking and Ducting Systems for Electrical Installations
IS: 13984	Socket for conventional Wiring
IS: 5571/ IEC 60079	Guide for Selection of Electrical Equipment for Hazardous Areas
IS: 3854/ IEC 60669	Switches for domestic and similar purposes
IS: 4160	Interlocking switch socket outlet
IS: 4615/ IEC 60309	Switch socket outlets (non-interlocking type)
IS: 418	Tungsten Filament Lamps for Domestic and Similar General Lighting Purposes
IS: 1112	Glass shells for general lighting service lamps
IS: 6665	Code of practice for industrial lighting
IS: 3553	Specification for Watertight Electric Lighting Fittings
IS: 3528	Waterproof electric lighting fittings

2.3 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet

v) Standard specification
vi) Codes & standard

3.0 GENERAL REQUIREMENTS

3.1 COMPONENTS AND EQUIPMENT

The Contractor has to take care that all components and equipment are selected considering easy maintenance, simple and quick diagnosis and long maintenance intervals. All components and equipment shall be designed for starting and continuous duty at rated load and under the given climatic conditions. Standard industrial components shall be used as far as possible. Components and equipment of same kind and type shall be selected for equivalent functions & shall have interchangeability.

3.2 TAGGING

All lighting fixtures shall receive the respective tagging plates, labels that indicate lamp type and lighting circuit etc, which have to be of extremely durable material, resistant against the environmental conditions. All equipment and installations must be tagged regarding the function and according to the drawings.

3.3 RATED DESIGN DATA

The electrical installation is to be designed for the following rated voltages:

Indoor Lighting: 230 V AC, 50 Hz, single phase (distribution should be in phase balance)

Socket outlets: 230 V AC, 50 Hz, single phase

Power socket/Welding socket outlets: 415 V AC, 50 HZ, three phase and neutral

For extension of existing buildings, the available voltage level and distribution system must be considered.

4.0 LIGHTING SYSTEM

4.1 INDOOR

GENERAL

Lighting installation for all indoor rooms and buildings, structural sheds, walk-ways, sheltered process installation etc includes the luminaries and all necessary switches, push buttons, switchboards, terminal boxes and installation facilities/accessories.

i) The lighting fixtures in the plant/structural shed are fed from lighting panel and group controlled from Local Control Station/LDB as per construction drawing/Cable schedule and site requirement. Electrical cable between Main Lighting panel and Local Control Station/LDB shall be as per Cable schedule/SOR. Wiring between Local control station/LDB and lighting fixtures in the plant/structural shed shall be done by PVC insulated, PVC inner Sheathed, PVC outer sheathed, FRLS 3-core (phase, neutral and earth) un-armoured/armoured cable for hazardous areas & non-hazardous areas in GI conduits/Cable

tray. GI conduit shall be supported at minimum distance of 1000mm. The lighting fixtures are grouped (3-5 fixtures or as per site condition and construction drawing) & controlled from Local Control Station/LDB through MCB's.

ii) The lighting fixtures in the buildings are fed & group controlled from switchboard as per construction drawing and site requirement. Electrical cable between LDB and switchboard shall be done by means of 3-core copper conductor PVC insulated, armoured cables or PVC insulated copper conductor flexible wires in PVC conduit as specified. Wiring between switchboard and lighting fixtures in the building shall be done by PVC insulated copper conductor flexible wires in PVC conduit as specified. All joints of conductors in Switch board/JBS/Fitting shall be made only by means of approved Mechanical connectors (nylon/ PVC connectors). Bare or twist joints are not permitted any where in the wiring system. Cost toward mechanical connectors is deemed to have been included in wiring.

iii) The lighting layouts furnished by MECON in drawings shall indicate approximately locations of lighting fixtures. The electrical contractor shall determine the exact nos. of lighting fixtures according to lux level indicated else where in this specification with approval of the Engineer-in-Charge or his authorized representative at the site. The exact locations of each fixture in order to avoid interference with piping or other mechanical equipment and also with a view to obtain as uniform illumination as practicable, and to avoid objectionable shadows. Conduit run shown on drawing are only indicative. The contractor shall decide the conduit run according to site conditions as per directions of the Engineer-In-Charge.

iv) On walkway, platforms, panel boards, other equipment requiring good illumination, lighting fixtures shall be nearer to these area to achieve good lux level.

v) Socket outlets in process areas shall be approximately 1200mm above finished grade and 300mm above grade in office area.

vi) In electrical room, battery room buildings & corridors, twenty (20) percent but at least two (02) & In the control rooms, additionally thirty (30) percent but at least three (03) of the lighting fixtures per room & shall be supplied with electric energy by the Emergency DG set or Emergency Inverter or UPS power supply. In all other rooms, at least one lighting fixture per room shall be supplied with electric energy by the Emergency DG set or Emergency Inverter or UPS power supply. The wiring for these emergency lighting shall be in scope of contractor.

vii) Fixtures shall be firmly supported from the structures, support clamps etc. may be bolted or welded to the existing steel work or metal inserts. In case of concrete structures, where metal inserts are not available, fixtures will be fixed to or supported from concrete surfaces with the help of anchor fastener. In such cases special care shall be taken to see that anchoring is firm.

viii) All hardware shall be galvanized or zinc passivated. Circuit cables shall be group cleared to structure by using galvanised strip clamps or run in cable trays wherever they are available. Spacers and cleats shall be of suitable size to accommodate the cables shall be got approved by Engineer-in-Charge before fixing from at site. For isolated structures lighting cables may be taken in underground G.I. pipes.

ix) The cost for cable clamps, metal spacers, anchors bolts, etc. shall be deemed to have been included in the installation of cables.

x) Contractor shall have close watch on the lighting drawings issued to him. Any discrepancy noticed between the figure given in the drawing and the actual requirement at site, shall be immediately brought to the notice of Engineer-in-Charge by the Contractor.

xi) All the fluorescent lighting wirings to be supplied under this contract shall consist of chokes, starters and capacitors. The fittings shall be high power factor type and shall be supplied with white light fluorescent tubes. All the lighting fittings shall be supplied complete with cable glands wherever applicable and the cost for the glands shall be deemed to have been included in the supply of fixtures.

xii) Mounting details shall be indicated on the drawings. If specified on the drawings, a group of fluorescent lighting fixtures, which are to be mounted end to end, shall be fixed to mild steel cold rolled sections "Metsec channel". The entire assembly will then by fixed to the ceiling with necessary number of supports as required to reduce the deflection. The `Metsec' channel shall run continuous in suitable sections from one end to other end of wall. The complete channel shall be spray painted, with approved colour as per the directions of Engineer-in- Charge. Nylon tape & buttons shall neatly bunch all wires inside channel.

xiii) Fixtures shall be firmly supported from the structures. Support clamps etc., may be bolted or welded to the existing steel works or metal inserts. In case of concrete structures minimum two numbers metallic anchor fasteners of approved size shall support fixtures. All supports shall be thoroughly cleaned and painted in an appropriate colour to suit the fixture.

xiv) In case of false ceilings employing minimum tee grid system, fixtures shall be supported from true ceiling. Exact locations of fixtures shall be supported from true ceiling. Exact locations of fixtures shall be finalized in consultation with air-conditioning contractor and as indicated on Architectural drawings. Wiring above false ceilings shall not be left loose and shall be supported along the structures/ceilings. Wiring above false ceiling shall be on surface and below false ceiling it shall be concealed. To facilitate easy maintenance `Looping back system' of wiring shall be followed throughout. Accordingly supply tapping and other interconnections are made only at fixtures connector blocks or at switch boards. Intermediate junction boxes shall be used for wire pulling as inspection boxes.

xv) All wires in conduit shall be colour coded as specified/as per IS. Each circuit shall have independent phase neutral and earth wire. Unless otherwise specified, insulated conductors of ac supply and dc supply shall be bunched in separate conduits.

Illumination Levels

The following illumination levels, after allowing for a 0.7 maintenance factor, shall form the basis for the lighting design:

Location Illuminance

LOCATION	Illuminance
Control rooms	400-500
Pump Houses (near equipment / metering area), structural sheds	200-300
Switchrooms, Electrical rooms, Battery rooms	200-300
Offices rooms, I/C Room	300-400

Workshops	300-400
Toilets, locker rooms, Storage rooms	100-200
Floors, stairways, cable cellars, walkable ducts, Corridors etc.	50
Sheltered or housed process installation	100

The illumination level and the type of luminaries in the various rooms must ensure a smooth and good illumination according to the demand, application and lay-out of the rooms.

4.2 LUMINARIES

The luminaries provided shall be suitable for standard lamps, preferably 11 W, 18 W, 25 W, 36 W or higher for fluorescent lamps/LED lights (as per SOR) and 70 W, 150 W, 250 W or 400 W HPMV/HPSV lamps or LED lights as specified in scheduled of rates & design basis. All luminaries must be fully equipped with starter and power factor compensation.

4.3 SOCKET OUTLETS

i) Power Socket Outlets/Welding receptacles

Power socket outlets shall be three phases, neutral and earth in compliance with IEC/IS-standard.

Power socket outlets with a nominal current of 16 A or specified in SOR shall be provided in sufficient quantity in all workshops, pump houses, structural sheds, electrical rooms etc as per drawings & instruction of Engineer-in Charge. Each workshop and each pump house must be equipped additionally with at least one power socket outlet with a nominal current of 32 A or 63A as specified in scheduled of rates. Each Power socket outlet must be protected by means of a dedicated miniature circuit breaker located in the distribution boards.

ii) Industrial Socket Outlets

Socket outlets shall be single phase, neutral and earth according to IEC/IS. Socket outlets shall be installed in sufficient number in each room as per tender drawings enclosed and instruction of Engineer-in-Charge. Socket outlets shall be protected by means of miniature circuit breakers as per construction drawing. Socket outlets designed for supplying dedicated consumers e.g. AC, boilers, heaters, refrigerators, etc.

iii) Receptacles/Convenience Socket Outlets

5A/15A combination type receptacles manufactured in accordance with IEC/IS: 1293 shall be used with the third terminal connected to the earth. All receptacles shall be provided with a switch mounted on the same enclosure but shall be a separate unit to facilitate replacement by part. Flush mounting type receptacles shall be used in areas where concealed wiring has been adopted and surface type shall be used in other areas.

iv) Switches

Switches, manufactured in accordance with IS: 3854 shall be used. Switches in areas where concealed wiring has been adopted shall be flush mounting piano type unless

otherwise specified. The switches shall be Shock proof, Fire retardant & Dust proof with more switching operations. Electronics type fan regulator shall be used for ceiling fans. Design and models of the regulator shall be same as that of switches.
Outlet Boxes

5.0 OUTDOOR LIGHTING

For outdoor lighting refer specification for outdoor lighting-MEC/TS/05/E9/03A.

6.0 CONDUIT SYSTEM

Surface or concealed conduit system of wiring shall be adopted, as specified in the drawings. Suitable pull boxes or inspection type fittings will be used to facilitate drawing of wires.

SURFACE WIRING

6.1 Only threaded type GI conduit fittings shall be used. Pin Grip type or clamp type fittings are not acceptable. Conduit ends shall be free from sharp edges or burrs. The ends of all conduits shall be reamed and neatly bushed with bakelite bushings.

6.2 In order to minimize condensation of sweating inside the conduit system, all cables shall be properly drained & sealed with non hardening silicon compound in such a manner so as to prevent entry if insects.

6.3 The outer surface of the GI conduit pipes, including all accessories forming part of the conduit system, shall be adequately protected against rust, particularly when such system is exposed to weather. In all cases, bare threaded portion of conduit pipe shall not be allowed unless such bare threaded portion is treated with anti corrosive preservative or covered with approved plastic compound.

6.4 Conduit connection to outlet boxes shall be by means of screwed hubs or check nuts on either side.

6.5 Conduit pipes shall be fixed by 16 gauge G.I. Saddles on 25x6 mm G.I. Saddle bars in an approved manner at intervals of not more than 500 cms vertical support & 1000mm for horizontal support. Saddles shall be fixed on either side of couplers, bends or similar fittings, at a distance of 30 cm from the center of such fittings. The cost of saddle bars, FLP junction box, saddles, clamps, etc. Shall be deemed to have been included in the installation of conduits.

CONCEALED WIRING

6.6 Where concealed wiring is to be adopted, PVC conduits shall be laid in time before concreting of the slab. The Contractor shall coordinate his work with other agencies involved in the civil works in such a way, that the work of these other agencies is not hampered or delayed because of any section on his part. Vertical conduit runs shall be made either through columns or chases prepared in the walls. Contractor shall fill these chases or any other openings made by him after completing. During Installation, care shall be taken to see that adequate covers are provided to the conduits. If required, conduits run may be concealed in the floor for low-level receptacles and exhaust fans. Contractor shall submit as built conduit layout drawing.

6.7 Wiring for exhaust fans shall be terminated at wall/receptacles and the connection from ceiling roses/ receptacles to the exhaust fan shall be by means of a flexible cord equivalent in size to the main run of wires.

6.8 After erection, the entire conduits system shall be tested throughout, for mechanical and wiring in conduit shall be tested for electrical continuity and shall be permanently connected to earth by means of approved type earthing clamps, in accordance with Indian Electricity Rules.

7.0 HAZARDOUS AREA

7.1 Wiring in hazardous area shall be done by minimum 2.5 mm2 Copper Conductor armoured, PVC insulated, FRLS cables.

7.2 Correct type of lighting equipment (fixtures and JBs etc.) as specified in the drawing, shall be installed for the particular classified zone 1 (Class I Div. I) and Zone 2 (Class I Div.II) locations as specified in design basis.

7.3 The wiring in hazardous area shall be carried out by highly skilled wireman with due regard for perfect terminations. The terminations in the junction boxes and the lighting fittings shall be done so as not to work loose due to vibrations. After the terminations are made the cover of the junction boxes and the lighting fittings shall be closed to make the complete fittings weatherproof. In fixtures having double cable entries, both the entries shall be used for looping in and looping out connection. Thus avoiding the use of a separate junction box.

7.4 Suitable size double compression nickel plated brass cable glands (Approved by CMRI as suitable for flameproof area) shall be provided for cable entry/exit to any of the flame proof apparatus.

7.5 The rate quoted shall include the cost of accessories required like FLP JB's, saddles, consumables etc for supply and installation of complete wiring system.

8.0 EQUIPMENT SPECIFICATIONS

All materials, fittings and appliances to be supplied by the contractor shall be of the best quality and shall confirm to the specifications given hereunder. The equipment shall be manufactured in accordance with the latest revision of respective Indian Standards. In the absence of any specifications, Material samples shall be brought to site by Contractor and get it approved by Engineer-in-Charge or his authorized representative before installation.

Each circuit phase/neutral shall be given ferrule numbers. Complete wiring inside the panel shall be neatly bunched with PVC tape & button. All cables entries shall be as marked in the schedule. Cables glands for PVC insulated armoured cables of sizes as specified on panel schedule shall be provided for the incoming cables of all surface mounted panels. For the outgoing circuits of these panels cable glands or conduit entry shall be provided as specified on panel schedule. Conduit entry shall be provided for the incoming and outgoing circuits of all flush mounted panels. All metal surfaces shall be cleaned free of rust given a coat of red-oxide primers and finished with 2 coats of approved paints.

8.1 Outlet Boxes

Outlet boxes for sockets, switches, fixtures and fan regulators etc shall be of minimum 16 gauge & M.S. Sheet 3" deep. Junction/Outlet boxes shall be used in roof slab where concealed wiring has been adopted. Front cover plate shall be of sheet steel in areas where surface wiring has been adopted. For concealed wiring the front cover plate shall be of Formica or approved equivalent with colour to suit the walls. Outlet boxes shall be electro-galvanized after fabrication. Cover plate shall be fixed by Nickel plated brass screw and suitable C.P. brass cup washers. Engineer-in-Charge shall approve samples of these.

8.2 Conduit and Fittings

GI conduits-

GI conduits shall be of galvanized iron, rigid, screwed type. The internal bore of all conduits shall be smooth 7 free from burrs. Conduits upto 32mm dia shall of 1.6 mm thick & conduits above 32 mm shall be 2mm thick.

PVC conduits-

PVC conduits shall be used in concealed wiring of 1.8 mm thickness.

For surface wiring GI conduit (in industrial buildings) and ERW conduit (in non industrial buildings) shall be used.

Point wiring shall included the length of conduits (GI & PVC) including all other accessories like joints, bends, junction/pull boxes etc as required for illumination & wiring.

Care shall be taken to see that all conduit ends have no burrs and ends are neatly reamed to avoid damage to wires. All metal conduit accessories shall be only of threaded type. Pin grip or clamp type accessories are not acceptable. Samples of these shall be furnished for approval by Engineer-in-Charge at site, before installation.

8.3 Wires

Wires shall be PVC insulated 660/1100 Volts grade as per IS: 1554. Conductor shall be stranded copper and size shall be Min. 2.5 mm^2 for lighting and Min. 4 mm^2 for power socket and industrial socket for Air Conditioner circuits. Red/ Yellow/ blue wires for phases black wire for neutral and green wire for earth shall be used. Wiring in conduits without colour coddling is not acceptable. Engineer-in-Charge shall approve make and samples of this before lying.

9.0 TESTING AND COMMISSIONING

Lighting installation shall be tested as per the instruction of Engineer-in-Charge and shall include but not be limited to the following:

9.1 Measure the insulation resistance of each circuit without the lamps (load) being in place and it should not be less than 500,000 ohms to earth.

9.2 Current and voltage of all the phases shall be measured at the lighting panel bus bars with all the circuits switched on with lamps, if required load shall be balanced on the three phases.

9.3 Check the earth continuity for all sockets outlets. A fixed relative position of the phase and neutral connections inside the socket shall be established for all sockets.

9.4 After inserting all the lamps and switches on all the circuits minimum and maximum illumination level should be measured in the area.

9.5 Ensure switch ON/OFF control for each point (light/fan/socket) is only on live side.

9.6 Contractor shall submit and forward the test reports of complete electrical installation in buildings to Engineer-in-Charge.

10.0 DOCUMENTATION

Complete documentation shall be provided for the design, manufacturing, testing, commissioning, start-up, operation, maintenance and repair of the electrical building installation and its components. The final documentation shall include the following documents and drawings (minimum requirements):

The following documents shall be submitted along with the offer:

a) Recommended list of two years operation and maintenance spare.

The following drawings shall be submitted for approval within 3 weeks of award of contract.

a) Data sheets of components
b) Single line diagrams
c) Wiring diagrams
d) Cable lists
e) Cable calculations
f) Cable route drawings within buildings
g) Installation details
h) Type test reports of various equipments

The documents listed above shall be handed over for approval. Special attention has to be given to the fact, that documentation must be submitted with sufficient time allocated for approval prior to manufacturing/assembly.

Documentation has to be prepared in accordance with the relevant ISO standards. The final documentation shall be delivered on paper in sufficient number and in electronic form, too.

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Rev.: 0
Edition: 1

SPECIFICATION
FOR
OUTDOOR LIGHTING

SPECIFICATION NO. - MEC/S/05/E9/03A, R-0



(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

CONTENTS

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ANNEXURE-1 SPECIFICATION FOR GALVANIZED IRON OCTAGONAL POLES

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION OIL & GAS SBU, DELHI		
TITLE	OUTDOOR LIGHTING	DOCUMENT NO. MEC/S/05/E9/03A	Page 1 of 1 REVISION : 0 EDITION : 1

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)
1	LED lights included	-	-	Oct'15	AM	MKJ

1.0 SCOPE

The intent of this specification is to define the requirements for the design, supply, installation, erection, testing and commissioning of the outdoor lighting within the station area.

2.0 STANDARDS

The work shall be carried out in the best workmanlike manner, in conformity with this specification, the relevant specifications/ codes of practice of the Indian Standard Institution, approved drawings and instructions of the Engineer-in-Charge or his authorized representative issued from time to time.

In addition the design, manufacturing, construction, installation, test and commissioning of outdoor lighting shall be in accordance with the following codes and standards, at least. The latest revision of the publication referred to shall apply.

i) Indian Electricity Act and Rules framed thereunder.

ii) Regulations laid down by the Chief Electrical Inspector of the State, State Electricity Board.

iii) Regulations laid down by the Factory Inspector of the State.

iv) Any other regulations laid down by the local authorities.

IS: 418/IEC 60598	Tungsten Filament Lamps for Domestic and Similar General Lighting Purposes/Luminaries
IS: 1112	Glass shells for general lighting service lamps
IS: 2418	Tubular Fluorescent Lamps for General Lighting Service
IS: 4012	Dust-proof Electric Lighting Fittings
IS: 5571 IS: 1944	Guide for Selection of Electrical Equipment for Hazardous Areas
IS: 2147/IEC 60529	Degrees of protection provided by enclosures (IP Code)
IS: 2165/IEC 60664	Insulation coordination for equipment within low-voltage systems
IEC 60085	Thermal evaluation and classification of electrical insulation

2.1 Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.2 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 ENVIRONMENTAL CONDITIONS

The outdoor lighting shall be suitable for continuous operation at rated load under the climatic and environmental conditions defined in the "Design Basis". The various equipment shall be appropriate for outdoor installation.

4.0 GENERAL REQUIREMENTS

4.1 Components and Equipment

The Contractor has to take care that all components and equipment are selected considering easy maintenance, simple and quick diagnosis and long maintenance intervals. All components and equipment shall be designed for continuous duty at rated load and under the given climatic conditions. Standard industrial high performance systems and components of suppliers standard lists shall be used as far as possible. Components and equipment of same kind and type shall be selected for equivalent functions.

4.2 Tagging

All components, equipment and installations shall receive the respective tagging plates, labels, etc which have to be of extremely durable material resistant against the environmental conditions. Tagging plates or labels on fronts of enclosures shall be fixed with screws.

5.0 DESCRIPTION OF LIGHTING SYSTEMS

For the purpose of illumination at outdoor areas within stations, the lighting system shall be divided into the following lighting sub-systems:

5.1 Station area lighting

The station area lighting will be provided by high Mast, Flood Light & Pole/Bracket Mounted Lighting fixture as per Schedule of rates.
The lighting shall mainly consist of flood light and street light fixtures (Pole/Bracket Mounted) equipped with high pressure discharge lamps (HPMV/HPSV/MH) or LED lamps mounted on poles and if necessary, with Pole/Bracket Mounted fixtures fluorescent lamp/LED light may be used as per particular requirement.

As far as possible, the maximum horizontal illumination levels of the lighting shall be near the equipment located in outdoor area.

5.2 Shed/Shelter lighting

The Shed/Shelter area lighting will be provided by Industrial High/Medium/Low Bay Integral/non-integral fixture, Industrial Integral/non-integral well glass fixture, Industrial T5 fixture as per Schedule of rates.

The lighting fixtures shall mainly consist of high pressure discharge lamps (HPMV/HPSV/MH).

As far as possible, the maximum horizontal illumination levels of the lighting shall be near the equipment located in Shed/Shelter.

5.3 Road/street and parking area lighting

The road/street and parking area lighting will be provided for all roads and parking areas. The lighting shall mainly consist of Pole/Bracket mounted street lighting fixtures, equipped with high pressure discharge lamps (HPMV/HPSV) or LED mounted on poles, if necessary, with Pole/Bracket Mounted fixtures fluorescent lamps/LED lights may be used as per particular requirement. The maximum horizontal illumination level of the lighting shall be in the middle (axis) of the roads and parking areas, respectively.

5.4 Entrance lighting

The entrance lighting will be provided for all doors and gates all buildings. The entrance lighting shall mainly consist of wall mounted lighting fixtures, equipped with fluorescent lamps/LED lights.

5.5 Periphery/Fence lighting

The Periphery/fence lighting will be provided for the boundary of stations. The lighting shall mainly consist of pole/bracket mounted flood light equipped with high pressure discharge (HPMV/HPSV) lamps or street light or T5 fixture with fluorescent lamp or pole/bracket mounted LED lights. The poles of Periphery/Fence lighting have to be installed inside the boundary or on the wall for bracket mounted fixture. Illumination level and the design of the devices of Periphery/Fence lighting must be in accordance with the relevant IS/IEC requirements.

5.6 Post top lantern

Two no. of post to lantern with CFL/LED luminary shall be provided at Main Gate of terminal.

5.7 Emergency solar street light

A stand alone dusk-dawn solar photovoltaic street lighting system comprises of solar PV module, CFL/LED lamp, lead acid battery, control electronics, Inter-connecting wire/cables, Battery box, Module mounting hardware, GI-Pole as per SOR.

6.0 RATED DESIGN DATA

The outdoor lighting shall be designed on basis of the following minimum requirements:

a) Average of illumination levels

- Station areas 25-30 lx
- Roads, streets 15 - 20 lx
- Parking areas 15 lx
- Entrances 30-40 lx

- Fences 5 – 10 lx

b) Uniformity of illumination levels

- Station areas 1: 3
- Roads, streets 1: 6
- Parking areas 1: 6
- Fences 1: 5

The uniformity of illumination levels means the ratio between the lowest and the highest measured horizontal illumination level in the reference area.

The outdoor lighting shall be fed with a voltage of 3 x 415V/1x230 V, 50 Hz, or with other voltages if supplied from existing switchboards.

7.0 LIGHTING POLES

For specification of lighting poles please refer **Annexure-I.**

8.0 LIGHTING FIXTURE FOR HAZARDOUS AREA

Refer specification no **MEC/TS/05/E9/077** for hazardous area fixtures.

9.0 HIGH MAST

Refer specification no **MEC/TS/05/E9/077A** for High Mast.

10.0 LIGHTING FIXTURES

10.1 Flood Light Fixture

The flood light fixtures shall consist of the following main parts:

- High pressure die-cast aluminium body and front cover frame, polyester powder coated (IP65)
- Electro polished, anodized and sealed aluminium reflector
- Lamp holder with adjustable for centralising the lamp within the fixture
- Heat resistant toughened front glass
- Hinged front cover
- Non-integral gear
- Galvanized steel stirrup with protractor for setting of elevation angle.

The flood light fixtures shall be equipped with HPMV/HPSV/MH/LED lamps of sufficient wattage (As specified in SOR/ Design Basis).

10.2 Street Light Fixture

The street light fixtures shall consist of the following main parts:

- Die-cast LM6 aluminium housing, polyester powder coated (IP65)

- Hydro formed, one piece reflector in high purity aluminium, anodised and electrochemically brightened
- A toughened heat resistant clear glass fixture.
- Integral/Non-integral gear with power factor improvement capacitor as per SOR

The street light fixtures shall be equipped with HPMV/HPSV/MH/LED lamps of sufficient wattage (As specified in SOR/ Design Basis).

LED lights/ Mercury Vapour or MH lamp used for lighting as per SOR/Design basis, unless otherwise specified Sodium vapour lamps may be used.

The fixtures shall be specially protected against damage in case of storms/heavy wind flow.

10.3 Street Lighting Fixture with CFL/LED Lamps

The lighting fixtures with fluorescent lamps shall consist of the following main parts:

- Canopy of CRCA MS, epoxy powder coated (IP54)
- Integral/Non-integral gear with power factor correction, steel column bracket for side entry or brackets for wall/structure mounting.

The lighting fixtures shall be equipped with CFL/LED lamps up to 1 x /2x 18W/36W etc (As specified in SOR or Design Basis)

10.4 Cables and Grounding

The lighting cables shall be three phase for connection to single pole fixture. The connection shall take into consideration the load balance on the three phase system. The cross section must be determined according to the current capacities and the voltage drops. The minimum cross section shall be 4 mm^2 for Cu cable & 6 mm^2 for Al cable. Separate grounding connection of the lighting poles and lighting towers with the grounding network shall be provided. Cables installations and the grounding shall be in accordance with specification "Cable Laying" and "Earthing and Lightning Protection", respectively.

11.0 TESTS

After erection of the outdoor lighting system all electrical installations shall be tested in accordance with applicable IEC/IS regulations. The horizontal lighting levels shall be checked by the Contractor in the presence of the Client/Consultant. The test results of the lighting level measurements shall be recorded in a respective report by the Contractor. The checking method shall be worked out by the contractor prior to tests and shall be subject to the Client's approval. The aim of the tests is to ensure the proper function of the complete scope.

12.0 DOCUMENTATION

Complete documentation shall be provided for the design, manufacturing, testing, commissioning, start-up, operation, maintenance and repair of the outdoor lighting and its components.

The following documents shall be submitted along with the offer:

a) Technical data sheets & catalogues
b) Type test reports

The following drawings (in three sets) shall be submitted for approval/review within 3 weeks of award of contract.

a) Street light pole GA & Mounting arrangement
b) Technical data sheets
c) Circuit diagrams
d) Wiring diagrams
e) Calculation of stability for poles
f) O & M Manual
g) Tests reports

ANNEXURE-I

SPECIFICATION FOR GALVANIZED IRON OCTAGONAL POLES

1.0 DESIGN

The Octagonal Poles shall be designed to withstand the maximum wind speed as per IS 875. The top loading i.e area and the weight of Fixtures are to be calculate maximum deflection of the poles and the same shall meet the requirement of BS: 5649 Part VI 1982.

2.0 POLE SHAFT

The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by Submerged Arc welding (SAW) process.

3.0 DOOR OPENING

The octagonal poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall be suitable arrangement for the purpose of earthing.
The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

4.0 MATERIAL

Octagonal Poles	HT Steel Conforming to grade S355JO
Base Plate	Fe 410 conforming to IS 226/IS 2062
Foundation Bolts	EN.8 grade.

5.0 WELDING

The welding shall be carried out conforming to approved procedures and duly qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal shafts.

6.0 POLE SECTION

The octagonal poles shall be in single section (upto 11 mtr). There shall not be any circumferential weld joint.

7.0 GALVANIZATION

The poles shall be hot dip galvanized as per IS 2629/ IS 2633 / IS 4759 standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.

8.0 FIXING TYPE

The octagonal poles shall be bolted on a pre cast foundation with a set of four foundation bolts for greater rigidity.

9.0 TOP MOUNTINGS

The galvanized mounting bracket shall be supplied along with the octagonal poles for installation of the luminaries.

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SPECIFICATION
FOR
LV & MV CABLE

SPECIFICATION NO. - MEC/TS/05/E9/073A, R-1

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

CONTENTS

SL NO.	DISCRIPTION
1.0	SCOPE
2.0	CODES AND STANDARDS
3.0	ENVIRONMENTAL CONDITIONS
4.0	DESIGN REQUIREMENTS
5.0	CABLE SPECIFICATION
6.0	GENERAL REQUIREMENT
7.0	CABLE DRUMS
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9.0	DRAWINGS AND DOCUMENTS
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'MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION ELECTRICAL SECTION, DELHI		
TITLE	LV & MV CABLE	DOCUMENT NO. MEC/TS/05/E9/073A	Page 1 of 1 REVISION : 1 EDITION : 1

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 SCOPE

This specification is intended to detail the selection criteria of MV power and control cables besides covering general requirements, testing at manufacturer's works, packing, transportation and receipt at site.

2.0 CODES & STANDARDS

The work shall be carried out in the best workman like manner in conformity with this specification, the relevant specifications, codes of practice of Indian Standards Institution, approved drawings and instructions of Engineer-in-Charge or his authorized representative issued from time to time. In case of any conflict between the standards, the instruction of Engineer-in-Charge shall be binding.

The cables shall comply in design, material, testing and performance to the following codes and standards. The latest revision of the publication referred to shall apply.

IS-209	:	Specification for zinc.
IS-1554	:	PVC insulated (heavy duty) electric cables.
IS-3961 (Part-2)	:	Recommended current ratings for cables; PVC insulated and PVC sheathed heavy duty cables.
IS-3975	:	Mild steel wires, straps and tapes for armouring of cables.
IS-5831	:	PVC insulation and sheath of electric cables.
IS-7098	:	Cross-linked poly ethylene insulated PVC sheathed cables.
IS-8130	:	Conductors for insulated electric cables and flexible cords.
IS-10418	:	Drum for electric cables.
IS-10810 (Pt-41)	:	Method of test for cables; mass of zinc coating on steel armour.
IS-10810 (Pt-58)	:	Method of test for cables; Oxygen Index test.
IS-10810 (Pt-61)	:	Method of test for cables; Flame Retardant test.
IS-10810 (Pt-62)	:	Method of test for cables; Flame Retardant test for bunched cables.

IS-13573	:	Joints and terminations for polymeric cables for working voltages from 6.6 KV & including 33KV; performance requirements & type tests.
IEC-323-3	:	Tests on cables under fire conditions.
IEC-502	:	Extruded solid dielectric insulated power cables for rated voltages from 1KV upto 30 KV.
IEC-540 & IEC-540 A	:	Test methods for insulation & sheaths of electric cables cords.
ASTM-D2863	:	Standard method of test for flammability of plastics using oxygen index method.
IEC 60028	:	International standard of resistance for copper
IEC 60502	:	Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV
IEC 61034	:	Measurement of smoke density of cables burning under defined conditions
IEC 60502	:	Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV

The cables and accessories shall conform to the provisions of Indian Electricity Rules and other statutory regulations as applicable.

2.1 Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.2 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 ENVIRONMENTAL CONDITIONS

The cables shall be designed and calculated for continuous operation at full load under the climatic and environmental conditions as described in the "Design Basis".

4.0 DESIGN REQUIREMENTS

The cross section of all power cables shall be determined in accordance with the current demand of the linked power consumer, the maximum permissible voltage drop, the operating temperature, thermal short-circuit capacity, maximum cable loop impedance for earth faults and laying conditions.

Cable cross-sections shall be determined using the manufacturer's published data and the respective reduction factors according to installation conditions. The current-carrying capacities of power cables shall be calculated according to the type of operation, the conditions of installation and the ambient condition. The reduction factor shall be related to the following parameters:

- Ambient or ground temperature
- Exposure to solar rays
- Ground thermal resistivity
- Grouping/spacing

The maximum voltage drop is limited to the values given in specification "Design Basis". The values for voltage drops are referred to the nominal voltage of the system. The maximum permissible continuous conductor temperature for power cables, depending on insulation material, shall be:

- PVC insulated cables 70 °C
- XLPE insulated cables 90 °C

The colours of the cores shall be in accordance with the IEC regulations.

5.0 CABLES SPECIFICATION

5.1 Power Cables for Medium Voltage up to 11kV.

Power cables for 3.3 KV, 6.6 KV and 11 KV systems shall be single core OR three core, U/UE as per SOR with the following construction (from inwards to outwards):

1. Screened Stranded Aluminium/copper Conductor as per SOR.
2. Conductor screening (with non-metallic semi conducting tape or by extrusion of semi-conducting compound)
3. XLPE insulation by extrusion
4. Insulation screening (Extruded semi Conducting layer followed by copper tape)
5. Core with suitable filler material (For three core cables)
6. PVC inner sheath ST2 by extrusion or wrapping
7. Galvanized flat steel strip armour/Round wire Armour (For three core cables)
8. Hard drawn Aluminium Round wire armour (For single core cables)
9. Outer sheath of cable will be FRLS PVC, ST2 type by extrusion

The minimum cross section of medium voltage cables shall be 70 mm^2. If cross sections larger than 240 mm^2 are required, in general two or more parallel cables shall be provided. For cables above 240 mm^2 single core cables shall be used only. The maximum conductor size shall be 400 mm^2. In general the bending radius during installation shall be within acceptable limits as specified by cable manufacturer.

Power cables for medium voltage shall be designed in accordance to IEC 60502.

Minimum value of oxygen index shall be 29% (min) as per ASTM-D-2863

5.2 Power Cables for Low Voltage

Low voltage cables (1100 V Grade) shall be multi – core with the following construction (from inward to outwards):

1. 1100 Volts grade
2. Aluminium/copper stranded conductor (Stranded Annealed Copper Conductor up to 16 mm2 & Stranded Aluminium Conductor from 25 mm2 and above)
3. XLPE/PVC insulation as per SOR
4. PVC inner sheath by Extrusion
5. Galvanized flat steel strip armour/Round wire Armour
6. Overall PVC outer sheathed by extrusion

For secondary circuits, building installations, outdoor lighting and sockets etc PVC insulation for the conductor may be used. If cross-sections larger than 240 mm^2 per phase are required, general two or more parallel cables shall be provided. The minimum cross section of low voltage power cables shall be 2.5 mm^2. Power cables for low voltage shall meet the requirements of IEC 60502. Direct buried cable shall be armoured cables. Unarmoured cables shall also be used wherever required.

Minimum value of oxygen index shall be 29 % (min) as per ASTM-D-2863.

Flame propagation properties shall meet the requirement as per IEC-332(part 3)

5.3 CONTROL CABLES

Control cables shall be 1100 Volt Grade, 2.5 mm2 copper conductor PVC insulated type A by extrusion, extruded inner PVC sheathed ST2 , single wire armoured with an overall PVC ST2 sheath, as per IS: 1554 Part-I. Unarmoured cables shall be used wherever required.

Cores shall be identified as per IS: 1554 (Part-1) for the cables up to five (5) cores and for cables with more than five (5) cores the identification of cores shall be done by printing on all cores as per clause 10.3 of IS 1554 (Part-1).

6.0 GENERAL REQUIREMENT

The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installations.

They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating conditions. The XLPE /PVC insulated L.T. power cables shall withstand without damage a 3 phase fault current for 1 second as specified in "Design Basis" **at rated conductor temperature (70° C for PVC insulated cables and 90°C for XLPE insulated cables)**.

The XLPE insulated cables shall be capable of withstanding a conductor temperature of

250°C during a short circuit without any damage. The PVC insulated cables shall be capable of withstanding a conductor temperature of 160°C during a short circuit.

The Aluminium/Copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be uniformly good quality, free from defects.

Progressive sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of all cables.

The fillers and inner sheath shall be of non-hygroscopic, fire retardant material, shall be softer than insulation and outer sheath shall be suitable for the operating temperature of the cable.

When armouring is specified for single core cables, the same shall consist of aluminium wires/strips. For classified area FRLS type cables shall be considered.

7.0 CABLE DRUMS

7.1 Cables shall be supplied in returnable wooden or steel drums of heavy construction. Wooden drum shall be properly seasoned sound and free from defects. Wood preservative shall be applied to the entire drum.

7.2 Standard lengths for each size of power and control cables shall be 500/1000 meters. The cable length per drum shall be subject to a tolerance of plus or minus 5% of the standard drum length. The owner shall have the option of rejecting cable drums with shorter lengths. However if shorter length of cable (Not standard as specified) is required shall be provided by the contractor in drums.

Maximum, One (1) number non standard length of cable size(s) may be supplied in drums for completion of project.

7.3 A layer of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.

7.4 Each drum shall carry the manufacturer's name, the purchaser's name, address and contract number and type, size and length of the cable, net and gross weight stencilled on both sides of drum. A tag containing the same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

7.5 Packing shall be sturdy and adequate to protect the cables, from any injury due to mishandling or other conditions encountered during transportation, handling and storage. Both cable ends shall be sealed with PVC/Rubber caps so as to eliminate ingress of water during transportation and erection.

8.0 TRANSPORTATION AND UNLOADING

All cables shall be shipped and transported on cable drums of adequate size. Drums shall be lifted by means of a crane or by means of a loading ramp. Throwing and dropping down of cable drums shall be strictly avoided. In order to prevent drums moving during

transportation, these must be securely wedged to prevent movement. Before unloading it is necessary to verify that the drum is received in proper condition. The directional arrow of the drums has to be observed during rolling. Empty cable drums have to be stored on a suitable central store place. Retransport to the cable manufacturer of returnable drums is the Contractor's responsibility.

9.0 DRAWINGS AND DOCUMENTS

Following minimum information shall be furnished with bid:

a) Data sheet for cables
b) Type Test Reports of cables

The following drawings (in three sets) shall be submitted for approval/review within 3 weeks of award of contract.

a) Data sheet for cables
b) Type Test Reports of cables

10.0 INSPECTION

Inspection and testing of equipment shall be carried out by the owner/ consultant at the works of the contractor on final product to ensure conformity of the same with the acceptable criteria of technical specification, approval drags. and reference national/ international standards.

The contractor shall submit Quality Assurance Plan (QAP) for respective equipments within 3 weeks of award of contract.

QAP shall be prepared and furnished by the contractor in MECON Form No. 11.20(4.4) F-10 along with their internal in process quality checks.

Routine test and type test certificate shall be furnished for review.

Acceptance test shall be witnessed by owner/consultant.

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Rev.: 1
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SPECIFICATION
FOR
POWER & LIGHTING DISTRIBUTION BOARD

SPECIFICATION NO.: MEC/TS/05/E9/076A, R-1

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

MECON LIMITED REGD. OFF. RANCHI 834002	STANDARD TECHNICAL SPECIFICATION OIL & GAS SBU, DELHI		
TITLE	POWER & LIGHTING DISTRIBUTION BOARD	DOCUMENT NO. MEC/TS/05/E9/076A	Page 1 of 1 REVISION 1 EDITION 1

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MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION OIL & GAS SBU, DELHI		
TITLE	POWER & LIGHTING DISTRIBUTION BOARD	DOCUMENT NO. MEC/TS/05/E9/076A	Page 1 of 1 REVISION : 1 EDITION : 1

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 INTENT

This specification defines the design, construction, testing and supply of LT Small Power Distribution Board suitable for installation in classified hazardous locations in Refineries/ Petrochemical plants. Unless specified in material requisition all fixtures shall be suitable for Hazardous area specified in Design basis/Scope of work.

2.0 CODES AND STANDARDS

The work shall be carried out in the best workman like manner in conformity with this specification, the relevant specifications, codes of practice of Indian Standards Institution, approved drawings and instructions of Engineer-in-Charge or his authorized representative issued from time to time. In case of any conflict between the standards, the instruction of Engineer-in-Charge shall be binding.

The switchboards shall comply in design, material, testing and performance to the following codes and standards. The latest revision of the publication referred to shall apply.

IS: 722	-	Specification for AC Electricity Meters
IS: 1248/ IEC 60051	-	Specification for direct acting indicating analogue electrical measuring instruments and their accessories.
IS: 8623	-	Specification for low voltage switchgear and control gear assemblies
IS: 10118	-	Code of practice for Selection, installation & maintenance switchgear & control gear
IS: 1554	-	PVC insulated (heavy-duty) electric cables
IS: 2551	-	Danger boards.
IS: 3043	-	Earthing
IS: 3618	-	Phosphate treatment of iron and steel for protection against corrosion.
IS: 3722	-	Letters and Symbols used in electrical technology.
IS: 8197	-	Terminal markings—Electrical measuring instruments.
IS: 13703	-	HRC cartridge fuse links
IS: 13947/ IEC 60439 IEC 60947	-	Specification for low voltage switchgear & control gear & assemblies
IEC 60529	-	Degrees of protection provided by enclosures (IP-Code)
IEC 60664	-	Insulation co-ordination for equipment within low voltage systems

2.1 Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.2 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 ENVIRONMENTAL CONDITIONS

The low voltage switchboards shall be designed and constructed for continuous operation at full load under the climatic and environmental conditions as described in the specification "Design Basis-Electrical".

Main switchgears and main distribution boards shall be installed inside without air-conditioned electrical buildings or rooms.

The installation of switchboards may be at outdoor locations as required, if any.

4.0 GENERAL REQUIREMENTS

The low voltage switchgears shall be industrial type, metal-enclosed, factory assembled, type tested.

4.1 Component & equipments

The Contractor has to take care that all components and equipment are selected considering easy maintenance, simple and quick diagnosis and long maintenance intervals. All components and equipment shall be designed for continuous duty at rated load and under the given climatic conditions. Standard industrial high performance systems and components of supplier's standard lists shall be used as far as possible. Components and equipment of same kind and type shall be selected for equivalent functions. The interchangeability must be guaranteed.

4.2 Tagging

All components, equipment and installations shall receive the respective tagging plates, labels etc, which have to be of extremely durable material resistant against the environmental conditions. Tagging plates or labels on fronts of enclosures shall be fixed with screws. For further requirements, reference is made to specification "Design Basis-Electrical".

4.3 Constructional Features

a) Power Distribution board-

i) Power Distribution boards shall be single/ double front, non-draw out/draw out type, floor/surface mounted, as specified in Bill of Quantities/SOR, Appropriate lifting facilities shall be provided. Overall height of panel shall not exceed 2500 mm and minimum operating height shall not be lower than 300mm & higher that 1800mm.

ii) The minimum thickness of steel shall be 2mm for load bearing members, 1.6 mm for non load bearing members & 3 mm for base channel. The doors & covers shall be fabricated from cold rolled sheet steel.

iii) All doors & removable covers shall be provided with non-deteriorating neoprene gaskets. Gasket & The door hinges shall be concealed type with pad locking arrangement.

iv) The structure, including doors, insulators and panels, shall be capable of withstanding the internal pressure created by faults within the structure (equal to the maximum fault-current rating) without danger to the operating personnel. Structures shall be self-ventilating.

v) Each PDB panel have horizontal bus-bar chamber running on top with module units (multi tiers) in centre having vertical bus-bar chamber & cable alley on either side.

vi) Door of modules shall be so interlocked that it is not possible to open the door when MCCB/SFU in closed position.

vii) Interlocks, covers, etc shall be provided to prevent incorrect or unsafe operation, and to prevent access to live parts. Mechanical interlock shall be provided between two incomers and bus coupler switches.

viii) Power Distribution boards shall be designed and constructed to facilitate easy inspection, cleaning, repair and maintenance and to ensure absolute safety during operation, inspection and maintenance. Similar parts and components shall be interchangeable.

ix) The overall Power distribution board enclosure shall have a degree of protection IP-52 as per IS: 13947 to make it dust & vermin proof.

x) Any equipped spares shall be arranged such that they can be connected without de-energising the complete distribution board.

xi) It shall be possible to operated individual circuit switches and replace fuses (where used) without de-energising the complete distribution board.

xii) Cable entry for all I/C & O/G cables shall be from the bottom of the PDB through removable Gland Plates of 2mm Thick.

xiii) LED (Cluster type) indicating lamps shall be used for incoming supply.

xiv) Inscription plate with inscription for all feeders shall be provided.

xv) Single line diagram to pasted inside the door.

b) Lighting Distribution board-

i) Lighting Distribution boards shall be single front operated, wall mounted, cubicle, non compartmentalised type. Where appropriate, lifting facilities shall be provided. Overall height of panel shall not exceed 2500 mm and minimum operating height shall not be lower than 300mm & higher that 1800mm.

ii) The minimum thickness of steel shall be 2mm for load bearing members, 1.6 mm for non load bearing members & 3 mm for base channel. The doors & covers shall be fabricated from cold rolled sheet steel.

iii) All doors & removable covers shall be provided with non-deteriorating neoprene gaskets. Gasket. The door hinges shall be concealed type with pad locking arrangement.

iv) The structure, including doors and panels, shall be capable of withstanding the internal pressure created by faults within the structure (equal to the maximum fault-current rating) without danger to the operating personnel. Structures shall be self-ventilating.

v) Concealed mechanical lock shall be provided for safety of LDB.

vi) Lighting Distribution boards shall be designed and constructed to facilitate easy inspection, cleaning, repair and maintenance and to ensure absolute safety during operation, inspection and maintenance. Similar parts and components shall be interchangeable.

vii) The overall lighting distribution board enclosure shall have a degree of protection IP-52 as per IS: 13947 to make it dust & vermin proof.

viii) Cable entry for all I/C & O/G cables shall be from the bottom of the LDB through removable Gland Plates of 2mm Thick.

ix) The door hinges shall be concealed type.

x) Any equipped spares shall be arranged such that they can be connected without de-energising the complete distribution board.

xi) It shall be possible to operated individual circuit switches and replace fuses (where used) without de-energising the complete distribution board.

xii) LED (Cluster Type) indicating lamps shall be used for incoming supply.

4.4 Busbar & connections

i) The bus bars shall be selected according to the electrical requirements and shall be of electrolytic copper or high-conductivity aluminium alloy grade E91E as per IS: 5082.

ii) Bus-bar size shall be sized to carry rated continuous current under the temperature specified elsewhere without exceeding the temperature 90°C. Bus-bars shall be of the same cross sectional area throughout the length of the distribution board.

iii) Bus-bar shall also be designed to withstand the system fault current for 1 sec as specified in

design basis with out exceeding the temperature 200°C for AL & 250°C for Cu. The minimum acceptable size of bus bar shall be 250 Sq mm (Aluminium).

iv) Contractor shall submit the size calculation of bus-bar for review/approval.

v) Bus-bars (Vertical & Horizontal) shall be insulated with colour coded Heat shrinkable PVC sleeves as per IS: 5578. Horizontal bus bar running at top of the panel shall have separate inspection covers (screwed type).

vi) Bus-bars shall be marked to indicate the phase colour, which shall be red, yellow, blue and neutral bus shall be marked with black colour.

vii) An earth bus-bar (continuous PE conductor) with earthing studs shall be provided along the full length of the distribution board, throughout its length.

viii) Bus-bars supports and connections shall be sized, braced and supported to withstand the mechanical forces and thermal effects resulting from the short circuit current & shall equally supported on insulators.

ix) Bus bar supports shall be of SMC/epoxy based insulator.

x) PDB & LDB shall be provided with two earthing terminal for earthing with earthing bolt, nuts & washers, enable to connect with earth grid.

4.5 Clearance, creepage distance & insulation level

The clearance & creepage shall not be the lesser than the values specified below-

Phase to Phase	-	26mm
Phase to earth	-	19mm
Minimum creepage distance	-	28mm

Rated insulation voltage 660V

One-minute power frequency withstands voltage: 2.5 kV for power circuits and 2 kV for control circuits.

4.6 Moulded Case Circuit Breaker

i) MCCB shall confirm to IS: 13947 & shall have rupturing capacity as specified in SOR/Data sheet for non-draw out / draw out type modules as applicable.

ii) MCCB shall be of AC23 duty, quick make & quick break type & trip free mechanism as per IS 13947. MCCB shall be provided with necessary alarm & auxiliary contacts.

iii) Rating and number of poles for the switch shall be as mentioned in feeder list/single line diagram.

iv) The thermal & short circuit tripping device shall be adjustable type.

v) Interlocking to prevent the compartment door being opened unless the isolator/MCCB is in the open position.

vi) Distribution board shall be provided with current transformers, earth fault and over current relay, contactors (mechanically and electrically interlocked, if required) as per SLD.

vii) Distribution board incomers shall have power monitoring meter and indication lamps for metering and indication purpose as shown in SLD for PDB/MLDB/MOVDB etc.

viii) MCCB tripping characteristics curves shall be submitted along with offer & MCCB shall be type tested (contractor shall submit the type test reports/certificates along with offer)

4.7 Miniature Circuit Breaker

MCB shall confirm to IS: 13032 & 8828 & shall have breaking capacity of 10kA. The overload & short circuit device shall be provided in heat resistance housing.

Short circuit time curve/tripping curves shall be submitted along with offer.

4.8 Switch and Fuse combination units

i) Sheet steel enclosed heavy duty Switch fuse unit as per SOR.

ii) Rating and number of poles for the switch shall be as mentioned in feeder list/single line diagram.

iii) Padlocking facility in the 'off' position.

iv) AC-23 duty as per IS: 13947 with Auxiliary contacts - 1 No & 1 NC

v) Fault-make, load-break type, unless specified otherwise

vi) Interlocking to prevent the compartment door being opened unless the isolator is in the open position.

vii) Distribution board shall be provided with HRC fuses with fuse holder as per IS: 9224 and shall be suitable coordinated with load & fault current.

4.9 Earthing

i) All metallic non-current carrying parts of the distribution board shall be bonded together and connected to the internal earth bus-bar.

ii) All doors shall be bonded to the main structure by means of a flexible copper connection arranged so that it cannot be trapped as the door is opened or closed.

iii) Provision shall be made, adjacent to the cable termination, for cable armour earthing.

iv) Distribution boards shall be supplied with an external M10 brass earth stud complete with nuts, spring and plain washers. This stud is to be internally connected to the earth busbar.

4.10 Secondary Wiring

i) Secondary wiring shall be copper conductor PVC insulated 660/1000 volts grade.

ii) Secondary wiring within the distribution board shall be securely held in position (either bunched or run in conduit/trunking).

iii) Wiring identification shall be by numbered and/or lettered interlocking sleeve ferrules of insulating material adjacent to the terminals. They shall be indelibly marked and removal without disconnecting the wire from its terminal shall not be possible.

iv) Flexible cables shall be used for connections on door mounted equipment. Wiring shall be bunched, wrapped in flexible conduit and be firmly clamped at both ends to prevent movement at terminations.

v) The minimum conductor size shall be 2.5 mm2 cable sheath colour shall be consistent with the phase/neutral/earth circuit to which they are connected.,

vi) All wiring for external connections shall be brought out to individual terminals on a easily accessible terminal block.

vii) Only one conductor shall be connected to each side of each terminal, additional linked terminals shall be provided where more connections are required.

viii) All control wiring shall be neatly arranged & properly supported.

4.11 Cable Terminations

i) All power & control cable shall enter to the distribution board from bottom unless otherwise specified. Cable terminating facilities and terminals shall be suitable for the specified cable type and conductor size. Contractor shall take consideration and provision on the equipment design for the use of cable with aluminium conductors.

ii) Terminal blocks shall be arranged and positioned for easy access for carrying out external cable termination, testing, inspection and maintenance. There shall be clear space allowed between the terminal block and the cable entry for the spreading and termination of external conductors.

iii) Terminal blocks shall be mounted in a single tier arrangement. 20% extra terminal shall be provided in terminal block.

iv) Terminal block for control cable shall be pressure clip type & terminal block for power cables are bolted type. Minimum current rating of terminal block shall be 16 amp.

v) The panel wiring shall be on one side of the terminal block only.

vi) All terminal blocks shall be shrouded or provided with transparent covers.

vii) Terminals for different voltages shall be separated by partition.

viii) For power cable connection suitable marking shall be provided to the terminal block for identification of phases of cable.

ix) An un-drilled gland-plate or entry panel of sufficient dimensions to terminate the specified cables shall be provided. Cable entry shall be from bottom unless specified.

x) Positioning of cable terminations shall avoid obstruction of other cable terminations, removable covers, etc. and sufficient space shall be available for maintenance work and cable termination.

xi) Cable clamping arrangement shall be provided to avoid undue strain on the cable termination.

4.12 Indication Lamp, Instrument & meters

Indication for the circuit conditions shall be as per drawing.

PDB & LDB shall have indication lamp for showing the availability of incoming power.

The colours of the lamp for various status of the circuit is shown below (Provided in all outgoing feeder's of PDB)-

i) Red - Switch/MCCB/Contactor ON

ii) Green - Switch/MCCB/Contactor OFF

iii) Amber - For Trip Indication

All lamps shall be LED (Cluster Type).

Measuring Instruments

i) The instrument shall be flush mounted to the door of distribution board.

ii) 96x96 mm size, CL 1.5 analog ammeter & voltmeter shall be provided with ammeter & voltmeter selector switch in PBDs & LDBs.

iii) One KW meter shall be provided in each PDB. Kw meter shall be 3 Ph 4 wire type & CT operated, the current coil shall be rated for 5A.

iv) Multi function meter-

PDB shall be provided with multi function meter having follow specification-

The MFM (Multi function Meter) shall be microprocessor based Electronic type having load survey facility and RS 485 communication port with necessary software / hardware for connectivity to SCADA.

The multi function meter shall have the following minimum features.

- Ammeter
- Voltmeter
- Frequency meter
- Power Factor meter
- KW meter
- KWH meter
- KVA meter
- KVAR meter
- 30 min or 15 min maximum demand meter
- Maximum Demand controller

4.13 Fuses

Fuses shall be non-deteriorating HRC cartridge link type as per IS: 9224 use for back up protection.

4.14 Anti-condensation Space Heaters

Thermostatically controlled heaters suitably rated to prevent condensation shall be provided within the distribution board.

The heater shall be supplied with a double pole isolator.

The heater terminals shall be clearly marked as to their use.

4.15 Name Plate

A main nameplate shall be affixed in a prominent position on the front of each distribution board giving the following information:

Manufacturers name.

Distribution board Tag Number and name.

System voltage, phase, wires and frequency

Year of manufacture

Danger Board

Characters shall be of 12 mm height.

Labels shall have black characters on a white background and be made of a non-corrodible material. Warning/Danger labels shall have black lettering on a yellow background.

Label shall be affixed by screws or rivets.

Each distribution board shall have fitted a circuit directory within a clear protective cover located on the inside of the outgoing circuit compartment door.

5.0 PAINTING

All sheet metal work shall undergo a process of Degreasing Pickling in acid cold rinsing & Phosphating Two primer coats of Epoxy based primer suitable for corrosive (seashore) atmosphere. Two finish coats of painting of RAL7032 or approved colour shade and quality. The interior of panel shall have eggshell white paint.

6.0 TROPICAL PROTECTION

All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects & corrosion.
Screens of corrosion resistant materials shall be furnished on all ventilating louvers to prevent the entrance of insects.

7.0 PACKING AND DISPATCH

Distribution boards shall be shipped to suit ease of handling for transportation and installation. Each shipping section shall be provided with location of lifting points clearly marked on shipping containers. Each shipping section shall have its weight clearly marked on the container.

Preparation for shipment shall protect the distribution board, auxiliary devices, accessories, etc. against corrosion, dampness, breakage or vibration injury during transportation and handling. The packing shall be completely suitable for long duration outdoor storage in areas with heavy rains/high ambient temperature.

Each shipping container shall be identified with the contents, purchase order number and item number.

Instructions shall be provided for reassemble of sections in the field.

8.0 DRAWINGS AND DOCUMENTS

8.1 The following documents shall be submitted along with the offer:

a) List of two years operation and maintenance spare.
b) Bus-Bar sizing calculation
c) Type test certificates of Bought Out items
d) Dimensional GA & foundation drawing of PDB/LDB indicating bus-bar arrangement, foundation details, gland plate location
e) Component specification details
f) Catalogues of bought out items like -relays, breakers etc

8.2 The following drawings/documents shall be submitted for approval within 3 weeks of award of contract.

a) Dimensional GA & foundation drawing of PDB/LDB indicating bus-bar arrangement, foundation details, gland plate location
b) Front view of PDB/LDB indicating component locations

c) Single line schematic diagram indicating feeder details
d) Control schemes of feeders
e) Component specification details
f) List of inscriptions
g) Internal wiring diagrams
h) Terminal plan and external connection diagrams
i) Cross sectional drawings of cubicle indicating details of bus-bar chamber, cable chamber breaker chamber, LV chamber etc
j) Operation and maintenance manuals
k) Bus-Bar sizing calculations
l) Catalogues of bought out items like -relays, breakers etc
m) Bill of material

9.0 INSPECTION AND TESTING

Inspection and testing of equipment shall be carried out by the owner/ consultant at the works of the contractor on final product to ensure conformity of the same with the acceptable criteria of technical specification, approved drawings and national/ international standards.

The contractor shall submit Quality Assurance Plan (QAP) for respective equipments within **three weeks** of award of contract. Owner's representative shall be given minimum **two weeks** advance notice for witnessing the final testing.

QAP shall be prepared and furnished by the contractor in MECON Form No. 11.20(4.4) F-10 along with their internal in process quality checks.

ANNEXURE-I

LIST OF MANDATARY SPARES

1.	MCB & MCCB	One no. of each rating
2.	Indication Lamps	10% of total installed quantity (Min quantity 2 nos.)
3.	Fuses	10% of each rating (Min quantity 2 nos.)

ANNEXURE-II

LIST OF 2 YEAR OPERATION & MAINTENANCE SPARES

The spare parts as listed below shall be quoted for the Electric Panel along with the offer with item wise unit prices:

1.	Contractor	1 No. of each rating
2.	Fuses	10% of each rating
3.	Fuse Fittings	1 No. of each type
4.	Overload Relay with Single phasing preventer	1 No. of each rating
5.	Indication Lamps	10% of total installed quantity (Min Quantity 2 nos. for each type)
6.	MCB & MCCB	One no. of each rating
7.	Control Switches	Two no. of each rating
8.	Meters	One no. of each type

NOTE: All spare parts shall be identical to the parts used in the distribution boards.

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SPECIFICATION
FOR
LIGHT FITTINGS FOR HAZARDOUS LOCATIONS

SPECIFICATION NO.- MEC/TS/05/E9/077, R-0

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

CONTENTS

SL. NO.	DESCRIPTION
1.0	SCOPE
2.0	STANDARDS
3.0	ENVIROMENTAL CONDITION
4.0	TAGGING
5.0	SYSTEM PARAMETER
6.0	CERTIFICATION
7.0	CONSTRUCTION
8.0	TERMINALS AND WIRING
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10.0	GUARANTEE AND INSPECTION
11.0	INFORMATION REQUIRED WITH QUOTATIONS

MECON LIMITED REGD. OFF: RANCHI 834002	STANDARD TECHNICAL SPECIFICATION OIL & GAS SBU, DELHI		
TITLE	LIGHT FITTINGS FOR HAZARDOUS LOCATIONS	DOCUMENT NO. MEC/TS/05/E9/77	Page 1 of 1 REVISION : 0 EDITION : 1

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

1.0 SCOPE

This specification defines the design, construction, testing and supply of lighting fixtures suitable for installation in classified hazardous locations in Refineries/Petrochemical plants. Unless specified in material requisition all fixtures shall be suitable for Zone-1 & Zone-2 & Gas Groups IIA & IIB as per IS 2148.

2.0 STANDARDS

2.1 The work shall be carried out in the best workman like manner in conformity with this specification, the relevant specifications, codes of practice of Indian Standards Institution, approved drawings and instructions of Engineer-in-Charge or his authorized representative issued from time to time. In case of any conflict between the standards, the instruction of Engineer-in-Charge shall be binding.

Complete lighting fixtures and other accessories shall conform to the following Indian Standards or other relevant internationally accepted standards.

IS-2148	Specification for Flameproof Enclosures
IS-5572	Classification of hazardous area for electrical installation
IS-6381	Construction and testing of electrical apparatus with type of protection `e'
IS-8289	Electrical equipment with type of protection `n'
IS-2206	Flameproof electrical lighting fittings Point I & II (well glass and bulk head type, fittings using glass tubes)
IS-8224	Electric lighting fitting for division 2 areas
IS-1913	Electric lighting fittings, general and safety requirements for Luminaries: Tubular fluorescent lamps

2.2 Wherever the requirements in this specification are in conflict with any of the above Standards, the requirements under this specification shall be binding.

2.3 In case any contradiction between various referred standards/specification/data sheets and statutory regulation etc the following order of priority shall be govern -

i) Schedule of rates
ii) Design Basis
iii) Scope of work/Job specification
iv) Data Sheet
v) Standard specification
vi) Codes & standard

3.0 ENVIRONMENTAL CONDITIONS

The lighting fixture shall be designed and calculated for continuous operation at full load under the climatic, Hazardous and environmental conditions as described in the specification "Design Basis Electrical".

4.0 TAGGING

All lighting fixtures shall receive the respective tagging plates, labels indicating lamp type and lighting circuit, etc, which have to be of extremely durable material resistant against the environmental conditions. All equipment and installations must be tagged regarding the function and according to the drawings.

5.0 SYSTEM

Unless until specified in material requisition all lighting fixtures shall be suitable for 220-250 volts single phase neutral & 50 Hz power supply.

6.0 CERTIFICATION

All flame proof fixtures and accessories shall be tested and certified by CMRI or independent authorities of country of origin for use in specified gas group location/Hazardous area. Certification number/data and gas group/temperature classification must be indicated on the manufacturer's nameplate on each fixture.
Contactor shall furnish the type test data & certificates of approval of fixture for use for hazardous location along with offer.

7.0 CONSTRUCTION

All fixtures shall be suitable for use in outdoor open location and shall have degree of protection IP-65 or above.

The body of the lighting fixture shall be of cast aluminium alloy LM-6 and should be free from frictional sparking hazard. Complete fixture body and accessories shall be suitable to withstand corrosive atmosphere. Outer metallic surface shall be treated/ prepared and provided with two coats of epoxy paint. All screws, nuts, studs, clamps, supporting brackets, etc. shall be electro galvanized or zinc passivated.

All fixtures shall be provided with sheet steel vitreous enamelled or approved type of reflector. Glass used for fixtures shall be clean, heat & impact resistant and toughened type suitable for use under conditions involving exceptional risk of mechanical damage and shall be type `A' as per IS 2206 or the requirements stipulated by international standards. All well glass fixtures shall be provided with steel wire protecting cage having mesh dimension not exceeding 50 mm.

The fixing parts of the enclosure which is to be opened for replacement of bulb shall be so fastened that they can only be unfastened with special tools. All fixtures shall carry a special warning inscription in English to "Isolate supply elsewhere before opening". Three sets of special tools required for maintenance of fixtures shall be supplied free of cost along with the fixtures.

The temperature rise of external surface shall not exceed the temperature specified in the

standards for the gas group to which fitting shall be suitable.

All fixtures and associated control gear boxes shall be provided with two 3/4" E.T. threaded entries with one approved type threaded plug to seal one of the entry. Two entries shall be used for looping of circuit wherever required.

All junction boxes for looping for SPN Lighting circuits using cables upto 4 mm2 shall be minimum 100 mm dia in size. Junction boxes for looping of large three phase cable and multiple single phase circuits shall be of minimum 300x250x100 mm. in dimension complete with flameproof cable glands as specified in material requisition.

The top of all well glass lighting fixtures shall be identically drilled/ threaded to facilitate the installation on pole/column or ceiling as per the enclosed sketch using stud/bracket supplied by others.

8.0 TERMINALS & WIRING

Each terminal for external cable connections shall be suitable for termination of minimum of two number 4Cx4 mm2 aluminium/Cu conductors for circuit looping facility. All terminals shall be of non-sparking and anti- loosening design such that they do not produce any arc or spark in normal operation.

Connection to current carrying parts shall be such that the contact is not appreciably impaired by temperature or by vibrations, which occur, in normal service or by shrinkage of insulating materials.

If flexible wires are used for internal wiring they should be soldered at the ends, preferable with lugs.

Whereas a screw type holder is used, the centre contact shall be connected to a terminal, which shall be clearly identified for connection to the live conductor.

One earthing terminal-M6 shall be provided inside the connection chamber suitable for termination of minimum 4-mm2 aluminium conductor & two earthing terminal-M6 shall be provided outside.

9.0 CONTROL GEAR AND LAMP HOLDER

Lighting fixtures suitable for discharge lamps shall be complete with power factor correction capacitor, choke and starter, etc. mounted within the fixtures as integral part completely wired upto terminals. Separate control for gearbox shall be acceptable only for flood lighting fixtures and these shall be of approved flameproof construction.

All incandescent lamp fixtures shall have screwed type E.S. cap lamp holder.

All lighting fixtures which are not certified as flameproof construction but approved for use in Div. II area shall have approved ENCLOSED BREAK lamp holder and complete enclosure certified as having restricted breathing type construction.

Mounting

All well glass fixtures shall be suitable for bracket, ceiling or pole mounting as per the enclosed sketch.

All flood lighting fixtures shall be supplied with adjustable mounting arrangement both in horizontal and vertical plane.

10.0 GUARANTEE & INSPECTION

All fittings shall be guaranteed for defective material/ design/ workmanship, for a period of 18 months from the date of commissioning or twenty four months from the date of despatch whichever is earlier.

Mechanical strength of well glass shall satisfy the requirements as specified above & IS 6381 and during inspection facilities shall be provided for impact testing of a random sample.

All fittings and accessories shall be inspected by the purchaser's representative before despatch and minimum two weeks notice shall be given to facilitate inspection. Purchaser's representative will also be allowed to visit works during execution of order for expediting/monitoring activities.

11.0 INFORMATION REQUIRED WITH QUOTATIONS

11.1 Three copies of catalogues/drawings giving details of make/catalogue No./Overall Dimensions/Weight/ Material of construction and mounting details etc.

11.2 Name/address of testing/certifying authority and certificate No./date for each item.

11.3 Clause wise deviations to the requirements of specification/material requisition, if any. It will be assumed that offer meets all the requirements except deviations furnished with the quotation.

11.4 Unpriced true copy of price quotation giving detailed description of each item.

11.5 Price variation due to part ordering or change in quantities, as the quantities specified in material requisition are tentative.

11.6 Drawing of the complete assembly for each item offered which shall be valid for the actual material supplied if ordered.

INCOMPLETE QUOTATION WITHOUT ABOVE INFORMATION SHALL NOT BE CONSIDERED.

-X-X-X-

STANDARD SPECIFICATIONS (INSTRUMENTATION WORKS)

STANDARD SPECIFICATIONS

Sl No	DESCRIPTION	SPEC. No.
1.	Specification for Installation of Instruments	MEC/S/05/26/01
2.	Specification for Instrument Tubing	MEC/S/05/26/02
3.	Specification for Instrument Tube Fittings	MEC/S/05/26/04
4.	Specification for Instrument Valves and Manifolds	MEC/S/05/26/05
5.	Specification for Junction Boxes and Cable Glands	MEC/S/05/26/06
6.	Specification for Signal Cable	MEC/S/05/26/07
7.	General Technical Specification for Instrumentation	MEC/S/05/E5/I/08
8.	Specification for Cabling	MEC/S/05/26/21
9.	Specification for Earthing	MEC/S/05/26/23 A
10.	Specification for Control Panel	MEC / 05 / E5 / TS/ CP - 030

SPECIFICATION

FOR

INSTALLATION OF INSTRUMENTS

SPECIFICATION NO.: MEC/S/05/26/01

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

0	15.10.2014			
Revision	Date	Ratnadeep Gupta Prepared By	Vikas Jain Checked By	Rakesh Kr. Shukla Approved By

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

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3) INSTALLATION OF INSTRUMENTS

4) TESTING

5) CALIBRATION OF INSTRUMENTS

INSTALLATION, TESTING AND CALIBRATION OF INSTRUMENTATION AND CONTROL SYSTEM

1.0 SCOPE

1.1 The purpose of this specification is to define the general requirements for the installation, installation materials, testing and calibration of instruments and control system.

1.2 The work shall be carried out in accordance with the codes, standards and recommended practice listed in this specification and in accordance with local `Statutory regulations'.

1.3 For installation of instruments and control system, of the new material where quality is of the prescribed standards and which is in every way fit for its intended purpose shall be used.

1.4 Unless otherwise specified all the materials shall be indicated in this specification except where it is not compatible with fluids being handled. In such cases the selection of the material shall be approved by MECON.

1.5 Only the best trade practices shall be used. All the work shall be carried out in a neat, workman like manner and to the satisfaction of MECON.

2.0 STANDARDS OF MATERIALS

2.1 Instrument process piping / tubing upto and including the first block valve and `in-line' instrument equipment shall conform to the line class or vessel rating concerned instrument piping or tubing after the first lock valve may use alternate materials consistent with service conditions. In general they shall conform to the following specification as a minimum.

2.1.1 Stainless tubes shall be fully annealed and cold drawn seam less as per ASTM A 269 TP316 with size 1/2"OD x 0.65" WT (wall thickness).

2.1.2 Monel tubing shall be fully annealed seamless as per ASTM B165 with size 1/2" OD x 0.35"WT.

2.1.3 Carbon steel pipe shall be 1/2" seamless and shall be as per ASTM A106 Gr B min of sch 80 & dimensions as per ANSI B36.10.

2.1.4 Seamless stainless steel pipes shall be as per ASTM A 312 Gr TP 316L Sch 80S, dimensions as per ANSI B 36.19.

2.1.5 Instrument air supply piping from the main instrument air header shall be galvanised heavy class pipes to IS 1239.

2.2 Individual pneumatic signal and air supply tubing shall conform to the following specifications:

2.2.1 Stainless tubes shall be used in general and shall be fully annealed and cold drawn seamless as per ASTM A269 TP 316 with 6mmOD x 1mmWT.

2.2.2 Copper tubing where specified shall be seamless 6mmOD x 1.0mmWT soft annealed as per ASTM 868.74a cd No. 122 (DHP) sheathed with PVC 1.0mm thick coloured Black.

2.3 All fittings shall be as a minimum of 100 rating except for tube fittings. The fittings shall have threading as per B2.1 and socket weld connections as per B 16.11. These shall conform to the following specifications in general.

2.3.1 Tube fittings shall be flare type compression fittings Swagelok or equivalents make double ferrule and pressure seat type.

All tube fittings in impulse lines shall be rated to 5000 PSIG at 38°C.

2.3.2 Carbon steel pipe fittings shall be forged as per ASTM A105 stainless steel pipe fittings shall be as per ASTM –182 Grf 316L

2.4 Valve shall have normally Globe body and shall be fabricated out of Bar-stock and rated to min. of 1500. These shall be screwed bonnet type with 13% GSS trim and plug shall be integral with the stem. Face to face dimensions shall be approx. 80mm. End connections shall be socket weld to ANSI 16.11 and threaded to B2.1

2.5 Multibore tubing shall have a maximum 19 single polyethylene tubes, 6mmOD x 1mm numbered for easy identification. The bundle shall be marked with inner and outer fire resistance PVC sheath. They shall carry a pair of telephone wire 0.6mm diameter flexible.

2.6 Single pair and multi pair extension cables for Thermocouples shall be matched and calibrated in accordance with ISA MC 96.1. Conductor size shall be AWG for single pair and 20 A for Multipair.

The cable shall be armoured, each twisted pair shall be individually shielded with aluminium Mylar tape and a tinned copper drain wire. The wires and the cable shall be colour coded as per ISA recommended practices.

2.7 Instrument Electrical cables shall conform to the following specifications:

2.7.1 Instrument electronic signal cables single pair/ Multipair shall have copper conductor, twisted in pair and individually shielded with Aluminium Mylar tape with drain wire. In multipair cables, each pair shall be armoured with inner and cut PVC sheath. Minimum conductor size shall be 1.5 mm^2.

2.7.2 Control Cables for control signal, alarms actuating devices and solenoid valves of the interlock and shutdown valves shall generally be 1.5 mm^2 copper conductors armoured with inner and cut PVC sheath.

2.7.3 All power supply cables shall have copper/Aluminium conductor depending upon the conductor size. The cables shall be armoured with inner and cut PVC sheath. The cables shall be sized adequately. Minimum conductor size shall be 2.5 mm^2.

2.7.4 2-core armoured cable shall be used for illuminator on level gauges.

2.7.5 The material and construction of all electrical cables shall conform to IS- 1554 Part I or appropriate equivalent code and standard.

3.0 INSTALLATION OF INSTRUMENTS

3.1 Instrument Mounting

3.1.1 No instrument shall be installed in such a way that it bends for support on the impulse piping or electrical connection on it.

3.1.2 Pressure gauges and temperature indicator shall normally be mounted directly on line. However direct on line mounting shall be avoided where vibrations are likely to be present.

3.1.3 Local mounted instruments shall be mounted on brackets, panels or placed on a suitable pedestal. Transmitters shall be mounted on 2" pipe supports where practical. Instruments to be mounted on steel columns, masonary structure etc. These shall not be mounted on heating equipments, pipelines and structures.

3.1.4 Blind transmitters shall be mounted at 130mm above graded platform. Local controllers, indicating transmitters and indicating instruments shall be mounted at approximately 1500 mm.

3.1.5 All the instruments shall be accessible from grade, ladder or platform etc. Pressures gauges and other local indicating instruments shall be readable from grade or operating level and if used for manual control shall be visible from the related valve.

All the instruments shall be located such that they don't impede the process operation.

3.1.6 Local mounted instruments which are not available in weather proof housing shall be mounted inside a weather proof case.

3.1.7 Items such as pilot valves, solenoid valves etc. shall be located local to its point of application or near to the device being actuated by them.

3.1.8 For blind transmitters output meters shall be mounted on instrument supports.

3.1.9 Filter regulators shall be mounted on the instrument supports below pneumatic transmitter or on the control valve yoke.

3.1.10 Instruments or instrument lines shall not be supported on hand rails, in general.

3.1.11 The use of process piping to support instrument lines shall be avoided as far as possible.

3.1.12 The instrument impulse piping shall be kept as short as possible.

3.1.13 Instruments and impulse lines shall be protected against mechanical damage.

3.1.14 In case of capillary tube instruments, capillary tube is to be supported and protected against mechanical damage.

3.1.15 Orifice meters shall not be installed on the top of orifice fittings. On horizontal lines orifice pressure taps shall be located as follows:

a) On top for air and gas service
b) Horizontal for liquid and condensible vapour service.

3.2 Instrument Piping & Tubing.

3.2.1 Impulse Piping/tubing

3.2.1.1 The primary instrument block valves for all instruments shall be as per piping specifications.

3.2.1.23-Valve manifold in general shall be integral type. For pressure gauges, 2-valve manifolds shall also be acceptable instead of isolation valve, drain valve and pipe fittings.

3.2.1.3Differential or static pressure sensing lines shall not exceed 6 mtrs. (20 feet) in general for direct connected or locally mounted instruments.

3.2.1.4 All impulse lines shall be run with a slope not less than 1 in 12 except where otherwise specified. Direction of slope is to be downward from the process for liquid service and upward from the process for gas service.

3.2.1.5 Tubing shall be joined by compression fittings.

3.2.1.6 Piping shall be joined by pipe fittings/flanges as per the piping specifications.

3.2.1.7 All instruments pipes and tubes shall run in horizontal and vertical planes only and shall run with minimum number of changes in direction, consistent with good engineering practices and neat appearance.

3.2.1.8 Tubing shall be bent with correct size tube bender as far as possible to avoid use of fittings. Hot bending shall be totally avoided.

Tube cutter shall always be used to cut tubing. The use of short lengths of tubing in long runs shall be avoided in order to avoid the fittings.

3.2.1.9 All tubing shall run in such a manner as to give the maximum protection against mechanical damage. Tubing runs shall be grouped together and clamped.

3.2.1.10 Tubing shall be arranged so that the unions can be tightened without distorting lines.

3.2.1.11 Instrument tubing or piping shall not run on trays intended for cables and shall not share the same transit.

3.2.1.12 No pipe or tube shall be left with mechanical strain on them.

3.2.1.13 A mechanical ferrule seater shall be used on tubing for 140 kg/cm^2 (2000 psi) or more.

3.2.1.14 Pipe bushings shall not be used.

3.2.1.15 Pipe plugs shall be fabricated out of bar stock and shall have hex-head.

3.2.2 Air/Signal Tubing

3.2.2.1 Signal Transmission tubes shall be laid on perforated trays prefabricated out of min 2.5 mm. thick steel plates. The width of the tray shall be selected as per the number of tubes to be laid.

3.2.2.2 Where tubing is run in permanent enclosures, it should be ensured that entry and exit of such enclosures is clean and smooth.

3.2.2.3 Tubing run in permanent enclosures shall not have joints, except at special junctions boxes provided for this purpose.

3.2.2.4 Where permanent enclosures are left with space for instrument tubing to be laid at some later date, a galvanised pull wire of adequate size shall be left in the tray.

3.2.2.5 Where the length of transmission tubing exceeds 60 mtrs (200ft) necessity of installing signal booster relays shall be considered.

3.2.2.6 In case of `Skidded' equipment or vessels with instrumentation, where off- skid alarms shutdown or control functions are provided the signal tubes shall be terminated on the control bulk head near the skid boundary.

3.2.3 All threaded pipe joints shall be joined after applying Teflon tape. It should be applied in a manner to ensure that the tape does not spill over the end of the male fitting. No other pipe joining compound shall be used except on high temperature service where graphite sealing compounds shall be used.

3.2.4 All reasonable precautions shall be taken to prevent foreign materials entering pipe lines or tubing before and during erection.

3.2.5 Pipes and tubes installed but not connected, shall have the ends clad in approved fashion to prevent the entry of foreign material. For a period upto one week adhesive tape may be used, for longer periods, caps or plugs shall be used.

3.2.6 Piping/Tubing supports

3.2.6.1 Piping and tubing shall be adequately supported and fixed at a distance not exceeding that in the following table:

Table

Single tubing/Piping	Max. distance between supports
3/8" OD or less	Continuous
1/2" to 3/4" Nom. size	2 meters (6ft.)
3/4" to 1" Nom. size	3 meters (9ft.)
Multitube bundle	3 meters (9ft)

3.2.6.2 All field mounted instrument air tubing shall be supported with galvanised steel angles or channels of minimum 1/8" thickness fabricated to present neat appearance.

3.2.6.3 All instruments tubing supports shall be galvanised prior to installation

3.2.6.4 Trays shall be properly supported either from any rigid steel structure or concrete member. In case of non-availability of above, a suitable support shall be fabricated.

3.3 Instrument Air Supply Distribution

3.3.1 Piping material for instrument main and branched air headers upto the isolation valve at each take-off from main or branch header shall conform to piping specification.

3.3.2 The air header size shall be established in accordance with the table below, unless otherwise specified, for a header pressure of 4 to 8.5 kg/cm^2

Table – 2

Max number of users	Nominal pipe size
upto 5	1/2"
upto 10	3/4"
upto 25	1"
upto 80	1-1/2"
upto 150	2"
upto 500	3"

3.2.3 All take off for branch lines are to be from the top of the main header with block valves equal in size to the branch line. All low point shall have a 1/2" valve installed as a drain and blow down point.

3.3.4 A minimum size of ½" pipe shall be run to the instrument with a ½" valve for each user. Tubing from the isolation valve to the instrument shall be 6.0 mm.

3.2.5 Union shall be provided at convenient location in the air header.

3.3.6 Filter regulator shall be provided for individual field mounted consumer and shall be complete with an output gauge.

3.3.7 In case of skid mounted equipments or vessels which incorporate instrumentation requiring pneumatic supply, on skid supply piping shall terminate at the skid boundary location and size of the supply connections shall be noted on the vendor approval drawings.

3.4 Installation of multitude and Multicore cables.

3.4.1 Multicore/ Multitube cables shall generally be installed on trays or ducts and properly clamped. At bends minimum radius shall be maintained as per cable manufacturer's standards.

3.4.2 All cables shall be rigidly supported on structural steel and masonary. Drilling of steel member should normally be avoided. However, if the drilling of steel must be resorted to, it must be drilled where minimum of weakening of structure will result cables shall be support at every 500 mm. At every vertical drop these shall be clamped at more frequent intervals max of 300 mm.

3.4.3 Directly buried cables shall be laid underground in excavated cable trenches. Trenches shall have sufficient depth and width to accommodate all cables correctly spaced and arranged with a view of heat dissipation and economy of design construction of trenches laying of cables and filling up of trenches shall be as per relevant standard.

3.4.4 Each underground cable shall be provided with identifying tag of load securely fastened every 30 M of its underground length with at least one tag at each end before the cable enters the ground.

Before cables are placed, the trench bottom shall be filled with a layer of sand. The cables shall be covered with 150 mm of sand on the top of the largest dia. cable tube and sand shall be lightly pressed. A protective covering of 75 mm thick second class red bricks shall be laid flat and the balance portion of the trench shall be filled with soil, compacted and levelled.

3.4.5 At each road crossing and other places where cables enter pipe sleeves, adequate bed of sand shall be given so that the cables don't slack and get damaged by pipe ends after back filling.

3.4.6 At the entry into concrete blocks loops shall be provided at either end to prevent any damage to cable.

3.4.7 The cable entry to control room shall be suitably filled and sealed after laying of cables so as to achieve a positive sealing against the entry of gas/water.

3.4.8 All wiring, tubing, cables, Junctions boxes and auxiliary equivalent shall be suitably identified as per applicable codes and practices. All piping and tubing shall be tagged with slip-on or clip on wire marker at both ends.

3.4.9 Jointing of cables is generally not permitted. Cables shall be cut after the exact site measurements at the cable drums shall be so selected before cutting the lengths as to avoid any unnecessary wastage.

3.4.10 Low signal cables like alarms, analysers cables, special cables for turbine meter, thermocouple compensating cables etc. shall be layed separated from power supply cables in ducts/trenches/trays.

3.4.11 Electric signal lines for electronic transmitters to receive and to final control element shall be continuously shielded with the shield grounded at the same point as the signal circuit generally at the control instrument.

3.4.12 Separate junction boxes shall be used for intrinsically sage cables.

3.4.13 Different intrinsically safe system e.g., systems having different rounds shall not be run in the same multicore cable, in general.

Recommended minimum separation distance between twisted pair signal leads and AC Power Lines.

AC Power Cable		Minimum Distance to Signal Lead
Voltage (Volts)	Current (Am)	in (cm)
0 to 125	0 to 10	12" (30)
125 to 250	0 to 50	15" (38)
250 to 440	0 to 200	18" (46)
5KV & Up	200 Amp. & Up	24" (61)

Different intrinsically safe circuits e.g., circuits having different voltage levels, of the same intrinsically safe system shall not be run in the same cable unless each conductor insulation is at least 0.25mm or no hazard can result from interconnection.

3.4.14 The physical separation of power and signal cables shall be as per API 550 Part I Section VII. Cable in intrinsically safe circuits shall preferably be not run in the same tray where-- on intrinsically safe circuits cables are being run. If these are being run in the same tray, a metallic earthed separately shall be provided.

3.4.15 For temperature controllers, single pair thermocouple extension cable or cable for resistance thermometer, shall be layed directly from the element to the transducer in the control room without intermediate terminal blocks.

3.4.16 In case of skid mounted equipment or equipment which incorporate skid instrumentation like alarms, shutdown or control function shall terminate signals or control junction box near skid boundary for connection of off skid equipment.

3.4.17 No wire shall be terminated or left with mechanical strain within any conductor.

3.4.18 Splices shall be made only at terminals, in instruments or approval equipment/ junction boxes using lugs and screwed connections. No intermediate splices shall be made in cable trays or in conduct. Number of junction boxes in any cable path shall be limited to only one.

3.5 Installation of Zener barriers

3.5.1 Zener barriers shall be installed in the circuit to make the system intrinsically safe provided:

a) There is no energy storage system in excess to the minimum permitted by the barrier design on the hazardous side of the barrier. The same shall be met by taking intrinsically safe transmitters and selecting the cable electrical parameters like inductance L/R ratio & capacitance in accordance with the maximum parameters given in barrier specifications.

b) No power source exceeding the voltage rating of Zener barrier shall be connected on safe side of the Zener barrier.

c) No outside power source including other intrinsically safe circuits shall be connected to the hazardous side of the barrier.

3.5.2 Zener barriers shall be located as close as possible to the field wiring entry point in the control room.

3.5.3 Single barrier are bolted directly to copper bus bar and multiple barriers on the barrier mounting plates. Copper bus or barriers mounting plates shall be isolated from the panel frame.

3.5.4 The signal ground system for intrinsically safe system shall be separate from power ground system and shall be connected to the signal ground reference point. The maximum resistance allocable between the farthest point on intrinsically safe barrier ground bus and signal ground reference point shall be less than 1 ohm.

3.5.5 Field wires shall directly terminate at the barriers and not through intermediate terminals.

3.6 Installation of Analyser / Gas Chromatograph

3.6.1 Installation of all analyser shall be in general, as per APIP 550 Part II.

3.6.2 The analyser housing at its installation shall meet all safety requirements as per classifications.

3.6.3 Sampled process fluid, if not returned to the process shall be disposed to a safe location. Piping shall be provided so that vapours can be vented to a safe location and liquids shall be drained in a clean and orderly fashion to a safe place. Toxic vapours shall not be vented to atmosphere.

3.6.4 Analyser shall be located as near to the sampling point as possible.

3.6.5 Analyser equipment must be protected from the following:

a) Hot equipment
b) Severe ambient temperature changes
c) Shock
d) Mechanical damage
e) Vibration

3.6.6 If a separate vent for the analyser is used, the location of that vent shall be in area of minimum air Turbulence. If the vents of different analysers are vented into a common vent, a back pressure regulator shall be used.

3.6.7 Vent piping shall be designed to prevent condensate from accumulation in low point and obstruct a free vent flow.

3.7 Ducts, Trays and Supports

3.7.1 Main cable duct shall be of bottom open type with flat/angle --- construction with side sheet and top cover of 3.2 mm thickness.

3.7.2 The ducts and trays shall be properly supported at regular intervals. Wherever insert plates are not available, support on concrete structure or ceiling shall be fixed with a minimum of 10 mm expansion bolts Angle supports for ducts shall be fabricated from minimum of 40 mm angle.

3.7.3 All supports shall be neatly cut with hacksaw only and not with gas cutting. Free ends of angle supports shall not have sharp ends and shall be properly rounded off.

3.7.4 Ducts and supports shall be painted with one coat of Red oxide Zinc chromate primer conforming to IS-2074 after cleaning to remove scale and then painted with

2 coats of final enamel paint as given below:

a) Duct - Dark admirately Grey as per IS0632.
b) Supports - Black.

3.8 Instrument Steam Tracing

3.8.1 Steam for Tracking of instruments shall be taken from main steam header take of valve through carbon steel pipes supported at regular intervals.

3.8.2 Steam tracing around individual instrument shall be by copper tube of 1/8" diameter.

3.8.3 Piping or tubing for steam tracing shall be installed in such a way as to avoid condensate pockets.

3.8.4 After steam tracing, the line is connected to drain funnel through steam trap.

3.9 Identification of Lines and Instruments

3.9.1 All site mounted instruments, junction boxes, air headers, tubing and wiring terminations shall be labelled or tagged.

3.9.2 Instruments shall be furnished with stainless steel name tags containing Tag no., manufacturer's name, and model no. serial number. This tag number shall be approximately 3"x1" size and shall be attached to the instruments with -- gauge stainless steel wire.

3.9.3 Unused cable entries in junction boxes and field instruments are to be plugged.

4.0 TESTING

4.1 Instrument Impulse piping/Tubing

4.1.1 All process impulse lines shall be disconnected both from the instrument and vessel/piping end and flushed with water.

4.1.2 After thorough flushing the impulse lines shall be isolated from the instruments and pressurised hydraulically to 1.5 times the maximum working pressure corrected for ambient temperature. They shall then be isolated from the pressure source and the pressure reading on a test pressure gauge shall not fall at a rate exceeding one psig/hour.

In case no isolation valve is provided near the instrument, impulse piping/tubing shall be pressurised along with the instrument to the maximum pressure of scale in case of pressure transmitter and max. Operating pressure in case of differential

pressure instrument with equalising valve open

4.1.3 In special conditions where hydro- testing is not permissible due to service requirements, testing shall be carried out by using compressed air/nitrogen.

4.1.4 The external displacer type instruments and cage type level switches shall be tested to 1.5 times the operating pressure using air/nitrogen after thorough flushing.

4.2 Instrument Air lines/signal tubing.

4.2.1 Instrument air lines/signal tubing shall not be hydrostatically tested.

4.2.2 Instrument air tubing shall be disconnected upstream of all filter regulators and blown down to remove water, slag and mill scale, from lines at 7.0 kg/cm^2 G for fifteen minutes.

Air filter shall be taken in line and tubing shall be disconnected at instrument end, and blown for 3 minutes to remove traces of dirt.

4.2.3 Testing of instrument air shall be carried out with instrument air at 7 kg/cm^{2}G upto the upstream of the filter regulator after thorough flushing. All lines shall be checked with soap solution and bubbler unit for possible leak at joints.

4.2.4 All signal tubing shall be checked with 1.5 kg/cm^2 after proper flushing. After pressuring, source shall be cut off and rate of fall in pressure shall be less than IPSL for each 100 feet of tubing for a test period of 2 minutes as per instrument society of American RP 7.1 `Pneumatic Control Circuit Pressure Test'

4.3 Cables

4.3.1 All wiring shall be checked to ensure that it is correctly connected and properly grounded.

4.3.2 All cables shall be checked for continuity proper connection and insulation testing.

Insulation test shall be carried out on all wiring with a certified magger after disconnecting the cables at both ends.

4.4 All the results of the above mentioned testing shall be recorded and submitted for check.

4.5 All the in line instruments like orifice plates, turbine meters, Rotameters, Target meters, vortex meters, control valves, safety valves etc. shall be removed and

spool pieces shall be provided prior to the flushing of the lines.

5.0 CALIBRATION OF INSTRUMENTS

5.1 All instruments shall be calibrated strictly as per manufacturer's instructions prior to the installation. In addition to calibration of instruments, setting of safety devices like process switches, safety valves etc. and simulation testing of all interlock and shutdown system shall be carried out.

5.2 In general, all tests shall simulate, as closely as possible, design process condition by the use of manometers, potentiometers, deadweight testers, test pressure gauges etc. Pour point calibration shall refer to the input signal to an instrument equivalent to 0, 25, 50, 75,100% of instrument range upscale (rising) and 75, 50, 25, 0% of instrument (downscale) (falling).

All instruments unless otherwise noted shall be calibrated in upscale and downscale direction and if necessary, adjusted until their accuracies conform to those limits state by the manufacturer.

Upon completion of these tests, the instruments shall be drained, completely.

5.3 Temperature Instruments

5.3.1 Temperature Gauges Filled type and Bi metallic dial type Thermometers shall be four point bench checked for proper operation and calibration using a temperature bath prior to installation.

5.3.2 Temperature Elements and Temperature Transmitters.

Temperature Elements and Transmitter shall be four point bench calibrated using a temperature bath precision meter or precision gauge prior to installation.

5.4 Pressure Instruments

5.4.1 Pressure Gauges

5.4.1.1 Direct connected bourdon type pressure gauges shall be dead weight tested or tested against a test gauges prior to installation.

5.4.1.2 Receiver type pressure gauges shall be four points calibrated using a precision gauge and precision air regulator.

5.4.1.3 Pressure and Differential Pressure Transmitters.

Pressure and differential pressure transmitters shall be four points calibrated using a hydraulic or dead weight tester or a precision pneumatic calibrator prior to the installation. A precision output meter or gauge shall be used to monitor the output.

5.5.1 Orifice plates shall be checked visually for the name plate and for an upstream sharp edge. Bore dia. shall be checked for compliance with the specification.

5.5.2 Differential pressure type of flow instruments shall be four points calibrated using precision pneumatic calibrator or a manometer and precision regulator. A precision output meter or gauge shall be used to monitor the output of the transmitter.

5.5.3 a) Rotameters shall be installed as received. A check shall be made to confirm that shipping stops have been removed and float has been installed.

b) Where rotameters have transmitting mechanism, the float shall be raised and lowered mechanically and output shall be checked. Vendor calibration data/ curve shall be checked.

C) A check shall be conducted with plumb for a vertical installation.

5.5.4 Turbine meters, Annubar, positive displacement meters, vortex meter, ultrasonic flow meter, etc. shall be installed as received.

5.5.5 Target meters shall be checked for calibration using calibration weights. Output shall be monitored using precision output meter.

5.6 Level Instruments

5.6.1 Level Gauge Glasses

Gauge glasses shall be installed as received installation of illuminators, frost protectors and other accessories shall be checked.

5.6.2 Displacer Type, Level Transmitter

- Displacer type level transmitter shall be checked by raising and lowering mechanically the displacement and checking the pilot or transmitter action. Check transmitter with out put gauge or meter for smooth and full output change.

- A check shall be conducted with plumb for a vertical installation.

5.6.3 Differential pressure type level transmitter Differential pressure type level transmitter shall be calibrated with pneumatic calibrator at four points prior to installation. A precision meter or gauge shall be used to monitor the output of the transmitter.

5.6.4 Tank level gauges

a) Tank level gauges shall be checked by raising and lowering mechanically the displacer and checking the indicator on the gauge board.

b) Check for proper liquid seal prior to installation in case of liquid seal tank gauges.

c) In case of servo type gauges, the displacer is hoisted from the tank into the calibration chamber.

5.7 Control Valves, shutdown valves and self actuated valves

5.7.1 All diaphragm and piston operated control valve shall be stroked pneumatically using a pressure regulator and pressure gauge against the spring range specified on the name plate of the valve.

5.7.2 Mechanical seating and travel of the valve stem shall be checked against the side indicator and the name plate

5.7.3 Valve positioner shall be calibrated with the control valve in accordance with the name plate data and specifications with the help of pneumatic calibrator or gauge with precision regulator. Zero position or fully close position of the valve shall be a live zero i.e., the plug shall be just off the seat at the minimum setting.

5.7.4 Volume bottles, where used shall be checked for proper filling. The signal line shall be bled to zero pressure and failure action shall be confirmed.

5.7.5 Control valve accessories such as handwheels, boosters, relays etc. shall be checked operationally. Declutch able handwheel shall be operable both with and without an air signal to the diaphragm.

5.7.6 Self actuated control valves shall be installed as received, checking inlet and outlet points and name plate data. Regulators with external pressure connections shall be inspected for proper installation.

5.7.7 Butterfly shall be checked carefully to see that the vane moves freely into the upstream and down stream piping. Proper vane movement to stroke shall be confirmed.

5.7.8 All control valves and regulators shall be removed from the line prior to flushing and during hydro testing.

5.8 Safety Relief Valves

5.8.1 Safety relief valves shall be installed as received after carefully checking the name plate data. Pilots, if used, shall be checked carefully for installation on the proper safety valve.

5.8.2 Valves, which are installed in such a manner as to permit on line testing, shall be pressure tested after installation to determine proper operation and setting. Compressed air or nitrogen shall be used for testing of safety relief valves.

5.9 Switches

5.9.1 Level Switches shall be actuated mechanically for switch operation but shall not be calibrated for level setting.

5.9.2 Pressure switches shall be calibrated using hydorlic or dead weight tester or precision air regulator and gauge. The setting/trip point shall be checked using a continuity tester.

5.9.3 Temperature switches shall be calibrated using a temperature both prior to installation and set to the required alarm/ trip point using a continuity tester.

5.10 Receiver Instruments

5.10.1 Receiver Indicator/Recorders

5.10.1.1 Pneumatic indicators/ Recorders shall be calibrated using pneumatic calibrator/ precision pressure regulator and gauge.

5.10.1.2 Electronics indicators/ Recorders shall be calibrated using a current generator and a precision meter.

5.10.1.3 Chart drive assembly shall be checked for proper operation.

5.10.2 Controllers

5.10.2.1 Proper balancing of the controller shall be checked as per the manufacturers catalogues.

5.10.2.2 Controllers shall be checked for manual and Auto operation and Transfer. The transfer from manual to Auto and vice versa shall be bumpless and smooth.

5.10.3.1 Manual loader station Output of the manual loader shall be checked with a precision meter.

5.10.4.1 Multipoint Temperature Recorders

Each point shall be calibrated using a temperature simulator/ decade box for RTD / voltage generator and precision meter for the thermocouples.

5.10.4.2 Point synchronisation shall be checked.

5.10.5 Pneumatic receiver switches shall be calibrated using precision air regulator and gauge. The setting/alarm/trip point shall be checked using continuity tester.

5.10.6 Trip Amplifiers Trip amplifiers shall be calibrated using a temperature simulators or voltage generator and precision meter for thermocouple or Resistance box for RTD's. The required setting/ alarm point/ trip point shall be checked using a continuity tester.

5.10.7 Receiver Switch module Receiver switch modules shall be calibrated using a current source and a precision meter. The required setting/alarm/trip point shall be checked using a continuity tester.

5.10.8 Alarm and Annunciator system

5.10.8.1 Alarm and annunciator system shall be checked for visual and audio alarm operation using dummy signals. Full alarm sequence of each alarm point shall be checked.

5.10.8.2 Each point shall be checked for proper engraving.

5.10.9 Shutdown System

5.10.9.1 Operation of final actuating elements shall be checked for proper operation using dummy signals.

5.10.9.2 All timers, push buttons and switches shall also be checked for their proper operation.

5.11 Analytical Instruments

5.11.1 Check the full analyser system including sample handling system for leakage.

5.11.2 Check the full sample handling system for its proper operation. Calibrate and check completely all analysers using zero and span samples as per vendor catalogues.

5.12 Flow computer / Volume corrector

5.12.1 Corrected flow values shall be checked for various D.C. inputs and pressure and temperature variations for upscale and downscale ranges.

5.13 The list of test and calibration instruments with traceability certificates shall be submitted to MECON for approval before carrying out the tests / calibration of instruments at site.

5.14 The formats / description of tests / calibration of all instruments shall be submitted to MECON for approval.

5.15 Daily / weekly reports shall be submitted during execution of work at site.

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SPECIFICATION

FOR

INSTRUMENT TUBING

SPECIFICATION NO.: MEC/S/05/26/02

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

0	15.10.2014			
Revision	Date	Ratnadeep Gupta	Vikas Jain	Rakesh Kr. Shukla
		Prepared By	Checked By	Approved By

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

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1.0 GENERAL

2.0 CONSTRUCTION

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1.0 GENERAL

1.1 Scope

1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, testing and shipping of Instrument Tubing which includes the following types:-

a) SS tubes
b) Copper tubes

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of Purchaser's enquiry:

ASTM A 269	-	Specification for seamless and welded ferritic stainless steel tubing for general services.
ASTM B 251	-	Specification for general requirements for wrought seamless copper and copper alloy tube.
ASTM B 251M	-	Specification for general requirements for wrought seamless copper and copper alloy tube (Metric)
ASTM B 68	-	Specification for seamless copper tube, bright annealed.
ASTM B 68M	-	Specification for seamless copper tube, bright annealed. (Metric)

1.1.3 In the event of any conflict between these specifications, data sheets, related standards, codes, etc., the vendor shall refer the matter to the purchaser for clarifications and only after obtaining the same shall proceed with the manufacture of the items in question.

1.2 Bids

1.2.1 Vendor's quotation shall include a detailed specification sheet for each type of tube which shall provide the following information:

a) All the details regarding the type, construction, materials etc. of the items.
b) Overall the dimensions in mm.

1.2.2 All the units of measurement and material specifications for various parts in the vendor's specification sheets shall be to same standards as in purchaser's data sheets.

1.2.3 Vendor shall attach a list of items, type wise, summing up all the deviations from this specification and purchaser's data sheets if there are any. Also vendor shall provide reasons for these deviations.

1.2.4 Vendor shall enclose catalogues giving detailed technical specifications and other information for each type of tube in the bid.

1.2.5 Vendor's quotation, catalogues, drawings etc. shall be in English language.

1.3 Drawings, Data and Certification

Detailed drawings, data, catalogues and manuals etc. required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible and prints shall be despatched to the address mentioned, adhering to the time limits indicated.

2.0 CONSTRUCTION

2.1 Stainless Steel Tubes

2.1.1 SS tubes of the tubes shall be Rockwell RB 70-70. Tubes shall be free from scratches and to be suitable for bending.

2.1.3 Tube wall thickness shall be 0.049" for 1/2" OD and 1mm for 6 mm unless otherwise specified.

2.1.4 Maximum working pressure shall be 153.0 kg/cm^2 at 38°C for 1/2" OD Tube, unless otherwise specified and 80.0 kg/cm^2 at 38° for 6mm OD tube.

2.1.5 Tubes shall be supplied in minimum length of 6 metres without brazing in between.

2.1.6 Dimensional tolerances shall be as per ASTM A 269.

2.1.7 The following shall be marked on the tube:

a) Name of manufacturer
b) Type and material grade of tube
c) Tube O.D. and wall thickness

2.2 Copper Tubes

2.2.1 Copper Tubes (PVC Jacket)

2.2.1.1 The tube shall be soft annealed copper with 6mm OD and a wall thickness of 1.0 mm as per ASTM B 68M Copper No.C12200.

2.2.1.2 The tube shall be jacketed with black PVC. The jacket thickness shall be 1.6mm. The PVC jacket shall confirm to ASTM D-1047.

2.2.1.3 The tube ends shall be plugged prior to transportation.

2.2.1.4 The tube shall be of continuous length without any brazing in between for 100 metres length.

2.2.1.5 Minimum length of single tube shall be 100 metres.

2.2.1.6 The dimensional tolerances shall be as per ASTM B 251M.

2.2.2 Bare Copper Tubes (For Steam Tracing)

2.2.2.1 The tube shall be soft annealed copper with 3/8" OD or 6mm OD with a wall thickness of 1.0 mm as per ASTM B68 copper No.C12200.

2.2.2.2 The tube ends shall be plugged prior to transportation.

2.2.2.3 The tube shall be of continuous length without any brazing in between for 100 metres length.

2.2.2.4 Minimum length of tube shall be 100 metres.

2.2.2.5 The dimensional tolerances shall be as per ASTM B 251.

3.0 TESTING

3.1 The following tests shall be done for SS tubes.

a) Hardness test
b) Hydrostatic test at 153.0 kg/cm^2 at 38° C for 1/2" tube and at 80.0 kg/cm^2 at 38°C for 6mm tube, unless otherwise specified.

3.2 PVC jacketed copper tubes shall be tested at 7.0kg/cm^{2}g with dry air for leak check.

3.3 Bare copper tubes shall be hydrostatically tested at 80.0 kg/cm^{2}g at 38°C.

3.4 Final test before delivery shall include ball test to ensure clear opening of the tube for copper tubes. The O.D of the ball shall be minimum 1mm for 6mm O.D tube and 2mm for 3/8" tube.

4.0 SHIPPING

4.1 The tubes shall be plugged at both ends to avoid entry of foreign matter. The tubes shall be packed carefully so as to avoid damage during transport.

5.0 REJECTION

Vendor shall make his offer in detail, with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summarily rejected.

SPECIFICATION

FOR

INSTRUMENT TUBE FITTINGS

SPECIFICATION NO.: MEC/S/05/26/04

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

0	15.10.2014	Gupta	Jain	
Revision	Date	Ratnadeep Gupta	Vikas Jain	Rakesh Kr. Shukla
		Prepared By	Checked By	Approved By

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1.0 GENERAL

1.1 Scope

1.1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, testing and shipping of instrument tube fittings which includes the following types:-

a) SS compression fittings (SS tube)
b) Brass compression fittings (copper tube)

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of Purchase's enquiry:

ANSI B 2.1	-	Pipe Threads
B16.11	-	Forged steel fittings-socket welding and threaded.
IS:319	-	Specification for free cutting brass bars, rods and sections.
ISA RP 42.1	-	Nomenclature for instrument tubing - fittings.

1.1.3 In the event of any conflict between these specifications, data sheets, related standards, codes etc., the vendor shall refer the matter to the purchaser for clarifications and only after obtaining the same shall proceed with the manufacture of the items in question.

1.2 Bids

1.2.1 Vendor's quotation shall include a detailed specification sheet for each type of tube fittings which shall provide the following information:

a) All the details regarding the type, construction, materials, etc. of the items.
b) Overall dimensions in mm.

1.2.2 All the units of measurement and material specifications for various parts in the vendor's specification sheets shall be to same standards as in purchaser's data sheets.

1.2.3 Vendor shall attach a list of items, typewise, summing up all the deviations from this specification and purchaser's data sheets if there are any. Also vendor shall provide reasons for these deviations.

1.2.4 Vendor shall enclose catalogues giving detailed technical specifications and other information for each type of fitting in the bid.

1.2.5 Vendor's quotation, catalogues, drawings, etc. shall be in English language.

1.3 Drawings, Data and Certification

Detailed drawings, data, catalogues and manuals etc., required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducibles and points shall be despatched to the address mentioned, adhering to the time limits indicated.

2.0 CONSTRUCTION

2.1 SS Tube fittings:

2.1.1 Nomenclature of all tube fittings shall be as per ISA RP 42.1.

2.1.2 Fittings shall be flareless compression type and of three piece construction with ferrule, nut and body suitable for use on SS tubes conforming to ASTM A 269 TP316, hardness not exceeding RB80.

2.1.3 All parts shall be of SS 316.

2.1.4 Hardness of the ferrules shall be in the range of RB 85-90 so as to ensure a minimum hardness difference of 5 to 10 between tube and fittings, for better sealing.

2.1.5 Nuts and ferrules of particular size shall be interchangeable for each type.

2.1.6 Spanner hold shall be metric.

2.1.7 Threaded ends of fittings shall be NPT as per ANSI B 2.1.

2.1.8 Copper Tube Fittings

2.2.1 Nomenclature of all tube fittings shall be as per ISA 42.1.

2.2.2 Fittings shall be of flareless compression type and of three-piece construction consisting of ferrule, nut and body suitable for use on copper tubes conforming to ASTM B 68/B 68M hardnesss not exceeding RB 50.

2.2.3 All parts shall be manufactured from Brass as per IS 319 barstock and Nickel plated.

2.2.4 For better grip, vendor shall maintain hardness difference between tube & ferrule and indicate the same along with the offer.

2.2.5 Nuts & ferrules of particular size shall be interchangeable for each type.

2.2.6 Threaded ends of fittings shall be NPT as per ANSI B 2.1.

2.2.7 Spanner hold shall be metric.

2.2.8 Vendor shall ensure that the ferrules and nuts supplied for fittings shall be suitable for sample tube which shall be supplied during manufacture.

3.0 TESTING

3.1 Random samples of SS tube fittings shall be hydrostatically tested as follows:-

For 6 mm fittings at 80.0 kg/cm^2, 1/2" fittings at 153.0 kg/cm^2 at 38°c unless otherwise specified.

3.2 Random samples of brass compression fittings shall be hydrostatically tested as follows:-

For 1/4" fittings, at 10 kg./cm^2, 3/8" at 80.0 Kg/cm^2 and all at 38°C.

4.0 SHIPPING

4.1 All thread/ends shall be protected with plastic caps to prevent damage/entry of foreign matter.

5.0 REJECTION

Vendor shall make his offer in detail, with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summarily rejected.

SPECIFICATION

FOR

INSTRUMENT VALVES AND MANIFOLDS

SPECIFICATION NO.: MEC/S/05/26/05

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

0	15.10.2014			
Revision	Date	Ratnadeep Gupta	Vikas Jain	Rakesh Kr. Shukla
		Prepared By	Checked By	Approved By

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1.0 GENERAL

1.1 Scope

1.1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, testing and shipping of Instrument Valves & Manifolds which includes the following types:-

a) Miniature instrument valves
b) Instrument valve manifolds
c) Instrument air valves

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of Purchaser's enquiry:

ANSI B 2.1	-	Pipe threads
ANSI B 16.11	-	Forged steel fittings-socket welding and threaded.

1.1.3 In the event of any conflict between these specifications, data sheets, related standards, codes etc, the vendor shall refer the matter to the purchaser for clarifications and only after obtaining the same shall proceed with the manufacture of the items in question.

1.2 Bids

1.2.1 Vendor's quotation shall include a detailed specification sheet for each type of Valves & Manifolds which shall provide the following information:

a) All the details regarding the type, construction, materials etc. of the items.
b) Overall dimensions in mm.

1.2.2 All the units of measurement and material specifications for various parts in the vendor's specification sheets shall be to same standards as in purchaser's data sheets.

1.2.3 Vendor shall attach a list of items, typewise, summing up all the deviations from this specification and purchaser's data sheets if there are any. Also vendor shall provide reasons for these in the bid.

1.2.5 Vendor's quotation, catalogues, drawings etc. shall be in English language.

1.3 Drawings, Data and Certification

Detailed drawings, data, catalogues and manual etc. required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible and prints shall be despatched to the address mentioned, adhering to the time limits indicated.

2.0 CONSTRUCTION

2.1 Instrument Valves (Miniature)

2.1.1 The instrument valves shall be globe pattern-needle valves forged/ barstock with inside screwed bonnet.

2.1.2 Body and trim material shall be 316 SS unless otherwise specified.

2.1.3 The valve body rating shall be 3000 lbs unless specified in piping material specification which shall govern in case it is specified.

2.1.4 The end connection shall be 1/2" NPTF to ANSI B2.1.

2.1.5 The packing material shall be teflon unless otherwise specified.

2.1.6 The hand wheel material shall be carbon steel zinc plated.

2.1.7 Flow direction shall be marked on the body.

2.1.8 The valve dimension shall be as follows:

a) End to end dimensions 76 mm (approximately).
b) Height in fully open condition - 135mm maximum.

2.2 VALVE MANIFOLDS

2.2.1 3-Valve & 5-Valve manifolds:

2.2.1.13 Valve manifold shall be designed for direct coupling to differential pressure transmitters having 2 bolt flanges with 54 mm (2-1/8") centre to centre connections and 41.3 mm (1-5/8") bolt to bolt distance. The manifold shall contain two main block valves and an equalizing by-pass valve. The valves shall be needle valves. They shall use self aligning 316SS ball seats.

2.2.1.25 Valve manifold shall contain two main line block valves and a combination double block and bleed for the bypass line.

2.2.1.3 The manifold shall be suitably for mounting directly on the stanchion (2" pipe).

2.2.1.4 All bonnets shall have teflon packing unless otherwise specified.

2.2.1.5 The material of construction shall be 316 SS unless otherwise specified.

2.2.1.5 The material of construction shall be 316SS unless otherwise specified.

2.2.1.6 The flanges shall be integral part of the block.

2.2.1.7 The process connection shall be 1/2" NPTF to ANSI B2.1.

2.2.1.8 The manifolds shall be supplied alongwith mounting accessories. The bolts and nuts shall be alloy steel as per ASTM A 193 Gr B ASTM A 194 GR 2H respectively. Rings shall be teflon and other accessories shall be cadmium plated.

2.2.1.9 Vendor shall furnish the material certificate for body.

2.2.2 3 Way 2 Valve Manifold for pressure gauges.

2.2.2.1 The manifold shall be designed for use with pressure gauges.

2.2.2.2 The valve shall be a ball valve.

2.2.2.3 The body shall be either straight or angle as specified in data sheets.

2.2.2.4 The body and trim material shall be 316SS, packing material shall be teflon unless otherwise specified.

2.2.2.5 The inlet connection shall be 3/4" plain end (female) for socket weld as per ANSI B 16.11.

2.2.2.6 The gauge connections shall be with union nut & tail piece threaded 1/2" NPT (F).

2.2.2.7 The drain connection shall 1/2"NPTF.

2.3 Instrument Air Isolation Valves

2.3.1 The valves shall be full bore ball valves.

2.3.2 Body material shall be Nickel or Cadmium plated carbon steel.

2.3.3 Trim material shall be 316SS.

2.3.4 The end connection shall be 1/2" NPTF to ANSI B2.1 unless otherwise specified.

2.3.5 The packing material shall be teflon.

2.3.6 The handle/wrench material shall be cadmium or nickel plated carbon steel.

2.3.7 The valve body rating shall be ANSI 800 lb.

2.3.8 End to end dimensions shall be 70mm (approximately).

3.0 TESTING

3.1 The instrument valves (miniature) shall be hydrostatically tested at 200kg/cm^2 g at 38^oC.

3.2 All manifolds (3 valves, 5 valves and 3 ways, 2 valves) shall be hydrostatically tested at 200 kg/cm2 at 38C.

3.3 The instrument air valves shall be hydrostatically tested at 15.0 kg/cm^2g at 38^oC and at 10.5 kg/cm^2g with dry air.

4.0 SHIPPING

4.1 All threads/ends shall be protected with plastic caps to prevent damage/entry of foreign matter.

5.0 REJECTION

Vendor shall make his offer in detail, with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summarily rejected.

SPECIFICATION

FOR

JUNCTION BOXES AND CABLE GLANDS

SPECIFICATION NO.: MEC/S/05/26/06

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

0	15.10.2014			
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2.0 JUNCTION BOXES

3.0 CABLE GLANDS & PLUGS, REDUCERS/ ADAPTORS

4.0 NAME PLATE

5.0 SHIPPING

6.0 REJECTION

1.0 General

1.1 Scope

1.1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, nameplate marking, testing and shifting of junction boxes & cable glands which include the following types:

a) Electrical junction boxes.
b) Pneumatic junction boxes
c) Cable glands (whenever specified)

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

ANSI B 2.1	:	Pipe threads
IS-5	:	Colours for ready mixed paints and enamels
IS-2147	:	Degrees of protection provided by enclosures for Low voltage switchgear and control gear.
IS-2148	:	Flame proof enclosure of electrical apparatus.

1.1.3 In the event of any conflict between specifications, data sheets, related standards, codes etc., the vendor shall refer the matter to the purchaser for clarifications and only after obtaining the same should proceed with the manufacture of the items in questions.

1.2 Bids

1.2.1 Vendor's quotation shall include a detailed specification sheet for each type of junction box and cable gland which shall provide the following information:

a) All the details regarding the type, construction, materials, housing, entries, etc.
b) All dimensions in millimetre.
c) Sketch for each type of JB with dimensional details showing the terminal and entries arrangement.
d) Mounting details.
e) Vendor shall furnish certificate from statutory body for explosion proof enclosure, indicating the gas group and temperature class.

1.2.2 All the material specifications for various parts in the vendor's specification sheets shall be to the same standards as those in purchaser's data sheets (e.g. BS IS, etc.)

1.2.3 Vendor shall attach a list of items, tag number wise, summing up all the deviations from the purchaser's data sheets, if there are any. Also vendor shall furnish reasons for these deviations.

1.2.4 Vendor shall enclose catalogues giving detailed technical specifications and other information for each type of JB/cable glands and its accessories covered in the bid.

1.2.5 Vendor's quotation, catalogues, drawings, etc. shall be in English language.

1.3 Drawings, Data and Certification

1.3.1 Detailed drawings, data, catalogues required from the vendor are indicated in vendor data requirements sheets. The required number of reproducible and prints shall be despatched to the address mentioned, adhering to the time limits indicated.

1.3.2 After placement of purchaser order, vendor shall submit certified drawings and specifications sheets for each type of JB/cable gland which shall include the following:

a) Detailed dimensional drawings
b) Weight of each in grams/Kg.
c) Certificate from statutory body suitable for installation in specified hazardous area.

2.1 Junction Boxes

2.0 Junction boxes shall be either of the following type as specified in data sheets.

I. Weather proof junction boxes.
II. Weather proof & Explosion proof junction boxes.

2.2 The enclosure shall be as per IS-2147 for weather proof junction boxes and for Explosion proof it shall be as per IS-2148 suitable for the area classification specified.

2.3 Number of entries and locations shall be as per data sheets.

2.4 Junction boxes shall be provided with telephone sockets and plugs for connection of hand powered telephone set.

2.5 Electrical Junction boxes

2.5.1 Material shall be die-cast aluminium of minimum 5 mm thick (LM-6 alloy)

2.5.2 Explosion proof junction boxes shall have detachable cover which is fixed to the box by means of cadmium plated triangular head/hexagonal head screws.

2.5.3 Weather proof junction boxes shall have doors which shall be hinged type and these shall be fixed with cadmium plated countersunk screws.

2.5.4 Explosion proof junction boxes shall have a warning engraved/integrally cast on the cover as given below:

"Isolate power supply elsewhere before opening"

2.5.5 Terminals shall be spring loaded, vibration proof, clip-on type, mounted on nickel plated steel rails complete with end cover and clamps for each row.

2.5.6 All terminals shall be suitable for accepting minimum 2.5 sq. mm copper conductor, in general. However for power supply distribution boxes, terminal detail shall be as per job specification/Data sheets.

2.5.7 Sizing shall be done with due consideration for accessibility and maintenance in accordance with the following guidelines.

i) 50 to 60 mm between terminals and sides of box parallel to terminal strip for upto 50 terminals and additional 25mm for each additional 25 terminals.
ii) 100 to 120mm between terminals for upto 50 terminals and additional 25mm for each additional 25 terminals.
iii) Bottom/top of terminal shall not be less than 100 mm from bottom/top of the junction box.

2.5.8 Terminals shall be marked as per the various types indicated in data sheets.

2.5.9 Shall be provided with external earthing lugs.

2.6 Pneumatic junction boxes

2.6.1 Pneumatic junction boxes shall be made of 3mm thick hot rolled steel. They shall have necessary neoprene gasket between door and body. Door shall be flush with the box and shall be hinged type and provided with wing nuts.

2.6.2 Single tube entries shall be suitable for 6mm O.D. copper tube with bulk head fittings. Multi tube bundle entry shall be suitable for the data furnished in data sheets.

2.7 Painting

2.7.1 Surface shall be prepared for painting. It shall be smooth and devoid of rust and scale.

2.7.2 Two coats of lead-free base primer and two final coats of lead free epoxy based paint shall be applied both for interior and exterior surfaces.

2.7.3 The colour shall be as specified in data sheets.

3.0 Cable glands & plugs, Reducers/Adaptors

3.1 Cable glands shall be supplied by vendor whenever specified.

3.2 Cable glands shall be double compression type for use with armoured cables.

3.3 The cable glands shall be of Nickel plated brass.

3.4 The cable gland shall be weather proof. Whenever specified they shall be explosion proof and certificate from statutory body shall be furnished.

3.5 Cable glands shall be supplied to suit the cable dimensions indicated along with tolerance indicated in data sheets. Various components like rubber ring, metallic ring, metallic cone and the outer/inner nuts etc. shall be capable of adjusting to the above tolerances of cable dimensions.

3.6 Reducers/Adaptors shall be supplied as per details indicated in data sheets. They shall be nickel plated brass. These shall be weather proof in general. These shall also be explosion proof wherever specified and certificate from statutory body for explosion shall be furnished.

3.7 Plugs shall be provided wherever specified. They shall be of Nickel plated brass.

3.8 Plugs shall be certified explosion proof when used with explosion and junction boxes.

4.0 Name Plate

4.1 Each junction box shall have an anodised aluminium name plate permanently fixed to it at a visible place bearing the tag no. & enclosure. The name plate shall also bear the stamp of certifying agency with certificate number.

5.0 Shipping

5.1 All threaded openings shall be suitably protected to prevent entry of foreign material.

5.2 All threaded components shall be protected with plastic caps to prevent damage of threads.

6.0 Rejection

Vendor shall furnish his offer in detail, with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summararily rejected.

SPECIFICATION

FOR

SIGNAL CABLES

SPECIFICATION NO.: MEC/S/05/26/07

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

0	15.10.2014			
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2.0 CONSTRUCTION

3.0 ELECTRICAL CHARACTERISTICS

4.0 TESTING

1.0 GENERAL

1.1 Scope:

This specification together with the job Specifications attached herewith forms the requirements for design, materials manufacturing, testing and shipping of PVC insulated signal cables.

1.2 Standards:

The cables shall conform to the latest editions of the various standards mentioned in the specification.

In case of any conflict between any standard and this - specifications the matter shall be referred to the purchaser before proceeding with the manufacture of the cables.

1.3 Bids:

1.3.1 Vendor's quotation shall include the following as a minimum.

Completed job spec. Pair identification method, type test certificates, technical literatures, various testing methods and cross sectional dimensional drawings. All information/data shall be in English language.

1.3.2 Vendor's quotation shall include a list of deviations if any from purchaser's specifications and shall also indicate the reasons for such deviations for consideration to arrive at mutually agreed deviations. However vendor shall note that no deviation shall be accepted in respect of the permissible limits of resistance capacitance and L/R ratio of cables.

1.3.3 Vendor shall quote unit price per metre for each type of cable.

1.4 Instructions to Bidder:

1.4.1 The quantity indicated against each type of cable in the job specification may vary by± 25% at the time of placement of order. Vendor shall confirm that there shall be no price implication on this account in unit prices typewise.

1.4.2 Drum length for each type of cable shall be 500 to 1000 metres. Vendor shall indicate the maximum drum length possible for each type of cable in his bid. Exact requirements of drum length will be specified after purchase order during detailed engineering and vendor shall confirm that the same shall not affect the price or delivery schedule. The actual produced drum length shall not vary by more than± 5% from the value indicated in the purchase order.

1.4.3 Tolerance over the total ordered length shall be as follows:
± 5% for total length less than 5 km
± 2% for total length 5 km or more

1.4.4 Cable dimensions furnished by vendor in his bid shall be firm. Vendor shall comply with all the values during execution.

1.5 All cables shall be suitable for laying in open air, corrosive hydrocarbon plant atmosphere, direct sun and in trenches. The cable shall also be designed for prolonged use in tropical atmosphere.

1.6 On demand vendor shall furnish documents such as invoice and test certificates to prove the quality and composition of the materials used for manufacturing the cable to the satisfaction of client/ consultant or authorised representative during various stages of expediting and inspection.

2.0 Construction:

2.1 Type 1

(Single pair/triad shielded cable)

2.1.1 Each core shall be 1.5 sq. mm made of 7 stranded annealed electrolytic copper conductors. Each strand shall be 0.53 mm dia.

2.1.2 Primary insulation shall be 85°C polyvinyl chloride (PVC) as per IS-5831 Type C. Thickness shall be 0.5 mm minimum.

2.1.3 Each wire shall have twisted cores and No. of twists shall be not less than 10 per metre. Colour of cores insulation shall be black blue in a pair and black, blue and brown in a triad.

2.1.4 Individual pair and triad shall be shielded. Shield shall be Aluminium backed by Mylar/polyester tape bonded together with the metallic side down helically applied with either side - 25% overlap and 100% coverage. Minimum shielded thickness shall be 0.05mm. Drain wire shall be 0.5 sq.mm multistrand bare tinned annealed copy conductor. The drain wire shall be in continuous contact with Aluminium side of the shield.

2.1.5 Inner and outer jacket shall be made of extruded flame retardant 90°C PVC to IS 5831-Type ST2 Oxygen index of PVC shall be 30. Temp. Index shall be over 250° C.

Inner jacket colour shall be black. Outer jacket colour shall be black except for cable to be used in intrinsically safe systems it shall be light blue.

2.1.6 Armour over inner jacket shall be of galvanised steel wire/flat as per IS-1554 part-I.

2.1.7 A pair or triad identification shall be with numbers at interval of not more than 250 mm as per vendor's standard.

2.1.8 Tolerance in overall diameter of cable shall be within +_ 2mm over offered value for cables with OD less than 30mm and+3mm for cables with OD more than 30mm.

2.2 Type-II

(Multipair / Multitraid cable with individual pair shield and overall shield)

The cable shall be same as single pair shielded cable except conductor size shall be 0.5 sq.mm made of 16 strands of annealed electrolytic copper conductor. Each strand shall be of 0.2mm dia.

Additional feature shall be as follows:

2.2.1 Overall shield shall be of Aluminium backed up by Mylar/polyester tape helically applied with the metallic side down either side - 25% overlap and 100% coverage. Minimum shield thickness shall be 0.075mm Drain wire shall be similar to individual pair drain wire and shall be in continuous contact with the Aluminium side of the overall shield.

2.2.2 Overall twist of all pair/triads shall be as per vendor's standard.

2.2.3 A pair of communication wire shall be provided for multipair/multitriad cables. Each wire shall be 0.5 sq. mm of plain annealed single or multistrand copper conductor with 0.4 mm thick 85°C PVC insulation. Insulation shall be green and red colour coded.

2.3 Type-III

(Multipair/Multitriad cable with only overall shield)

These cables shall be same as type-II cables except that the individual pair/triad shall not have shielding.

2.4 Type-IV

(Multipair/ multitriad cable with individual pair shield and overall shield)

The cable shall be same as Type II except conductor size shall be 1.5 sq.mm made of 7 stranded annealed electrolytic copper conductor. Each strand shall be 0.53 mm dia.

2.5 Type-V

(Multipair/ Multitriad cable with overall shield only)

The cable shall be same as type IV except that the individual pair/triad shall not have the shielding.

3.0 Electrical Characteristics

3.1 Maximum d.c. resistance of the conductor of the completed cable shall not exceed 12.3 ohms/km at 20° C for cables with 1.5 sq.mm conductor and 39.7 ohms/km at 20°C for cables with 0.5 sq.mm conductor.

3.2 Capacitance

3.2.1 Mutual Capacitance

The mutual capacitance of the pairs or adjacent cores shall not exceed a maximum of 250 pF/Meter at a concequency of 1 KHz.

3.2.2 Capacitance between any core or screen.

The capacitance between any core or screen shall not exceed a maximum of PF/Meter at a frequency of 1KHz.

3.3 L/R ratio of adjacent core shall not exceed 40 micro henry/ohm for cables with 0.5 sq. mm conductor.

3.4 The drain wire resistance including shield shall not exceed 30 ohms/km.

3.5 Electrostatic noise rejection ratio shall be over 76 dB.

4.0 Testing

4.1 Type test: Cable shall be flame retardant to IEC 332 Part III Cat. A. For qualification certificates from third party or client /consultants authorised representative for this test shall be furnished by vendor for cables similar to those being offered.

4.2 Routine tests: (To be carried out by vendor during various stages of manufacture. Purchaser shall review the related documentation).

4.2.1 Insulation and jackets: All tests as per IS-5831 except insulation resistance, voltage and spark test shall be as per BS-5308. Part-II(1986)

4.2.2 Armour test as per IS-3975.

4.2.3 Conductor resistance.

4.2.4 Cable capacitance and L/R ratio.

GENERAL SPECIFICATIONS
FOR
INSTRUMENTATION

SPECIFICATION NO.: MEC/S/05/E5/I/08

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

0	15.10.2014			
Revision	Date	Ratnadeep Gupta	Vikas Jain	Rakesh Kr. Shukla
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AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

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1.0 GENERAL

1.1 INTRODUCTION

1.1.1 This part of the technical specifications covers in general, definitions, standards, scope of works, specifications of work, documentation, scope of supply of materials and scrap and excess materials and different requirements to be adhered to during the course of execution of instrumentation works.

1.1.2 Instrumentation works shall be performed in accordance with this technical specification and various other drawings and schedules supplied during the execution and time to time instructions from Engineer-in-Charge or his authorised representative(s) during the progress of the work.

2.0 DEFINITIONS

2.1 MANIFOLDS

2.1.1 For close coupled instruments "Manifold" shall mean complete piping of instruments from first block valve upto the instruments, if the distance of the Instrument is within 2 feet (0.6m), from the Instrument tapping. If the distance of instrument is more than 2 feet (0.6m) from primary tapping such as orifice, then the installation is to be considered under remote installation.

2.1.2 For remote mounted instrument, "Manifold" shall mean the assembly of nipples, valves and fittings around the instrument to form a block and bleed or by pass manifold or drain manifold as the case may be. These shall be generally according to the hook up drawings enclosed with tender. Wherever the instruments are with 3--way-valve manifold, this definition shall not be applicable as 3-way manifold forms part of instrument.

2.2 FIRST BLOCK VALVE

First block valve shall mean the valve/valves that are mounted directly on equipment, columns, pipe, standpipe etc. and shall be operated to isolate the instrument and connected instrument piping from the above items.

2.3 SUPPORTS

Supports shall mean the MS angles, flats, channels that are generally provided to support the main cable ways, cable ducts, junction boxes, angle trays, perforated trays, instrument piping, signal tubing, instrument air supply lines etc., at specified intervals from the structures, concrete columns etc. to keep all items firmly secured against vibration, warping, bending etc.

2.4 SCRAP

2.4.1 Salvageable scraps

Salvage scrap shall mean lengths of tubes, pipes, multicables, other cables etc. that can be used one time or other at later date and normally they are recovered from the cut-pieces of tubes, pipes, multicables, cables, etc.

2.4.2 Non Salvageable Scrap

Non salvageable scrap shall mean the lengths of tubes, pipes, multicables, cables, etc. that cannot be used at all one time or other.

2.5 Standards

The instrumentation erection and calibration works shall be carried out generally in accordance with various international and Indian standards in instrumentation listed below but not limited to the following:

2.5.1 API -RP-550 Manual on Practices for instrumentation.

2.5.2 ISA standards and Practices for instrumentation

2.5.3 Instrumentation hook-up standards enclosed.

2.5.4 Instrumentation supports standard enclosed.

2.5.5 Manufacturer's standards and Practices.

3.0 SCOPE OF WORK

3.1.0 The Scope of work shall consist of supply of instrument items (as per schedule of quantities/rates and SCC), instruments, their erection, testing, calibration and commissioning and making it ready for commercial operation. The scope covers various jobs listed under the schedule of quantities/rates. However to ensure proper execution and completeness of instrument--work any or all of the following shall also form the part of the scope and shall be covered in the quoted rates.

3.1.1 Fabrication of pipe nipples, including threading whenever required.

3.1.2 Fabrication of seal pot/syphon/drain pot as per standards. Filling of seal pots with filling liquids as per instructions from Engineer-in-charge.

3.1.3 Back/seal welding of screwed fittings as required by standards.

3.1.4 Laying of cable underground including excavation, sand filling, brick laying and back filling.

3.1.5 Connection of purging devices for instruments to the systems provide as per drawings.

3.1.6 Civil works including the casting of foundation as per requirements for instruments supports where paved surface do not exist.

3.1.7 Minor civil works like chipping of pavement and grouting on the pavements the instrument panels/supports/stanchions, and chipping and refilling of the pavement for conduits.

3.1.8 Sealing of cables/ tube entries into the control room after laying and testing of all tubes, cables etc.

3.1.9 Degreasing of handwheels of control valves, stud bolts, nuts of side and bottom flange of control valves, orifice plates, other primary elements flanges, oxygen service impulse lines, instruments as per manufacturers instructions and other items as required by Engineer- in-charge.

3.1.10 Rotation of control valve bonnet wherever required.

3.1.11 Reversing the action of control valves either the replacement of springs, accessories or in positioner wherever required.

3.1.12 Minor modification/repairs required to be done on the instruments namely, changing the dial, glasses for pressure gauges, temperature gauges and other instruments, replacement of rotameter tubes, level gauge glasses, replacement of damaged signal tubes, threads, couplings etc.

3.1.13 Painting of all structural supports for trays, pipes, junction boxes, instruments, etc, as per painting specification.

3.1.14 Identification with approved colour of paint the instruments/impulse, lines manifold connected with alarm/trap circuit. Also, punching of tag numbers on items shall be carried out as per instructions of Engineer-in-charge.

3.1.15 Coordination with mechanical and other sub-contractors for proper installation of line/ vessels/ equipment mounted instruments like control valves, orifice assemblies, turbine meters, PD meters, level transmitters, level gauges, level switches etc. which involves removal of instruments, disconnection of tubes/cables, reconnection for alignment proper installation etc.

3.1.16 Drilling holes on all panels, shut down cabinets, power supply cabinets, control panels pneumatic enclosures etc., for cables/ multitubes/ glands/ groomats.

3.1.17 Grounding of shield of all shielded cables to respective instruments earth bus provided in the control room/local panel/thermocouple head.

3.1.18 Laying and termination at both ends between instrument earth buses provided in control room/ local panel to instrument earth pit provided by others.

3.1.19 Supply of all types of consumables required for the execution of the job.

3.1.20 Submission of monthly material appropriation statements for cables, piping materials fittings, including the quantity issued and expended in standard proforma.

3.1.21 Completion of owners drawings/documents, as per the execution of work at site.

3.1.22 Preparation and submission of as built drawings as required.

3.1.23 Start-up and commissioning.

3.1.24 Submission of final material appropriation statements for all the materials issued by the owner.

3.1.25 Any other work not mentioned above, but required for the proper execution of the works.

3.1.26 Where requested by owner/Engineer-in-charge or his authorised representatives, all or any of the works detailed above and schedule quantities shall also be performed on package units, local panels/cabinets/gauge board installed by owner or by others.

3.1.27 Sealing of safety valves/switches with standard lead seals after final setting in the presence of Engineer- in-charge.

4.0 DESCRIPTION OF WORK

4.1.0 <u>INSTRUMENT PIPING</u>

4.1.1 All primary piping shall be installed in the best workman like manner and shall follow installation standards in each case. Where there is no installation standard, the instruction of the Engineer-in-charge shall be followed.

4.1.2.1 Horizontal and vertical lines shall be installed using levels and plumo bobs.

4.1.3 Unless otherwise specified in the drawings pipelines shall have a slope of 8% on the horizontal runs.

4.1.4 All welding shall be carried out as per welding procedures and codes with electrodes approved by Engineer-in-charge. Only qualified welders approved by Engineer-in-charge shall carry out welding. Charges for non-destructive testing like radiography, Dye penetration tests, post heat treatment tests and stress relieving shall be carried out on the basis of actual man hours spent towards these works and man-hour charges with cost of all materials, test equipments, etc. shall be used. However, any materials like electrode, equipments, testing charges for various tests, etc., required for the initial qualification of the welder/welders shall be or the scope of the contractor.

4.1.3.1 Pipe shall be bent using pipe benders only and any bending will be totally rejected. Pipes shall be cut using pipe cutting device. Hot cutting will not be allowed.

4.1.6 Piping for steam tracing shall be installed according to the standards and avoiding condensate pockets.

4.1.7 All threaded joints shall be jointed with Teflon tape and no other pipe jointing compound shall be used except on high temperature service where graphited sealing compounds shall be used.

4.1.8 All primary piping shall be properly supported at regular intervals of 1.0 meters. Angle supports shall be fabricated from 40mmx40mmx5mm MS angles as minimum.

4.2.0 PVC COVERED/BARE TUBE (COPPER/SS/ALUMINIUM)

4.2.1 Single copper/SS/Aluminium tubes shall be laid as per standards on trays. Fabricated out of 2.5 mm thick perforated steel plate. The width of the trays shall be selected as per the number of tubes laid. Tubes shall be clamped to the trays at every 300 mm using clamps made of galvanized steel/Aluminium strips. The practice of flattening tubes for clamping purposes shall be avoided. In case of PVC covered tubes, any exposed portion at ends and connection shall be neatly taped to appropriate thickness.

4.2.2 Trays shall be properly supported either from any rigid steel structure or concrete member as detailed under trays and supports below.

4.2.3 All male/female tube connectors shall be installed with Teflon tape only. Identification tag plates/ferrules shall be provided on either side of copper tubing as per tubing/junction box schedules. Ferrules shall be single sleeve type with letters and numbers neatly printed.

4.3.0 INSTALLATION OF MULTITUBES AND MULTICORE CABLES

4.3.1 Multiple cables/ multitubes shall always be installed on ducts/trays and properly clamped. At every vertical drop to junction boxes, they shall be clamped at more frequency intervals (Maximum of 300mm). They shall be connected inside junction boxes strictly according to the number system as mentioned in cable schedule. At bends minimum radius shall be maintained as per manufacturer's standard. The angle tray supports shall be fabricated from 40mmx40mmx5mm angles minimum size.

4.3.2 Identification tags shall be provided on either end of multitubes, multicore cables as per cable/tubing/cable schedules. Engraved tag plates or PVC ferrules shall be used for identification of tubes/cables.

4.3.3 All Multitubes and Multicables shall be cut after the exact site measurements are taken between ends and the cable/tube drums shall be selected before cutting the lengths so as to avoid any wastage.

4.3.4 In the field, the cables shall be laid in perforated trays as per layout drawings. Cables shall also be buried or laid in concrete trenches. Inside control room, these shall be laid in concrete trenches or under false floorings.

4.3.5 In the field, the cables shall be laid in perforated trays as per layout drawings. Cables shall also be buried or laid in concrete trenches. Inside control room, these shall be laid in concrete trenches or under false floorings.

4.4.0 INSTALLATION OF INSTRUMENTS

4.4.1 All instruments shall be generally installed on supports as per installation standards in each case, and shall be accessible.

4.4.2 Receiver gauges shall be mounted on instrument support itself as per tubing hook up standards.

4.4.3 Filter regulators shall be mounted on the instruments support itself below the instruments or on the control yoke.

4.5.0 INSTRUMENT AIR SUPPLY

4.5.1 The main instrument air header in each area is laid by other contractor. Air supply from the main air header take off valve to individual instrument shall be through either galvanized steel pipe or 1/4" OD PVC covered copper tube or SS tubes.

4.5.2 Individual takes off valves shall always be located on top of the main air header. Unions shall be provided at convenient locations. There shall be one isolation valve at each instrument end. The galvanised pipe shall be supported at a minimum interval of 1000 mm with 40mmx40mmx5mm MS angles. Final

connection to be instrument shall be copper/SS tubing as per tubing hookup standards.

4.5.3 Teflon tapes shall be used on all threaded joints.

4.6.0 INSTRUMENT STEAM TRACING

4.6.1 The mainsteam header in each area is laid by the other contractor. From the main steam header take off valve, steam to individual instrument shall be taken through carbon steel pipes supported at regular intervals. Steam tracing around individual instruments shall be to copper tubes. After steam tracing, the line is connected to the drain funnel through individual steam trap/condensate return header/tapper point as the case may be.

4.6.2 Electrical tracing shall be done by others.

4.7.0 PERFORATED TRAYS AND SUPPORTS

4.7.1 The perforated trays / angle trays shall be properly supported at a regular interval of max. 1000mm from insert plates or steel structures. Wherever insert plates are not available supports on concrete structures on ceiling shall be fixed with a minimum 10mm diameter expansion bolts. Angle supports for perforated trays/angle trays shall be fabricated from 40mmx40mmx5mm M.S. angles minimum size.

4.7.2 All supports shall be cut with hacksaw and any work executed by gas cutting for cutting and drilling holes will be totally rejected. Free ends of angle support shall not have sharp edges and shall be properly rounded off.

4.7.3 Perforated trays/angle trays shall be used for branching cables and tubes from main trays. Perforated trays shall be used for branching cables and tubes from main trays. Perforated trays shall be fabricated out of 2.5 mm perforated steel sheet. Width of trays shall be selected according to number of tubes and cables. Trays shall be laid generally as per site conditions with the approval of Engineer-in-charge.

4.8.0 LAYING OF CABLES

4.8.1 All cables shall be laid in accordance with installation drawings and cable schedules. Before laying, cable/multicable on drums shall be meggered and tested to ascertain the transit damages.

4.8.2 All cables routes shall be carefully measured and cables cut to the required lengths, leaving sufficient amount for the final connection of the cable to the terminals on either end. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. Sufficient extra length

of cable shall be kept at the terminal on points.

4.8.3 Cables shall have complete uncut lengths from one terminal to the other.

4.8.4 All cables shall be identified close to their termination point by cables number as per cable schedules/junction boxes schedules. PVC ferrule/tag plate shall be used and these identification tags shall be securely fastened to the cables.

4.8.5 All cores of electrical cables shall be identified by their wire numbers by means of the PVC ferrules. Wire numbers shall be as per schedules. All temporary ends of cables shall be protected against dirt and moisture. For this purpose, ends of all PVC insulation cables shall be taped with an approved PVC or rubber insulating tape. Use of function type or other fabric type is not permitted.

4.8.6 The cable shall be bent in a large radius. Cables installed above ground shall be run exposed on walls, ceilings, structures and shall run parallel or at right angles with beams, walls or columns.

4.8.7 Cables shall be rigidly supported on structural steel and masonary individually or in groups as required using galvanised clips, multiple cable supports or cable trays. If drilling of steel must be resorted to, approval must be obtained and steel must be drilled where the minimum of weakening of the structure will result. Cable shall be supported at every 500 mm.

4.8.8 All special cables and power supply cables will be laid directly to the field instrument without any junction boxes, unless otherwise specified.

4.8.9 While laying cable in trenches or burying them care shall be taken to ensure that low signal cables like alarm, analyser cables, special cables, special cables from turbine meters, compensating cable etc. are separated from other power supply cables.

4.8.10 Each underground cable (either in concrete trenches or burried) shall be provided with identifying tag of lead securely fastened every 30m of its underground length with atleast one tag at each end before the cable leaves/enters the ground.

4.8.11 Directly buried cables shall be laid underground in excavated cable trench wherever specified in layout drawings. Trenches shall have sufficient depth and width to accommodate all cables correctly spaced. Before cables are placed the trench bottom shall be filled with 100 mm layer of sand and leveled. Each layer of cables shall be covered with 150 mm of sand on top and sand shall be lightly pressed. A protective covering of 75 mm thick second-class red bricks shall be placed flat on the final layer of sand and cable. The remaining portion of the trench shall be then back filled with soil compacted and leveled. On complete of every group of cable laying and before sand filling, every cable shall be given insulation test in the presence of Engineer-in-charge. Any cable proved to be defective should be replaced before the next groups of cables are laid. Cable route markers indicating number of cables, depth and direction will be placed

enroute, on crossovers/turnings, etc. to mark the cable route.

4.8.12 At each road crossings and other places, where cables enter pipe sleeves, adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends after pack filling.

4.8.13 At the entry into concrete blocks at road crossings cable loops shall be provided at either end to prevent any damage to cables. Each cable shall have one tag at each end before the cable enters/leaves conduct pipes

4.8.14 After laying of all the cables and multitubings, cables, the cable entry to control room shall be suitably filled and sealed so as to achieve a positive seal against the entry of gas/water.

4.8.15 All cables and tubes shall be laid in accordance with the layout drawings with sand and precast concrete slabs shall be placed on the trench.

4.8.16 On completion of cable laying in concrete trenches, the trenches shall be filled with sand and precast.

4.9.0 EARTHING

4.9.1 Earthing of junction boxes, local cabinets as per the documents and instruction from Engineer-in-charge.

4.10.0 PAINTING

4.10.1 This part of the specification is applicable to cable ducts, MS cable ways, angle trays, instrument supports, perforated trays, all structural supports for the above items, etc.

4.10.2 The surface to be painted shall be thoroughly cleaned with wire brush, sand paper to remove all scales. After cleaning, the surface is painted with one coat of red oxide zinc chromate primer conforming to IS- 207 and allowed to dry completely.

4.10.3 Primer coated surface is painted with one coat of paint to the colour nearest to the final paint and allowed to dry. The colour number shall be specified from IS-5.

4.10.4 Final second coating shall be with the paint of desired colours and shall be selected from IS-5.

4.10.5 It shall be noted that final second coating of external surfaces not covered by cables, copper tubes etc. shall be applied just before handling over the plant or commissioning of the plant whichever is earlier.

4.10.6 The name of manufacturer, colour and quality of all types of primer paint shall be

subject to approval of Engineer-in-charge.

4.11.0 TESTING

4.11.1 Electrical cables for signal power supply alarms, and compensating cables for thermocouples; resistance thermometer cables shall be checked for megger values and continuity before proper termination and ferruling.

4.11.2 Testing shall be carried out after the installation of instrument with primary piping complete in all respects and approved by Engineer-in-charge.

4.11.3 Primary piping shall be tested hydraulically pneumatically to 1.5 times the operating pressure after isolating the instruments. Flushing of piping shall be carried out as per instructions of Engineer-in-charge. Lines shall be blown after hydro-testing. All external displacement /float type level instrument level gauges shall also be tested as per instructions of Engineer- in-charge.

4.11.4 Tubes and air line shall be tested with compressed air to 7 kg/cm^2 upto the filter regulator. The down steam side of the filter regulator shall be tested for 1.5kg/cm^2. The lines shall be blown with the instrument air upto the regulator for 15 minutes to remove any traces of oil, dust & moisture. All lines shall be checked with soap solution and bubbler unit for possible leak at joints. After pressurizing, source shall be cut off and rate of fall in pressure shall be less than 1 p.s.i. for each 100 ft. of copper tubing for a test period of 2 minutes as per I.S.A.R.P.7-1 "Pneumatic control circuit pressure test".

4.11.5 All test results shall be recorded in the approved format.

4.12.0 CALIBRATION

4.12.1 All instruments shall be calibrated strictly as per manufacturer's instructions prior to installation. The scope of calibration includes all field and control rooms of all types namely, pneumatic, electronic, electrical etc.

4.12.2 Contractor shall use his own oil free instruments, air compressor for calibration purposes.

4.12.3 The level switches (external cage type) shall be set by filling the cage with water to the desired alarm/trip level, while setting the switches, it shall be ensured that the micro switches do not reset for full rated travel of the float.

4.12.4 Control valves and positioners shall be checked for hysterisis and linearity and calibration for rated strokes. Prior to calibration, valves shall be cleaned externally. The stem is then lubricated if required, and stroked few times to extreme positions of plug to ensure that movement is free from friction. The valve shall then be calibrated for rated stroke and linearity also. Subsequently the valves shall be checked for hysterisis to the accuracy of 1% FS with positioners and 5% FS without positioners.

Stroke speed has to be evaluated for all trip/shutdown valves.

4.12.5 All calibrations reading shall be recorded in the enclosed format and submitted to Engineer-in-Charge for approval. Where significant deviations from specifications are obtained, the matter shall be brought to the immediate notice of the Engineer-in- Charge for corrective actions.

4.12.6 Furnished hereunder is a list of recommended calibration and test equipments required as a minimum for calibration work. The contractor shall clearly state in his offers the complete list of calibration and test equipments along with the range, accuracy and quantity, which he proposes to use for this job. Contractor should also ensure that any equipment not listed below but required at the time of calibration shall be made available at his own cost.

4.12.7 All test equipments/kits shall be approved by NPL authorities.

4.12.7.1	Controller test stands	Mft. Standard
4.12.7.2	Indicator/recorder test stands	-do-
4.12.7.3	Squeeze bulb (Flow calibrator Range: 0-770, 10,000 mm wg.	-
4.12.7.4	Dead weight testers (Budenberg or equivalent) For ranges upto 350 kg/cm^2	- +/- 0.1%
4.12.7.5	Gauge comparator for pressure gauges Rating : upto 350 kg/cm^2	-
4.12.7.6	Oil bath for temperature calibrations max. Temp 350°C.	Mfr's Std
4.12.8.7	Standard Mercury in glass thermometers Range : -50 to + 50°C. 0 to 100°C (NPL certified) 0-250°C, 0-350°C	$\pm$ 0.25%
4.12.7.8	Standard gauges for Ranges upto 350kg/cm^2	$\pm$0.25%
4.12.7.9	U-tube differential manometers/inclined	

	tube manometer Static pr. rating : 7 kg/cm^2	+_ 1mm
4.12.7.10	Single leg manometers Scale: -1500 mm water and 1500 mm hg. Static pr. rating : 7 kg/cm^2.	+_ 1mm
4.12.7.11	Decade resistance box	MFR' std.
4.12.7.12	Millimeters	±0.05Mv
4.12.7.13	Potentiometer (Cable of generating and measuring mV)	-
4.12.7.14	Meggers 500V/1000V	-
4.12.7.15	Air hydro pump/hydraulic pump	-
4.12.7.16	Vacuum pump	-
4.12.7.17	Instrument air compressor with filters and Regulators and deoilers.	-
4.12.7.18	Current generator (instrument checker) 4-20mA dc(YEW make or equivalent)	-

4.13.0 LOOP TEST

4.13.1 Loop test shall be performed after calibration of all instruments and leak test of signal lines. Loop tests are conducted to check the functional performance of all elements comprising the loop, thereby ensuring proper connections and operations.

4.13.2 Before proceeding for loop tests the calibration results of individual elements shall be recorded on the enclosed proforma and shall get it approved by Engineer-in-Charge for correctness of installation, measurements and calibration results.

4.13.3 Loop testing for all control loops shall be generally by simulation of process

conditions and shall fix points namely 0%, 25%, 50%, 75% and 100% of full-scale inputs. Detailed procedure shall be submitted to Engineer-in-charge for approval before proceeding with the loop testing.

In case of shutdown system field/receiver pressure switches are simulated for abnormality by disconnecting the wires at terminal and function of all associated systems are checked.

4.13.5 Performance of individual loops may be accepted for an overall accuracy of $\pm$ 1.5% where deviations exist, contractor shall recalibrate the instruments, which form part of loop testing wherever required, at no extra cost.

4.13.5.1 After the loop test is complete, the contractor shall connect back any terminations and connections removed for loop test.

4.13.7 A loop shall be considered as handed over only after measurements in that particular loop are complete and certified by Engineer-in-Charge, in addition to loop sheets being duly filled in all respects and approved and accepted by Engineer-in-Charge and client.

4.13.8 In case of loops in which certain instruments of the loops are calibrated by other agency, loop testing shall be performed in coordination with the agency involved. Any defect in the calibration of the instrument in contractor's scope is observed, it shall be rectified to the satisfaction of the Engineer-in- Charge. However, defect in calibration of the instruments in the scope of other agency, same shall be rectified by the agency involved. After the calibration has been rechecked by the other agency/agencies the loop checking would be performed to the satisfaction of Engineer-in-Charge, and this part covers under the scope of the contract.

4.13.9 Final certified loop sheets shall be submitted in 4 copies and one transparency.

5.0.0 DRAWINGS AND DOCUMENTS TO BE SUPPLIED FOR EXECUTION BY OWNER/ENGINEER IN CHARGE

5.1.1 Piping ad Instrumentation diagrams.

5.1.2 General layout plan for all units, showing all information like position of field instruments junction boxes indicative routes of cables, main ducts/cable trays.

5.1.3 Cable schedules for alarm, signal, shutdown, power supply and pneumatic cables, earthing guide lines.

5.1.4 Termination details/drawings for connecting at control room end.

5.1.5 Individual Instrument specifications

5.1.6 Bill of materials

5.1.7 Installation standards/ Hook-up

5.1.8 Manufacturers hand book with instructions for installation and calibration wherever necessary for reference.

6.0 DRAWINGS AND DOCUMENTS TO BE PROVIDED BY CONTRACTOR

6.1.1 The drawings for materials that are included on their supply and erection scope namely local control panel, junction boxes and local cabinets.

6.1.2 The detailed engineering drawing wherever such drawing is assigned.

6.1.3 Two sets of layout drawings, standards bill of materials cable schedules etc., duly incorporating the changes/modification carried out during the course of execution of works.

6.1.4 Final material appropriation statement for all free issue materials indicating shortages of any in the proforma duly approved by Engineer-in-Charge.

7.1.0 SCRAP AND EXCESS MATERIAL

7.1.1 Every month, the contractor shall submit an account for all the materials issued by the Owner in the standard proforma prescribed for this purpose by the Engineer- in-Charge.

7.1.2 On completion of the work, the contractor shall submit `Material appropriation' statements for all materials issued by the Owner in the proforma prescribed by the Engineer-in-Charge.

7.1.3 The following scrap allowances are permissible.

Length below 0.5 mm	Non-salvageable	Unaccountable
Steel pipes, SS Tubes single pair/ Twocore / Three Core cables.	2%	0.5%

length below 20 m	Non-salvageable	Unaccountable
Multitube, Multicables	2%	0.5%

8.0 SPECIAL INSTRUCTIONS TO CONTRACTOR:

8.1.4 All excess materials and scrap shall be returned after duly accounting for, to the storage points designated by the Owner. Where materials are to be weighed before return, the contractor shall be responsible for making the necessary section obtained during the course of construction for fabricating temporary supports or other items, without prior permission of the Engineer - in -Charge.

8.1.5 If the contractor fails to return the surplus material as aforesaid, the owner will charge the contractor for such unreturned materials at panel rates, which will deducted from whatever amount is due to the contractor. In case any material issued by the Owner deteriorates during storage by the contractor, new materials will be issued to him at penal rates, but the delay in procuring such materials will be at the contractor's account only.

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STANDARD SPECIFICATION

FOR

CABLING

SPECIFICATION NO.: MEC/S/05/26/021

ELECTRICAL & INSTRUMENTATION
(OIL & GAS SBU)
MECON LIMITED
DELHI 110 092

0	15.10.2014			
Revision	Date	Ratnadeep Gupta	Vikas Jain	Rakesh Kr. Shukla
		Prepared By	Checked By	Approved By

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Revision	Date	By (Name)	Verified (Name)

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1.0 SCOPE

This is to define the requirements for supply, wherever applicable, the installation, testing and commissioning of the cabling system.

2.0 STANDARDS

The work shall be carried out in the best workman like manner in conformity with this specification, the relevant specifications, codes of practice of Indian Standards Institution, approved drawings and instructions of Engineer-in-Charge or his authorized representative issued from time to time. In case of any conflict between the standards, the instruction of Engineer-in-Charge shall be binding.

3.0 CABLE SPECIFICATIONS

3.1 Power Cables

Power cables for use on 415 V systems shall be of 1100 Volts grade, aluminium stranded conductor, PVC insulated, PVC sheathed, armoured and overall PVC sheathed. Power cables for 3.3 KV 6.6 KV and 11 KV system shall be aluminium conductor, XLPL insulated, screened, PVC bedded galvanized steel flat armoured and PVC sheathed cable. All L.T. Cables conform to standard specification and relevant sections of IS: 1554 Part-I and H.T. Cables shall conform to IS: 7098 (Part II). Unarmoured cables will be used wherever specified on the cable schedule.

3.2 Control Cables:

Control cables shall be 1100 Volt Grade, 2.5 mm^2 copper conductor PVC insulated PVC sheathed, single wire armoured with an overall PVC sheath, as per IS: 1554 Pt. Unarmoured cables shall be used wherever specified on the cable schedule.

3.3 Communication cables:

Communication cables shall comprise 1 pair unarmoured, 2-pair, 5-pair and multipair armoured cables of sizes as specified in the cable schedule. Minimum conductor size shall be 0.5 mm telephone system and 0.71 for plant communication system.

4.0 MISCELLANEOUS MATERIALS SPECIFICATIONS

4.1 Connectors:

Cable terminations shall be made with aluminium / tinned copper crimped type solder less lugs of M/s. Dowell's make or approved equivalent for all aluminium conductors and stud type terminals.

4.2 Cable Identification

Cable tags shall be of 2 mm thick, 20 mm wide aluminium strap of suitable length to contain cable number, equipment no., etc.

4.3 Ferrules

Ferrules shall be of approved type size to suit core size mentioned and shall be employed to designate the various cores of control cable by the terminal numbers to which the cores are connected for case in identification and maintenance.

4.4 Cable Glands:

Cable glands to be supplied shall be nickel-plated Brass double compression type of approved/ reputed make. Glands for classified hazardous areas shall be certified by CMRS.

4.5 Multi Cable transit

Multi Cable Transit shall be used for cable entry to all type of control room walls, Decks, Firewall etc. The MCT Block system should have only few components for facilitating simple, easy and quick assembly. The Multidiameter based cable transits shall be repeatedly re-openable and re-usable without the need of special tools and discarding the modules in normal operation.

Frame shall be G type galvanized or stainless steel. Block should be multi diameter blocks with center core in all the blocks / add blocks with plug / galvanized or stainless steel stay-plates / single piece compression wedge with galvanized or stainless steel bolts. Solid blocks and insert blocks should not be used. MCT should have 100% spare for each cable size / O.D. Spare blocks should be available on the frame as usable Multidiameter blocks / add blocks with center plug, so that these spare blocks in future can be used for wide range of cables also, solid blocks should not be used at all on frame. Apart form spare if there is any additional uncovered space left on frame then this uncovered space should also be filled only with usable Multidiameter

blocks with center plug only.

The Multi Cable & Pipe Transit penetrations should have been tested for Gas Tightness / water tightness & fire tests.

4.6 Cable Trays:

This shall be either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron trays as specified elsewhere. Prefabricated hot dip galvanized sheet steel cable trays shall be used for maximum support span of 2000 mm unless design is approved for larger span. For requirements of larger than 750 mm width two trays shall be run side by side. Cable trays shall be suitable for a cable weight of 50 kg/meter running length of tray. Minimum thickness of sheet steel/galvanizing shall be 2mm/86 microns respectively.

Cable trays fabricated from standard rolled sections shall use 50x50x6 /ISMC 100 Sections for runners for supporting spans limited to 2000 mm/more than 2000 mm respectively. Cross support shall be 32 x 6 mm flat/ 25x25x6 angle for width upto 500 mm/ more than 500 mm respectively.

Vertical supports for both the above type of trays shall be fabricated out of ISMC 100 and horizontal supports with 75 x 50 x 6 angle iron/ ISMC 75 as approved by Engineer-in-Charge.
If unit rate is not included in schedule of rates, then cable trays if required, shall be fabricated and installed at site as per tone rate for electrical structural supports etc.

5.0 CABLE LAYING

5.1 Cable network shall include power, control, lighting and communication cables, which shall be laid in trenches, cable trays or conduits as detailed in the relevant drawings and cable schedules. Erection of cable trays as required shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc. and minor adjustments shall be done to suit the field conditions wherever deemed necessary without any extra cost.

5.2 High voltage, medium voltage and other control cables shall be separated from each other by adequate spacing or running through independent pipes, trenches or cables trays, as applicable.

All communication cables (telephones, P.A.S.) RTD Cables shall run on instrument trays/ducts/trenches. Wherever these are not available, cables shall be taken in a separate trench with a minimum clearance of 300 mm away from electrical trench as per the direction of Engineer-in-Charge and Communication

cables shall cross power cables at right angles.

All cable routes shall be carefully measured and cables cut to the required lengths, leaving sufficient lengths for the final connection of the cable to the terminal of the equipment. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. The quantity indicated in the cable schedule is only approximate. The contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works. Before the start of cable lying, cable drum schedule; shall be prepared be electrician contractor and get that approved by Engineer-in-Charge to minimize/avoid straight through joints required. Contractor shall work out the actual number of straight through joints required.

5.4 Cables as far as possible shall be laid in complete, uncut lengths from one termination to the other.

5.5 Cables shall be neatly arranged in the trenches/trays in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the Contractor. Cable routing between lined cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 45° to the trench wall. In case of larger dia cables, i.e., 50 mm and above, adequately sized pipe with larger bend radius shall be provided for ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Engineer-in-Charge.

5.6 All cables will be identified close to their termination point by cable numbers as per cable schedule. Cable numbers will be punched on aluminium straps (2 mm thick) securely fastened to the cable and wrapped around it. Alternatively cable tags shall be circular in construction to which cable numbers can be conveniently punched.

Each underground cable shall be provided with identity tags of lead securely fastened every 30 m of its underground length with at least one tag at each end before the cable enters the ground. In unpaved areas, cable trenches shall be identified by means of markers as per standard drawing. These posts shall be placed at location of changes in the direction of cables and at intervals of not more than 30 M and at cable joint locations.

5.7 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be taped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.

5.8 RCC cable trenches shall be with removable covers. Cables shall be laid in 3 or 4 tiers in these trenches as indicated on the sectional drawings. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases, RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. The electrical Contractor at no extra cost shall do removal of concrete covers for purpose of cable laying and reinstating them in their proper positions after the cables are laid.

Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving trenches shall be coiled and provided with a protective pipe or cover, until such times the final termination to the equipment is connected.

5.9 Directly buried cables shall be laid underground in excavated cable trenches where specified in layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables correctly spaced and arranged with a view of heat dissipation and economy of design.

Minimum depth of buried cable trench shall be 750 mm for low voltage and 900 mm for H.V. Cables, the depth and the width of the trench shall vary depending upon the number of layers of cables.

Cables shall be laid in trenches at depth as shown in the drawing. Before cables are placed, the trenches bottom shall be filled with a layer of sand. This sand shall be levelled and cables laid over it. These cables shall be covered with 150 mm of sand on top of the largest diameter cable and sand shall be lightly pressed. A protective covering of 75 mm thick second class red bricks shall then be laid flat. The remainder of the trench shall then be back-filled with soil, rammed and levelled.

5.10 As each row of cables is laid in place and before covering with sand every cable shall be given an insulation test in the presence of Engineer-in-Charge / Owner. Any cable, which proves defective, shall be replaced before the next group of cables is laid.

All wall openings / pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/-lined trench.

Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection upto a minimum of 300 mm above finished ground level.

Cable ends shall be carefully pulled through the conduits, to prevent damage to the cable. Where required, approved cable lubricant shall be used for this

purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

Following grade of the pipe fill shall be used for sizing the pipe size:

a) 1 cable in pipe - 53% full
b) 2 cables in pipe - 31% full
c) 3 or more cables - 43% full
d) Multiple cables - 40% full

After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/ `PUTTI' for sealing purpose. Alternatively G.I. Lidsor PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to have been included in the installation of G.I. Pipe and no separate payment shall be allowed.

5.11 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures, the electrical contractor shall determine their location and obtain approval of the Engineer-in-Charge before cutting is done.

5.12 At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.

5.13 Drum number of each cable from which it is taken shall be recorded against the cable number in the cable schedule.

5.14 Cables installed above grade shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel or at right angles to beams, walls or columns.

Cables shall be so routed that they will not be subjected to heat from adjacent hot piping or vessels.

5.15 Individual cables or small groups which run along structures/walls etc. will be clamped by means of 10 SWG GI saddles on 25x6 mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables and no separate payment shall be made on this account. Alternatively small group of cables can be taken through 100 mm slotted channel/ISMC 100.

They shall be rightly supported on structural steel and masonry, individual or in groups as required, if drilling of steel must be resorted to, approval must be secured and steel must be drilled where the minimum weakening of the structure will result.

Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300 mm for cables up to 25 mm diameter and maximum 450 mm for cables larger than 25 mm dia.

5.16 All G.I. Pipes shall be laid as per layout drawings and site requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the contractor), all the burrs from the pipes shall be removed. GI Pipes with bends shall be buried in soil/concrete in such way that the bends shall be totally concealed. For G.I. Pipes buried in soil, bitumen coating shall be applied on the buried lengths. Installation of G.I. Pipes shall be undertaken well before paving is completed and necessary co-ordination with paving agency shall be the responsibility of Electrical Contractor. The open ends of pipes shall be suitably plugged with G.I. Plugs after they are laid in final position. The Contractor at no extra cost shall supply G.I. Plugs.

5.17 Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable trays shall be suitably clamped by means of G.I. Saddles/Clamps, whereas cable in horizontal run of cable trays shall be tied by means of nylon cords.

5.18 Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint unless otherwise specified.

6.0 TERMINATION

6.1 All PVC cables up to 1.1 KV grade shall be terminated at the equipments by means of double compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.

All Cable entries shall be through bottom only and top entry terminations are made only after getting approval of Engineer-in-Charge.

6.2 Power cables wherever colour coding is not available shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections is made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.

6.3 In case of control cables all cables shall be identified at both ends by their terminal numbers by means of PVC ferrules or Self-sticking cable markers. Wire numbers shall be as per schematic/ wiring /inter- connection diagram. Bidders shall have the samples of PVC ferrules/cable markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends.

6.4 Where threaded cable gland is screwed into threaded opening of different size, suitable galvanized threaded reducing bushing shall be used of approved type, at no extra cost. All switchgear and control panels shall have undrilled gland plate.

Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables.

6.5 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom close fit hole should be drilled in the bottom plate for all the cables in one line, then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.

6.6 Cable leads shall be terminated at the equipment terminals, by means of crimped type solder less connector as manufactured by M/s. Dowell Electro works or approved equivalent.

Crimping shall be done by hand crimping hydraulically operated tool and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

6.7 <u>Cable accessories for H.V. Systems</u>

6.7.1 The 11, skilled and experienced jointers duly approved by the Engineer-in-Charge shall do 6.6 and 3.3 KV cables terminations joints. Termination including supplying of jointing kit shall be threaded in Contractor scope unless specified otherwise.

6.7.2 The termination and straight thro' joint kit. For use on high voltage system shall be suitable for the type of cables red by the contractor or the type of cables issued by owner for installation. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fitting and consumables items. An installation instruction shall be included in each sheet.

6.7.3 The termination kits shall be suitable for termination of the cables to indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer motor. The terminating kits shall preferably be of the following types:

a) TAPLEX' of M-seal make using non-linear resistance material fortress grading.

b) `PUSH-ON' type of CCI make using factory - moulded silicone rubber insulators.

c) `TROPOLINK' type of CCI makes.

d) Heat-shrinkable sleeve type of M/s. Raychem.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

6.7.4 The straight thro jointing kits shall be suitable for underground-buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types.

a) `TAPLEX' of M-seal make

b) `TROPOLINK' type of CCI make

c) Heat-shrinkable sleeve type of M/s. Raychem.

6.7.5 Makes of kits other than those specified in 6.7.3 and 6.7.4 may be considered provided the Contractor furnishes type test certificates, along with the offer.

6.7.6 Type tests are to be carried out at manufacturer's works to prove the general qualities and design of a given type of termination/jointing system. The type tests shall include the following tests conforming to the latest IEC 502.2, 466 and VDE 0278 specifications. The Contractor along with the offer for the jointing system considered shall submit the type test certificates.

a) A.C. Voltage withstand dry test for 1 minute

b) Partial discharge test - Discharge magnitude small be less than 20 p.c.

c) Impulse voltage withstand test with 10 impulses of each polarity.

d) A.C. high voltage test following load cycling test with conductor temperature at $95^{o}C$.

e) Thermal short circuit test of 250°C for 1 second.

f) DC Voltage withstand test for 30 minutes.

g) Humidity test.

h) Dynamic short circuit test.

i) Salt log test

j) Impact test

7.0 TESTING:

7.1 Before energizing, the insulation resistance of every circuit shall be measured from phase to phase and from phase to ground.

7.2 Where splices or termination are required in circuits rated above 600 volts, measure insulation resistance of each length of cable before splicing and or/ terminating. Repeat measurement after splices and/or terminations are completed.

7.3 Measure the insulation resistance of directly buried cable circuits before cable trenches are back-filled. Repeat measurement after back- filling.

For cables up to 1.1 KV grade, 1KV Megger and for H.V. Cables 2.5 KV/5 KV, 2.4 KV/4.9 KV Megger shall be used

7.4 D.C. High Voltage Test shall be conducted after installation on the following and test results are recorded.

a) All 1000volts grade cables in which straight through joints have been made.

b) All cables above 1100 V grade.

For record purposes test data shall include the measure values of leakage current versus time.

The D.C. High Voltage test shall be performed as detailed below in the presence of the Engineer-in- Charge or his authorized representative only.

Cables shall be installed in final position with the entire straight through joints complete. Terminations shall be kept unfinished so that motors, switchgears,

transformers etc. are not subjected to test voltage.

The test voltage shall be as under: -

i) For cables 3.3 KV grade 5.4 KV DC

ii) For cables 6.6 KV grade 10.8 KV DC

iii) For cables 11 KV grade 18 KV DC

7.5 All cables shall be tested as per standard test Performa available with site engineer.

7.6 Cable schedule and layout drawings must be marked for AS BUILT conditions during the installation work and shall be approved by Site Engineer.

SPECIFICATION FOR
EARTHING AND LIGHTNING PROTECTION

SPECIFICATION NO. MEC/S/05/26/23A

(ELECTRICAL SECTION)
MECON LIMITED
DELHI 110 092

0	15.10.2014			
Revision	Date	Ratnadeep Gupta Prepared By	Vikas Jain Checked By	Rakesh Kr. Shukla Approved By

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1.0 SCOPE:

The intent of this specification is to define the requirements for the supply, installation, testing, and commissioning of the Earthing System.

2.0 STANDARDS:

The work shall be carried out in the best workmanlike manner in conformity with this specification, the relevant specifications/codes of practice of Indian Standard Institution, approved drawings and instructions of the Engineer-in-Charge or his authorized representative issued from time to time. In case of any conflict between the standards, the instructions of Engineer-in-Charge shall be binding.

3.0 CONDUCTOR ELECTRODE:

The main grid conductor shall be hot dip galvanized G.I. Flat or PVC insulated aluminum conductor/copper conductor. Sizes for main conductors shall be marked on the drawings. Thickness of hot dip galvanizing shall not be less than 75 microns.

4.0 EARTHING NETWORK:

4.1 The earthing installation shall be done in accordance with the earthing drawings, specifications and the standard drawings of reference attached with this document. The entire earthing system shall fully comply with the Indian Electricity Act and Rules framed thereunder. The contractor shall carry out any changes desired by the Electrical Inspector or the owner, in order to make the installation conform to the Indian Electricity Rules at no extra cost. The exact location on the equipment shall be determined in field, in consultation with the Engineer-in-Charge or his authorized representative. Any changes in the methods, routing, size of conductors etc. shall be subject to approval of the Owner/Engineer-in-Charge before execution.

Excavation and refilling of earth, necessary for laying underground earth bus loops shall be the responsibility of the contractor.

4.3 The earth loop impedance to any point in the electrical system shall have a value which will ensure satisfactory operation of protective devices.

4.4 The main earth loop shall be laid at a depth of 500 mm below grade level. Wherever cable trenches are available, the earth lead shall be laid in the trenches and shall be firmly cleared to the walls of concrete lined trenches. The earthing strip shall be protected against mechanical damage.

4.5 In process unit areas, the earthing cable shall be run along cable trays wherever specified in the layout drawings. The earthing cable shall be suitably cleated and electrically bonded to the cable tray at regular intervals.

4.6 Joints and tapping in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and suitably protected by giving two coats of bitumen and covering with Hessian tape. All joints above ground shall be by means of connectors/lugs as far as practicable. Tee connectors shall be used for tapping, earth leads from the main earth loop wherever it is installed above ground. Earthing plates shall be provided for earthing of two or more equipment at a place from earth grid. Where aluminum cable risers are to be connected to the underground GI earth bus, the aluminum cable riser shall be taken to the nearest earth pit and terminated through a bolted joint. If this is not practicable, then a G.I. risers shall be brought above grade and a bolted joint shall be made between this GI riser and the aluminum cable termination. This G.I. Riser shall be protected applying two coats of bituminous paint/bitumen on the exposed portion.

4.7 Conduits in which cables have been installed, shall be effectively bonded and earthed. Cable arm ours shall be earthed at both ends.

5.0 <u>EARTH ELECTRODES</u>:

5.1 Earth pipe electrodes shall be installed as shown in the earthing layout drawings and in accordance with the standard drawings of reference and IS:3043. Their location shall be marked to enable accurate location by permanent markers.

5.2 All earth electrodes shall preferably be driven to sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. Wherever practicable, the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes.

5.3 All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months, preferably after a protracted dry spell. If necessary, a number of electrodes shall be connected in parallel to reduce the earth resistance. The distance between two electrodes shall not be less than twice the length of electrode.

5.4 The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.

5.5 The exact location and number of earth electrodes required at each location shall be determined in the field in consultation with the owner/Engineer-in- Charge, depending on the soil strata and resistively, to meet the ohmic values prescribed in clause 5.3. Earth Electrodes shall be located avoiding interference with road, building foundation, column etc. Individual earth electrode shall be provided for each lightning arrestor and lightning mast. The electrodes shall be so placed that all lightning protective earths may be brought to earth electrode by a short and straight a path as possible to minimize surge impedance.

5.6 The disconnect facility shall be provided for the individual earth pits to check their earth resistance periodically. All the earth electrodes shall be suitably numbered and this should be indicated in as built drawings.

6.0 CONNECTION:

6.1 All electrical equipment is to be doubly earthed by connecting two points on equipment to a main earthing ring. The earthing ring will be connected via links to several earth electrodes. The earth grid formed shall be a closed loop as shown in the drawing with earth electrodes connected to the grid with double strip connection. The cable armour will be earthed through the cable glands.

6.2 In hazardous areas all major process equipments shall be connected to the earthing ring by means of anti- loosening connections and all pipelines will be bonded and earthed on entering the battery limit of the process area.

6.3 The following shall be earthed.

1. Transformer neutrals, CT/PT neutrals.

2. Neutral Grounding Resistors.

3. Transformer Housing.

4. Lightning Arrestors.

5. All switchgear and their earth buses, bus duct.

6. Motor Frames.

7. Non-current carrying metallic parts of electrical equipment such as switchgear, switch racks, panel boards, motor control centers, lighting, power and instrument panels, push button stations, cable trays, pipes, conduits, terminal boxes, etc.

8. All fences, gates/enclosures, housing electrical equipment

9. All steel structures, rails etc. including bonding between sections.

10. Shield Wire

11. Structural steel and Columns.

12. Loading racks.

13. Lighting Mast, poles.

14. Lighting rods (Mast).

15. Tanks and vessels containing flammable materials.

16. Rotating parts of the agitators, pumps etc. through spring loaded brushes of suitable grade.

17. Earth continuity conductor shall be provided for flanges.

Conductor size for connection to various equipments shall be as indicated on Earthing Layout Drawings.

6.4 Two distinct conductors directly connected to independent earth electrodes, which in turn, shall be connected to the earth too, shall earth system.

The earth connection shall be properly made. A small flexible aluminum cable loops to bridge the top cover of the transformer and the tank shall be provided to avoid earth fault current passing through fastening bolts when there is a lightning surge, high voltage surge or failure of the bushings.

6.5 Each Lightning Arrestor shall be connected to a separate electrode located as close as possible to it and within the fenced area for each set of arrestors. The three nos. electrodes for each set of arrestors shall be spaced about 5 meters apart so that they are all within the enclosing fence. Each of these electrodes shall be connected to the main earth grid.

6.6 The shield wire shall be connected with the main grid solidly and not through supporting steel structures.

6.7 All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.

6.8 All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground. In case of G.I. Earth Loop all underground "T" connections shall be of the same size as main loop however in case of PVC insulated aluminum conductor loops underground joints shall be completely avoided. Connections to motors from earth plate or main loop conductor brought above ground shall not be less than following:

i) No.8 SWG G.I. Wire upto 3.7 KW motors.

ii) 3/8" DIA G.I. FINE WIRE ROPE for all motors above 3.7 KW upto 30 KW with tinned copper lug at both ends or 35 mm^2 PVC insulated stranded aluminum conductor with crimped lug.

iii) 5/8" DIA G.I. FINE WIRE ROPE OR 70 mm^2 PVC insulated aluminum stranded conductor for motors above 30 KW upto 75 KW terminated as described above.

iv) For all motors above 75 KW conductor size shall be same as that of loop conductor with equivalent size flexible, if required.

Anchor bolts or fixing bolts shall not be used for earthing connection.

6.9 All hardware used for earthing installations shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections of equipment.

6.10 Lighting fixtures shall be earthed through the extra core provided in the lighting cable for this purpose.

7.0 TESTING:
Earthing systems/connections shall be tested as follows:

7.1 Resistance of individual electrodes shall be measured after disconnecting it from the grid.

7.2 Earthing resistance of the grid shall be measured after connecting all the electrodes to the grid. The resistance between any point on the metallic earth grid and the general mass of earth shall not exceed 1 ohm.

7.3 The resistance to earth shall be measured at the following:

a) At each electrical system earth or system neutral earth.

b) At each earth provided for structure lightning protections.

c) At one point on each earthing system used to earth electrical equipment enclosures.

d) At one point on each earthing system used to earth wiring system enclosures such as metal conduits and cable sheaths or armor.

e) At one point on each fence enclosing electrical equipment.

Measurement shall be made before connection is made between the ground and the object to be grounded.

8.0 LIGHTNING PROTECTION

8.1 Lightning protection system shall generally comprise lightning finials (air terminals), roof conductors, down conductors, test links, and earth electrodes. the number, types, materials and sizes shall be in accordance with the drawings.

8.2 Air terminals shall be mounted on top of buildings or structure as required. All air terminals shall be inter-connected with roof conductors,pipes,hands rails or any other metallic projection above the roofs shall also be bonded to the roof conductors.

8.3 Down conductors from air terminals or from roof conductors shall be routed as directly as possible to the test links on earth buses, with minimum bends.

8.4 All provisions regarding connections of conductors for equipment earthing system shall also apply to lightning protection system.

8.5 In corrosive atmospheres, plumbing metal for corrosion protection shall cover lightning finials or air terminals.

9.0 TEST PROFORMA

(INSTALLATION TESTING REPORT EARTHING INSTALLATIONS)

1. Earth system data

Type of electrode :

Total number of electrodes :

Main grid size :

Material :

2. General checks Put Tick √ if O.K.; otherwise give details.

Construction of earth electrodes as per Standard.

Size of earth conductor for various equipment O.K. as per Standard.

Minimum distance kept between two electrodes.

Cleanliness and tightness of connectors.
Inspect bolted & clamped connectors.

3. TESTS

3.1 Measured earth resistance of each electrode in ohms

No. 1

2

3

4

5

3.2 Measurement of earth grid resistance (with all electrodes connected to grid)

a) At each electrical system earth or system neutral earth. :

b) At each point provided for structure lightning protection :

c) At one point on each earthing systems used to earth electrical equipment enclosure :

d) At one point on each earthing systems used to earth wiring systems such as metal conduits etc. :

e) At one point on each fence enclosing electrical equipment. :

4. Remarks:

PROJECT:	UNIT:		
TESTED BY	WITNESSED BY		DATE
CONTRACTOR	MECON	OWNER	

TECHNICAL SPECIFICATION

FOR

WALL MOUNTED PANEL

TS No. : MEC / 05 / E5 / TS/ CP - 030

MECON LIMITED
DELHI - 110 092

SPECIFICATIONS
FOR
PANEL

GENERAL

Site of Installation

1.	Location	:	As per TENDER
2.	Client	:	IGGL
3.	Consultant	:	MECON LIMITED.
4.	Location of panel	:	Control Room and accessories.
5.	Floor	:	
6.	Air Conditioning	:	No
7.	Control Panels Quantity	:	As per Tender

Scope of Work :

a) Supply of Panel (Wall Mounted, cubicle type) along with all accessories like Lamps, MCBs, Switch Sockets, etc.

d) Quantities of panel accessories shall be as per the Technical Requirements during drawing approval/detail engineering.

PANEL CONSTRUCTION

1.	Type	:	Self-supported, Wall Mounted, enclosed cubicle and Non-graphic.
2.	Lighting	:	Required for inside panel with door switch on each side of door.
3.	Ventilation	:	Required with louvers backed by wire fly screen & fan. Fan Failure alarm required.
4.	Doors	:	Perforated CRCA door in the front of the Panel with locking arrangement. Doors shall be provided with Ergofoam type Lock (3 point lock) or similar with key and handle
5.	Door width	:	Shall suit width of the panel. Panel width is indicative only. The sizes shall be sufficient to accommodate the required hardware specified in PJS.
6.	Cable Entry	:	Bottom, Cable Glands shall be double compression type for external armoured cables. All unused entries shall be plugged.
7.	Receptacles	:	Required for incomer supply.
8.	Painting	:	The finish shall include sand blasting, grinding, chemical cleaning, surface finishing by suitable filter and two coats of high grade lacquer with wet sanding between coats.. Two coats of paint in panel colour shall be given for Non-glossy high stain finish. Panel face final colour shall be of the following: a) Siemens Grey (RAL 7035) b) Panel internal shall have a finish color of pale cream – IS 352
9.	Wheel	:	To be provided with Lockable arrangement
10.	Tag Plates	:	Front of Panel Instrument Tag plates shall be black laminated plastic with white core.
11.	Name Plates	:	Name plates shall be black laminated plastic with white core. It shall include project details. It shall be provided on Front/ Right Side of Panel.
11.	Laptop Tray	:	Not Required

11 Dimensions & Material of Construction

a)	Panel dimension	:	1200 (mm) H x 800 min.(mm) W x 450 min. (mm) D
b)	Control Panel	:	2 mm thick CRCA steel
c)	Side & Top plates	:	1.5 mm thick CRCA steel
d)	Door panel	:	Front and rear doors.
e)	Cable gland plate	:	3 mm thick CRCA steel
f)	Anchor Bolt Size	:	By vendor
g)	Lifting Eye Bolt	:	Required
h)	Laptop Tray	:	NA

Note :

1. The Dimensions of panel indicated are minimum. If more height , width or depth is required to fit all the components in the panel as per the requirement, the same shall be provided without any extra cost.

2. The panel dimensions shall be finalized during detail engineering.

12 WIRING

a) Type : General purpose, Intrinsically safe

b) Wiring details

230 VAC Wiring : 3C x 4.0 mm² copper conductor

c) Signal Wiring

External to Cabinet	:	1.5 mm² twin twisted individual shielded overall shielded with overall drain PVC insulated armoured
Inside the cabinet	:	Multi stranded min. 1.5 mm² copper conductor PVC insulated twin twisted and shielded.
Electrical Earth	:	Multi stranded min. 6.0 mm² copper conductor PVC insulated
Instrument Earth	:	Multi stranded min. 4.0 mm² copper conductor PVC insulated

d) **Terminal type** : Screw clamp type (with fuse)with Pressure Plate
Terminal size for signal : Suitable for min. 2.5 mm² size conductor
Terminal size for power dist. : Suitable for min. 6.0 mm² size conductor and higher as per actual cable sizes.

e) **Wiring colour code**

Power Supply(230V AC)	:	Hot – Red, Neutral - Black, Earth – Green
Power Supply(24V DC)	:	Positive – Red, Negative – Black
Alarm System	:	Yellow, White
Control & shutdown	:	Grey, White
Analog signals (IS)	:	Light blue, White
Electrical Earth	:	Solid Green
Instrument Earth	:	Yellow Green
Identification of Cable		Criss – Crossing PVC tube ferruling. Solid Green

f) **Power Indication Lamps** : 230VAC UPS – Red color, 230VAC NUPS – Red Color
24VDC – Green Color

SPECIFICATIONS FOR ACCESSORIES

1. MCB

Make	: As per Vendor List
Qty.	: As required + 20% spare

2. Lamps

Type	: LED Clustered Type
Voltage	: 230V AC UPS, 230V AC Non-UPS, 24 VDC
Make / Model No.	: As per Vendor list
Quantity	: As required + 20% spare

3 Relays

Type	: Plug in relays
Contact Type	: Potential free contact
Contact No.	: 4 NO. + 4 NC
Rating	: 24V DC, 5.0 A
Make / Model No.	: As per vendor list.
Quantity	: As required + 20% spare

4 **SMPS with MOSFET O ring**

Make	As per Vendor List
Qnty	Redundant with MOSFET O ring

5 **Space Heater**

Make	KEC/ equivalent
Rating	60W, 230V AC with Thermostat

6 **Digital Indicator**

Make	Vendor to Provide
Quantity	2 Nos (1 for Pressure Transmitter and 1 spare)

SPECIFICATION FOR SIGNAL DISTRIBUTION CARDS

SL.NO.	DESCRIPTION	DETAILS
1.	TYPE	DUAL OUTPUT CURRENT ISOLATOR
2.	INPUT	4-20 mA D.C
3.	OUTPUT	TWO NOS. 4-20 mA ISOLATED OUTPUTS AS MINIMUM
4.	ISOLATION	BETWEEN INPUT & OUTPUT, BETWEEN INPUT & OUTPUT WITH POWER SUPPLY, BETWEEN OUTPUT & OUTPUT
5.	ACCURACY	± 0.1%
6.	POWER SUPPLY	24 V D.C
7.	TRANSMITTER POWER SUPPLY	24 V D.C
8.	OUTPUT LOAD DRIVING CAPACITY	600 Ohms MINIMUM FOR EACH OUTPUT
9.	MOUNTING	DIN RAIL (BACK OF THE PANEL)
10.	MAKE	**MTL / P&F**
11.	MODEL NO	*

NOTES:-

* - BY VENDOR

STANDARD SPECIFICATIONS (CIVIL, ARCH & STRUCTRAL WORKS)

MEC/S/05/11/01

SPECIFICATION

FOR

CIVIL ENGINEERING WORKS

MECON LIMITED

SPECIFICATION FOR CIVIL ENGINEERING WORKS

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1.0 GENERAL

1.1 Scope

This part deals with the requirements of materials for use in construction work with regard to quality, testing, approval and storage, before they are used on work. This part is supplementary to Part-II: Workmanship and Other requirements of the Technical Specifications for civil works.

1.2 Standard

A high standard of quality is required for all materials used in construction work. They shall be the best of the kind obtainable indigenously in each case and shall be procured from manufacturers of repute in order to ensure uniformity of quality and assurance of timely supply.

1.3 Approval and Tests

1.3.1 All materials to be used in construction shall be subject to approval of the Engineer. The Contractor shall apply sufficiently in advance with samples of the materials including the supporting test results from the approved laboratory and other documentary evidence from the manufacturer wherever applicable and indicating the types of materials and their respective sources. The delivery of materials at site shall commence only after the approval of the quality, grading and sources of the materials by the Engineer.

1.3.2 The quality of all materials once approved shall be maintained throughout the period of construction and periodical tests shall be carried out to ensure that it is maintained. Such routine tests shall be listed under the different materials and/or as may be ordered by the Engineer from time to time.

1.3.3 Where a particular "Brand" or "Make" of material is specified in the Schedule of Items or Technical Specifications, such "Brand" or "Make" of material alone shall be used on the work. Should it become necessary for any reason (such as non-availability/ceased to be produced), to use any material other than the specified "Brand" or "Make", the Contractor shall submit sample of the same to the Engineer for approval together with test certificates and other documents necessary for examining and giving approval thereof.

Should such change or substitution of materials, subsequently approved, results in use of material of price lower than that of the material specified in the Schedule of Items or Technical Specifications, the rates of work affected by the substitution shall be proportionately reduced. Similarly, in case the substitution results in use of material of price higher than that specified in the Schedule of Items or Technical Specifications, the rates of work affected by the substitution shall be proportionately increased.

1.4 Codes

1.4.1 The years of publication against various standards, referred in this specification, correspond to the latest standards as on date of preparation of this specification. During use of this specification in future, the latest publication as on date shall be referred to. Where standards are not yet published by the BIS or IRC, adoptable British Standards or other International Standards shall apply.

1.4.2 In case of any conflict in meaning between these specifications and those of BIS or IRC, or British /International Standard; the provisions of these specifications shall prevail.

1.5 Rejection of Materials

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

1.5.2 If the routine tests or random site tests show that any of the materials, brought to site, do not comply in any way with the requirements of this specification or of I.S. Codes as applicable, then that material shall be rejected.

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

2.0 MATERIALS FOR CONCRETE

2.1 Aggregates

2.1.1 Aggregates shall comply with the requirements of IS: 383-1970 "Coarse and Fine Aggregates for Concrete". They shall be hard, strong, dense, durable, clean and free from veins and adherent

coating, vegetable matter and other deleterious substances; and shall be obtained from approved sources. Aggregates shall not contain any harmful material such as pyrites, coal, lignite, shale or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of concrete. Aggregates which are chemically reactive with alkalies of cement shall not be used. Aggregates which are not sufficiently clean shall be washed in clean fresh water to the satisfaction of the Engineer.

2.1.2 Testing

All aggregates shall be subject to inspection and testing. The Contractor shall submit samples for testing as may be required by the Engineer. Sampling and testing shall be carried out in accordance with IS: 2386-1963 "Methods of Test for Aggregates for concrete".

2.1.3 Grading

The Contractor shall ensure that the full range of aggregate used for making concrete is graded in such a way as to ensure a dense workable mix. The delivery of aggregates will commence only when the Engineer has approved the samples and the quality and grade shall be maintained consistent and equal to the approved sample. Before construction commences, the Contractor shall carry out a series of tests on the aggregates and on the concrete made therefrom to determine the most suitable grading of the available aggregates. Once the most suitable grading has been found, the grading shall be adopted for the construction of the works and periodic tests shall be carried out to ensure that it is maintained.

2.1.3.1 Size and grading of fine aggregates

The grading shall conform to IS: 383-1970 and shall be within the limits of Grading Zone-III. The maximum size of particle shall be 4.75mm and shall be graded down. Sand containing more than 10% of fine grains passing through 150 micron sieve or having the fineness modulus less than 2 shall not be used for concrete work.

2.1.3.2 Size and grading of coarse aggregates

The nominal maximum size of the aggregates for each mark of concrete or for each type of work shall depend upon the description of the particular item in the Schedule of Items and/or according to

relevant clauses of IS: 456-1978. The aggregates shall be well graded and the grading shall conform to relevant requirements of IS: 383-1970 depending upon the maximum nominal size as specified or as required.

2.1.3.3 Fine aggregate for mortar and grout

The grading of fine aggregate for mortar and grout shall be within the limits of grading zone III and IV as defined in IS: 383-1970.

2.1.4 Storage & stacking

Care shall be taken in the storage to avoid intrusion of any foreign materials into the aggregates and where two types of aggregates are stored close to each other, they shall be separated by a wall or plate. In case of stockpiling, care shall be taken to avoid forming pyramids resulting in segregation of different sized materials. The height of the stacks shall be generally limited to 150 cm.

2.2 Coarse Aggregates

2.2.1 Types

The type of coarse aggregate viz., stone chips, gravel or broken brick shall be as described in the Schedule of Items. Unless otherwise specified in the Schedule of Items, stone chips shall be used as coarse aggregate.

2.2.2 Stone chips

It shall be crushed or broken from hard stone obtained from approved quarries of igneous or metamorphic origin. The stone chips shall be hard, strong, dense, durable and angular in shape. It shall be free from soft, friable, thin, flat, elongated or laminated and flaky pieces and free from dirt, clay lumps, and other deleterious materials like coal, lignites, silt, soft fragments, and other foreign materials which may affect adversely the strength & durability of concrete. The total amount of deleterious /foreign materials shall not exceed 5% by weight according to relevant clause of IS: 383-1970. If found necessary the stone chips shall be screened and washed before use.

2.2.3 Gravel

It can be either river bed shingle or pit gravel. It shall be sound, hard, clean, irregular in shape and suitably graded in size with or without

some broken fragments. It shall be free from flat particles, powdered clay, silt, loam and other impurities. Before using, the gravel shall be screened and washed to the satisfaction of the Engineer. However, the foreign/deleterious materials shall not exceed 5% by weight.

2.2.4 Broken bricks / Brick aggregates

These shall be obtained by breaking well burnt or over burnt dense brick bats. They shall be homogeneous in texture, well graded in size, roughly cubical in shape, clean and free from dirt, clay, silt or any other deleterious matter. Before use, these shall be screened.

2.3 Fine Aggregates

2.3.1 Unless specified otherwise it shall either be natural river sand or pit sand.

2.3.2 Sand shall be clean, sharp, strong, angular and composed of hard siliceous material. It shall not contain harmful organic impurities in such form or quantities as to affect adversely the strength and durability of concrete. Sand for reinforced concrete shall not contain any acidic or other impurities which is likely to attack steel reinforcement. The percentage of all deleterious materials including silt, clay etc., shall not exceed 5% by weight. If directed, sand shall be screened or washed before use to the satisfaction of Engineer.

2.3.3 Crusher dust

Crusher stone dust (that is retained on 300 micron sieve) may be used as replacement for certain quantum of sand aiming to improve the fineness modulus of fine aggregate. The quantum of replacement for sand shall be arrived at by suitable trial mixes. The Engineer will decide the final usage of crusher dust depending on the circumstances.

2.4 Lime

Lime for mortars and concrete shall conform to IS: 712-1984 The total of CaO and MgO content in quick lime shall not be less than 85% (MgO shall not exceed 5%). Quicklime, after slaking, shall leave a residue of not more than 5% by weight on IS sieve 85.

2.5 Surkhi

Surkhi used in lime concrete for flooring, terracing etc., shall conform to IS: 3182-1986. Surkhi shall be made from well burnt bricks or brickbats. Surkhi shall pass through I.S. sieve 3.35mm with at least 50 % of it passing through I.S. sieve 1.70mm and be perfectly clean and free from foreign matter. Surkhi shall not be made from bricks which have come in contact with any mortar.

2.6 Cement

Ordinary Portland cement / Portland slag cement complying with the requirements of IS:269-1989 and I.S. 455-1989 respectively shall be used for making plain and reinforced concrete, cement grout and mortar.

Other types of cement may be used depending upon the requirements of certain jobs with the approval of the Engineer. These shall conform to the following standards :

Portland Pozzolana Cement	IS: 1489-1991
Rapid Hardening Portland Cement	IS: 8041-1990
43 Grade Ordinary Portland Cement	IS: 8112-1989
53 Grade Ordinary Portland Cement	IS: 12269-1987
Hydrophobic Portland Cement ..	IS: 8043-1991
High alumina cement for structural work	IS: 6452-1989
White portland cement	IS: 8043-1989
Sulphate Resisting Portland Cement	IS: 12330-1988

2.6.1 Testing of samples

The Contractor shall supply a copy of the manufacturer's test certificate for each consignment of cement supplied by him and consignments shall be used on work in the order of delivery. The Contractor shall supply samples of cement to the Engineer as frequently as he may require for testing. The sampling of cement for testing shall be according to IS: 3535-1986. All tests shall be in accordance with the

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

2.6.2 Contractor's responsibility

From the time a consignment of cement is delivered at site and tested and approved by the Engineer until such time as the cement is used on the works, the Contractor shall be responsible for keeping the same in sound and acceptable condition and at his expense and risk. Any cement which deteriorates while in the Contractor's charge and is rejected as unsuitable by the Engineer, shall be removed from the site to outside the limits of work at the cost of contractor within two days of ordering such removal by the Engineer.

2.6.3 Stock of cement

In order to ensure due progress, the Contractor shall at all times maintain on the site at least such stock of cement as the Engineer may from time to time consider necessary. No cement shall be used upon the works until it has been accepted as satisfactory by the Engineer.

2.6.4 Storage of cement

The cement shall be stored in such manner as to permit easy access for proper inspection and in a suitable weather-tight, well ventilated building to protect it from dampness caused by ingress of moisture from any source. Different types of cement shall be stored separately. Cement bags shall be stacked at least 15 to 20 cm clear of the floor leaving a space of 60 cm around the exterior walls. The cement shall not be stacked more than 10 bags high. Each consignment of cement shall be stacked separately to permit easy access for inspection.

2.7 Water

Water used for mixing concrete and mortar and for curing shall be clean and free from injurious amounts of oil, acid, alkali, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The pH value of water shall generally be not less than '6'. Water has to meet the requirements mentioned in clause 4.3 of IS: 456-1978. Water shall be obtained from an approved source.

Where it is obtained from a source other than a supply main, it shall be tested to establish its suitability. Water for construction purpose shall

be stored in proper storage tanks to prevent any organic impurities getting mixed up with it.

2.8 Admixture for Concrete

2.8.1 Approval

Admixtures to concrete shall not be used without the written consent of the Engineer. When permitted, the Contractor shall furnish full details from the manufacturer and shall carry out such test as the Engineer may require before any admixture is used in the work.

2.8.2 Types

2.8.2.1 Integral water proofer

Admixtures used as integral water proofer shall be free of chlorides and sulphates and shall conform to IS: 2645-1975. The application and doses shall be as per manufacturer's specification.

2.9 Interval of Routine Test

2.9.1 The routine tests of materials, delivered at site, shall be at the following intervals :

Aggregates - Fortnightly or for every 200 m3 for each aggregate whichever is earlier and in other respects generally as per IS : 2386 (Part 1 to 8)-1963.

Cement - Fortnightly or for each consignment, within 4 days of delivery and in other respects generally as per IS : 4031-1988.

Water - Once in two months for each source of supply and in other respects generally as per IS : 456-1978.

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

3.0 STEEL

3.1 For Reinforcement

Reinforcing bars for concrete shall be round steel bars of the following types as may be shown on the drawing :

i) Plain mild steel bars conforming to Grade-I of IS : 432-1982 "Mild Steel & Medium Tensile Steel for Concrete Reinforcement".

ii) "High strength deformed steel bars conforming to IS : 1786-1985 for Concrete Reinforcement".

iii) Reinforcement fabrics conforming to IS:1566-1982 "Hard Drawn Steel Wire Fabric for Concrete Reinforcement"

All reinforcement bars shall be of uniform cross sectional area and be free from loose mill scales, dust, loose rust, coats of paint, oil or other coatings which may destroy or reduce bond. Unit weight of reinforcement bars conforming to I.S. 1786-1985 is as given below.

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

28	4.830
32	6.310

3.2 Binding wire

Binding wire for reinforcement shall be annealed steel wire 20 BWG conforming to IS : 280 -1978 "Specification for Mild Steel Wire".

3.3 Light structural work and inserts

Steel for light structural work and for preparation of inserts and embedments shall conform to IS: 2062-1992 "Steel for general structural purposes - Specification."

3.4 Steel Tubes

Steel tubes for use in light structural work and inserts shall be of light or medium class (as may be specified in drawings or the schedule of items) and of grade YST 25 conforming to IS : 1161 - 1979 "Specification for Steel Tubes for Structural Purposes".

3.5 Foundation Bolts

3.5.1 Bolts to be embedded in concrete shall, unless otherwise detailed in drawings, conform to IS : 5624-1970 "Sp ecification for Foundation Bolts". Material for bolts, shall, unless otherwise mentioned in drawings or the schedule of items, be of steel conforming to IS : 2062-1992.

3.5.2 Nuts and locknuts shall conform to IS : 1363 (Part 1 to 3) -1992 "Specification for Black Hexagon Bolts, Nuts and Lock Nuts (Diameter 6-39 mm) and Black Hexagon Screws "Specification for Hexagon Bolts and Nuts (M-42 to M-150)".

3.5.3 Plain washers shall conform to IS : 2016 -1967 "Specification for Plain Washers and spring washers shall conform to IS : 3063 -1972 "Spring Washers for Bolts, Nuts & Screws".

3.6 Steel Tubes for Non-structural use

3.6.1 Steel tubes for non-structural use shall conform to IS : 1239 (Part-I) -1990 "Specification for Mild Steel Tubes, Tubular and Other Wrought Steel fittings, Part-I : Mild Steel Tubes".

3.6.2 Fittings for steel tubes used for non-structural purposes shall conform to IS : 1239 (Part-II) -1992 "Specification for Mild Steel Tubular and Other Wrought Steel Pipe Fittings".

3.7 Threaded Fasteners

Bolts and nuts for fastening shall conform to IS:1367 (Part 1)-1980 "Technical Supply Conditions for Threaded Fasteners".

3.8 Testing

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

3.9 Cast Steel

3.9.1 Quality

Cast steel shall conform to IS : 1030-1989 "Carbon Steel Casting for General Engineering Purpose". Unless otherwise specified, it shall conform to Grade2.

3.10 Conduits

3.10.1 Steel for electrical wiring

Rigid steel conduits for electrical use shall conform to IS : 9537 (Part 2) - 1981 for rigid pipes and to IS : 3480-1966 for flexible conduits. Fittings for conduits shall conform to IS : 2667-1988.
All conduit pipes shall be finished with galvanised or stove-enamelled surface. All accessories shall be of threaded type and pipes shall be jointed by means of screwed couplers only. Bend in conduits shall be made to the dimension shown in drawing, but a minimum of 12 times the diameter. Where shown in drawing they shall be treated with anticorrosive preservative as specified.

3.10.2 Non-metallic conduit for electrical wiring

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

Bends shall be achieved by bending the pipes by inserting suitable solid or inspection type normal bends, elbows or similar fittings.

4.0 ASBESTOS CEMENT PRODUCTS

4.1 General

Asbestos cement products shall be free from visible defects, uniform in colour, of required density, length, thickness and diameter within the allowable tolerance. They shall be obtained from an approved source of manufacture and stored safely. Methods of test shall be according to IS:5913-1989 "Method of Test for Asbestos Cement Products."

4.2 Building Boards

These shall be of Class A, B and C with board thickness being 6.5mm , 5mm and 4mm respectively. The length shall be 2400, 1800 and 1200mm and width in all cases 1200 mm. Building boards shall conform to IS : 2098 - 1964 "Asbestos Cement Building Boards". They shall, when tested in two perpendicular directions, take a load of not less than 15 kgf for Class-A and 10 Kgf for Class-B and Class-C boards.The boards shall show water absorption of not more than 40% of their dry weight.

4.3 Flat Sheets

Flat sheets shall conform to IS : 2096-1992 "Asbestos Cement Flat Sheets". They shall have a bending stress of not less than 225 kgf/cm2 & a density of 1.6 kg/dm3 for compressed sheets & a bending stress of not less than 160 kgf/cm2 and a de nsity of 1.2 Kg/ dm3 for uncompressed sheets. Nominal thickness shall be 5,6,8,10 and 15 mm , length 2400, 1800 and 1200mm and width 1200mm. Water absorption shall not exceed 28% of dry wt.

4.4 Pipes and fittings

Pressure pipes shall conform to IS : 15 92-1989 "Asbestos Cement Pressure Pipes" and to IS : 9627 -1980 "Asbestos Cement Pressure Pipes (Light Duty)". Pipes for sewerage and drainage shall conform to IS

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

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

4.5 Corrugated and Semi-Corrugated Sheets

These shall conform to IS : 459 -1992 "Unreinforced Corrugated and Semi-Corrugated Asbestos Cement Sheets". Unless otherwise stated the sheets shall be corrugated and not less than 6mm thick. The sheets shall have a load bearing capacity of not less than 5 N/mm width of specimen and shall not absorb more water than 28% of its dry weight. Overall width of corrugated sheets is 1050mm and of semi-corrugated sheet is 1100mm.

4.6 Asbestos Cement Roof fittings

These shall conform to IS : 1626 (Part 3)-1981. Shapes and dimensions shall be as given in the above mentioned code. All finished products shall be free from visual defects that impair appearance or serviceability. Surface of fittings shall be of uniform texture and shall have neatly trimmed edges. Mean water absorption shall not be more than 28% of dry mass of the material.

5.0 BRICK AND STONES

5.1 Bricks

Bricks for masonry in foundations, walls and other locations shall be common burnt clay building bricks having minimum crushing strength of 5 N/sq.mm., or such other strength as may be described in the Schedule of Items, when tested in accordance with IS : 1077-1992 "Common Burnt Clay Building Bricks". They shall be sound, hard and thoroughly well burnt, with uniform size having rectangular faces with parallel sides and sharp straight right angled edges and be of uniform colour with fine compact uniform texture. Bricks shall be of uniform deep red cherry or copper colour. They shall be free from flaws, cracks and nodules of free lime. Water absorption after 24 hours immersion in cold water shall be not more than 20% by weight. They shall not absorb more than 10% by weight of water after immersion for six hours. They shall emit a clear

metallic ringing sound when struck by a mallet and shall not break when dropped on their face, from a height of 60 cm. Fractured surface shall show homogeneous, fine grained uniform texture, free from cracks, air holes, laminations, grits, lumps of lime, efflorescence or any other defect which may impair their strength, durability, appearance and usefulness for the purpose intended. Underburnt or vitrified bricks shall not be used. Samples of bricks brought to the site shall be tested periodically for compression and other tests according to IS : 3495 (Parts-1 to 4) -1992 "Method of Test for Burnt Clay Building Bricks". Where the size of bricks is not specifically mentioned, it shall be taken to mean conventional sizes as is commonly available in the area. In case modular bricks are to be used, it shall be accordingly specified in Schedule of Items. The bricks shall be classified on the basis of average compressive strength as given in table 1 of IS : 1077-1992.

5.2 Handling

Bricks shall be unloaded by hand and carefully stacked and all broken bricks shall be removed from the site.

5.3 Samples and Inspection

Representative samples shall be submitted by the contractor and approved samples retained by the Engineer for comparison and future reference. Bricks shall be obtained from approved manufacturer. All bricks shall be subject to inspection on the site and shall be to the approval of the Engineer who may reject such consignment as are considered by him to be inferior to the quality specified. The Contractor shall provide all labour and plant required for the inspection and conduct such test as shall be required by the Engineer without additional charges.

5.4 Brick Bats

Brick bats shall be obtained from well burnt bricks of approved quality.

5.5 Laterite Stone Blocks

These shall conform to IS : 3620 -1979 "Laterite Stone Blocks for Masonry". The laterite stone blocks shall have a minimum compressive strength of 30 kg/cm2 and to be tested as per IS : 1121-1974. The blocks shall be minimum 15 cm thick but not exceeding 30 cm. They shall be dressed to the desired sizes and shapes with an axe. Laterite

stones shall be well seasoned by exposure to air before dressing and using on work.

5.6 Stone (granite, trap, sandstone, quartzite etc.)

5.6.1 Stone used shall be strong, durable, dense, compact, close grained, homogeneous, fire resistant and shall be obtained from sources approved by Engineer. Stones shall additionally be hard, sound, free from cracks, decay and other flaws or weathering and shall be easily workable. Stones with round surfaces shall not be made use of.

5.6.2 Stones shall have a crushing strength of not less than 200 kg/cm2. Stones with lesser crushing strength may be used in works with prior approval of the Engineer. Stones shall be non-porous and when tested in accordance with IS : 1124 -1974 "Method of Test for Determination of Water Absorption Etc.," shall show water absorption of less than 5% of its dry weight when soaked in water for 24 hours. Tests for durability and wheathering shall be done in accordance with IS : 1126-1974 and IS : 1125-1974 respectively. The working of stones to required sizes and their dressing shall be as per IS : 1127-1970 "Recommendations for dimensions and workmanship of natural building stones for masonry work" and IS : 1129 -1972 "Dressing of Natural Building Stones". Stones especially limestone and sand stones shall be well seasoned by exposure to air before use in construction works.

5.6.3 Size

Normally stones shall be of size that could be lifted and placed by hand, between 20 to 30 kg per piece. The length of stones shall not exceed 3 times the height and the breadth on base shall not be greater than 3/4 of the thickness of wall or less than 15cm. The height of stone may be upto 30cm.

5.6.4 Dressing

5.6.4.1 Random rubble

Stones shall be hammer dressed on the face, the sides, and the beds to enable it to come into close proximity with the neighbouring stone. The bushings in the face shall not project more than 4cm on all exposed faces and 2cm on a face to be plastered, nor shall it have depressions more than 1cm from the average wall surface.

5.6.4.2 Coursed rubble - First sort

Face stones shall be hammer dressed on all beds, and joints, so as to give them approximately rectangular block shape. These shall be squared on all joints and beds. The bed joint shall be rough chisel dressed for atleast 5cm back from the face, and side joints for atleast 4cm such that no portion of the dressed surface is more than 6mm from a straight edge placed on it. The bushing on the face shall not project more than 4cm as an exposed face and one cm on a face to be plastered. The hammer dressed stone shall also have a rough tooling for a minimum width of 2.5cm along the four edges of the face of the stone, when stone work is exposed.

5.6.4.3 Coursed rubble - Second sort

Dressing shall be as specified in 5.6.4.2 except that no portion of dressed surface shall exceed 10mm from a straight edge placed on it as against 6mm for first sort.

5.6.4.4 Stone for veneering

Stone lining upto 8cm shall be treated as veneering work. The stone shall be cut into slabs or required thickness along the planes parallel to the natural bed. Every stone shall be cut to the required size and shape so as to be free from any waviness and to give truly vertical and horizontal joints. Adjoining faces shall be fine chisel dressed to a depth of a 6mm, so that when checked with a 60cm straight edge, no point varies from it by more than 1mm. All edges shall be chisel dressed to be true, square and free from chippings. Top and bottom faces shall be dressed to within 3mm tolerance and vertical faces to within 6mm tolerance, when checked with a 60mm straight edge. Dressing at the back shall not be done.

5.7 Hollow and Solid Concrete Blocks

5.7.1 Cement concrete blocks used in the construction of concrete masonry load bearing as well as non-load bearing walls shall conform to the requirements of IS : 2185 (Part 1)-1979. Physical properties such as density, compressive strength, water absorption etc., shall be determined in accordance with the procedure laid down in IS : 2185 (Part 1) - 1979 and shall conform to the requirement laid therein. When inspected visually all blocks shall be sound, free from cracks, broken edges,

honeycombing and other defects which would interfere with the proper placing of blocks or impair strength or permanence of construction.

5.7.2 Dimensions and tolerance

The blocks shall be made in sizes and shapes to suit the particular job and shall include stretcher, corner, double corner or pier, jamb, header, bullnose and floor units.

5.7.2.1 The nominal dimensions of concrete block shall be as follows :

Length : 400, 500 or 600mm
Height : 200 or 100mm
Width : 50, 75,100, 150, 200, 250 or 300mm

In addition, blocks shall be manufact ured in half and other suitable lengths and shapes to suit Architectural requirements.

5.7.2.2 The maximum dimensional tolerances shall be plus or minus 5mm in length and plus or minus 3mm in height and width.

5.7.3 Hollow blocks (open and closed cavity)

5.7.3.1 The blocks having solid material about 50% to 75% of total volume of the block ca lculated from the overall dimensions shall be termed as hollow blocks. Grade-A blocks used as load be aring units shall have a minimum block density of 1500 kg/m3 and shall have minimum average compressive strength of 3.5, 4.5, 5.5 or 7.0 N/mm2 at 28 days as specified.

5.7.3.2 Grade-B Blocks used as load bearing units sh all have block density less than 1500 kg/m3, but not less t han 1000 kg/m3 and shall have compressive strength of 2.0, 3.0, or 5.0 N/ mm2 or as specified.

5.7.3.3 Grade-C blocks used as non lo ad bearing units shall have block density less than 1500 kg/m3, but not less than 1000 kg/m3 and compressive strength of 1.5 N/mm2 at 28 days.

5.7.4 Solid blocks

The blocks having solid material m ore than 75% of the total volume of the be block shall be termed as solid block. Solid blocks (Grade-D) used

as load bearing units shall have a block density of not less than 1800 kg/m3 and compressive strength of 4.0 or 5.0 N/mm2 as specified.

5.7.5 Mix proportion

The concrete mix used for blocks shall not be richer than one part by volume of cement to six parts by volume of combined aggregates before mixing.

5.7.6 Surface texture and finish

Surface texture, that is, very fine closed texture or coarse open texture and finish, whether coloured or not shall be according to the drawing, description in the Schedule of Items or instructions of the Engineer.

5.7.7 Marking and certificate

The blocks shall be marked permanently indicating the Grade of the unit, identification of the manufacturer and the year of manufacture. Manufacturers test certificate shall be supplied with the delivery of each lot.

5.8 Cement, Lime and Water

Cement, lime and water shall conform to the specification under the Section Concrete of this part.

5.9 Sand for Masonry Mortar

Sand for masonry mortars shall be natural sand, crushed stone sand or crushed gravel and shall comply with IS : 2116 - 1980 "Sand for Masonry Mortars". The sand shall be hard, durable, clean and free from adherent coatings and shall not contain amount of clay, silt and fine dust more than 5% by wt. Sand shall not contain any harmful impurities such as iron pyrites, alkalies, salts, coal, mica and organic matters. The particle size grading of sand for use in mortars shall be within the limits as specified in Table I of above code.

6.0 SAND FOR PLASTERING

Sand for use in mortars for internal wall, ceiling and external plastering and rendering shall conform to IS:1542 -1992. It shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal, mica and organic matters. Percentage of salt and dust shall not be more than 5% by weight. Grading of sand shall be within the limits specified in clause no. 5.1 of above code. Fineness modulus of naturally occuring sand shall not be less than 1.5.

7.0 MATERIALS FOR FLOORING & PAVING

7.1 Cement and Binders

7.1.1 Cement

Cement, fine aggregates, reinforcement and water used shall comply with the requirements of concrete as per clauses 2.1, 2.3, 2.6 and 2.7 of this part.

7.1.2 Water

Water for construction shall be clean, soft, free from loam, salt and organic materials. Hard water shall not be used.

7.2 Aggregates

7.2.1 Coarse Aggregate

7.2.1.1 Coarse aggregate shall conform to the requirement as per clauses 2.1 and 2.2 of this part.

7.2.1.2 For granolithic floor the screeded bed shall comprise of aggregates size 15mm and down graded and topping shall comprise of clean fine stone chippings, size 4mm and down. For concrete floor with hardener treatment the topping shall comprise of stone chippings, size 6mm and down and for in-situ terrazzo flooring, chippings shall be within sizes 12mm to 6mm graded. The marble chips for topping of terrazzo floor shall be of 3-6mm size and shall conform to Grade-I of IS : 2114-1984 "CP for laying in-situ terrazo floor finish".

7.2.2 Common burnt clay bricks

Common burnt clay bricks shall conform to IS : 1077-1992 and comply with requirements under the section "Brick and Stones" of this part.

7.2.3 Rubble

Rubble of approved quality shall be used and shall be clean and free from dirt. The loose and weathered sections shall be removed before use. Rubble used as hard core shall have a least lateral dimension (thickness) between 100mm and 225mm, depending on the thickness of hardcore.

7.3 Tiles

7.3.1 Terrazzo Tiles

Terrazzo tiles shall be machine made under a minimum pressure of 140 kg/cm2. It shall have a minimum total thickness of 20mm including a minimum of 6mm thick topping. It shall be of size, texture, colour, shade and pattern as specified in schedule of item and as approved by the Engineer.

7.3.2 White Glazed Tile

White glazed tiles shall be of approved manufacture and quality and shall conform to IS:777 - 1988 "Glazed Earthenware Tiles. They shall be true in shape, free from hair cracks, crazing spot, chipped edges and corners and surface shall be perfectly flat without warps and of uniform colour. The top surface shall be glazed either gloss or matt as specified. The tiles, normally shall be 149mm x 149mm or 99mm x 99mm size and shall not be less than 5mm thick or as specified. The tolerance on average facial dimension value shall be plus or minus 0.8 and on thickness plus or minus 0.5mm. The specials such as coves, internal and external angles, beads, cornices and their corner pieces shall be of specified sizes and of thickness not less than the thickness of tiles.

7.3.3 Coloured tiles

Only glaze shall be coloured as specified. The size and specification of tiles shall be same as for the white glazed tiles.

7.3.4 Marble tiles

It shall conform to IS : 1130 -1960 "Marble (Blocks, Slabs and Tiles)". Marble for paving and facing work shall be of selected quality, hard,

sound, dense and homogeneous in texture (with crystalline texture) and free from cracks, decay, weathering and flaws and shall be of kind and quality, size and thickness as specified in schedule of items. The samples of tiles shall be got approved by the Engineer before use. The tiles shall be cut to the requisite dimensions.

7.4 Pigments

Pigments incorporated in mortar or used for grouting shall be subject to approval of Engineer and as per table I of IS : 2114-1984.

7.5 Red Oxide of Iron

Red oxide of iron where used for "Red Artificial Stone Flooring" shall be of quality approved by the Engineer, and shall be of uniform tint.

7.6 Hardening Agents

Hardening agents such as ironite used for "Cement Concrete Flooring with Hardener Treatment", shall be of quality approved by the Engineer for every work.

7.7 Dividing Strips

Dividing strips shall be of aluminium, glass, brass, copper, plastic or similar materials as specified in the schedule of item and of quality approved by the Engineer. Strips shall be 1.5 mm thick unless otherwise specified penetrating to the full depth of the flooring. Aluminium strips when used shall have a protective coating of bitumen.

7.8 Marble Chips

It shall be in sizes varying from 1mm to 25mm and in different colours as per requirement. Marble chips shall be hard, sound, dense and homogeneous in texture with crystalline and coarse grains. It shall be uniform in colour and free from cracks, stains, decay and weathering and shall be obtained from approved source.

7.9 Marble Powder

It shall be clean, free from dust and other foreign materials and of approved quality, obtained from approved source. It shall pass through sieve 300 conforming to IS: 460- (Part-1)-1985.

8.0 TIMBER

8.1 General

All timber used for carpentry and joinery works shall be new. It shall be well seasoned by a suitable process conforming to IS : 1141-1973 before being planed to the required sizes. It shall be sound, straight, free from sap, radial cracks, decay, fungal growth, boxed heart, pitch pockets, borer holes, splits, loose knots, flaws or any other defects and shall show a clean surface when cut. Timber shall conform to the requirements of IS : 1003 (Part 1&2)-1983 to 1991. The finished components shall be given suitable preservative treatment wherever necessary.

8.2 Teak wood/Sal / Bija Sal / Deodar / Kail and other varieties of timber

8.2.1 Teak wood

The timber shall be of good quality and well seasoned. It shall be of fairly uniform colour and shall be free from defects such as cracks, dead knots, shakes etc. No individual hard and sound knot shall be more than 15 sq. cm. in size and aggregate area of all such knots shall not exceed 2 % of the area of the piece. Wood shall be generally free from sap wood but traces of the same shall be allowed. The timber shall be fairly grained having not less than 2 growth per cm width in cross section.

8.2.2 Sal / Bija Sal wood

Timber shall be of good quality and well seasoned. It shall have fairly uniform colour, reasonable straight grains and shall be free from all defects as mentioned in previous clauses. No individual hard and sound knot shall be more than 6 sq. cm. in size and aggregate area of all such knots shall not exceed 2 % of the area of the piece. There shall not be less than 5 growth rings per 2 cm of the width.

8.2.3 Deodar wood

The timber shall be of good quality and well seasoned. It shall have fairly uniform colour, reasonable straight grains and shall be free from all defects as mentioned in previous clauses. No individual hard and sound knot shall be more than 15 sq.cm. in size and aggregate area of

all such knots shall not exceed 2 % of the area of the piece. There shall be at least 3 growth rings per cm width in cross section.

8.2.4 Kail wood

The timber shall be generally as specified in clause 8.2.3 for Deodar wood. However, there shall not be less than 2 growth rings per cm width in cross section.

8.2.5 Other varieties of timber

The timber as named in the item of work shall be used. It shall be well seasoned and generally free from defects such as dead knots, cracks, shakes, sap wood etc. However, traces of sap wood shall be allowed and sound and hard knots up to 2 % of the area of the piece shall be allowed.

8.3 Storage and Inspection

Timber shall be carefully stored and subject to inspection on site, piece by piece. The Engineer may reject such pieces as are considered by him not of the quality or meeting the requirements specified herein.

8.4 Moisture Content

Timber shall be accepted as well seasoned if its moisture content does not exceed the permissible limit as per IS : 287-1973.

8.5 Tolerances for Timber

For timber allowance as specified in the IS : 1003 (Part 1&2) 1983 to 1991 shall be applicable.

8.6 Flush Door Shutters, Shelves

Flush door shutters, shall be wooden, solid core or cellular and hollow core type, as may be shown in drawing or described in the Schedule of Items or directed by Engineer. They shall be obtained from an approved source of manufacture, covered on face with commercial ply, wood veneer or other finish as may be necessary. Solid core shutters

shall conform to IS : 2 202 (Part 1&2)-1983 to 1991 and cellular or hollow core shutters to IS : 2191 (Part 1&2)-1983. The resin used shall be phenol formaldehyde. A full size sa mple door shall be offered for inspection and approval.

8.7 Wood Particles Boards

Particle boards for general purposes shall be of medium density conforming to IS:3087-1985. These are of four types, Flat pressed single layer board (FPSI),Flat pressed three layer board (FPTH), Extrusion pressed soli d board (XPSO) and Extrusion pressed tubular core (XPTU). Adhesive shall be BWR, WWR or un-extended CWR type. High density wood particle board shall conform to IS:3478-1966 and are in flat sheets or moulded forms. These shall be of type 1 (BWR type of resin) or Type 2 (WWR or CWR type of resin). Both types of boards shall be of Grade A (resin content 20 to 50 percent) and Grade : (resin content 8-12 percent).

8.8 Veneered Particle Board

These shall conform to IS : 3097-1980 and shall be of two grades. Exterior (grade-I with BWP or BWR type adhesive) & interior (grade-II with WWR or CWR type adhesive). Each grade of boards shall be of 4 types, solid core general purpose, solid core decorative, Tubular core general purpose and Tubular core decorative and accordingly designated.

8.9 Plywood for General Purpose

Plywood for general purpose shall conform to IS:303-1989. Depending on type of adhesive used for bonding veneers, it is of 4 grades, BWP (boiling water proof), B.W.R (boiling water resistant), WWR (warm water resistant) and CWR (Cold Water resistant). Any species of timber may be used for plywood manufacture. However list of species, for the manufacture of plywood is given in Annexure 'B' of the IS : 303-1989 for guidance.

Plywood is classified in 10 different types as pe r appearance of the surface. These are type AA,AB,AC,AD,BB, BC,BD,CC,CD and DD as detailed in IS : 303-1984. It is ava ilable from 3 pl y to 11 ply with thickness from 3mm to 25mm.

8.10 Veneered Decorative Plywood

This quality of plywood shall conform to IS : 1328-1982. These plywood shall be of two types Type 1 and Type 2 as per details given in IS : 1328-1982. Species of timber for decorative face commonly used are given in Table 1 of IS : 1328-1982 but the purchaser shall specify the particular veener to be used. Timber for cores and backs shall be either class I or II as specified in IS : 303-1989. Adhesive used shall be BWR or WWR synthetic resin.

9.0 FITTINGS FOR DOORS, WINDOWS, ETC.

9.1 General

Fittings shall be of iron, brass, aluminium or as specified. These shall be well made, reasonably smooth and free from sharp edges, corners, flaws and other defects. Screw holes shall be countersunk to suit the head of specified wood screws. All hinge pins shall be of steel and their riveted heads shall be well formed.

Iron fittings shall be finished bright or black enameled or copper oxidised or painted as specified. Brass fittings shall be finished bright, oxidised or chromium plated and aluminium fittings shall be finished bright or anodised as specified. Fittings shall be got approved by the Engineer before fixing. Screws used for fittings shall be of the same metal and finish as the fittings. However, anodised cadmium/chromium plated M.S. screws of approved quality shall be used for fixing aluminium fittings.

9.2 Hinges

9.2.1 Butt hinges

These shall be mild steel but hinge (medium), brass butt hinges, extruded aluminium alloy butt hinges or as specified. Type (light/medium/heavy weight) and size shall be as specified in the drawing or schedule of items. Brass / Aluminium and M.S butt hinges shall conform to Indian Standard Specification for butt hinges IS : 205-1992 and IS : 1341-1992 respectively. Hinges shall be finished bright or satin polished or anodised.

9.3 Sliding Door Bolts

Mild steel sliding door bolts shall conform to IS : 281-1991 and are of 2 types, plate type and clip or bolt type. Plate type bolts shall have plates and straps stove enameled black with hasp and bolt finished bright or copper oxidized or nickel / chromium plated. Clip or bolt type are copper oxidized or plated. All screw holes in the M.S bolts shall be countersunk. Diameter of bolt for plate type is 12mm and for clip type is 16mm.

Non ferrous metal sliding doors are of brass or aluminium alloy and shall conform to IS:2681-1979. Brass sliding bolts are of 150 to 450mm size with bolt dia being 16mm for 150 to 300mm and 18mm for 375 and 450 size. Aluminium alloy sliding bolts are of size 200 to 450mm with 16mm bolt dia. Brass quality is finished satin, polished or plated and aluminium alloy bolts are anodised.

For both ferrous and non-ferrous metal bolts the size of the sliding bolt is determined by the length of the bolt.

9.4 Door Rim Latch

This shall be of mild steel, brass, aluminium alloy or as specified and of sizes 75, 100, 125 and 150mm denoted by overall length of the body measured from outside face of the fore end to the rear end. These are of type 1 and type 2 and shall conform to IS : 1019-1974.

9.5 Tower Bolts

Tower bolts may be of one of the following types and shall conform to IS : 204 (Part 1 and 2)-1991 and 1992.

i) Barrel tower bolts

These shall be of bright finished/stove enamelled/ black painted mild steel tower bolts, brass barrel tower bolts with cast brass barrel and rolled or drawn brass bolt/brass barrel tower bolts with barrel of extruded sections of brass and rolled or drawn brass bolt/brass barrel tower bolts with brass sheet barrel and rolled or drawn brass bolt. Aluminium barrel tower bolts with barrel and bolt of extruded section of aluminium alloy-bolts and barrel anodised.

ii) Semi-barrel tower bolts

These shall be mild steel semi barrel tower bolts full cover/open type with mild steel sheet pressed barrel and cast iron/mild steel bolt. Bolt bright finished other parts stove enameled black.

iii) Rivetted or spot welded tower bolts

These shall be mild steel tower bolts rivetted type with black flat and mild steel/cast iron bolt and open staple.

iv) Skeleton tower bolts

These shall be of bright finished / stove enameled / black painted mild steel or brass bright finished skeleton tower bolts with cast brass/extruded sections plate and staples and rolled or drawn brass bolt or Aluminium skeleton tower bolts with plates staples and bolt or extruded sections of Aluminium alloy plate and staple anodised.

9.6 Door Handles

Door handles shall conform to IS : 208-1987 and shall be of 4 types. Type 1 is cast Iron / Brass / Aluminium or zinc alloy die casting and available in 75,100,125 150mm sizes. Type 2 is mild steel pressed oval in 75, 100,115 and 135mm sizes. Type 3 is mild steel present half oval in 75,90 and 100mm sizes. Type 4 is fabricated (brass / aluminium alloy) in 75,100 and 125mm sizes. The size of the handle shall be determined by inside (grip) size overall size and internal depth of the handles shall be as detailed in IS : 208-1987.

Finish for type 1 shall be satin/nickel plating, copper oxidising and bronze finish for cast-brass and zinc die cast handles and stove enamelled black or copper oxidized for cast iron handles. Aluminium handles shall be anodized. Type 2 and 3 handles shall be stove enamelled black. For type 4 it shall be satin finish, nickel plating, copper oxidized and bronze finish for brass handles and anodizing for aluminium handles.

9.7 Mortice Lock and Rebated Mortice lock

Mortice lock with latch and pair of lever handles shall have body of steel, Aluminium alloy or brass and shall be right or left handed as

shown in the drawing or as directed by the Engineer. It shall be of the best Indian make of approved quality and shall conform to IS: 2209 / 6607-1976/1972. The shape and pattern shall be approved by the Engineer. The size of the lock shall be determined by its length. The lock for single leaf door shall have plain face and that for double leaf door a rebated face. Lever handles with springs shall be mounted on plates and shall weigh not less than 0.5 kg per pair. These shall be of brass, finished, bright chromium plated or oxidised. The locks shall be of 65, 75 and 100 mm sizes.

9.8 Floor Door Stopper

These are for the use of the door shutters of 30, 35,40 & 45mm thickness. It is made of aluminium alloy/ brass with springs of phosphor bronze or hard drawn steel wire and tongue of aluminium/brass/nylon/ plastic. The floor door stoppers shall conform to IS : 1823-1980 and shall be best Indian make of approved quality. Width of cover plate is 40mm but its overall length is 140mm for 30 and 35mm thick shutters & 150mm for 40 and 45mm shutters. The body shall be cast in one piece and fixed to cover plate by brass or M.S screws. On the extreme end there shall be rubber cushion to absorb shocks. The extension of the door stopper shall be in flush with floor and be finished bright/satin/chromium plated or anodised.

9.9 Hooks and Eyes

These shall be of mild steel or hard drawn brass and shall generally conform to IS : 207-1964.

9.10 Casement Window Handles

These shall be made of cast brass, steel protected against rusting, aluminium, pressed brass or as specified. Casement handles for single leaf window shutter shall be left or right handed and shall weigh as specified.

9.11 Casement Peg Stays

These shall be made of cast brass, steel protected against rusting, aluminium, cast alloy or as specified. The stay shall be made from a channel section and shall be 300mm long with steel peg and locking bracket. The peg stay shall have three holes to open the window in three different angles. The shape and pattern of stays shall be

approved by the Engineer. The peg stay shall be minimum 2mm thickness in case of brass and aluminium and 1.25 mm in case of steel.

9.12 Quadrant Stays

These shall be made of cast brass, aluminium alloy, CP iron or as specified. The shape and pattern shall be approved by the Engineer. It shall weigh as specified.

9.13 Fan Light Pivots

These shall be made of mild steel, cast brass or aluminium alloy or as specified and shall generally conform to IS : 1837-1966.

The pattern and the shape of the catch shall be as approved by the Engineer and size and finish shall be as specified.

9.14 Fan light catch

These shall be made of mild steel, cast brass, aluminium alloy or as specified and shall generally conform to IS : 364-1993. Steel springs of the catch shall be 0.90 mm dia, 6 coils, 12 mm internal diameter and 20 mm long. The pattern and the shape of the catch shall be as approved by the Engineer.

9.15 Steel Frames

These shall conform to IS:4351-1976. The frames shall be manufactured from commercial mild steel sheets of 1.25mm thickness and are suitable for door shutters 30 to 40mm thick. The door frames are designated as per profile A, B and C.

Profile A Size 105x60mm : rebated for one set of shutters

Profile B Size 125x60mm : rebated for one set of shutters

Profile C Size 165x60mm : rebated for two sets of shutters.

Miscellaneous Items :

9.16 Putty

The material shall be homogeneous paste and shall be free from dust and other visible impurities. Putty shall conform to IS : 419-1967 for wood work.

10.0 METAL DOORS, WINDOWS, VENTILATORS AND ROLLING SHUTTERS

10.1 General

Materials used in the fabrication of doors, windows, and ventilators shall be the best procurable and conforming to relevant Indian Standards.

10.2 Steel Doors, Windows and Ventilators

Steel sections used for fabrication of doors, windows and ventilators shall be standard rolled steel sections specified in IS : 1038, IS : 1977, IS : 1361 or IS : 7452 year 1983, 1975, 1978 and 1990 respectively as appropriate or as specified in drawing and Schedule of Items. Rivets shall conform to IS : 1148-1982.

10.3 Aluminium Door, Windows and Ventilators

Aluminium sections for fabricating doors, windows, ventilators, partitions etc., shall be extruded sections conforming to IS : 1948-1961 & IS : 1949-1961 or as manufactured by Indian Aluminium Company Limited or approved equivalent The alloy used shall conform to Designation HE 9 - WP of IS : 733-1983.

10.4 Steel Rolling Shutters, Rolling Grills

These shall conform to IS : 6248-1979.

10.5 M.S. Bolts etc.

M.S. bolts, nuts, screws, washers, peg stays and other mild steel fittings shall be treated for corrosion. Putty for glazing shall conform to IS : 419-1967. Glass panes and glazing shall conform to the specification detailed under this series.

10.6 Hardware and fixtures shall be as specified in the drawings or Schedule of Items. All hardware and fixtures shall be able to withstand repeated use. Door closers shall be suitable for doors weighing 61 80 kg, unless otherwise stated. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the closer replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance requirements and endurance test stated in IS : 3564 1986 Appendix-A.

10.7 The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer. In general, the mastic for fixing of metal frames shall conform to IS : 1081-1960 and/or as approved by the Engineer.

11.0 GLASS

11.1 General

Plain, ground, frosted or rough cast wired glass shall be used as shown on the drawing or as specified in the Schedule of Items. It shall be procured from a reputed source of manufacture and be of the best quality. All glass panes shall be free from flaws, specks, bubbles etc. Glass panes shall be of thickness 3mm or more as required. Weight of 3mm thick glass pane shall not be less than 7.5 Kg//sqm. The tolerance of glass panes, except wired glasses, in length and width shall be plus or minus 2 mm for 3 to 6.3 mm glass sheets. Tolerance in thickness of glass sheets shall be +/- 0.2mm for 3mm and 4mm thick glasses and +/- 0.3mm for 4.8, 5.5 and 6.3mm thick glasses.

11.2 Plain Transparent Glass

Plain transparent glass for glazing and framing shall conform to IS: 2835-1987. It shall be free from flaws, specks, bubbles or distortions.

11.3 Ground and Frosted Glass

Glare reducing or heat absorbing glass shall be "Calorex" or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.

11.4 Thickness

Glass shall have the following thickness, unless otherwise stated in the Schedule of Items or drawings

Upto 60 cms x 60 cms	...	3 mm
do- of larger size	...	4 mm and 4.8mm
Sheet glass for doors	...	5.5 mm
Rough cast wired	...	6.4 +/- 0.4 mm

11.5 Inspection

All glasses shall be subject to inspection on the site. Glass found to suffer from defects shall be rej ected. Samples submitted for inspection shall be selected so as to be representative of the consignment.

12.0 PAINTS

12.1 General

All paints, varnishes, distemper or other surface coating materials shall be of approved quality conforming to the appropriate Indian Standard, wherever such standard is available, and be obtained from a manufacturer of repute. If th ere is more than one quality for one particular product, only first quality shall be used unless otherwise stated in the Schedule of Items.

12.2 Sampling and Testing

The Engineer may, at his discretion, require samples of paint to be tested. In such cases testing will be according to IS : 101 (Part 1 to 8) - 1964 to 1993.

12.3 Storage

Paints, primers, distempers and varnishes shall be delivered in sealed containers. They shall be stored in cool dry condition to the satisfaction of the Engineer.

12.4 Paints for Priming

Ready mixed paints for priming coats of steel and iron work shall either comply with IS : 2074-1992 "Ready Mixed Paint", "Red Oxide Zinc Chrome Priming" or Red Oxide metal primer as specified. For wood work it shall be pink/ white wood primer as specified by the manufacturer of the synthetic enamel paints, conforming to IS : 3536-1966.

12.5 Paints for finishing

Ready mixed oil synthetic enamel paint of approved manufacturers like Berger, Jenson & Nicholson, Shalimar, I.C.I., Asian, Garware and Goodlass Nerolac paints only shall be used unless otherwise specified. Paint shall be of first grade quality of the above manufacturers ie., Luxol Brolac, Superlac, Dulox gloss, Apocolite, Garcoat and Nerolac respectively.

If for any other reason, thinning is necessary, the brand of the thinner recommended by the manufacturer, shall only be used with the specific permission of the Engineer.

Aluminium paint for general purpose shall be in Duel Containers. It shall be of manufacturers as for synthetic enamel paints above.

12.6 White wash

White was shall be prepared from freshly burnt fat, white in colour lime slaked on spot, conforming to IS : 712-1984 mixed and stirred with sufficient water to make a thin cream. Best and approved quality gum and ultra marine blue only shall be used in lime wash.

12.7 Colour wash

Colour wash shall be prepared by adding mineral colours, not affected by lime, to white wash.

12.8 Water proofing Cement Paint

Cement paints shall comply with IS: 54 10-1992 and shall be of approved brand and manufacture like Snowcem India Ltd., Berger, Jenson & Nich olson & Shalimar paints. The shade shall be approved by the Engineer before its application.

12.9 Distemper

Dry/synthetic washable distemper of approved brand and manufacture like Berger, Jenson & Nicholson, Asian, Shalimar, Garware & Goodlass Nerolac shall be used. The shade shall be approved by the Engineer before application of the distemper. and shall comp ly with IS : 427-1965 and IS : 428-1969.

12.10 Varnish

Varnish for the finishing coa t shall be copal finish or synthetic class varnish of approved brand. Varnish for the under coat shall be flatting varnish of the same make as the top coats and shall be to the satisfaction of the Engineer.

12.11 Polish

French spirit polish shall be of an approved make conforming to IS: 348-1968. In case it is to be prepared on site, the polish shall be made by dissolving 0.7 kg of best, shellac in 4.5 litres of methylated spirit without heating. To obtain required shade pigment may be added and mixed. Shallac shall conform to IS : 5467-1986.

12.11.1 Wax polish for Wood work

The polish shall consist mainly of waxes and Organic solvents with or without water and shall be of smooth consistency, homogeneous, Semi-Solid mass and free from gritty materials. It shall not flow at ordinary temperature. It ma y be tinted with an oil soluble colour. The polish shall not crumble or dry too rapidly and shall produce non-tacky polished surface. The polish shall be amenable to smooth spreading on the furniture surface and the gloss shall appear on gentle rubbing with a soft polishing cloth.

The wax polish shall conform to IS : 8542-1977.

12.11.2 Where wax polishing is to be prepared at site, it shall be prepared by heating two parts of "Bee Wax" two parts of boiled linseed oil over a slow fire. When dissolved but still warm, one part of turpentine is to be added. The boiled linseed oil, bees wax and turpentine used shall be of approved quality and complying with IS : 77-1976, IS : 1504-1974 and IS : 533-1973 respectively.

12.12 Plastic (Acrylic) emulsion paint

Plastic emulsion paint of approved manufacturers like Jenson & Nicholson, Goodlass Nerolac, Shalimar, Berger, Asian and Garware paints only shall be used unless otherwise specified and shall comply with IS : 5411 (Part 1)-1974 & (Part 2)-1972 as applicable. Cement primer used for priming work both for oil bound distemper and plastic emulsion paint shall be of the same manufacture as that of distemper or plastic emulsion paint used. For dry distemper priming, whiting of approved quality shall be used.

12.13 Creosote oil or Coaltar Creosote

It is primarily used for preservation of wood. It shall be a homogeneous liquid and shall liquify completely on being warmed to 38 degree C with stirring and shall remain liquid on cooling down to 32 degree C and on standing at that temperature for 2 hours.

The material shall conform to IS : 218-1983. All persons handling the creosote oil should be fully aware of the hazards involved in handling . Skin should be protected from coming in direct contact and eyes should be protected by using safety goggles while ha ndling the material.

12.14 Coaltar Black Paint

Coaltar paint film protects surfaces by serving as a barrier against the action of moisture and other corrosive agents. Coaltar black p aint is generally used as a protective and anti corrosive paint of iron and steel as well as protection of other building surfaces. For this it has to be applied under proper condition and on suitably prepared surface. Coaltar should be applied by brush only and is not recommended for locations which are not likely to be well ventilated. Coaltar paint shall conform to IS : 290 1961.

The material is of two types : Type A Quickly drying and Type B Slow drying. It shall be a homogenous black solution type paint consisting of a base prepared by blin ding suitable grades of Coltar pitch, washed free from ammoniacal liquor, tar acid bases etc. Consistency, permeability, thickness and surface preparation etc. shall be as per para 5 and A-2 of the above code.

12.15 Floor Polish - Paste

The polish shall consist mainly of waxes and organic solvents with or without water.

The paste floor polish shall be of smooth consistency, homogenous, semi-solid-mass and free from gritty material. It shall not flow at ordinary temperature. It shall be so constituted and prepared that on application by means of a clean cloth, it shall spread easily and evenly and shall give with minimum buffing a firm and glossy surface free from greasiness or tackiness. The polish film after spreadng with a cloth shall not take more than 10 minutes to dry. The polished floor shall neither be slippery nor show any resistance to easy walking.

Floor polish paste shall conform to IS : 8591-1977.

13.0 WATER PROOFING MATERIALS

13.1 Integral Cement Waterproofing Compounds

Integral cement waterproofing compounds, i.e. admixture for waterproofing purposes shall fully comply with the requirements of IS : 2645-1975. Properties like permeability, setting time, compressive strength shall be in ac cordance with the requirements of this code when tested as per procedure laid therein. Calcium chloride content of the product used shall be made known to Engineer before use.

13.2 Bitumen

The bitumen bonding material for waterproofing shall conform to the requirements laid down in IS : 702-1988 or IS : 9 3-1992 or IS : 217-1988 or IS : 454-1961 depending upon whether industrial bitumen, paving bitumen or cutback bitumen is used. For selecting the particular type and grade of bitumen to be used the relevant item in Schedule of Items shall be referred to.

13.3 Bitumen Primer

Bitumen primer used for application to concrete and masonry surfaces and bitumen for the purpose of waterproofing shall conform to requirements given in IS : 33 84-1986 and pass tests in accordance with the procedure laid down in appropriate IS mentioned in Table-I of IS : 3384-1986. Bitumen primer should be free from water and shall preferably ;be made from the same grade of bitumen as used in bonding.

13.4 Bitumen Felt

Bitumen felts used for water proofing purposes shall be as specified in IS: 1322-1982. Physical properties shall conform to the requirements and tests shall be carried out as per procedure laid down in IS :1322-1982. Base, (whether fibre or Hessian), type and grade of felt shall be as mentioned in the relevant items under Schedule of Items. Unless otherwise stated, hessian base felt Type-3, Grade-2 shall be used.

13.5 Bitumen Mastic

Bitumen mastic used for water proofing of roofs shall have the physical properties as mentioned in IS : 30 37-1986 when tested with the procedure laid down in appropriate IS mentioned in IS : 3037-1986.

13.6 Bituminous Compounds

Bituminous compounds when used for waterproofing of porous masonry, concrete floors, walls and roofs shall conform to the requirements of IS : 1580-1991. Physical properties shall be governed by the requirements of this code when tested in accordance with the procedure laid therein.

13.7 Surface Application Materials

Waterproofing material for application on mortar or concrete surface shall conform to IS: 9862 1981. The primer shall be suitable for spray or brush application. It shall have properties enabling it to penetrate through pores or cracks and fill them up, making the surface impervious.

13.8 Polymer based paints

The materials used shall be high polymer based chloride and sulphide free cement and waterproofing additions and epoxy based waterproofing paints as per manufacturer's specification and approved by Engineer.

13.9 Fibre glass R. P. Tissue

The fibre glass R.P. tissue is a thin flexible uniform mat, composed of glass fibre in an open porous structure bonded with a suitable inert material compatible with coal tar, asphaltic enamel and oil plast ic based wall paint. The fibrous glass mat is reinforced with continuous filament glass yard at 3/8" (10mm) pitch in the longitudinal direction.

PHYSICAL PROPERTIES

i)	Weight	The average weight of fibre glass R.P. tissue shall not be less than 50 gms/sq.sm.
ii)	Thickness	The fibre glass R.P. tissue shall have a thickness not less than 0.4mm.
iii)	Tear Strength	The tear strength shall be not less than 900 grams in the transverse direction.
iv)	Breaking Strength	This shall have a minim um breaking strength of 13 lb/in (2.32kg/cm) in t he longitudinal direction.
v)	Porosity	This shall have a porosity when related to pressure difference across the sample of not less than 0.022" (0.56mm) and not more than 0.76" (1.92mm) of water guage at an air velocity of 200fpm.(100cm/sec.).
vi)	Pliability	There shall be no crac king of the tissue mat when bent over a 1/8" (3.2mm) radius after immersing for 10-15min. through a 90 degree arc.
vii)	Temperature	The fibre glass tissue shall be Resistance under a load of hot bitumen at 530 degree F (276 degree C) for one minute.

13.9.1 Primer

Primer shall conform to requirements laid down in IS : 3384-1986. It is to be prepared by blending turpentine and blown grade bitumen in the ratio of 60:40 by weight.

13.9.2 Blown Materials

Blown grade bitumen shall be conforming to IS : 702-1988 and residual grade bitumen conforming to IS:73 respectively. This shall be prepared by heating to correct working temperature.

13.9.3 Surface finish

Pea sized gravel/grit 6mm and down.

13.10 P.V.C. Membrane/Sheets

Polyvinyl chloride sheets for the purpose of water proofing and other underground use are specially developed sheets made from the compounded resin of grade MP/DP/CR-02 and shall be resistant to the passage of gross water and water vapour. It shall be corrosion resistant and resistant to a wide range of acidic and alkali reagents, saltpetre action, salt water and ultra violet rays etc. PVC sheets manufactured by approved and reputed firms like Maxlok Polymer Ltd. shall only be used

The sheets shall consist of Knobs or Lugs jutting out of the sheets in a grid fashion so as to provide a perfect grip in the mortar and concrete. Sheet thickness, spacing of the knobs and their projection from the sheet shall be as specified in the item. The sheets shall be of maximum practicable length and width unless otherwise specified.

The adhesive used for jointing shall be of approved quality and of grade C-02.

The sample of the material shall be got approved before use.

13.10.1 Properties

i)	Chemical Composition	:	Resin Plasticiser Inhibitor Stabiliser UV Barrier.
ii)	Thickness	:	Not less than 0.25 mm

iii) Rupture/Tensile Strength : Not less than 225Kg/cm2

iv) Adhesive bond Strength [width] : : Not less than 7.1 Kg/cm

v) Elongation at Break : 130%

14.0 WATER BAR

14.1 General

Water bar for use in co nstruction/expansion joints in co ncrete and reinforced concrete structures shall be of copper sheet, galvanised steel sheet, rubber or PVC as sh own in drawing or described in the Schedule of Items. It shall be subject to approval of Engineer.

14.2 Jointing

The water bar shall have dimensions as sh own in drawing. Where water bars are required to be lengthened or otherwise jointed the joining shall be done in such a way as to achieve a perfectly watertight joint.

15.0 LEAD

15.1 General

Lead for joints in cast iron spigot and socket pipes shall be melted from pure soft pig lead conforming to Type-I of IS : 782-1978. "Caulking Lead". Where lead wool is allowed for caulking, it shall be equal to or better than Type-II of IS : 782-1978. Lead flashing shall conform to IS : 405 Part I&II-1992.

16.0 BUILDING PAPER

16.1 Building paper shall be bitumen impregnated paper conforming to IS: 5134 1977, or such other as may be approved by the Engineer.

17.0 FILLING MATERIAL

17.1 General

Filling material shall conform to what is shown in drawing, described in the Schedule of Items or otherwise directed by the Engineer. Earth or sand for filling under floors shall correspond to those described elsewhere in these specifications.

17.2 Mastic Bitumen

Mastic Bitumen shall conform to IS : 3037-1986 or IS : 5871-1987 as appropriate.

17.3 Flexible Boards

Flexible boards for use in expansion joints shall correspond to the description given in drawing or the Schedule of Items or the instruction of Engineer.

18.0 DRAINAGE & SANITATION (INTERNAL)

18.1 General

All materials, pipes, specials, fittings, fixtures etc., to be used in the works shall be of best quality and class specified in relevant IS Code. Where specified these shall be of specific manufacture and quality and shall be procured from manufacturer or their accredited stockists and be marked with manufacturers' names and trade mark. Contractor shall submit to the Engineer samples of all materials, pipes, specials, fittings fixtures for approval before use in the works. Such approved samples shall be retained by the Engineer till completion of works. Pipes and Specials may be any or combination of following types:-

i) PVC Pipes

ii) Stone Ware Pipes

iii) Sand Cast Iron Pipes for soil waste & Ventilation

iv) CI Pipes for rain water

v) AC Pipes for rain water

vi) R.C.C Pipes

18.1.1 High density PVC pipes and fittings

This shall conform to IS : 4984-1987 and IS : 8008 (Part 1 to 7)-1976 unless otherwise specified.

18.2 PVC Waste Pipe

This shall conform to IS : 4985-1988 unless otherwise specified.

18.3 Stoneware Pipes & Fittings

All stoneware pipes, bends, gully traps and sewer traps shall be of the best salt glazed variety inside and outside, hard burnt dark grey colour, perfectly sound, free from fire cracks and imperfection of glaze, truly circular in cross section, perfectly straight, of standard nominal length and depth of socket and barrel. These shall be of approved manufacture and shall comply with the requirement of IS: 651-1992. These pipes shall be of grade AA unless otherwise specified.

18.4 Sand Cast Iron Pipes & Fittings conforming to IS : 1729-1979

All soil waste and vent pipes and fittings used in the work shall be cast iron and shall conform to IS: 1729-1979. The pipes shall have spigot and socket ends, with bead on spigot end and shall be with or without ears. The pipes shall be free from cracks and other flaws. The interior of the pipe and fittings shall be clean, smooth painted inside and outside with DR Angas smiths solution or other approved anti-corrosive paint.

The standard weights and thickness of pipe shall comply with the requirements of IS: 1729-1979. The tolerance on wall thickness and weight shall be minus 15 percent and minus 10 percent respectively. Pipes weighing more than the nominal weight given below may be accepted provided they comply in every other respect.

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

Specials and Fittings shall include bends, offsets, branches of various types, junctions etc., as required for the work which shall be provided according to drawings and directions of the Engineer. B.M. trap shall have water seal as per I.S. provisions.

The specials and fittings shall be provided with access doors where so specified or directed by the Engineer. The access door fittings shall be of proper design so as not to form cavities in which the filth may accumulate. Doors shall be provided with 3 mm thick rubber insertion packing, and when closed and bolted they shall be water tight. The access doors shall have MS studs and bolts or screws or bolts and nuts.

18.5 Cast Iron Pipes & A.C. pipes : Rainwater pipe

18.5.1 Pipes shall be of approved manufacture, true, smooth and cylindrical, their inner and outer surfaces being as nearly as practicable concentric and shall conform to IS : 1230-1979. These shall be sound and uniform casting, free from laps, pin holes or other imperfections and shall be neatly finished inside and outside. The ends of pipes shall be reasonably square to their axis.

18.5.2 Dimensions

CI rain water pipes shall be of the dia specified in the description of the item and shall be in full lengths of 1.8 metres including socket ends of the pipes, unless shorter lengths are required at junctions with fittings. The pipe lengths shall in each case be with sockets. The pipes shall be supplied without ears unless otherwise specifically mentioned.

The pipes supplied shall be factory painted with a tar based composition both inside and outside which shall be smooth and tenacious unless specified otherwise.

Every pipe shall ring clearly when struck all over with a light hand hammer. When shorter pipes are cut from full lengths they shall be cut with a hacksaw.

Where the pipes are to be embedded in masonry they shall be of Class of pipes as are used for soil and vent pipes. For the weights of different sizes of these pipes, the specifications under SCI and vent pipes may be referred to.

18.5.3 A.C. pipes and fittings the pipes and fittings shall be of approved manufacture and shall conform to IS:1626. These shall be homogeneous and free from cracks and other defects. The pipes shall be straight, smooth and regular in thickness.

The diameter of the pipe shall be as specified. The fittings like heads, bends of different degrees, offsets of different projections, shoes and junctions shall be of the type, diameter and size as required for the work. The pipes shall be used in full lengths as far as possible.

18.6 Sanitary appliances

Sanitary appliances like I.W.C/E.W.C pans, wash basin, urinals and sinks etc. shall be made of vitreous china or fire clay as specified. These shall be of Hindustan Sanitary ware or Parry ware make unless otherwise specified and to be approved by the Engineer. These shall conform to A class quality of IS : 2566 (Part 1 to 15)-1972 to 1985 and IS : 771 (Part 1 to 15) –1979 & 1985 respectively.

18.6.1 European Pattern W.C.

Unless otherwise specified, these shall comprise of :

a) White 'glazed earthenware wash down closet set with 'S' or 'P' trap of standard size.

b) 'Duco' spray painted 12.5 litres mosquito proof low level M.S or C.I flushing cistern with valveless siphon, 15 mm ball cock, C.P. brass unions & couplings for the 32 mm dia flush pipe, 20 mm dia overflow PVC pipe with mosquito proof cover etc.

c) 'Duco' spray painted 1 1/4" (32 mm) dia G.I. telescopic flush pipe with buffer clamp, holder bat clamp and 38mm dia PVC pipe or 35/40mm O.D. high density polythene flush pipe with buffer clamp, holder bat clamp.

d) Approved quality solid plastic W.C. seat and cover, bar hinges, screws bolt, rubber buffers conforming to IS : 2548 (Part 1&2)-1983.

e) 15 mm PVC connection pipe with brass couplings at both ends and 15 mm brass CP cock.

f) Hard wood wooden blocks or other suitable fixing arrangement with screws and detofix for fixing WC in floor and putty joint with flush pipe and soil pipe.

18.6.2 Indian Pattern W.C.

Unless otherwise specified these shall comprise of :-

a) White glazed earthenware WC pan back entry type.

b) White glazed earthenware 'P' or 'S' trap with or without vent.

c) 12.5 litres approved make mosquito proof M.S.high level flushing cistern with valveless siphon, 15 mm ball cock, galvanised iron chain handle, cast iron brackets with wall plugs, brass unions and couplings for flush pipe, 20 mm dia overflow PVC pipe with mosquito proof cover etc.,

d) 32 mm dia GI telescopic or 35/40 mm O.D high density PVC flush pipe with holder bat clamps.

e) One pair of white glazed earthen ware foot rest set in cement mortar 1:3.

f) 15 mm PVC connection pipe with brass couplings at both ends and 15 mm brass stop cock.

18.7 Wash Hand basin

Unless otherwise specified these shall comprise of :-

a) White glazed earthenware basin with 2 nos. Concealed Cast Iron Brackets with wall plugs.

b) 1 no. 15 mm C.P. brass pillar tap.

c) 32 mm C.P. brass waste fitting, C.P. brass chain and rubber plug.

d) 32 mm PVC waste pipe with brass couplings/32 mm C.P. bottle trap.

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

18.8 Flat Back Lipped Urinal

Unless otherwise specified these shall comprise of:-

a) White glazed earthenware urinal basin back type.

b) CI/M.S mosquito proof high level automatic flushing cistern of capacity as specified in the Schedule of Quantities with all accessories, cast iron brackets with wall plugs, brass unions and coupling for flush pipe, 20 mm dia overflow pipe with mosquito proof cover.

c) 25 mm dia CP brass flush pipe and spreaders with wall clips and brackets.

d) 15 mm PVC connection pipe with brass couplings joint at both ends and 15 mm brass stop cock.

e) 32 mm C.P. brass outlets complete with PVC waste.

18.9 Mirror Frames

Mirror frame where specified shall be of fibre glass of approved shape, size, colour and make.

18.9.1 Mirror shall be of superior glass with edges rounded off or leveled as specified. It shall be free from flaws, specks or bubble and its thickness shall not be less than 5.0 mm. The glass for the mirror shall be uniformly silver plated at the back and shall be free from silvering defects. Silvering shall have a protective uniform covering of red lead paint.

18.10 Toilet Shelf

18.10.1 Glass shelf unit shall consist of an assembly of glass shelf, anodised aluminium / CP brass guard rail and supporting brackets. The shelf shall be of glass of best quality with edges rounded off and shall be free from flaws, specks, bubbles and of thickness not less than 5.0

mm. The shelf shall have guard rail, resting on rubber washers on glass plate.

18.10.2 Ceramics shelf shall be of shape, size and design as specified in the Schedule of Items.

18.11 Towel Rail

Towel rail shall be of CP brass / anodised aluminium with two brackets of same material, diameter and length as specified.

18.12 Soap Container

Soap container shall be of C.P brass, PVC with cp brass brackets of approved make and design.

18.13 CP Flush Valves for EWC

The CP flush valve for EWC shall be of "Jaquar" brand of Jaquar & Co., 'ACCO' brand of Asia Continental Metallwaren Fabric or equivalent quality.

18.14 CP Flush Valve for Urinals

CP flush valve for urinal shall be of "Jaquar" brand of Jaquar & Co., 'ACCO' brand of Asian Continental Metallwaren Fabric or of equivalent quality.

18.15 Gully Trap

Each gully trap shall have one C.I. grating 150 mm x 150 mm and one water tight pre-cast R.C. cover 300 x 300 x 40 mm thick with 1:1 1/2:3 mix concrete (one cement: one and half sand : 3 stone chips 20 mm down) including neat cement finish.

18.16 CI Manhole Covers & Frames

These shall be of light or medium duty (LD or MD) as specified in Schedule of Items and of cast iron with raised chequered design, lifting key and key hole and shall be coated with black bituminous base material,. Light duty covers and frames shall be of either rectangular type, single seal, pattern 1 and 2 having minimum weight of cover and frame 38 Kg and 25 Kg. respectively or with double seal, minimum

weight of cover and frame being 52 Kg. These may be of square type also. Single seal with clear openings of 455 and 610 mm with minimum weight of cover and frame being 20 Kg and 38 Kg respectively, double seal of same openings shall have minimum Wt. of cover and frame 30 Kg and 55 Kg respectively. Medium duty covers and frames shall be either of circular type with 500 and 560 mm clear openings and minimum Wt. of cover and frame 116 Kg and 128 Kg respectively or of rectangular type with minimum Wt. of cover and frame 144 Kg.

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

18.17 Flushing Cisterns

Manually operated high level and low level flushing cisterns are of 5 litre and 10 litre capacities, both single flush and dual flush type. The cisterns shall conform to IS : 774-1984 and be made of Cast Iron, Vitreous China or enamelled pressed steel. The cisterns shall be mosquito-proof.

The thickness of the body including cover shall be not less than 5 mm for Cast Iron and 6 mm for Vitreous China Cisterns. Steel and lead flush pipe shall have internal diameter of 32 plus or minus 1 mm for high level cisterns and 38 plus or minus 1mm for low level cisterns. For high density polyethlyne and unplasticised PVC pipes the outside diameter of the pipe shall be 40 mm. In case of PVC plumbing pipes the outside diameter of the pipes shall be 40mm for high level and 50mm for low level cisterns. Steel flush pipes shall be hot dip galvanized electroplated or vitreous enameled.

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

Cast Iron Cisterns shall be painted and finished in accordance with recommendation made in IS : 1477 (Part 1&2)-1971 or shall have a coating of enamel.

In general, Materials Construction and operational and performance requirements shall be as specified in para 3, 4 and 6 of IS : 774-1984.

18.18 Plastic Seats & Covers for Water Closets

These shall conform to IS : 2548 (Part 1&2)-1983 and shall be either of thermo-set or of thermo-plastic quality.

Thermo-set Seats and Covers are moulded from phenolic plastics (Type A) or Urea Formaldehyde (Type B). Thermo-plastic Seats and Covers are also of Type A, moulded from Polystyrene or Type B, moulded from Polyprophlene.

Underside of the seats may be either flat or recessed and colour shall be as agreed. Table Dimesions of the seats and covers shall be as per Table-I of the Code (both Part 1&2). Hinging device may be either of the following materials :

i) Bronze or Brass with Nickel Chromium Plating

ii) Mild Steel with Nickel Chromium Plating

iii) Aluminium alloy with anodic coating

iv) Suitable plastic with reinforcement.

19.0 WATER SUPPLY & PLUMBING (INTERNAL)

19.1 General

This section deals with the specification of material for pipes, fittings, fixtures etc., to be used in water supply works.

All materials, pipes, fittings, fixtures to be used in the works shall be of the best quality and of the class specified in various clauses herein under. Where specified these shall be of specific manufacture and quality and shall be procured from the manufacturer or their accredited stockist and be marked with manufacturers name and trade marks. The Contractor shall submit to the Engineer samples of all pipes, fittings, fixtures for approval before being used in the works. Such approved samples shall be retained by the Engineer till completion of works.

Pipes and pipe fittings may be of any or combination of following types:

i) Wrought iron galvanised pipe

ii) PVC pipes

iii) Cast iron pipes

iv) Steel pipes coated with bitumen composition inside a nd galvanised outside.

v) Reinforced concrete pipes

vi) Asbestos cement pipes

vii) Pre-stressed concrete pipes

viii) Lead pipe (not to be used for potable water)

19.2 Galvanised Iron Pipes and Fittings

Generally pipes for installations in buildings shall be medium quality malleable steel galvanised pipe 'B' class for cold water supply and 'C' class for hot water supply, having threaded ends with socket at on e end.

The details of standard medium quality "B" class pipes and sockets regarding nominal bore thickness and weight in kg/m are given below:-

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

Note :- Manufacturing tolerances shall be permitted on tubes and sockets in addition to above as per IS : 1239 (Part 1&2) 1990 to 1992.

The galvanised iron pipes shall be of approved make and conform to IS:1239 (Part 1&2) 1990 to 1992 and of tested quality. The GI pipes shall be of threaded ends with a socket at one end only. The fittings for GI pipes shall be either galvanised wrought iron or galvanised malleable iron.

19.3 R.C.C, Asbestos, Prestressed Pipes and Fittings

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

19.4 Cast Iron Pipes and Fittings

The cast iron pipes shall be of approved manufacture and quality and shall conform to IS: 1536 1989 "Centrifugally Cast (Spun) iron pressure pipe and/or IS : 1537 1976". Vertically Cast Iron pressure pipe for water, gas and sewage. CI fittings shall conform to IS : 1538 (Part 1 to 23) 1976.

19.5 Steel Pipes

This shall conform to IS: 1239 (Part 1&2) 1990 to 1992) and IS : 3589-1991. Steel pipes shall be coated with bituminous composition inside and galvanised outside.

19.6 Bib Tap and Stop Tap

Bib tap and stop tap for water services shall be of brass screw down type and shall conform to IS: 781. Minimum finished weight of bib and stop taps shall be as given below:

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

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

The taps shall be tested under internal hydraulic pressure of at least 20 kgf/cm2 and maintained at the pressure for a period of at least two minutes during which period it shall neither leak nor sweat.

19.7 Valves

Unless otherwise mentioned in the Schedule of Quantities these shall be copper alloy gate, globe and check valve of nominal sizes 8 to 100mm and shall conform to IS : 778 1984. Valves shall be of class 1 and class 2, suitable upto a temp. of 45 degree C and can sustain non shock working pressure upto 1.0 and 1.6 MPA respectively. They shall have screwed or flanged ends. All the metal parts shall be of brass/brass alloy except hand wheel of Cast Iron or other approved quality.

19.8 Shower Rose

The shower rose shall be of heavy quality chromium plated brass with flat bottom, of diameter 100 mm or as specified with uniform perforations.

19.9 Storage Tank

Storage tank shall be either pressed steel, Galvanised iron, R.C.C or PVC of specified sizes, capacities, make, manufacture as specified in Schedule of Items. It shall have facilities for connecting inlet, outlet overflow and washout pipes and a top cover. Where tanks are to be fabricated by the Contractor the fabrication/R.C.C detailed drawings shall be got approved by Engineer.

19.10 Miscellaneous items

19.10.1 Half round channel

This shall be made of vitreous china channel with or without outlet/stop end as specified in Schedule of Items and shall be of approved manufacture.

19.10.2 Urinal partition

This shall be made of vitreous china or R.C.C. with mosaic finish or marble as specified and shall be of approved make and quality.

20.0 EXTERNAL SEWERAGE & DRAINAGE

Unless otherwise specified CI pipe and specials, caulking lead, SW pipe, RCC pipe shall conform to the following.

20.1 C.I. Pipes

i) C.I. pipe shall conform to IS : 1536 - 1989 or/and IS : 1537 – 1976 of class as specified in Schedule of Items.

ii) C.I. pipe fittings shall conform to IS : 1538 (Part 1 to 23) -1976 as specified in Schedule of Items.

iii) Bolts and nuts shall be hexagonal bolts and nuts conforming to IS : 1363 (Part 1 to 3) - 1992.

20.2 Washers

Spring washers conforming to IS : 3063 - 1972 shall be used near the pumps to take care of vibration. In other places plain washers conforming to IS : 2016 - 1967 shall be used.

20.3 Gaskets

Gaskets shall be reinforced rubber sheet or compressed fibre board conforming to IS : 638 - 1979 of thickness between 1.5mm to 3mm or as specified.

20.4 Caulking Lead

Lead for the spigot and socket joints shall conform to IS : 782 - 1978.

20.5 Salt Glazed Stone Ware Pipes

Salt glazed stone-ware pipes used shall conform to IS : 651 - 1992 and shall be laid as per IS : 4127 - 1983. The pipes shall be of grade AA unless otherwise specified.

20.6 Steel Pipes

Steel pipes and fittings used for encasing shall conform to IS : 1239 (Part 1&2) - 1990 to 1992 medium Class upto 150 mm dia and as per IS : 3589 - 1991 for pipes of dia 200 mm and above. For pies of dia 200 mm and above fittings, if required shall be fabricated from pipes itself.

20.7 Cast Iron Manhole Covers & Frames

These shall be of medium or heavy duty (M.D. or H.D.) as specified in Schedule of Item and of Cast Iron with raised chequered design, lifting key and key hole and shall be coated with black bituminous base material. Medium duty covers and frames shall be either of circular type with 500 mm clear opening and minimum weight of cover and frame 116 Kg and 128 Kg respectively or of rectangular type with minimum weight of cover and frame 144 Kg.
Heavy duty covers and frames shall be either of circular type with clear openings of 500 and 560 mm and 170 and 208 Kg weight respectively or of double triangular type with clear openings of 500 and 560 mm and 229 and 255 Kg weight respectively.

The CI manhole cover and frames shall conform to IS : 1726 - 1991.

21.0 ROAD

21.1 General

Roads shall be understood to include road bed, the wearing surface, berms, foot-paths, kerbs, culverts and bridges.

21.2 Soling Stones

Material for soling shall be natural stone boulders or crushed blast furnace slab. Stones for soling shall be of height equal to thickness of the soling with tolerance of plus or minus 25mm and shall not have a base area of less than 250 sq.cm. nor more than 500 sq.cm. and the smallest dimension of any stone shall not be less than half the largest dimension. Stones shall be tough, angular, durable and generally free from flat, elongated, soft and disintegrated particles. They shall also be free from dirt or other objectionable matter and be obtained from quarries approved by the Engineer.

Crushed slag obtained from air-cooled blast furnaces slag shall be angular, of reasonably uniform quality and density and generally be free from any thin, elongated, and soft p ieces, dirt or other objection able matter. The density of sl ag should not be less than 1.12 gm/cc and glassy material shall not exceed 20%. Water absorption when determined in accordance with IS:2386 (Part-III) - 1963. "Methods of Tests for Aggregates for Concrete : Specific Gravity, Density Voids, Absorption and Bulking", shall not exceed 10%.

21.3 Coarse Aggregate for Water Bound Macadam

Coarse aggregate for water bound macadam shall be natural gravel, crushed stone obtained from approved quarries or crushed blast furnace slag. Crushed stone shall be hard, durable, tough and of uniform quality, generally free from flat, elongated, soft and disintegrated particles. It shall have sharp edges and also not have excess of dirt and other objectionable matter. When tested as per IS: 23 86 (Part-IV) - 1963 for Los Angeles Abrasion Value or Aggregate Impact Value, the limiting values shall be 50% and 40% respectively for base course and 40% and 30% respectively for surfacing course. The flakiness index shall not exceed 15% when tested in accordance with IS: 2386 (Part-I)-1963 "Methods of Test for Aggregates for Concrete : Particle size and Shape". Crushed slag aggregates shall meet the requirements given for soling stones from blast furnace slag.

Size and grading requirements of co arse aggregates shall be as specified in Table-2 of IRC : 19 - 198 1, "Standard Specification and Code of Practice for Wa ter Bound Macadam". The grading number of the table shall correspond to the following layer thicknesses :

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

21.4 Screenings

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

aggregate. Non-plastic materials such as Kankar nodules, moorum or gravel (other than river bore rounded aggregates) may be used, provided that the liquid limit and plasticity index are below 20 and 6 respectively. The fraction passing 75 microns sieve shall not exceed 10%. Size and grading of screenings shall be as specified in Table-3 of IRC-19 - 1981. Type-A screening shall be used for grade number 1 coarse aggregate. Type-B screenings shall be used for grade number 3. Either Type-A or Type-B screenings may be used for grade number 2.

21.5 Stone Chips for Bituminous Surfacing

Coarse aggregate shall consist of crushed stone, crushed slag or crushed gravel (Shingle) retained on 2.36 mm sieve. The aggregates shall be clean, strong, durable and fairly cubical, free from disintegrated pieces, organic and other objectionable matter. The aggregates shall preferably by hydrophobic and of low porosity. The mechanical properties and grading shall be in accordance with IRC-29 - 1988 "Tentative Specifications for 4 cm Asphaltic Concrete Surface Course", having aggregate impact value 30%, Flakiness Index 25% and graded between 20mm and 2.36 mm.

21.6 Sand

Sand for use as fine aggregate in bituminous surfacing shall consist of crushed screenings, natural sand or a mixture of both, passing a 2.36mm sieve and retained on 75 micron sieve. It shall be clean, hard, durable, uncoated and dry, free from injurious, soft or flaky pieces and organic deleterious substances.

21.7 Binder

Binding material for water bound macadam shall consist of fine grained material such as stone dust, kankar modules or moorum. The plasticity index shall be between 4 to 9 when water bound macadam is to be used as surface course and upto 6 when used as sub/base or base course.

21.7.1 Paving Bitumen

It shall conform to IS : 73 - 1992 and shall be of the specified type and grade. The material shall be homogeneous and shall not foam when heated to 175 degree C. Various properties like specific gravity, flash point, softening point, penetration etc. shall be as given in the above code.

21.7.2 Bitumen Cut Back

Bitumen cut-back shall conform to specification given in IS : 217 - 1988. It shall be of three types, Rapid Curing (RC), Medium Curing (MC) and Slow Curing (SC). These shall comply with the requirements specified in Table - 1, 2 and 3 respectively of the above code.

The above three types of cu tback bitumens shall be classified into different grades on the basis of Kin ematic viscosity. Rapid curing type shall be used with aggregates containing practically no fine aggregates passing through 2.36 mm sieve. Medium curing bitumen shall be used with aggregates containing less than 20 per cent of fine aggregates passing through 2.36 mm sieve. Slow curing type shall be used with aggregates containing more than 20 per cent of fine aggregate passing through 2.36 mm sieve.

Medium curing bitumen of 30 grae i.e. MC 30 shall be used as primer. Manufacturer shall indicate source and type of the bitumen.

21.8 Kerbs

Kerbs may be of stone, concrete or brick as may be shown in drawing or otherwise directed by Engineer.

21.8.1 Stone kerbs

Stones shall conform to the dimensions and shapes given in drawing.

Exposed faces shall be dressed to lines.

21.8.2 Concrete kerbs

Shape and dimension shall conform to the drawing. They shall be pre-cast and the road side top corner shall be given a chamfer.

21.9 Galvanized Steel Barbed Wire for Fencing

These shall be of two types A&B. In both types Barbs shall have 4 points formed by twisting two point wires, each two turns. In type A (Iowa type) twisting is done around both line wings and in type B (Glidden type) around one line wire, in both cases making altogether four complete turns. It shall conform to IS : 278 - 1978 and shall have the diameter of

line and point wire as described in schedule of item. Galvanized mild steel wire shall conform to IS : 280 - 1978.

Line and point wire shall be circular in section, free from scales and shall be uniformly galvanized. Line wire shall be in continuous length and shall not contain any welds other than those in rod before it is drawn.

21.10 Galvanized Steel Chain Link Fabric

It will conform to IS : 2721 - 1979. It shall be of width, mesh and wire dia as per description of Item. For chain link fabric having width upto 2.00 M, of all mesh sizes, two line wires shall be provided. Whereas for width of 2.40 M and mesh size exceeding 50mm three line wires shall be provided. These shall be provided at top and bottom of the fabric, but wherever three line wires have been specified, these shall be provided at top, bottom and middle of fabric.

The mesh wire and line wire of the fabric shall be manufactured from Galvanised steel conforming to IS : 280 - 1978. It will have zinc coating of type medium as given in IS : 4826 - 1979. " Specification for Hot dipped galvanized coatings on round steel wires". Unless otherwise mentioned in the description of item fabric with both ends twisted shall be used.

The galvanised steel pipe posts shall consists of 80 mm and 50 mm nominal diameter. The pipe posts shall conform to IS : 1161 and shall be of medium grade and galvanised.

21.11 Concertina Coil fencing

Angle iron post and strut shall be as specified in Clause3.3 Part I of specification. Concertina Coil fencing shall be dia 600 mm (having 50 nos. round per 6 metre length), spring core(2.5mm thick) wire of high tensile strength of 165 kg/sq.mm with tape(0.52 mm thick) and weight 43.478 gm/metre.

22.0 LIST OF MATERIALS OF PREFERRED MAKES/BRAND AND/OR MANUFACTURE

Unless otherwise specifically mentioned in the Schedule of Items, Contractor shall use materials as listed below, of these brand names/Company's names, which are mentioned in the preferred list for civil items thereon.

A) List of preferred makes for Civil works-

Sl No	Items/Name of Products	Makes / Brands / Manufacturers
1.	Reinforcement Steel	Tata,SAIL,RINL,IISCO, JSW Steel Ltd, Jindal Steel and Power,RATHI
2.	Cement	Ambuja, ACC,JK,Grasim,Ultratech, Birla,L&T,Cement Corporation of India, Maihar
3.	Chemical for Antitermite treatment	DE- NOCIL Bombay, Pest Control of India, Trishul
4.	Water proofing for cementitions surface IS-2645	Acrocrete & Acrocote, CICO, Fosroc, STP, Sika, Chryso
5.	Bituminous Product	M/s Faridabad Spinning & Woolen Mills Pvt Ltd,M/s STP Ltd (Formerly Shalimar Tar Products) M/s Bitufelt Pvt Ltd ,Texas India Ltd, Multiplas, IWL Chennai
6.	Hardeners	Ironite, Ferrok, Hardonate
7.	Construction Chemicals	Choksey, CICO, Forsroc, Sika, STP Limited, Chryso
8.	Non Metalic Surface Hardners	CICO, Fosroc, STP, Sika
9.	SGSW Pipes (IS-651) ISI Marked	Perfect Agra, Devraj Ind Gaziabad, Buran, RK, Prince, Supreme pipe and Fittings, M/s Perfect Jabalpur
10.	CI (Centrifugally Cast) Pipes for sewage disposal ISI marked	NICCO, SRIF, A-1 Singhal Casting Co Agra, Jindal Saw, Kesoram, NECO, SKF/ CIF
11.	PVC rain water/sewage pipes (IS-4985)	Reliance, Finolex, Supreme, Kisan, Prince
12.	Cast Iron Pipes and Fittings	Hindustan Engineering Products Company Calcutta, S..L.C
13.	RCC Pipes	Indian Hume Pipe Company, Delhi / Allahabad /

		Chandigarh / Lucknow; Hindustan Pressure Pipes, Kolhapur; Dhere Concrete Products, Pune
14.	Stone Ware (Salt-Glazed) Pipes	Hind Ceramics Limited, Orissa; Ceramic Industries Limited, Sambalpur; Shrikamakshi Agencies, Madras; Binary Udyog Pvt. Limited, Howrah; Tirumati Moulds Limited, Nagpur; Kiran Potteries, Hyderabad; Perfect Sanitary Pipes, Bharatpur
Note- In case the items listed above are not available in the market or in case of change in trade name, equivalent makes/ re-designated manufacturer shall be used with prior approval of Engineer-in-charge. All materials shall conform to relevant IS codes.		

B) List of preferred makes for Architectural works-

Sl No	Items/Name of Products	Makes / Brands / Manufacturers
1.	Synthetic Enamel Paint (1st quality only)	ICI Paint, Asian Paint (Apcolite), Berger Paints. Goodlass Nerolac Paints (Nerolac)
2.	Flush doors IS-2191, 2202	Archidply, Merino flush doors, Greenply, Century Plyboards Limited
3.	PVC Panel Door (Solid Core)	Rajshri Plastiwood Limited, Sintex, Plasopan
4.	AI Section for AI Door/ Window/ Partitions	Hindalco, Bhoruka, Jindal
5.	AluminumI Door/ Window/ Glazing Fabricated and Anodized	M/s Ahlcon, M/s Alumilite Pvt Ltd, M/s Ajit India Pvt Ltd, M/s Argent Industries
6.	Aluminium door and windows Fittings	Godrej & Boyce, Everite Agencies (P) Ltd, Golden Industries
7.	Aluminium Grill	Alu Grill, Arihant Aluminium Corporation, Decogrille
8.	Door Closer	Everite, Golden, Gandhi, Godrej, Dormacaba
9.	Builders Hardware	M/s Golden Industries Pvt. Ltd., Everite, M/s Godrej, Dormacaba
10.	Plywood for general purpose (IS-303)	Merino Plywood, Archid Ply, Century Ply, Green Ply
11.	Pre laminated Particle board	Century, Greenlam, Archid ply, Merino

12.	Laminated Sheets	Merino, Greenlam, Century
13.	Dry wall Partitions	USG Boral, Saint Gobain – Gyproc
14.	False Ceiling (Calcium Silicate Board)	Aerolite, Ramco Hilux, Everest
15.	False Ceiling (POP/ Gypsum Board)	Gypboard, Saint Gobain, USG Boral
16.	Flooring Tiles (Mosaic / Terrazzo / PCC) (1st quality only)	M/S Mehtab Tiles, NITCO, Royal Tiles, Gem Tiles, Hindustan Tiles, M/S National Tiles & Industries, Ultra Tiles
17.	Glazed Ceramic Tiles, Non-Skid (Floor/Wall), (1st quality only)	Kajaria, Somany, NITCO, Johnson (Marbonite), Orient, Asian, RAK
18.	Designer Paver Tiles/ Interlocking tiles ISI marked/ Grass-jointed Tiles (1st quality only)	Pavit, Ultra, Hindustan, Eurocon, Vyara, Unistone, Konkrete
19.	Wall care Putty for Base preparation (1st quality only)	Birla Wall care putty, Berger, Jenson & Nicholson, JK White
20.	White Cement (1st quality only)	Birla, JK
21.	Cement based Paints (1st quality only)	Super Snowcem, Duracem, Super Acrocem
22.	Dry Distemper / Oil bound Distemper (1st quality only)	Goodlass Nerolac Paint, Shalimar Paint, Jenson & Nicholson, Asian Paint, Berger. ICI Dulux
23.	Acrylic Washable Distemper (1st quality only)	Asian, Berger, ICI Dulux, Jenson & Nicholson, Nerolac, Shalimar
24.	Plastic Emulsion Paint (1st quality only)	Asian, Berger, ICI, Nerolac, Jenson & Nicholson, Nerolac, Shalimar
25.	Exterior Acrylic Emulsion (1st quality only)	ICI (Weathercoat), Excel (Nerolac), Apex (Asian), Berger, Jenson & Nicholson
26.	Textured Paint / Wall Tile (1st quality only)	Unitile, Heritage, Spectrum, Iokos, Acropaints, Asian
27.	Integral water proofing compound	STP, Pidilite, Fosroc, CICO, Sika, Chryso
28.	Stainless Steel Railing	Jindal, Koncept, Indiana, Kich, Ozone
29.	FRP/ HDPE Garbage	Sintex, Swift, Nutech, Sheetal

	Bins	
30.	Bollard	STP, Ace Polymers, FAAC, Pioneer Swift
31.	Cateye	TATA, STP, Pioneer Swift, Unicorp
32.	Readymade Speed Breaker	STP, Ace Popymers, Pioneer Swift
33.	All Sanitary ware with faucets,taps,stop cock	HSW,Jaquar,Somany
34.	Kitchen Stainless Steel Sink	Diamond, Nirali, Neel Kanth, Jayna
35.	Looking Mirror	Saint Gobain, Modi Float, Triveni Float Glass, Crown, Atul.
36.	PVC rain water/sewage pipes (IS-4985)	Reliance, Finolex, Supreme, Kisan, Prince
37.	HDPE Water storage tanks (Rotational Moulded)	Sintex, Swift, Nutech, Sheetal
38.	Brass Fittings	Leader Engineering Works, Jalandhar; L & K Mathura; Luster Sanitary, Jalandhar; Annapurna Metal Works, Calcutta; Neta Metal Works, Jalandhar; Honey Industrial Corporation, Bombay
Note- In case the items listed above are not available in the market or in case of change in trade name, equivalent makes/ re-designated manufacturer shall be used with prior approval of Engineer-in-charge. All materials shall conform to relevant IS codes		

23.0 MATERIALS NOT SPECIFIED

Any materials not fully specified in these specification and which may be offered for use in the works shall be subject to approval of Engineer-in-charge

SPECIFICATION FOR CIVIL WORKS

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1.0 GENERAL

1.1 Standard

A high standard of workmanship in all trades will be required. The Contractor shall ensure that only skilled and experienced workmen are employed.

1.2 Supervision

The Contractor's supervising staff shall be fully qualified and experienced in the types of work being carried out under their supervision and shall be capable of ensuring that work is executed efficiently and as per specification.

1.3 Temporary works

Where required, the Contractor shall furnish such details of his temporary works as may be called for by the Engineer and the Contractor shall satisfy the Engineer as to their safety and efficiency. The Engineer may direct that temporary works, which he considers unsafe or insufficient, shall be removed and replaced in a satisfactory manner.

1.4.0 Codes

1.4.1 The years of publication against various standards, referred in this specification, correspond to the latest standards as on date of preparation of this specification. During use of this specification in future, the latest publication as on date shall be referred to. Where standards are not yet published by the BIS or IRC, adoptable British Standards or other International Standards shall apply.

In case of any conflict in meaning between these specifications and those of BIS or IRC, or British/International Standards, the provisions of these specifications shall prevail.

1.5 Base lines and bench marks

The Contractor shall establish and maintain, to the satisfaction of Engineer, the base lines and bench marks, based on which the works are set out. Where such base lines and bench marks are provided by

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

1.6 Setting out

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

1.7 Dewatering

The Contractor shall carry out all the works, in dry and workable condition and maintain the same in dry condition till the final handing over of works at no extra cost to the Owner. For this the Contractor shall make all the necessary provisions of dewatering, wherever necessary, to the entire satisfaction of the Engineer.

1.8 Safety of existing work

Before taking up any construction adjoining other property or existing work, the Contractor shall take all steps necessary for the safety and protection of such property or work at no extra cost to the owner.

1.9 Protection of existing services

The Contractor shall take all precautions necessary to prevent damage to or interference with underground or overground services such as cables, drains, piping or piles, whether shown on drawings or not. Equipment etc., mounted in position shall be protected against falling debris etc., by means of tarpaulin or such other material at no extra cost to the owner.

1.10 Handing over of work site

On completion of work, the Contractor shall remove all rubbish, debris, surplus materials, temporary work etc., from the site. The site shall be

handed over in a tidy and workmanlike manner at no extra cost to the owner.

2.0 EARTH WORK

2.1 Scope

This chapter deals with earth work and excavation for civil works in site, formation/oversite leveling, foundations, cutting and grading for roads/pavement and railways, canals, embankments other than water retaining embankments trenching for drainage and other burried services and the like.

2.2 General

The Contractor shall carry out the excavation strictly to the lines and levels, in conformity with the drawings or instructions of the Engineer.

2.3 Setting out

Before commencement of ea rthwork block levels of existing ground shall be taken by the Contractor jointly with the Engineer, plotted and signed in token of acceptance of ground levels. Excavation shall not be commenced until the initial ground levels have been recorded and accepted. Reference lines, bench marks and base lines shall be set out by the Contractor for control of earthwork operation. Setting out shall be done with pegs, blocks, bamboo poles or rails, marking boundaries or centre lines, as the case may be, and the same maintained for reference and future checking. Chainaie stones at regular intervals shall be set up for embankments. All setting out operations shall be got checked and approved by Engineer. However, such checking and approval by the Engineer shall in no way absolve the Contractor of his responsibilities for carrying out the work to the true lines, levels and positions as per drawing, and in case any error is noticed at any stage in t he contractor's work, it shall be corrected/rectified by him without any cost to the Owner.

2.4 Site clearance and demolition

The site shall be cleared of all trees, stumps, roots, brush wood, bushes and other objectionable materials. Useful and saleable material, if any, shall be the property of the owner and shall be stacked properly as directed by the Engineer. The areas to be covered with

embankments shall be stripped of top soil to required depths to expose acceptable founding strata. Top soil unsuitable for use in embankment construction and other fills shall be disposed off as directed. All combustible materials shall be stacked and burnt in locations sufficiently remote to eliminate all danger of fire hazards. All old concrete, brick works and drains which interfere with construction works shall be dismantled with the approval of the Engineer taking all necessary precautions prescribed in safety specification. Top soil which is suitable for use in construction work shall be stockpiled for later use. Other objectionable materials such as trash, debris, stones, brick, broken concrete, scrap metal etc., shall be disposed off as directed by the Engineer. Payment for cutting and removal of trees, stumps, dismantling existing structures and stripping shall be regulated by the description in the Schedule of Items or Part V of these specifications.

2.5 Classification of soil

The Engineer will decide the class of any particular soil. Classification of soil shall be as under and the decision of the Engineer shall be binding on the Contractor :

A) Ordinary Soil

Soils which yield to ordinary application of pick and shovel, phawra rake or other ordinary digging implements (including earth moving equipment such as bulldozer, shovels without resorting to blasting) without offering much resistance, shall be classified as ordinary soil. This includes organic soil, turf, sand, gravel, loam clay, mud, peat, black cotton soil, soft shale and loose moorum etc.

B) Hard Soil

This comprises of all soils that cannot reasonably be excavated by the above mentioned digging implements, but can be excavated with close application of pick axe or scarifiers or jumpers to loosen. This includes compact moorum, stiff clay, hard shale, cobble stone etc.,

C) Soft /Decomposed Rock

This comprises of rock or boulders which may be quarried or split with crow bars, pavement breakers etc., This include lime stone, sand stone, weathered rocks and hard conglomerates etc .and existing structures embedded in earth and tarred macadam roads, pavements, met in th e excavation. The fact that contractor resorts to blasting for his own reasons shall not mean that the rock is hard and classified as hard rock.

D) Hard Rock

This comprises of rocks which require blasting for excavation. Where blasting is prohibited, excavation has to be carried out by chiseling, wedging or any other agreed methods.

2.6 Method of excavation

The Contractor may carry out excavations, filling and compaction by any method considered most suitable, and befitting the site conditions subject to any stipulations contained in the contract and the specifications. All excavations shall be required to be kept completely free from water, from whatever source it may come, during the construction. No foundation work shall be taken up until the surfaces are properly drained.

2.7 Excavation of soils other than hard rock

Excavation shall be carried out in the most expeditious and efficient manner to the lines and levels as indicated in drawings or as directed by Engineer. Pr ior approval of the Engineer shall be taken for the method to be adopted for excavation including dimensions, side slopes, dewatering, shoring etc., Such approval shall not make the Engineer responsible for any consequent damage or loss ca used. All precautions shall be taken to preserve the material below and beyond line of excavation in soundest condition. All damages done beyond limits of excavation shall be made good by the Contractor at his o wn cost in a manner approved by t he Engineer. All e xcavated materials shall be removed to spoil heaps, dumping yards or transported for filling as may be necessary. When soil heaps are formed for future use, heaps shall be protected from washing away due to rain or surface run off. The sides of excavation shall be maintained in st able condition by adequate stepping and batter. To prevent entry of surface water and accumulation of subsoil water in excavated areas, suitable drainage arrangements as may be needed and directed by Engineer,

shall be provided and maintained. Pumped out water shall be drained off properly avoiding damage to other existing works. If any pipelines, cables or service lines are likely to be exposed, excavation around these services shall be carried out manually and all such services shall be adequately supported and protected at no extra cost.

Excavation shall be carried out in any material encountered including road surfaces, pavements, burried parts of old foundations, pits or other structures. Excavated materials shall be placed beyond 1.5 metres of the edge of the excavation pit/trench or half the depth of the pit/trench whichever is more or further away as directed by the Engineer. Sumps made for dewatering must be kept clear of the foundations.

In firm soil the sides of the trenches shall be kept vertical upto a depth of 2.0m from the bottom and for a greater depth, trench shall be widened by allowing steps of 50cm on either side after every 2.0m depth from the bottom, so as to give a vertical side slope of 1/4 : 1. Where the soil is soft, loose or slushy, the width of the steps shall be suitably increased or sides suitably sloped or suitable shoring and strutting provided as directed by the Engineer. For trenches deeper than 2.0m, the Contractor shall obtain detailed instruction from the Engineer in writing regarding the stepping, sloping of sides or shoring and strutting to be done. For these bye-works, no extra cost will be paid to the Contractor.

2.8 Excavation in hard rock

Where hard rock is met and blasting is considered necessary for its excavation, the Contractor shall intimate the Engineer in writing. Excavation in hard rock shall be done either by blasting or chiseling or by such other agreed methods as may be required. Levels of hard rock surface shall be taken and got approved by Engineer before start of excavation. Blasting shall be permitted only when proper precautions are taken for protection of persons, works and property. The Contractor shall obtain the necessary licence for procuring, storing and using explosives.

Blasting operations shall be carried out by a licensed Blaster. The quality and quantity of explosives, size and spacing of holes depth of holes etc., shall be such that they will neither open seams nor damage or shatter the rock beyond the specified lines of excavation. A tolerance of 150 mm will however be allowed beyond the excavation

lines. As excavation approaches final stages, the depth of holes and the amount of explosives used shall be reduced progressively to avoid over breakage or damage to founding strata. Any fissures, cracks and voids below prescribed depth of excavation shall be corrected by removing loose pieces, shattered or affected rock and replaced by lean concrete of M-5 grade or (1:5:10) cement concrete in the case of foundations. Where excavated surface is to receive structural concrete, the surface shall be cleaned of dust and other objectionable materials.

In cases where blasting, though otherwise required, is prohibited because of any reason, the excavation shall be carried out by chiseling, wedging or such other agreed methods. All materials excavated from blasting, chiseling or any such methods shall be stacked for measurement as directed by Engineer.

2.9 Cutting and filling for site leveling

Excavation and filling operations for site leveling shall be so planned and executed, that transportation and re-handling are minimised. The sides of excavation and fills shall be maintained in stable condition by adequate batters, stepping and dewatering. Materials not desirable shall be disposed off in area indicated by Engineer. When it is required to blend the material, it shall be done by selective excavation and filling operation. Wells, ponds, cesspools and water logged areas shall be emptied of water and deslushed before filling. Filling shall be done in horizontal layers not exceeding 300mm in thickness as specified or as directed by the Engineer. All clods shall be broken before placing the fill. Earth moving equipment shall be allowed to ply over the fill to permit compaction. Adequate allowance shall be made for subsidence of fill material. Levels shall be taken and excess or shortfall shall be made good by appropriate cutting or filling.

2.10 Excavation for trenches

Excavation for trenches shall be carried out in materials encountered to enable laying of service lines or drainage channels or any other desired purpose. Excavation shall be done to lines and levels shown in drawings and shall be done providing adequate measures for stability. Vertical wooden sleepers or light rails shall be erected at uniform levels at places where changes of direction and gradients occur. Centre lines shall be marked on horizontal sleepers or rails, laid across the trenches. Depths of excavation and pipe invert levels shall be checked

by means of boning rods of appropriate lengths. Trench beds shall be trimmed and rammed with sprinkling of sand or moorum to required gradients for continuously supporting the pipelines. Trenches shall be locally deepened and widened to receive sockets and permit joints to be inspected.

Timbering

In case of trenches, tunnels, channels, drains, manholes, chambers, basement and other places where the soil is not capable of being retained without the support, timbering as directed by the Engineer shall be resorted to. It shall be the responsibility of the Contractor to take all the necessary steps to prevent the sides from collapsing.

2.11 Excavations for foundations

Excavation for foundation shall be done to the lines and levels indicated in the drawings. Excavated material shall be transported and stored at convenient spots for reuse in back filling of foundations and other fills. Surplus material shall be transported, spread and levelled at dumping areas. Side slopes of excavation and/or shoring shall be adequate from consideration of stability and working space. When so required and authorised by Engineer, the sides of excavation shall be protected with proper shoring, strutting, sheeting and sand bags etc., These shall be removed only when work in the pit is completed, with the approval of the Engineer. When it is felt that removal of supports may result in side collapse or settlement of adjoining ground or endanger adjoining structures and foundations, they shall be left permanently in position. The last 150 mm of excavation shall be done and the bottom trimmed to the required levels only when concreting is imminent. If at any point the natural ground is disturbed or loosened for any reason, it shall be consolidated by tamping or rolling or made up with concrete of M-5 grade, or (1:5:10) cement concrete if so ordered by the Engineer at no extra cost. Where the soil encountered at depths indicated in drawings is loose or weak, it shall be further excavated to levels of firm strata as may be directed by the Engineer and filled with lean concrete of M-5 grade/(1:5:10) cement concrete or sand as directed. If the bottom of excavation has been left exposed not through neglect or fault of the Contractor and it has become deleteriously affected by atmospheric action and water, such portion of deteriorated foundation material shall be removed and made good by lean concrete of grade M-5/(1:5:10) cement concrete or sand as directed and such extras will be paid for.

2.11.1 For deep excavation in the proximity of existing buildings, foundations, streets, railway tracks, underground ca bling, gas piping, water and drainage lines, and the like, adequate appropriate precautions shall be taken to protect such structures or works from damage, displacement or settlement, either as an immediate result of the excavation or as after effect, discernible with the passage of time. The method of protection of existing structures and services may in clude sheet piling, shoring, strutting slinging or any other method including dewatering. Payment for such protective work shall be governed by the description given in the Schedule of Items for the particular work.

2.11.2 For excavation adjoining existing piles care shall be taken to ensure that no pile under any circumstances is ex posed from the top for a height exceeding 2 metres. No strutting shall be done against exposed piles, nor exposed piles e ver used for tying guy ropes or supports either temporarily or permanently.

2.12 Excess excavation

All excavation done beyond the specified limits or directions of Engineer shall be considered as excess excavation. The y shall be made good as prescribed below by the Contractor at his cost:

i) Excess excavation in case of site leveling shall be made good by filling and compacting with material same as the surrounding material. Degree of compaction shall be at least the same as the surrounding material.

ii) Excess excavation in case of trenches shall be made good by filling and compacting with selected earth to the same compaction as the surrounding material or as directed by Engineer. This shall be done in layers not exceeding 150 mm thick, moistened and thoroughly compacted by tamping.

iii) Excess excavation in case of foundation beyond required depths shall be made good by filling with lean concrete of M-5 grade/(1:5:10) cement concrete.

2.13 Disposal of excavated materials

Excavated materials that are unsuitable for use in construction works or in e xcess of construction requirements shall be disposed off in

dumping yards or in locations indicated by Engineer. W aste piles/heaps shall be located in such places where they will not interfere with natural flow of rain water access or transport or with the access to nearby structures. When required, they shall be levelled and trimmed to such lines and levels as indicated by Engineer.

2.14 Back filling of trenches

Trenches shall be backfilled after pipes or service lines are tested and approved. Filling shall be done with earth in 150 mm thick layers free from unwanted material and well rammed. Soft material shall be used in bottom of trenches upto a level of 150 mm above the top of pipes before backfilling with other fill materials. All clods and lumps shall be broken before placement. Care shall be taken not to disturb, break or damage the pipes during backfilling and compaction process.

2.15 Backfilling of foundations

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

2.16 Filling under floors

Material for filling under floors shall be soil free from harmful minerals, vegetable matter etc., and shall not be expansive soils. Filling shall be done in well compacted layers not exceeding 150 mm in thickness. Each layer shall be compacted to 95% Standard Procter Density. Sufficient soaking shall be done before compaction. The entire area to

be covered by flooring shall be finally dressed and trimmed to required levels. Mechanical equipment like vibratory roller, vibro earth rammer or vibratory compactor shall be used for compaction.

2.17 Load bearing fills

Load bearing fills include embankments for roads and railways and such other earth fills above ground levels provided for protection of fuel oil tanks, pads for storage tanks, drain, bunds and the like. Fill materials shall either be selected earth obtained from excavations for site leveling, trenches and foundations or from selected borrow areas as may be required. Soils selected for filling in embankments shall be of uniform quality and free from boulders, organic materials and other objectionable matter. Soils having high silt and clay content and having laboratory maximum dry density less than 1.44 gms per c.c. shall not be used for load bearing fills. For fills greater than 3 m in height soils shall have laboratory density not less than 1.52 gms per c.c. Soils for top 500 mm of fills for roads and railways shall have laboratory density not less than 1.65 gms per c.c. and shall not have marked swelling and shrinkage properties.

Foundation preparation for embankments shall be done as prescribed under site clearance. The founding strata shall be compacted as much as possible by rolling or tamping before placement of fill material. The water content of founding strata should be same as that specified for embankment fill. Any pockets of loose material or depressions left in founding strata as a result of clearing operation shall be filled and compacted with the same material as the surrounding founding strata. When an embankment is to be placed on steep sloping ground the surface of the ground shall be trenched in steps or trenched or broken up in such a manner that the new materials bonds well with the founding strata.

Fill material shall not be placed until foundation has been inspected and approved by Engineer. Material shall be placed in even, continuous, horizontal layers over full width of embankment in well compacted layers not exceeding 200 mm thickness. Each layer shall be compacted by means of smooth rubber tyred rollers, sheep-foot rollers, tractors, tampers or other mechanical means as may be found suitable for the location. Before rolling, the water content shall be checked and corrected by sprinkling with water or adding dry material or aeration as may be required. This shall be followed by mixing and the layer left for soaking before compaction. The water content shall

be within plus or minus 2% of Standard Proctor Optimum. Density of compacted layers shall be determined by sand replacement method. Average compacted density shall be at least 95% of Standard Proctor Density. The number of tests to be conducted for determination of moisture content and density shall be as prescribed by the Engineer. Side slopes of embankments shall be formed along with the main embankment. No side dumping shall be done for the formation of slopes. When required the width of each layer shall be constructed slightly in excess of required width and slopes trimmed to remove loose edge materials and completed to lines shown in drawings or as directed by the Engineer. Subgrades for road works shall be thoroughly wetted sufficiently in advance of placing of any base course and it shall be ensured that it is firm and moist for at least 50 mm below the surface. Should the subgrade for any reason be loose or have density less than required, it shall be recompacted and refinished. Excessive loss of moisture in the subgrade shall be prevented by sprinkling and/or scaling. No traffic or hauling equipment shall be permitted to ply on finished subgrade and any damage caused to such portion shall be made good by the Contractor at his own cost.

2.18 Turfing

The slopes of embankment shall be dressed to line and slightly roughened to bond and hold a surface dressing consisting of 150 mm humus layer of soil. The entire surface shall then be covered with turf consisting of blocks or strips of grass of approved species. The sod shall include a net of roots and earth at least 75 mm thick. The sod shall be laid on slope in close contact and then tamped in place so as to close and fill the joints between blocks.

Immediately after placing the turf, slope shall be thoroughly wetted and kept wet for a sufficient period to assure plant growth. Watering shall be continued until the grass takes root firmly and the whole area presents a uniform appearance. In the event that the plant growth has not taken place within the period of maintenance such areas or patches shall be redone by the Contractor at his own cost.

3.0 ANTI-TERMITE TREATMENT

3.1 Scope

The scope of work includes setting up a chemical barrier against attack by subterranean termites while the building is under construction.

3.2 Execution

3.2.1 General

Unless otherwise specified all work shall in general be executed as specified in IS : 6313 Part-II -1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

3.2.2 Chemicals and rate of application

Chemical like chlorpyriphos 20% EC (Conforming to IS 8963 - 1978) in 1% emulsion shall be applied by pressure pumps, uniformly over the area treated. (1 part chemicals + 20 parts water = 1% emulsion).

3.2.2.1 Treatment of pits, trenches & basement excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300mm) for column pits, walls, trenches and basements shall be treated with emulsion @ 5 liters per sq.m. of surface area. Backfills around columns, walls, etc., shall be treated @ 7.5 liters per sq.m. of the vertical surface. Treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150mm centers closed to the wall surface and spraying the emulsion in the specified dose.

3.2.2.2 Treatment of top surface of plinth filling

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crow-bars on the surface of compacted plinth fill. Emulsion at the rate of 5 litres per sq.m of surface shall be applied prior to laying soling or subgrade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

3.2.2.3 Treatment of doors, windows & soil surrounding pipes, Wastes and conduits.

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building. All the wooden door/window frames on the ground floor of the buildings shall be treated with the insecticidal solution.

3.2.2.4 Treatment of expansion joints

These shall receive special attention and shall be treated in a manner approved by the Engineer.

3.3 Acceptance Criteria

The Contractor shall give a 10 year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period at no extra cost to the Owner.

4.0 CONCRETE PLAIN & REINFORCED

4.1 Scope

This chapter covers the workmanship, special requirements & regulations with which the contractor must comply to achieve the following two objectives :

(a) The provision, at all locations on the site, of dense workable concrete, having the specified characteristic strength.

(b) The placing of concrete at all elevations, well compacted by vibrations, in well aligned and well fixed formwork ensuring the

internal and external dimensions of structures as per drawings and maintaining the size, shape number and locations of reinforcements, inserts etc., as specified in the drawings providing the surface finish after stripping off the formwork to ensure the structural configurations as p er drawings as w ell within the specified tolerance limits, curing and guaranteeing the characteristic strength, all as specified.

4.1.1 The mixing, placing, compacting, curing and finishing of concrete shall be done according to IS: 456-1978 "Code of Practice for Plain a nd Reinforced Concrete".

4.2 Materials

For materials, reference to Part - I (Materials) shall be made.

4.3 Grades of Concrete

The grades of concrete unless otherwise specified shall be in accordance with the following table. The grade of concrete to be used in each section of work will be shown in the drawings or in the schedule of items :

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

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

Notes : A,B,C,D mentioned along with grade of concrete correspond to the maximum size of coarse aggregate being 63mm, 40mm, 20mm & 12mm respectively.

Unless otherwise specified in the drawings or schedule of items the maximum nominal size of co arse aggregates for different grades of concrete shall be as under :

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

4.4 Mix Design

4.4.1 General

At the commencement of the contract the Contractor shall make preliminary tests to determine the proportions by weight of cement, fine aggregates, coarse aggregates and water necessary to produce required grades of concrete. The mix proportions shall be selected to ensure that workability of the fresh concrete is suita ble for the conditions of handling and placing and when concrete hardens, it shall have the required strength, durability and surface finish. The Contractor shall get approval of Engineer to such proportions before he starts concreting. Ho wever, such approval shall no t relieve the Contractor of his responsibility to produce concrete having compressive strengths as laid down in the foregoing Table.

No departure from the approved proportions will be pe rmitted during the works unless a nd until the Engineer gives written authorisation for any change in proportion. The Engineer shall have authority at any time to check whether the mixing of concrete is b eing carried out according to the approved proportions.

4.4.2 For the all ma jor and important R.C. works and for all special works, the design of mixes shall be mad e by th e Contractor at his own cost, for each grade of concrete as w ell as for va rious workability. Th e design of mixes shall be made according to I.S. 10262-1982 or any other approved standard methods.

4.4.3 The concrete made by designing the mix is termed hereinafter as "Design Mix Concrete".

4.4.4 The cement content for various grades of concrete shall be based on design mix. However, irrespective of requirement of cement found out from design mix, the minimum cement content & maximum cement content of concrete shall be in accordance with Clause No. 8.2.4.1 & Clause No. 8.2.4.2 of I S 456 -2000 respectively.

4.5 Water/Cement Ratio

4.5.1 Where a particular water/cement ratio is stipulated in the design or drawing along with the characteristic grade of concrete the design of mix shall be carried out by adjusting the other variable factors to obtain the characteristic strength of concrete with stipulated water/cement ratio.

4.5.2 In the structures where the impermeability and shrinkage of concrete have an important bearing on the durability and serviceability of the structures, such as water retaining structures, basements, underground premises, tunnels, pump houses, exposed structures near sea side or deserts, prestressed s tructure, thin precast members etc. the water cement ratio shall be kept low and preferably not exceeding 0.45.

4.5.3 The water cement ratio, as achieved in the Mix Design, or as specified in the drawings shall be adhered to strictly and shall not be varied without the permission of the Engineer.

4.6 Workability

4.6.1 The workability of fresh concrete shall be such that the concrete is just suitable for the conditions of handling & pl acing so tha t after compaction if b ecomes completely consistent and homogeneously surrounds all the reinforcement and completely fills the formwork.

4.6.2 The workability of fresh concrete at the place of batching/mixing shall be measured by compacting factor test and at the place of disposition by means of slump test. Du ring the finalisation of Trial Mixes, the relationship between compacting factor and slump test shall be established for each grade of concrete as well as for various levels of workability. The workability tests shall be carried out in accordance with IS:1199-1959.

4.6.3 Normally, in the condition of low water cement ratio as well as for medium/high workability, the workability shall be achieved by increasing the cement content, in consistent with added water.

4.6.4 In cases where the cement content is to be limited to reduce the heat of hydration, and the water/cement ratio is also to be kept low to reduce the permeability or due to other requirements the desired workability may be achieved with use of limited doses of plasticiser or air entraining agent. In such cases the method of mixing and dosage of the plasticiser/air entraining agent shall be according to the manufacturer's specification and with the approval of the Engineer.

4.6.5 The usual limits of consistency for various types of structures are given below :

Limits of consistency

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

Note : Not withstanding any thing mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer. With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in

trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

4.7 Durability

The durability of concrete, depending on the exposure condition, is to be taken into account while designing the mix. For given aggregates, the cement content should be sufficient to make sufficiently low water cement ratio and Appendix A of IS: 456-1978 shall be taken as guideline for durability considerations.

4.8 Trial Mixes

4.8.1 After approval of the Mix Design by the Engineer, the Contractor shall make in presence of Engineer the Trial Mixes for each grade of concrete as well as for required workability.

4.8.2 Before starting the trial mixes, necessary preparatory works like sieve analysis of the aggregates, determination of densities of different ingredients and moisture contents in the aggregates, shall be completed according to the I.S. Codes 383-1970 and 2386-1963.

4.8.3 Each trial mix shall be handled and compacted by the method which the Contractor proposes to use for that mix in the works and the mixes shall not show tendency of inadequate compaction by the method proposed.

4.8.4 The compacting factor and the slump of each trial mix shall be determined immediately after mixing and the values shall not exceed the maximum value obtained in the mix design.

4.8.5 Six numbers of 150 mm test cubes shall be made from each trial mix. These shall be cured and tested in accordance with relevant I.S. codes. In order to have the specified characteristic strength in the field, the concrete mix as designed in the Design Mix shall have higher average compressive strength depending on the degree of quality control at site. If the size and special requirement of the work so warrants, the trial may be extended to cover larger ranges of mix proportions as well as other variables such as alternative source of aggregates, maximum size and grading of aggregates and different type and brands of cement.

4.8.6 Before commencement of the concreting works of particular grade of concrete, the Contractor must complete the work of trial mixes and subsequent testing of the test cubes obtained therefrom the design of the Approved Mix for that particular grade of concrete.

4.8.7 The entire cost of all the trial mixes including all the preparatory works for trial mixes, preparation of test cubes and their testing shall be borne by the Contractor.

4.9 Nominal Mix Concrete

4.9.1 Nominal mix concrete may be used for all concrete of Grade M-10 and below. If design mix concrete cannot be used for any reason for Grade M-15 & M-20, nominal mix concrete may be used with the permission of Engineer, Nominal mix concrete shall not be used, in any case for Grade of concrete above M-20.

4.9.2 The proportioning of materials for nominal mix concrete shall be in accordance with Table-3 of clause 8.3 of I.S. 456-1978. The stipulations of Clauses 8.3.1 & 8.3.2 of IS: 456-1978 shall also be taken into consideration.

4.10 Volumetric Mix Concrete

Where concrete is specified in volumetric proportions such as 1:4:8, 1:3:6, 1:2:4, 1:1 1/2:3, 1:1:2 etc., in the schedule of items, coarse and fine aggregates shall be measured by volume and cement by weight. The water cement ratio shall be within 0.45 to 0.70 depending upon the workability.

4.11 Batching of Concrete

4.11.1 Cement

Cement shall always be batched by weight. A separate weighing device shall be provided for weighing cement. Where the weight of cement is determined by accepting the weight per bag, number of bags shall be weighed separately to determine the average net weight of cement per bag and the same shall be checked regularly

4.11.2 Aggregates

4.11.3 For both Design Mix concrete and Nominal Mix co ncrete, the aggregates (coarse and fine) shall be batched by weight.

4.11.4 In particular cases, or where weigh-batching is not possible proportioning by volume batching may be a llowed by the Engineer, provided the Contractor guarantees the uniformity of aggregates through out the period of construction. For this purpose, the Contractor shall submit to the Engineer sufficient data indicating the weight/volume relationship of aggregates for different types of concrete and after such approval, periodic checks on the weight/volume relationship of the aggregates shall be made by the Contractor to the satisfaction of the Engineer. Where aggregates are moist and volume batching is adopted, allowance shall be made for bulking in accordance with I.S. 2386 (Part-III)-1963.

4.11.5 Suitable adjustments shall be ma de for the variation in the weight of aggregates due to variation in their moisture contents.

4.12 Water

4.12.1 Water may be mea sured either by weight or by volume. When measured by volume, it shall be by well calibrated conical shaped jar or vessel or from a calibrated tank fitted to the mixer.

4.12.2 Adjustment of water due to moisture contents in coarse and fine aggregates

It is very important to maintain the water cement ratio constant at its correct value. For the correct determination of amount of water to be added in the concrete mix, to maintain the water cement ratio constant, the amount of moisture content in b oth coarse and fine aggregates shall be taken into consideration, be as frequently as possible, the frequency for a given job being determined by the Engineer according to weather conditions.

4.12.3 Determination of moisture content in the aggregates

Determination of moisture content in the aggregates shall be according to I.S. 2386 (Part-III)-1963. W here tests are not conducted, the amount of surface water may be estimated from the following table :

Aggregates	Surface water carried by Aggregates	
	% by weight	Lit / m^3
Very wet sand	7.5	120
Moderately wet sand	5.0	80
Moist sand	2.5	40
Moist gravel & stone chips**	1.25 - 2.5	20-40

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

4.12.4 Admixtures

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

4.12.5 Accuracy of batching

The accuracy of batching shall be within the following tolerance:

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

4.13 Mixing & Transportation of concrete

4.13.1 Mixing of Concrete

4.13.1.1 Machine mixing

Concrete shall always be mixed in mechanical mixer. Water shall not, normally, be charged into the drum of the mixer until all other ingredients are already in the drum and mixed for at least one minute. Mixing shall be continued until there is uniform distribution of materials and the mass is uniform in colour and consistency. The mixing time

from the time of adding water shall be in accordance with IS: 1791-1985 but in no case less than 2 minutes or at least 40 revolutions.

4.13.1.2 Hand mixing

When hand mixing is permitted by the Engineer it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand mixing 10% extra cement shall be added to each batch at no extra cost to the Owner.

4.13.2 Transportation of concrete

4.13.2.1 Concrete shall be transported from the place of mixing to the place of placing concrete as rapidly as practicable by such means which will prevent the segregation or loss of any of the ingredients and maintain the required workability. No water shall be mixed with the concrete after it has left the mixer.

4.13.2.2 Where concrete is transported over long distances, the Contractor shall provide suitable means by which different grades of concrete are readily identifiable at the place of final deposit.

4.13.3 Actions before placement of concrete

4.13.3.1 Programme of works

At the beginning of every fortnight, the contractor shall give his detailed concreting programme for that fortnight to the Engineer. Such programmes, shall specify all information such as the locations where concrete is to be poured, type/grade of concrete, volume of concrete to be poured, number and Type of vibrators proposed to be used as well as proposed to keep as standby, number of skilled technicians and supervisors proposed to be engaged, the proposed time and period of pouring etc.

4.13.3.2 Checking & approval

Before placement of concrete, the contractor shall get all the form works, reinforcements, inserts, conduits, openings, surface preparation etc., checked and approved by the Engineer. To facilitate such checking, the contractor shall complete all his works according to the drawings and specifications well in advance before placement of

concrete at least 36 hours for all major/important/complicated works and 24 hours for all minor/ordinary/simple works. The checks are purely in the interest of the work and to draw the contractor's attention to his contractual obligations to execute the works according to the drawings/specification and do not relieve the contractor from his responsibility in getting the end results for the quality & strength of concrete and for maintaining the shape, level & dimensions of the finished concrete, as well as the inserts, openings, other features within the tolerance limits.

4.14 Preparatory Works/Surface Preparation

4.14.1 For concrete directly on earth foundation

4.14.1.1 Earth foundation on which direct placement of concrete is specified, shall be rammed and consolidated as directed by the Engineer such that it does not crumble and get mixed with concrete during or after placement. If the foundation is quite wet, the same shall be kept dry and then sufficiently consolidated, if necessary, a thin top layer of the wet soil shall be removed and replaced by sand or other suitable materials as directed by the Engineer without any extra cost to the Owner. Care shall also be taken that earth from the sides also does not get mixed with the concrete, during or after placement, before it has sufficiently set and hardened.

4.14.1.2 The earth foundation, over which concrete is to be placed direct, shall not be kept abandoned at the specified level and concrete shall be placed immediately following the final preparation of the formation otherwise suitable measures shall be taken, as directed by the Engineer without any extra cost to the Owner.

4.14.2 For construction joints

All such joints shall have continuous square bond grooves to produce a substantial and water-tight key. Where the placement of concrete has to be resumed on a surface which has hardened, it shall be roughened, cleaned by wire or bristle brushing, compressed air, water jet etc., and thoroughly wetted. For vertical construction joints a neat cement slurry shall be applied on the surface immediate before the placement of concrete. For horizontal joints the surface shall be covered with a layer of freshly mixed mortar about 10 to 15 mm thick composed of cement and sand in the same proportion as the cement and sand in the concrete mix and applied immediately before placing of the concrete.

On this surface (i.e. on the surface of joints) a layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against old work, particular attention being paid to corners and close spots. To ensure water tightness, care shall be taken to punn concrete properly against the old surface.

4.14.3 (a) On vertical surfaces of masonry

When the concrete is placed on the vertical surface of masonry (as in the case of thin concrete fins projected from the vertical masonry surface), a groove of di mension as directed by the Engineer shall be cut in the masonry to ensure a proper bond and the surface shall be clean ed thoroughly. Before the placement of concrete, the surface shall be kept moist by spraying water at least for the period of 2 hours and a thick coat of cement slurry shall be applied immediately before the placement of concrete.

b) Over walls

Building paper over average 12mm thick cement sand bearing plaster of 1:4 mix with neat cement finish shall be provided at the bearings of slabs over walls as directed by the Engineer.

4.14.4 Inside the formwork (cleaning, surface preparation etc.,)

The interior of the form works, where the concrete is to be placed, shall be thoroughly washed by high pressure water jet or air jet to completely clean the entire volume from all sort of dirts, grease/oil, foreign and deleterious materials etc. The reinforcement shall be completely clean and free from all so rts of dirts, grease/oil, rust, foreign/deleterious materials etc., Before placement of concrete, the form works coming in contact with concrete, shall be coated with form oil or raw linseed oil material or provided with any approved material to prevent adhesion of concrete to the form work, but utmost care shall be ta ken so that such oily material do not come in contact with the reinforcement.

4.15 Placing and Compaction of Concrete

4.15.1 The concrete shall be placed and compacted before setting commences & should not be subsequently disturbed. No water shall be mixed with the concrete after it has left the mixer. Method of placing should be such as to preclude segregation. Approved mechanical vibrator shall be used

for compacting concrete, and concrete shall not be over vibrated or under vibrated.No concrete shall be placed until the place of deposit has been thoroughly inspected and approved by the Engineer. all inserts and embedments properly secured in position and checked and forms properly oiled. No concrete shall be placed in the absence of the Engineer.

4.15.2 Concrete shall be placed on clean bed having the designed level. The bed shall be cleaned of all debris and other objectionable materials. Seepage water, if any, shall be controlled or diverted.

4.15.3 Concreting shall not be carried on during rains unless all precautions have been taken by the Contractor and necessary permission has been given by the Engineer. Su itable measures shall be taken to control the temperature of concrete.

4.15.4 Where plums are permitted in massive concrete, they shall be washed and carefully placed. No stone shall be closer than 30 cm to an exposed face, nor nearer than 15 cm to an adjacent stone.

4.15.5 Concrete shall not be dropped from a h eight of more than 2m except through a chute, the design and type of which shall be subject to approval of the Engineer.

4.15.6 The concrete shall be place d, spread and compacted by approved mechanical vibrator. Vibrators shall not be used for pushing concrete to adjoining areas.

4.15.7 For members involving vertical placing of concrete (eg. columns, walls etc.,), each lift shall be deposited in horizontal layer extending the full width between shutterings and of such depth that each layer can be easily and effectively vibrated and incorporated with the layer below by means of compaction.

4.15.8 For member involving horizontal placing of concrete (e.g. slabs, beams etc.,) the concrete shall be placed along the line of starting point in such quantities as will a llow members to be cast to their full depth along the full width between side shuttering and then gradually brought towards the finishing po int along its entire front parallel to the starting line. Vibration and surface finish shall follow behind the placement as closely as possible.

4.15.9 Utmost care shall be taken to avoid the displacement of reinforcements/embedded parts or movement of formwork or damage to faces of the form work or transmission of any harmful vibration/shocks to the concrete which has not yet hardened sufficiently.

4.15.10 All members shall be concreted at such a rate that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable.

4.15.11 Should any unforeseen occurrence results in a stoppage of concreting for one hour or such other time as might allow the concrete, already placed, to begin to set before the next batches can be placed, the Contractor shall make at his own cost, suitable tongue, and groove construction joint, as approved by the Engineer. Any additional reinforcement required as directed by the Engineer shall also be provided by the Contractor at his own cost. Before placement of new batches of concrete over that construction joint, the surface preparation according to this specification stipulated earlier, shall be done by the Contractor at his own cost.

4.15.12 The concrete shall be worked well up against whatever surface it adjoins and compacted to such a degree that it reaches its maximum density as a homogeneous mass, free from air and water holes and penetrates to all corners of moulds and shuttering and completely surrounds the reinforcement. All measures shall be taken to make the shape, size, and location of the finished concrete including its embedments, holes, openings etc., well within the accepted tolerance limit.

4.16 Construction Joint & Cold Joints

4.16.1 Construction joints

4.16.1.1 Normally, the construction joints including crank inducing joints shall be constructed as per locations and details indicated on the drawings.

4.16.1.2 Where the location of the joint is not specified in the drawings, it shall be in accordance with the following guide lines :

(a) In Columns

(i) In case of Projection from basement slab, 300 mm from the top of base slab or 75 mm from the top of the haunches whichever is higher.

(ii) In framing of beam at different elevation, 75 mm below the lowest soffit of the beam and in case of projection from beams and slabs 75 mm from the top surface of the beam/slab or at the top surface of beam/Slab whichever facilitates formwork.

(iii) For columns under flat slabs 75 mm below the lowest soffit of the slab.

(b) In walls (horizontal construction joints)

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

Note :

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

(c) In beams

Beams shall be cast, as a rule, without a joint. But if provision of a joint is unavoidable, the joint for simply supported beam shall be vertical and at the middle of the span ; in continuous beam, the same shall be at the point of minimum shear force.

(d) In suspended slabs

(i) In slab of small span, there shall be no construction joints.

(ii) In slabs of large span and continuous slabs, construction joint, if allowed by the Engineer shall be vertical at the middle of span and at the right angles to the principal reinforcement.

(e) In walls (Vertical construction joint)

As a rule, walls shall be cast monolithically without any vertical construction joint, unless specified in the drawing. However, for a long wall, the Engineer may allow vertical construction joint and the same shall be at the place of minimum shear force. In water retaining structures and in structures under the influence of ground water approved water bars of suitable size shall be provided to make the joints completely water tight.

(f) In slabs resting on ground

(i) For Plain concrete

Concreting shall be done in alternate panels not exceeding 10 sq.m in area. The largest panel dimension shall be 5 m.

(ii) For nominally reinforced slab

The area of pour shall not exceed 40 sq.m and the maximum panel dimension shall not exceed 8m.

(i) For the basement slabs which act as structural member

There shall be no construction joint.

(g) In ribbed beam

The beams shall be cast monolithically with the slab in one continuous operation.

4.16.1.3 In all construction joints the reinforcements shall pass through as per drawings and the same shall not be disturbed in any way.

4.16.1.4 The vertical construction joints shall be provided by insertion of board keeping provision for passage of reinforcement/fixtures / embedments. All construction joints shall be made to form a tongue and groove joint.

4.16.2 Cold joint

An advancing face of a concrete pour, which could not be covered before expiry of initial setting time for unexpected reasons, is called a cold joint. The Contractor shall remain always vigilant to avoid cold joints. If however, a cold joint is formed due to unavoidable reasons, the following procedures shall be adopted for treating it :

(a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly over the old surface and the fresh concrete along with the old concrete shall be vibrated systematically and thoroughly.

(b) In case the concrete has hardened a bit more than (a), but can still be easily removed by a light hand pick, the surface shall be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. Then a rich mortar layer of 12 mm thickness, shall be placed on the cold joint and then the fresh concrete shall be placed on the mortar layer and vibrated thoroughly, penetrating deep in to the layer of concrete.

(c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise in spite of extensive vibration, a tongue and groove joint shall be made by removing some of the older concrete and the joint shall be left to harden at least for 12-24 hours. It will then be treated as regular construction joint and the surface preparation of the same, before placement of concrete, shall be as described in the appropriate clauses of these specifications.

4.17 Requirements for Concreting in Special Cases

4.17.1 Concreting in deep lifts

Placing of concrete in lifts exceeding 2 M in columns and walls is in the category of deep lifts.

4.17.1.1 Before commencement of work, the contractor shall submit for the approval of the Engineer, the details of the methods he proposes to adopt for concreting.

4.17.1.2 The placement of concrete shall preferably be by tremie, chute or any other approved method.

4.17.1.3 In structures of heavy/complicated reinforcement or in complicated form works, the contractor shall provide sufficient number of windows in the form works as directed by the Engineer to check the placement and compaction of concrete in different stages. Such windows shall be closed as soon as the concreting reaches the bottom level of the same.

4.17.2 Concreting under water

When it is necessary to deposit concrete under water, the special requirements, over and above those of this specification shall be in accordance with Clause 13.2 of IS: 456-1978.

4.17.3 Cold weather concreting

When conditions are such that the ambient temperature may be expected to be 4.5 C degree or below during the placing and curing period, the work shall conform to IS: 7861 (Part-II)-1981.

4.17.4 Hot weather concreting

When concreting in very hot weather the Contractor shall take all precautions as stipulated in IS: 7861 (Part-I)-1975 and stagger the work to cooler parts of the day to ensure that the temperature of wet concrete used, specially in massive structure, does not exceed 38 degree 'C'.

Positive temperature control by methods like pre-cooling, post cooling or cooling of concrete by circulating cold water through small embedded pipe lines inside concrete, if required, shall be specified and shall be undertaken.

4.18 Finishes to Exposed Surfaces of Concrete

The Contractor is to include in his quoted rate for concrete, the provision of normal finishes in both formed & unformed surfaces as and where required by the Engineer without any extra cost to the owner. Some common finishes are indicated below:

4.18.1 Surface which do not require plastering

Surface in contact with casings shall be brought to a fair and even surface by working the concrete smooth against casings with a steel trowel while it is being deposited and also by working over the surface with a trowel immediately after the removal of the casings or centerings, removing any irregularities and stopping air holes, etc. Use of mortar plaster is not permissible for correcting levels, removing unevenness etc. However, if, in the opinion of the Engineer, such plastering is unavoidable then the thickness of plaster shall in no case exceeds 5 mm and the plastering shall be in cement and sand mortar.(1:3).

4.18.2 Exposed surfaces which need plastering

Surfaces of beams/columns flushing with the block work or other structures where intended to plaster, shall be hacked adequately as soon as the shuttering is stripped off so that proper bond with the plaster can develop.

4.18.3 Surface for non-integral finish

Where a non-integral finish such as floor finish is specified or required, the surface of the concrete shall be struck off at the specified levels and finished rough.

4.18.4 For monolithic finish

Where no more finishing course is to be applied as in the case of basement floor, industrial flooring or the screed concrete flooring etc, the concrete shall be completed and struck off at the specified levels and sloped with a screed, board and then floated with a wooden float. Steel troweling is then started after the concrete has hardened enough to prevent the excess of fines and water to rise to the surface but not hard enough to prevent proper finishing. Troweling shall be such that the surface is flat, smooth and neatly finished.

4.19 Curing of Concrete

4.19.1 General

The purpose of curing is to prevent loss of moisture from the concrete itself so that the cement inside the concrete is sufficiently hydrated which of course is slow and prolonged process. As soon as the

concrete has hardened sufficiently the curing shall be started. To cure the concrete properly and sufficiently is also the sole responsibility of the contractor.

4.19.2 Different methods of curing

Any one of the following methods may be used for curing as approved by the Engineer.

(a) Curing by direct water.

(b) Curing by covering the concrete with absorbent material and kept damp.

4.19.3 Curing by direct water

This is done either by ponding or spraying water.

(a) Ponding

Ponding is widely used for curing slab and pavements. Earth bunds are formed over the slabs and water is pumped or poured into them and the same is replenished at interval to make up for the loss of evaporation. As this type of curing is one of the best methods, 10 days of curing after final setting is sufficient.

(b) By spraying water

Curing is done by spraying water by suitable means at approved time intervals. While spraying , it shall be ensured that the complete area is covered. In order to avoid cracking, cold water shall not be applied to massive members immediately after striking the form work, while the concrete is still warm. Alternate wetting and over drying shall be avoided.

Curing by spraying water shall be continued at least for 18 days after final setting.

4.19.4 Curing of concrete with absorbent material kept damp

The entire concrete surface is covered either with hessian, burlap, sawdust, sand, canvas or similar material and kept wet continuously for at least 12 days after final setting.

4.20 Testing of Concrete

4.20.1 General

The Contractor shall carry out, entirely at his own cost, all sampling and testing in accordance with the relevant I.S. standards and as supplemented herein. The Contractor shall get all tests done in approved Laboratory and submit to the Engineer, the test result in triplicate within 3 days after completion of the test.

4.20.2 Consistency test (tests of fresh concrete)

4.20.2.1 At the place of deposition/pouring of the concrete, to control the consistency, slump tests and/or compacting factor tests shall be carried out by the Contractor in accordance with I.S. 1199-1959 as directed by the Engineer.

4.20.2.2 The results of the slump tests/compacting factor tests shall be recorded in a register for reference duly signed by both the Contractor and the Engineer. That register shall be considered as the property of the Owner and shall be kept by the Contractor at site in safe custody.

4.20.2.3 The results of the slump tests/compacting factor tests shall tally, within accepted variation of plus or minus 12% with the results in the respective design mix, in case of mix design concrete and with the values indicated in the table under clause 6.1 of IS: 456 in case of nominal mix concrete.

4.20.2.4 For any particular batch of concrete, if the results do not conform to the requirements as specified in 4.20.2.3 or do not conform to any requirement of this specification, the Engineer has the right to reject that batch and the Contractor shall remove the same immediately from the site, at no cost to the Owner.

4.20.3 Strength test of concrete

4.20.3.1 While placing concrete, the Contractor shall make 6 nos. of 15 cm test cubes from particular batches of concrete as desired by the Engineer.

The frequency of taking test cubes shall be either according to clause 14.2 of IS: 456-1978 or as directed by the Engineer.

4.20.3.2 The cubes shall be prepared, cured and tested according to IS: 516-1959. Out of 6 nos. of test cubes 3 shall be tested for compressive strength at 7 days after casting and the remaining 3 at 28 days after casting.

4.20.3.3 A register shall be maintained at site by the Contractor with the following details entered and signed by both the Contractor and the Engineer. That register shall be considered as the property of the Owner.

(a) Reference to the specific structural member

(b) Mark on cubes

(c) The grade of concrete

(d) The mix of concrete

(e) Date and time of casting

(f) Crushing strength at 7 days

(g) Crushing strength at 28 days

(h) Any other information directed by the Engineer.

4.20.4 Acceptance criteria for test cubes

The acceptance criteria of concrete on strength requirement shall be in accordance with the stipulations under clause 15 of IS: 456-1978.

4.20.5 Non-destructive tests on hardened concrete

4.20.5.1 If there is doubt about the strength or quality of a particular work or the test results do not comply with the acceptance criteria as stipulated under clause 15 of IS: 456-1978, non-destructive tests on hardened concrete like core test and/or load tests or other type of non destructive tests like ultrasonic impulse test etc. shall be carried out, as may be directed by the Engineer, by the Contractor at entirely his own cost.

4.20.5.2 The core tests and load tests shall comply with the requirements of clause 16.3 and 16.5 of IS: 456-1978 respectively. In case of other types of special tests like ultrasonic impulse test etc., the stipulation of clause 16.6 of IS: 456-1978 shall be applicable.

4.20.6 Concrete below specified strength

In case of failure of test cubes to meet the specified requirements the Engineer may take one of the following actions:-

1) Instruct the Contractor to carryout additional test and/or works to ensure the soundness of the structure at Contractor's expense.

2) Reject the work and instruct that section of the works to which the failed cubes relate shall be cut out and replaced at Contractor's expense and the resultant structures affected due to such rejection shall be made good at contractor's expense.

3) Modification/remedial measures if approved by the engineer to be carried out at contractor's expense.

4) Accept the work with reduction in the rate in appropriate item subject to the provisions of clause 15 of IS 456-1978 provided it is technically acceptable. The reduction in the rate shall be as given below :-

   i) When test strength of the sample is above 90% of the characteristic strength, payment shall be made 10% less than the contract rate.

   ii) When test strength of the sample is between 80-90% of the characteristic strength, payment shall be made 25% below than the contract rate.

4.20.7 Concrete failed in non-destruction tests

In case the test results of the core tests or load tests in a particular work do not comply with the requirements of respective clause (16.3 for core test and 16.5 for load tests) of IS: 456-1978 the whole or part of the work concerned shall be dismantled and replaced by the Contractor as may be directed by the Engineer at no extra cost to the Owner and to the satisfaction of the Engineer. No payment for the dismantled concrete including relevant form work, reinforcement, embedded

fixtures etc. shall be made. In the course of dismantling if any damage occurs to the adjacent structure or embedded item, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

4.21 Steel Reinforcement

4.21.1 Material

Material shall be as specified in the respective schedule of Items. The specifications of materials shall be as per Part-I.

4.21.2 Storage

Steel reinforcement shall be stored in such a manner that they are not in direct contact with ground. Bars of different classifications and sizes shall be stored separately. In cases of long storage or in coastal areas, reinforcement shall be stacked above ground level by at least 15 cm, and a coat of cement wash shall be given to prevent scaling and rusting at no extra cost of the owner.

4.21.3 Bending and placing

Bending and placing of bars shall be in conformity with IS: 2502-1963 "Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement" and IS: 456 -1978 "Code of Practice for Plain and Reinforced Concrete".

4.21.4 Welding of Reinforcement

Welding of mild steel reinforcement bars conforming to IS:432 (Part-I)-1982 shall be done in accordance with IS: 2751 -1979 "Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete construction" with additional precaution that for lap welded joints the throat thickness of weld beads shall be at least 3 mm or 0.6 times the nominal size of weld (which is the radius of bar) whichever is more.

Welding of cold worked high strength deformed bars conforming to IS: 1786-1985 shall be done using electric arc welding process using low hydrogen electrodes (Ferro Weld- I or Ferro Weld-II or equivalent). Oxy-acetylene welding shall not be used.

Butt welding of bars upto 32 mm diameter for vertical splices shall be done either by single bevel groove weld or double bevel groove weld, with bevel angle 45 degree. Butt welding of bars upto 32 mm diameter for horizontal splices shall be done either by single Vee-groove weld or double Vee-groove weld with chamfered angle of 45 degree to 60 degree. The diameter of welded joint shall be 1.2 times the diameter of bar. Edge preparation for butt welding shall be done by shearing, machining and grinding. Oxy-acetylene flame shall not be used for cutting. Chamfered faces shall be smooth finished by hand file if required.

Lap welding of bars upto 20 mm diameter shall have a minimum bead length of 12 times the diameter of bar or 200 mm whichever is more arranged on one or both sides. The throat thickness of weld beads shall be 5 mm or 0.75 times the nominal size of weld (which is the radius of bar) whichever is more. In case of unsymmetrical lap weld with weld bead on one side only, the maximum length of each weld bead shall be 6 times the diameter of bar or 100 mm (whichever is more), separated by an equal length in between weld beads. Splice bars used in symmetrical weld joint shall have same diameter as the parent bars. Lap joint with single splice bars shall have weld beads on both sides.

Lap welding of bars above 20 mm shall be done using splice plate or splice angle. Thickness of splice plate shall not be less than 0,65 times the diameter of bar and width shall not be less than twice the diameter of bar. The size of splice angle shall be such that its area of cross section is at least 1.62 times the area of bar being spliced.

More than one third of the bars shall not be welded at any one section and welded joints shall be staggered at a distance of 50 times the diameter of bars. Welding shall not be done at bends or curved parts of bars and it shall be located at least at a distance of 50 times the diameter of bar from bends.

Tests

Test pieces of welded bars shall be selected and tested in accordance with the provisions of IS: 2751-1979. The number of tests will be as laid down in IS: 2751-1979 or such larger number as the Engineer may decide having regard to the circumstances.

4.21.5 Cleaning

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

4.21.6 Placing in position

All reinforcements shall be accurately fixed and maintained in positions as shown on the drawings and by adequate means like mild steel chairs and/or concrete spacer blocks as required. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by 20G annealed soft steel wire or by tack welding in case of bars larger than 25 mm dia, as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers.

4.21.7 Clear cover

Clear cover shall be as specified in the drawings. If nothing is specified in the drawing the clear cover shall be in accordance with the relevant clause of IS: 456-1978.

4.21.8 Light structural work and embedded metallic parts, conduits

4.21.8.1 Fabrication of metallic parts & light structural works

Fabrication of all structural steel work shall be done in accordance with IS: 800 -1984 "Code of Practice for use of Structural Steel in General Building Construction". Workmanship shall match to the best practice in modern structural shops. Greatest accuracy shall be observed in the manufacture of every part and all identical parts shall be strictly inter-changeable. Steel work shall be shop fitted and shop assembled as far as practicable to minimise site work and to meet transport restrictions. All materials shall be straight and if necessary before being worked shall be straightened of flattened by pressure and shall be free from twists. Shearing or flame cutting may be used and the resulting edges shall be clean and straight. Flame cut edges shall be planed/cleaned by chipping or grinding. Sheared members shall be free from distortion at sheared edges. Welding and welded work shall conform to IS: 816 -

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

4.21.8.2 Transportation and Storages

All pieces shall be properly identified and bundled for transportation to work site. Care shall be exercised in the delivery, handling and storage of material to ensure that material is not damaged in any manner. Materials shall be kept free of dirt, grease and foreign matter and shall be stored properly on skids or any other suitable supports to avoid contact with ground, damage due to twisting, bending etc.

4.21.8.3 Erection of light structural work

Erection of light structural work shall be carried out in accordance with the provisions of IS: 800-1984. No component which is bend or twisted shall be put in place until the defects are corrected. Components seriously damaged during handling shall be replaced. No riveting, permanent bolting or welding shall be done until proper alignment has been completed. Whenever field welding is to be done it shall be in accordance with the requirements of shop fabrication. Shop paints shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

4.21.8.4.1 Erection of embedded metallic parts, inserts, conduits

Bolts and inserts shall be securely fixed in position as shown in the drawings, before commencement of concreting. Bolts shall be checked for accuracy in alignment on both the axes. Limits of tolerance in alignment and level shall be as shown in the drawing or described elsewhere in these specifications.

Where bolts are housed in sleeves, special care shall be taken after concreting is over and has partly set to ensure that the bolts move within the sleeves. The annular space of the sleeve shall be plugged with suitable stoppers to prevent the ingress of water, grout, dust, rubbish or other foreign material into it, both during and after concreting. Opened conduits shall be plugged similarly. Where channels, Unshapely profiles or other similar inserts are required to be

placed in concrete, special care shall be taken to keep the grooves of such profiles free from the ingress of concrete, slurry etc., by suitable packing material, if necessary.

All threads for bolts and inserts shall be greased at intervals and kept covered to prevent damage.

4.21.8.4.2 Necessary templates, jigs, fixtures, supports shall be used as may be specified or required or directed by the Engineer free of cost to the Owner.

Exposed surfaces of embedded materials shall be painted with one coat of anticorrosive paint or bituminous paint, as desired, without any extra cost to the Owner. If welding is to be done subsequently on the exposed surfaces of the embedded parts, the painting for a length of 50mm beyond each side of the weld line shall be cleaned off.

4.22 Shuttering

4.22.1 General

All shuttering, formwork, supports and staging shall be designed by the Contractor and be subject to approval by the Engineer. The Contractor shall submit drawings and calculations to the Engineer for scrutiny when called upon to do so. The shuttering shall be designed for a live load of 400 Kg/m2 in addition to the weight of the green concrete, or such other load as the Engineer may specify. The Contractor shall be responsible for the correctness and strength of the formwork including its supports and centering and approval by the Engineer will not relieve him of his responsibilities.

4.22.2 Material

The staging and supports may be of round or sawn timber or tubular or other shapes in steel. Round timber shall preferably extend over the full height in one piece. These shall be securely jointed or otherwise fastened and spaced at suitable intervals as the design may warrant and shall be suitably braced at regular intervals horizontally and diagonally.

The form work shall be of steel plate on steel frame, wooden boards with steel sheet lining, or plywood or seasoned timber board. Where

ornamental and curved surfaces are required the material shall be very good seasoned timber or plywood which can be shaped correctly.

4.22.3 Fixing

The shuttering shall conform to the shapes, lines, levels and dimensions shown in the drawing. It shall be fixed in perfect alignment and securely braced so as to be able to withstand, without appreciable displacement, deflection or movement of any kind, the weight of all construction, movement of persons and plant. It shall be so constructed as to remain rigid during the placing and compacting of concrete without shifting or yielding and shall be sufficiently water tight to prevent loss of slurry from the concrete.

All props shall be supported on sole plates and double wedges. At the time of removing props these wedges shall be gently eased and not knocked out. The form work shall be so designed that the sides are independent of the soffits and the side forms can be removed easily without any damage or shock to the concrete.

4.22.4 Wrought shuttering

Wrought shuttering shall be such as to produce a first class fair face on the concrete free from board marks or any other disfigurements. This shall be used for exposed surfaces where specified or directed by the Engineer. It may be made of heavy quality plywood or steel sheets having smooth, plain surface.

The joints in shuttering shall be arranged in a regular pattern approved by the Engineer. Wrought shuttering shall be aligned within a tolerance of 3 mm.

4.22.5 Rough shuttering

Rough shuttering shall be used for all surface of concrete walls, footings etc., which are not exposed in the finished work or which are to receive plaster and as directed by the Engineer. It may be made of timber, ordinary plywood or steel sheets.

4.22.6 Special provision

4.22.6.1 Wherever concreting of narrow member is required to be carried out within shutters of considerable depth, temporary openings in the sides

of the shutters shall, if so directed by the Engineer, be provided to facilitate cleaning, pouring and consolidation of concrete.

4.22.6.2 In liquid retaining structures and structures below ground water level, through bolts for the purpose of securing and aligning the form work shall not be used.

4.22.6.3 Forms shall be given an upward camber, if so desired by the Engineer, to ensure that long beams do not have any sag. The camber may be 1 in 250 or as the Engineer may direct.

4.22.6.4 The joints in form work shall be sealed by adhesive tapes or by other means, to prevent any leakage of slurry or mortar if so directed by the engineer.

4.22.7 Preparation for concreting

Before any concreting is commenced the shuttering shall be carefully examined for dimensional accuracy and safety of construction. The space to be occupied by concrete shall be thoroughly cleaned out to remove rubbish, debris, shavings and saw dust. The surface in contact with concrete shall be coated with an approved substance such as mould oil or other non-staining mineral oil to prevent adhesion. Where necessary the surface shall be wetted to prevent absorption of moisture from concrete. Care shall be taken to avoid the reinforcements coming in contact with shutter oil.

4.22.8 Removing

4.22.8.1 Removal of forms shall never be started until the concrete has thoroughly set and aged to attain sufficient strength to carry twice its own weight plus the live load that is likely to come over it during construction

4.22.8.2 Removal of forms shall not entail chipping or disfiguring of the concrete surface. Shuttering shall be removed without shock or vibration and shall be eased off carefully in order to allow the structure to take up its load gradually.

4.22.8.3 Under normal circumstances (generally where temperatures are above 21 degree 'C'), and where ordinary portland cement is used shuttering may be struck after the expiry of the following periods :-

i)	Walls, columns & vertical faces	24 to 48 hours as may be directed by the Engineer.
ii)	Bottom of slab upto 4.5 m span	7 days
iii)	Bottom of sl ab above 4.5 m span, bottom of beam and arch, rise upto 6 m span	14 days
iv)	Bottom of beam and arch rise over 6 m span	21 days

These periods may be increased at the discretion of the Engineer. Special care shall be taken while striking the shuttering of cantilevered slabs and beams, portal frames etc.,

4.22.8.4 Before removing the form work, the Contractor must notify the Engineer to enable him to inspect the condition of the finished concrete immediately after the removal of the form works.

4.22.9 Contractor's responsibility

Any damage resulting from faulty preparation, premature or careless removal of shuttering shall be made good by the Contractor at his own expense.

4.22.10 Irrecoverable shuttering

In cases where the shuttering cannot be removed without damaging the structure itself or w here removal of shuttering is rendered impossible due to the nature of construction or where the Engineer may so instruct, such sh uttering shall be classified as i rrecoverable shuttering. However, such abandoning of shuttering will be permitted only in situations where it will not remain exposed or otherwise cause damage of any kind.

4.22.11 Metal Forms

Where permanently left-in-place metal forms o r deck are shown in drawings or otherwise ordered to be provided by the Engineer, they shall satisfy the re quirements with regard to load carrying capacity. The metal forms shall be obtained from a reputed manufacturer, whose performance guarantee shall be obtained and submitted to the

Engineer. Designs and drawings giving full details shall be submitted to the Engineer in advance for approval.

4.23 Damp Proof Course Concrete

4.23.1 Thickness

It shall be as specified in the drawings or in the items.

4.23.2 Mix

The grade of mix shall be as specified in the drawing or schedule of quantities. If nothing is specified, the mix shall be 1 part of cement : 1 1/2 part of coarse sand : 3 parts of stone chips. The stone chips shall be 12 mm down graded.

Approved water proofing admixture shall be mixed with cement as per manufacturer's specifications. The water cement ratio shall be as low as possible to increase the impermeability of concrete and in no case more than 0.5.

4.23.3 Preparation of base surface

The base surface shall be well roughened by chipping and brushing with steel brush and shall be cleaned of all dirt, dust, grease, oil and all other foreign & deleterious materials. Then the surface shall be well moistened with water.

4.23.4 Placing and compaction

Just prior to placement of D.P.C. Concrete, a thick coat of cement slurry shall be applied on the base surface. The placement shall be as specified for the concrete in beams. The concrete shall be well compacted to make it dense.

4.23.5 Finishing

When the concrete has set enough but remains still green, the top surface shall be marked in regular pattern by steel trowel so as to have proper bond with the future work.

4.23.6 Curing

The D.P. course shall be kept continuously moist at least 10 days.

4.24 Grout

4.24.1 Scope

The scope covers the grouting under base plates, grouting between the joints of precast concrete, grouting the pockets/holes/opening etc.

4.24.2 Grouting under base plates

Grouting under base plates of equipments/structures shall be of cement mortar 1:2 for thickness upto 25 mm. For thickness exceeding 25 mm, concrete of grade specified in the drawing or minimum M-20 grade using 10 mm down graded aggregates shall be used. The grout shall be placed in position well rammed until the whole space is completely filled with concrete. No vibrators shall be used. Quick setting cements shall be used in the preparation of mortar or concrete, where so specified.

The grout shall either be "dry" concrete or mortar or "wet expanding" concrete or mortar as the Engineer may direct. A dry grout shall have a slump not exceeding 6 mm. It shall be rammed under the horizontal surface with the aid of suitable tools. A "wet expanding" grout shall have a slump of at least 125 mm but not exceeding 225 mm. To this shall be added an expanding admixture approved by the Engineer and in accordance to the Manufacturer's instructions.

4.24.3 Grouting the pockets/holes in concrete

Depending upon the size of the pockets/holes in the concrete, the mix of the grout shall be either of concrete or of cement sand mortars. Normally the grade of such concrete/mortar shall be M-20 unless specified otherwise. In filling the holes of foundation bolts and expanding admixture of approved type shall be used as per manufacturer's specification.

4.24.4 Workmanship

4.24.4.1 The surface of the concrete over which grouting is to be applied shall be thoroughly prepared to provide a clean rough surface. If necessary, chipping shall be carried out on such surface to make it completely

rough. Then the surface shall be wetted. Bolt pockets shall be cleaned immediately before the base plate is placed in position. Before grouting the surface shall be thoroughly cleaned with compressed air/water jet.

4.24.4.2 Before placement of grout, the surfaces (except in the case of bolt holes) shall be wetted with cement slurry. In case of bolt holes/pockets water from such pockets shall be thoroughly removed by some suitable means and no cement slurry shall be applied.

4.24.4.3 Hand mixing is not permitted and the grout shall always be machine mixed. If however in some special cases where the quantity of grout is so small that it cannot be machine mixed, hand mixing may be allowed but the same shall be done under the strict supervision of an experienced supervisor of the Contractor.

4.24.4.4 The grout shall be placed within 30 minutes of being mixed. The grout shall be poured and then worked into position by suitable means until the space is completely filled. The Contractor shall take all possible measures during grouting so that the grout fills the space completely and thoroughly. Where the gap is very small or unapproachable for the placement of concrete, the Contractor shall grout by pressure grouting and in that case the mix may be of cement sand mortar of the appropriate grade but in any case the water cement ratio shall be as low as possible. Neither "Dry" grout (having slump 6mm or less) nor expanding wet grout shall be grouted with any type of vibrating machine

4.24.5 Curing

After 10 hours of grouting, the same shall be covered with wet gunny bags and the surface shall be kept continuously moist at least for 10 days.

4.25 Concreting in Water Retaining Structures

General requirements

The basic specifications as regards 'mix' design, placing, compacting, curing etc. shall conform to the requirements as specified herein before

in this Chapter. Over and above the materials and workmanship shall conform to the stipulations of IS: 3370 (Part-I & II)-1965 to make dense and impervious concrete. As spe cified herein before all the construction joints shall be provided with approved water bars. The expansion and construction joints, if any, shall be provided with the requirements as specified in the drawing or as dir ected by t he Engineer.

4.26 Application of Live Load

The designated live load shall be allowed on any structure only after 28 days, after proper curing is carried out on the last concrete poured in structure.

4.27 Foam Concrete

This shall be of average 50mm thickness or as specified or as shown on the drawings. This may be laid in in-situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m2h/degree C. The weight of the insulating material shall be from 0.5 to 0.75 gm/cm3, strength not less than 5 Kg /sq.cm or (0 .5N/sq.mm.). In general, the main ingredients of Foam Concretes are cement, fly ash and foaming agent and the work shall be carried on by specialised Agencies/Companies. Before starting the laying of foam concrete sample shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to take the usual work loads and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, sample batches of mix shall be kept for test if so desired by the Engineer.

5.0 MASONRY

5.1 General

This specification deals with masonry and allied works in foundation,

plinth and superstructure.

5.2 Materials

For specifications of materials Part-I shall be referred.

5.3 Selection of Mortars

Mortar for masonry shall conform generally to IS: 2250-1981 "Code of Practice for Preparation and Use of Masonry Mortars", and proportion shall be as specified in the drawing or in the Schedule of Items.

5.4 Cement Mortar

5.4.1 Cement mortar shall be prepared by mixing cement and sand in specified proportion. It is convenient to take unit of measurement for cement as a bag of cement weighing 50 Kg equivalent to 0.035 cubic metre. Sand is measured in boxes of suitable size (say of 40 x 35 x 25 cm). It shall be measured on the basis of dry volume. In case of damp sand, the quantity shall be increased suitably to allow for bulkage in accordance with IS:2386-1963 (part-III) or by any approved method.

5.4.2 The mixing of the mortar shall be done preferably in a mechanical mixer. This condition may be relaxed by the engineer taking into account the nature, magnitude and location of the work.

If mixed in the mixer, cement and sand in the specified proportion shall be fed in the mixer and mixed dry thoroughly, water shall be then added gradually and wet mixing continued for at least 3 minutes. In case of hand mixing also after mixing dry on a water-tight masonary platform, water shall be added and the mortar turned over and over, backward and forward several times.

5.4.3 Fresh mixed mortar, in case becoming stiff due to evaporation of water may be retempered by adding water as frequently as needed to restore the requirement of the consistency but this shall be permitted only upto a maximum of 2 hours from the time of addition of cement in the mortar.

5.5 Brick Work

5.5.1 Storage and handling bricks

Bricks shall not be dumped at site. They shall be carefully handled and carefully stacked in regular tiers to avoid breakage and defacement of bricks and prevent contamination by mud or other materials. The supply of bricks shall be so arranged that as far as possible at least two days' requirement of bricks is available at site at any time. Bricks selected for different situations of work shall be stacked separately.

5.5.2 Soaking & Cleaning bricks

Bricks required for masonry shall be cleaned to be free from dirt, dust and sand and fully soaked in clean water by submerging in vats before use, till air bubbling ceases. The bricks shall not be too wet at the time of use. After soaking they shall be removed from the tank sufficiently early so that at the time of laying they are skin dry and stacked on a clean space.

5.5.3 Setting out

The building lines shall be set out by the Contractor as per clause 7 of IS: 2212-1991 and got checked by the Engineer.

5.5.4 Laying of bricks

5.5.4.1 Brickwork in general shall be as per IS 2212-1991. Bricks shall be laid in English bond, unless otherwise specified, with frogs upward over a full bed of evenly laid mortar, and slightly pressed and tapped into final position to the lines levels and shape as shown in the drawing fully embedded in mortar. All joints including inside faces shall be flushed and packed. Not more than 8 courses shall generally be laid in a day. The first course itself shall be made horizontal by providing enough mortar in the bed joint to fill up any undulations. The horizontality of courses and the verticality of wall shall be checked very often with spirit level and plumb bob respectively.

5.5.4.2 Horizontal joints shall be truly horizontal and vertical joints shall line up in every alternate course. The joints shall not exceed 10 mm in thickness and shall be well finished and neatly struck. The joints shall be kept uniform throughout the brick work. All the brick joints of the face works shall be neatly raked out to a minimum depth of 15 mm with the help of raking tools and the faces of brick wall cleaned with wire brush to remove any splashes of mortar before the close of the day's work, while the mortar is still green and the last brick layer shall be cleaned with wire brush and the frogs free from mortar.

5.5.4.3 Walls coming in c ontact with R.C.C. structures shall perfectly be bonded with M.S. inserts or lugs where shown on drawings and the sides butting against the R.C.C structures neatly and efficiently flashed and packed with rich mortar & cement slurry at no extra cost (cost of M.S. inserts or lugs used shall be measured and paid separately under relevant items). Where such lugs are not required to be provided, brick work shall be built tightly against columns, slabs or other structural parts, around door and window frames with proper distance to permit caulked joint. Where drawings indicate structural steel column or beam to be partly or wholly covered with brick work, bricks shall be built closely against all flanges and webs, with all spaces between steel and brick work filled solid with mortar not less than 10 mm thick.

5.5.4.4 Damaged or broken brick or brick bats shall not be used in brick work. Cut bricks may be used to c omplete bond or as closers or around irregular openings.

5.5.4.5 Bricks shall not be thrown from he ights to the ground, but shall be handled carefully and put gently in p osition to avoid damaging their edges.

5.5.4.6 Selected bricks of regular shape and dimension shall be used for face work.

5.5.4.7 Making of grooves, sleeves and chases shall be done, during the construction, to the lines, levels and position as shown in the drawing or as instructed by the Engineer. Such sleeves shall slope outward in external walls so that their surface cannot form channels for the easy passage of water inside.

5.5.4.8 Fixtures, plugs, frames,pipes, inserts etc., if any, shall be built in at the right places to the lines & levels as shown in the drawings while laying the course and not later by disturbing the brick work already laid.

5.5.4.9 Brick walls of one brick thick or less shall have one selected face in true plane and walls more than one brick thick shall have both the faces of wall in true plane.

5.5.4.10 All connected brick work shall be carried out simultaneously with uniform heights throughout the work, and in exceptional cases, with the approval of the Engineer, the brick work built in any part of the work may be lower than another adjoining wall/connected wall by a

maximum of one metre and the difference in height of adjoining wall/connecting wall shall be raked back according to bond by stepping at an angle not steeper than 45 degree, without sacrificing the necessary bond, horizontality of layers, verticality of joints and the wall. Toothing shall not be allowed in brick work, for raking back. The top layer just below the R.C.C slab or beam shall be laid with frogs down over a layer of mortar on full width.

5.5.4.11 Openings in brick work

Openings shall be made in brick work, which may be of any shape, size, at all levels, heights or depths, including round openings, as shown in the drawing or as directed by the Engineer, maintaining the necessary bond using a minimum of cut bricks. Openings in external face walls, the sills, jambs, soffits of opening may be rebated and the sill shall be sloped slightly for drainage of rain water.

5.5.4.12 All exposed brick work shall be rubbed down, thoroughly washed, cleaned and pointed as specified. Where face bricks of specific quality are used the same shall be rubbed with carborundum stone.

5.5.5 Half-brick masonry

5.5.5.1 Half-brick work shall be done in the same manner as for brick work except that all courses shall be laid in stretchers. Both faces shall be true to plane and the joints raked on both faces.

Where reinforcement is considered necessary or specified and shown in drawing, M.S. bars or hoop iron shall be provided as stipulated in the Schedule of Items or as directed by the engineer. The reinforcement shall be cleaned of rust and loose scale with a wire brush, and shall be laid straight on the mortar and lapped with the dowel bars provided in the column, securely anchoring them at their ends where the half-brick wall butts. The batching of mortar usually shall be in the proportion of 1:4 or as stipulated in the Schedule of Items. Half of the mortar for the joints shall first be laid and the other half laid after the reinforcement is laid in position, so that the reinforcement is fully embedded in position.

5.5.6 Brick on edge masonry

The work brick on edge masonry wall in superstructure shall be done in the same manner as mentioned for brick work except that it shall always be reinforced with wire mesh netting of approved variety as

specified in the item and embedded in cement mortar at interval as specified in the Schedule of Items. The wire netting shall be continuously laid and securely anchored with the dowel bars provided & projecting from the walls/RCC structure or steel structures at their ends where brick on edge wall butts. The batching of mortar usually shall be in the proportion of 1:3 or as stipulated in the Schedule of Items.

5.5.7 Protection of brick work

The brick wall shall be protected and covered with gunny bags or

water proof sheets from the effects of inclement weather, rain, frost, etc., during the construction and until the mortar sets. Care shall be taken during construction that the edges of jambs, sills and soffits of openings are not damaged.

5.5.8 Curing

All brick works shall be kept moist for 10 days after laying.

5.5.9 Scaffolding

5.5.9.1 Necessary and suitable scaffolding shall be provided at all heights to facilitate the construction of brick wall. Scaffolding shall be sound, strong and all supports and other members shall be sufficiently strong and rigid, stiffened with necessary bracings and shall be firmly connected to the walls securing them against swing or sway. Planks shall be laid over the scaffolding at required levels. Scaffolding shall preferably be of tubular steel, although the Engineer may permit other material, depending upon the circumstances.

5.5.9.2 Scaffolding shall be double, having two sets of vertical supports, particularly for the face wall and all exposed brick work. Single scaffolding may be used for buildings upto two storeys high or at other locations, if permitted by the Engineer. In such case the inner ends of horizontal members shall rest in holes provided in header course only. Such holes shall not be allowed in pillars under one metre in width, or immediately near the skew backs or arches. The holes thus left in masonry shall be filled with bricks set in rich mortar and the surface made good on removal of scaffolding.

5.5.9.3 If for any reason the Contractor is required to erect scaffolding in property other than that belonging to the Owner, including municipal corporation or local bodies, necessary permission shall be obtained by the Contractor from the appropriate authorities and necessary licensing fees if any shall have to be borne by him.

5.5.9.4 All scaffoldings once erected shall be allowed to remain in position, efficiently maintained by the Contractor, till all the finishing works required to be done are completed and shall not be removed without the approval of the Engineer.

The Contractor shall allow workmen of other trades to make reasonable use of the scaffolding without any extra cost.

5.6 Stone masonry

5.6.1 General

All aspects of the work shall be in conformity with the "Code of Practice for Construction of Stone Masonry, IS : 1597 (Part-I & II)-1992. Relevant clauses under brick work, such as setting out, making chases, openings, fixing frames and plugs, protection, curing, scaffolding etc., shall apply to stone masonry and concrete block masonary.

5.6.2 Mortar

The mortar used shall be as specified in the Schedule of Items or drawing.

5.6.3 Holes and Plugs

Holes in stone walls shall be left for water supply, plumbing, sanitation, electrification, etc., where shown on drawings or ordered by the Engineer as the work proceeds. These holes shall, on completion, be made good to match with the adjoining wall. The Contractor shall provide and fix wooden plugs, water supply piping and electric conduit pipes etc. where so specified.

5.6.4 Random rubble masonry

5.6.4.1 Laying

All stones shall be wetted and cleaned of all dust and loose materials before laying. Stones shall be laid on their natural beds, fitted carefully to the adjacent stones to form neat and close joints fully packed with mortar and chips and spalls of stone may also be used wherever necessary to avoid thick mortar bed or joints. Walls shall be carried to plumb or to the specified batter. Stones may be brought to level course at plinth, window sills and roof levels and the leveling shall be done with concrete comprising of 1 part of the mortar as used for the masonry and 2 parts of 20 mm down graded hard stone chips at no extra cost. Bond shall be provided by fitting in closely the adjacent stones and by using bond stones running through the thickness of wall in a line from the face to back with at least one bond stone, or a set of bond stones, for every 0.5 sq.m. of the wall surface. Face stones shall extend and bond well into the backing. These shall be arranged to break joints as much as possible, and to avoid long vertical lines of joints.

5.6.4.2 Quoins

Quoins shall be of selected stones, neatly dressed with hammer or chisel to form the required angle and laid header and stretcher alternately. No quoin stone shall be smaller than 0.025cum (25dcum in volume and it shall also not be less than 300mm in length, 25% of them being not less than 500mm in length).

5.6.4.3 Joints

The stones shall be so laid that the joints are fully packed with mortar and chips and face joints shall not be more than 20 mm thick. When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying, otherwise the joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

5.6.5 Coursed rubble masonry - First sort

5.6.5.1 Laying

All stones shall be wetted before use. The walls shall be carried up truly plumb or to specified batter. All courses shall be laid truly

horizontal and all vertical joints shall be truly vertical. The height of each course shall not be less than 15 cm nor more than 30 cm.

Face stones shall be laid alternate headers and stretchers. No pinning shall be allowed on the face. No face stone shall be less in breadth than its height and at least one third of the stones shall tail into the work for length not less than twice their height.

The hearting or the interior filling of the wall shall consist of stones carefully laid on their proper beds in mortar, chips and spalls of stone being used where necessary to avoid thick beds of joints of mortar and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The chips shall not be used below the hearting stone to bring these upto the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10% of the quantity of stone masonry. The masonry in a structure shall be carried up regularly but where breaks are unavoidable, the joints shall be raked back at an angle not steeper than 45 degree. Toothing shall not be allowed.

5.6.5.2 Bond Stones

Bond stone or a set of bond stones shall be inserted 1.5 to 1.8 metres apart, in every course.

5.6.5.3 Quoins

The quoins, shall be of the same height as the course in which these occur. These shall be at least 45 cm long and shall be laid stretchers and headers alternately. These shall be laid square on the beds, which shall be rough-chisel dressed to a depth of at least 10 cm. In case of exposed work, these stones shall have a minimum of 2.5 cm wide chisel drafts at four edges, all the edges being in the same plane.

5.6.5.4 Joints

All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar, face joints shall not be more than one cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints

shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

5.6.6 Coursed rubble masonry - Second sort

5.6.6.1 Laying

Shall be as specified in 5.6.5.1 except that the use of chips shall not exceed 15% of the quantity of stone masonry, and stone in each course need not be of the same height but more than two stones shall not be used in the height of a course.

5.6.6.2 Bond stone, quoins

Shall be as specified for first sort respectively.

5.6.6.3 Joints

All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar, face joints shall not be more than 2 cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

5.7 Hollow concrete block masonry

5.7.1 Construction of hollow concrete masonry shall be done in accordance with procedures laid down in IS: 2572-1963. General procedures for construction shall conform to IS: 2212-1991 except for the following :

5.7.2 Storage, handling and preparation

The blocks shall be stored in stable stacks over planks or other supports with sufficient care taken to prevent ingress or moisture.

Blocks shall be handled carefully to avoid cracking. All damaged units shall be rejected and removed from site.

Blocks need not be wetted before or during placement. Unless the climatic condition so require, the top and sides may be slightly wetted.

5.7.3 Mortars

Mortar for use in hollow concrete block masonry shall be made from cement, slaked lime and sand unless otherwise specified. The mix preparation shall be as recommended in Table-I of IS: 2572-1963. Preparation of mortar shall be in accordance with IS: 2250-1981.

5.7.4 Laying

Laying of block for first and subsequent courses and requirements of horizontal and vertical joints shall be as described in IS: 2572-1963. Use of hollow blocks in foundations shall be avoided. Use of blocks filled with sand and blocks filled with 1:3:6 concrete for foundation courses, plinths and basements shall be done with approval of Engineer. Closure blocks of superstructure shall have all openings battered with mortar. A course of solid concrete block masonry shall be provided under door and window openings or a 10 cm thick precast concrete sill block shall be provided under windows. This course shall extend at least 20 cm beyond the openings on either side. Solid blocks or hollow blocks filled with 1:3:6 concrete shall be used for jambs or fixing of hold fasts etc., Similarly solid blocks or U-shaped blocks filled with 1:3:6 concrete shall be used for roof course. They shall be finished smooth at top with 1:3 cement mortar and covered with a coat of crude oil, craft paper or oil paper for free roof movement.

5.7.5 Bond

Wherever two walls intersect, bond between at least 50% of the units intersecting shall be provided. If intersecting walls are laid separately pockets shall be left in the first wall at a maximum vertical spacing of 20 cm for the corresponding course of second wall to be built into these pockets.

Pilasters shall be of twice the thickness. Hollow blocks shall not be used for isolated piers unless they are filled with 1:3:6 concrete.

6.0 PLASTERING AND POINTING

6.1 Materials

The specification of materials shall co nform to the requirements as specified in Part-I.

6.2 Plastering

6.2.1 General

Plastering shall be done in accordance with provisions of IS: 1661-1972. Mix proportions of mortar for plastering and thickness of plaster shall be as given either in the drawing, or as per Schedule of Items or as directed by the Engineer. For special plaster work, necessary admixtures shall be added to mortar in r equired proportion as pe r manufacturer's specifications or as specified herein. The thickness mentioned in the Schedule of Items shall be minimum thickness.

6.2.2 Preparation of surface

The surface to be plastered shall be cleaned of all extraneous matter and rubbish. In masonry the joints shall be raked to a minimum depth of 12 mm and cleaned with wire brush. Concrete surfaces to be plastered shall be roughened and hacked to form key for plastering. All plastered surfaces shall be finished smooth with a wooden float in one plane and all int ernal angles shall be finished slightly rounded. If desired by the Engineer, any unevenness shall be r ubbed down by carborundum stones. The surface to be plastered shall be wetted evenly before the application of plastering. Trimming of projections on brick/concrete surfaces wherever necessary shall be done.

For one coat plastering the plaster shall be laid slightly thicker than the specified thickness and the surface then leveled with flat wooden float to the required thickness. For two coat plaster work, the first co at (usually half of total thickness) shall be applied as detailed above except that the surface shall be left rough and keys formed for the application of seco nd coat. Th e second coat shall be laid on with a wooden float to the specified thickness and shall be applied a day or two after the first coat has set, but has not dried up.

Cement mortar for plastering work shall be used within 30 minutes after adding water to cement and should be kept agitated at intervals of 20 minutes.

If specified cement punning shall be done over the plastered surface by sprinkling neat cement powder evenly on the surface and rubbed

smoothly with a trowel to give a fine coating. The plaster shall be kept wet for at least seven days and protected from extreme temperature and weather during this period

The arises of doors and windows shall have richer mortar 1:3 in a width of 75 mm on either side or as required at respective location.

6.2.3 Concrete beams, slabs, columns etc. framing into masonry are to be plastered along with masonry walls with these edges wrapped with chicken wire mesh of gauge 24. Overlapping of mesh shall be minimum 75 mm on either side of the edge of the concrete element. Minimum lap for chicken wire mesh shall be 50 mm.

6.3 Cement Pointing

6.3.1 Where shown on drawing, Schedule of Items, or as directed by the Engineer, exposed brick faces shall be cement rule pointed. The mortar shall be raked out of the joints to a depth of 12 mm. The dust shall be brushed out of the joints and the wall well wetted.

Unless otherwise specified the pointing shall be made with cement and sand mixed in proportion 1:3. The joints of the pointed work shall be neatly finished truly vertical and horizontal or as directed and the lines shall be kept wet till the cementing material has set and become hard. If required, the whole brick face shall be rubbed and polished with fine grade of carborundum stones. Particular care shall be taken to see that no brick face or brick edge is damaged during this work.

6.3.2 Flush pointing

The mortar shall be pressed into the joints and shall be finished flush and levelled. The edges shall be neatly trimmed with trowel and straight edges.

6.3.3 Ruled pointing

The joint shall be initially formed as for flush pointing and then, while mortar is still green, a groove of required shape and size shall be formed by running a forming tool straight along the centre line of the joint till a smooth and hard surface is obtained. The vertical joints shall also be finished in similar way. The pointing line shall be uniform in width and truly horizontal in case of floors and ceilings.

6.3.4 Cut or weather struck pointing

The mortar shall first be pressed into joints. The top of the horizontal joints shall then be neatly pressed back by about 3mm with the pointing tool so that the joint is sloping from top to bottom. The vertical joint shall be ruled pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles.

6.3.5 Raised and cut pointing

This type of pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6mm raised and width 10mm or more as directed. The pointing shall be finished to a smooth but hard surface. the superfluous mortar then shall be cut off from the edges of the lines and the surface of the masonry shall also be cleaned off all the mortar.

Curing

The pointing shall be kept wet for 7 days. During this period it shall be suitably protected from all damages.

6.3.6 Pointing on brick flooring

Specification for this shall be conforming to under sub head "Pointing".

6.3.7 Pointing on random rubble stone masonry

In such pointing, the mortar shall be simply struck off with a trowel and the work left showing the natural irregularities in line and surface of the stones themselves. Other specifications shall remain same as per para 8.3 under sub head "Pointing".

6.4 Rough Cast Concrete Facing

6.4.1 The surface shall be prepared as for Cement plaster and then 2 cm backing coat of cement sand mortar 1:3 shall be applied. Subsequently, when the backing coat is in plastic state, a top coat 12 mm average thick cement and stone chips mixture in proportion 1:3 (stone chips 10 mm size and below) shall be applied by dashing the mixture on top with trowel to produce uniform rough texture. The mix shall again be dashed over the vacant spaces if any. The surface shall afterwards be cured for 10 days. After curing, the surface shall be

brushed with hard wire brush to remove loose chips from the surface. A coat of cement wash shall then be applied, the cost of which shall be included in the rate of the item.

6.4.2 Rendered sand faced cement plaster

The surface shall be prepared as for cement plaster. The backing coat shall be 12 mm thick of cement plaster proportion 1:4 (1 cement and 4 sand) and keys shall be formed on the surface. After curing this coat sufficiently, the finishing coat 6 mm thick consisting of grey cement and screened coarse sand to required gradation (1:3) shall be applied and finished to the desired te texture to the satisfaction of the Engineer. The surface afterwards shall be cured for 7 days.

6.4.3 Plaster moulding

Where specified, plaster moulding shall be strictly as per drawings and details, and shall run clean and true from proper templates and moulds, to the entire satisfaction of the Engineer. Rates shall include for brick or concrete cores and for any necessary dabbing in cement mortar or brick or metal lath curing and final finish as desired. Where desired, all angles in internal moulding work shall be covered to a radius of 50 mm or as directed without any extra charges.

6.4.4 Floating coat with neat cement

When the plaster has been brought to a true surface with the wooden straight edge, it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth so that whole surface is covered with neat cement coating. Smooth finishing shall be completed with a trowel immediately and in no case later than half an hour of adding water to cement.

6.4.5 Pebble dash plaster

Specification shall be same as that for rough cast concrete facing vide 8.4.1 except that pebbles or graded crushed stone, of size 10mm to 20mm or as specified/directed by the Engineer, shall be well washed and drained and then dashed/thrown wet on the plaster surfaces while it is still plastic, using strong whipping motion at right angles to the face of wall, pressed flat and filling uncover parts by hand so that finished surface represents homogeneous look. The finished surface shall be lightly tapped with a trowel to ensure good bond.

6.5 Punning with Lime or Plaster of Paris

6.5.1 Lime Punning

Lime punning shall be carried out with best quality approved lime. Lime shall be properly stirred, tempered with water to form a homogeneous mass and strained through fine cloth. The punning shall be laid and rubbed and troweled to an uniform smooth even finish using special trowels. Any unevenness shall be rubbed down with fine sand paper. The plaster must be dry before the lime punning is applied. The punning shall be kept wet for a period of 7 days. The lime paste shall be kept wet until use and no more quantity than can be consumed in 10 days shall be prepared at a time. No portion of the surface shall be leftout initially to be patched up later on.

6.5.2 Plaster of Paris punning

This shall be provided by using the best quality of plaster of Paris from approved manufacturer. Unless otherwise specified same procedure as for lime punning shall be followed for getting uniform smooth finish.

7.0 FLOORING, PAVING & FACING

7.1 Scope

Flooring, Paving and facing includes flooring, skirting and dado of various types encountered in plants, buildings, pavements etc. as described under respective heads. For the items which have not been covered up in this chapter completely or covered up only partly, specifications suggested by the manufacturers for the materials, surface preparation, workmanship and all other byeworks etc., shall be strictly followed. In addition to this the entire job will have to be carried out as per direction of the engineer, which shall be final.

7.2 Materials

Materials shall conform to Part-I of this series.

7.3 General

Flooring, skirting & dado may have to be done in discontinuous strips or areas to suit the needs of erection and commissioning of equipment. Flooring shall be done in close co-ordination with erection of equipment or other services and shall keep pace with the demands in respect of commissioning of individual equipment. No claims for extra shall be tenable for reasons of discontinuity of work or delay in having areas available for work.

Unless otherwise specifically included in the Schedule of Quantities or stated in the description of work, no extra shall be payable for works such as forming covers at internal angles, nosing at plinths, steps, window sills and stair treads, dishing in bath rooms, toilet & other places and cutting to line and fair finish to top edge of skirting and dado. Thickness mentioned shall be the minimum.

7.4 Sub-base

Flooring at ground level having sub-base of sand or earth as specified shall be laid in layers of 15 cm, watered and consolidated by rolling with hand roller or ramming with iron rammer and with butt ends of the crow bars. When filling reaches the required level, the surface shall be flooded with water for 24 hours, allowed to dry and then rammed and consolidated to avoid any settlement later. The thickness of the sub-base shall be as specified either in the drawing or in the Schedule of Items.

7.5 Subgrade

The surface shall be brought to the desired level before subgrade is laid, loose pockets shall be filled up and whole surface shall be consolidated by tamping. Vegetable growth and other decomposed matter, rubbish etc., shall be removed.

7.5.1 Hard core subgrade

Where hardcore subgrade is specified, stone/slag boulders/laterite boulders shall be laid closely stacked together, the longer edge being laid vertically. All interstices shall be filled with smaller particles of the same material or with gravel or red earth. The top surface shall be spread with loose moorum sufficient to cover the gap and to achieve

uniform top surface. The surface shall then be adequately watered and rolled by roller.

Hard core shall be laid to form the desired slope in the finished floor.

7.5.2 Brick Khoa subgrade

Over burnt bricks shall be used for getting brick khoa as per sizes described in Schedule of Items. The khoa shall be laid uniformly and rammed in dry and wet conditions so as to get a uniform compact surface.

7.6 Cement Concrete Flooring with Integral Finish

Cement concrete shall be mixed, laid, consolidated and cured as described in Chapter "Concrete". Laying of concrete shall be done in alternate panels. The size and division of panels shall be as per direction of Engineer. The mix or grade of concrete shall be as specified in Schedule of Items.

The finished surface may be rendered smooth by trowel finishing to provide an appearance of fine and smooth textured surface and in panels or in geometric pattern as specified in Schedule of Items or as directed by Engineer.

7.7 Concrete Flooring with Granolithic Finish (Artificial Stone Flooring)

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete. The subgrade shall be either brick khoa/lime concrete/cement concrete, as specified. Flooring shall be laid and finished according to IS : 5491-1967.

7.7.1 Thickness

Unless otherwise mentioned the thickness of flooring including topping shall be either 25 mm or 40 mm or 50 mm as shown on drawing/Schedule of Items. The net thickness of topping shall be 6 mm for 25 mm thick floor, 10 mm for 40 mm and 12 mm for 50mm thick floor. An additional allowance of 2mm in thickness of topping shall be made for cutting and grinding margin wherever polishing is specified in the item. The rate of the item will be inclusive of this.

7.7.2 Mix

For base or under bed course, the mix shall be 1:2:4 concrete, unless specified otherwise. The mix of the topping shall consist of 1 part cement :1 part coarse sand : 1 part coarse aggregated by volume or 1 part cement and 1 part stone chips. The coarse aggregate shall very hard like granite and well graded and size of chips shall be 3mm for 6mm topping & 6mm to 3mm for 10mm or more thick topping. Minimum quantity of water to get workability shall be added.

7.7.3 Laying

a) Laying of monolithic topping

The concrete base or underbed shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The surface shall remain sufficiently rough to take the finish.

To prevent construction cracks, the panels shall be divided in square or rectangular pattern. For floor finish of 40mm thickness or above, the maximum panel area shall be 2.5 sq.m. with none of the sides exceeding 2.5m, however for lesser thickness these shall be 1.5sq.m. and 2.5m respectively. The dividing strip may be aluminium or glass or as specified and shall have the same depth as that of floor. Within about 2 to 3 hours of laying the base while it is still fully 'green' the topping shall be laid evenly to proper thickness and grade. The topping shall be pressed firmly and rigorously to form full bond with the base/underbed.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly troweled to remove all marks and shall be left for sometime till moisture disappears from it. Fresh quantity of cement @ 2.2 Kg per sq.m. of the flooring shall be mixed to form a thick slurry and spread over the surface while concrete is still green. The cement slurry then shall be floated even & smooth. Polishing, if specified, shall be done with polishing machine and the portion where machine cannot be used manually to the satisfaction of the Engineer. If specified so the surface of the flooring shall be finished ribbed, chequered or laid in slope without any extra cost unless specified so in the item. On completion, the floor shall be kept flooded with water

for 10 days and shall be adequately protected before it is sufficiently hard.

(b) Laying of topping separately on hardened base

The sub base shall be laid as in clause 7.7.3. The surface of the base concrete shall be thoroughly brushed and cleaned free from all dirt, mortar droppings and laitance etc.. Where the surface has hardened too much, chipping or hacking of the surface may be necessary. The surface shall then be wetted with water for several hours and surplus water mopped. Neat cement slurry at 2.75Kg/sq.m. of surface shall be brushed into the clean surface. The topping then shall be laid as described in clause 7.9.3.

7.7.4 General

The junction of the floors with all plaster dado or skirting shall be rounded of with 1:1 cement sand mortar & polished, if specified or shown in drawing.

7.7.5 Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or ponding of water on the surface. The floor shall not be exposed to use during this period.

7.7.6 Grinding & finishing

Where grinding is specified, it shall start only after the finish has fully set. The grinding shall be done with carborundum stone of No. 60, then No. 80 and then 120 as per the method as specified in in-situ mosaic flooring. After final polishing, the floor shall be rubbed with oxalic acid and then wax polished.

7.8 Dado & Skirting Work (Grey Cement Skirting/Dado)

A backing coat of 12 mm thick and 15 mm thick shall be applied on walls after proper dabbing of the surface for a finished thickness of 18 mm and 21 mm thick respectively, with cement plaster of proportion 1:4

(1 cement and 4 approved quality sand) or as specified. Over this a top coat 6mm/7mm thick consisting of one cement to one stone chips 3 mm nominal size shall be applied. If grinding and polishing specified, the same shall be done as per granolithic flooring with carborundum stones.

7.8 Flooring & Facing with Redoxide of Iron (Red Artificial Stone Flooring)

It shall consist of an underbed or base course and topping over already laid & matured concrete subgrade.

7.9.1 Thickness

Unless otherwise specified the total thickness of the flooring shall be either 40 mm or 25 mm of which the topping shall not be less than 6 mm (net) for 25 mm thickness and 10 mm (net) for 40 mm thickness. The topping shall be of uniform thickness, the underbed may vary in thickness to provide necessary slopes. For vertical surfaces the total thickness shall be 18 mm, of which the topping thickness shall be 6 mm (net). Where grinding (cutting) & polishing is specified a minimum allowance of 2 mm shall be kept for cutting & polishing so that the net specified top thickness is achieved. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm or as shown in the drawing.

7.9.2 Mix

i) Course or base course

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 2 parts coarse sand and 4 parts 10 mm down graded stone chips by volume. For vertical and similar surfaces the mix shall consist of 1 part cement to 3 or 4 parts coarse sand by volume as specified in the item.

ii) Topping course

For the topping white cement and red oxide of iron pigment powder shall be dry mixed thoroughly (generally 10:1 by weight) to produce the desired colour when laid. The mix shall then be prepared with 1 part white cement (mixed with pigment) and 3 parts coarse sand by volume. The whole quantity required for

each visible a rea shall be prepared in one batch to ensure uniform colour.

7.9.3 Laying

The underbed shall be laid in panels of maximum area 2.5 sq.m. each and no side shall be more than 1.5m long. For outdoor locations the maximum area shall be 2.0 sq.m. or as specified. The forms for the panels shall have perfectly aligned edges to the full depth of the total thickness of finish. Aluminium or glass dividing strips shall be used as forms. The underbed shall be laid compacted, levelled and brought to proper grade with a screed or float. The topping shall be placed after about 24 hours while the underbed is still somewhat 'Green' but firm enough to receive the topping.The surface of the underbed shall be roughhead for better bonding. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water to achieve a compact dense mass fully bonded with the underbed. The topping shall then be levelled up by troweling and finished smooth with a slurry made with already prepared cement and pigment mixture. About 2.0 kg of the mixture shall be consumed/per sq.m. for horizontal surface, and 1.0 kg for vertical surface.

7.9.4 Grinding & polishing

Where grinding & polishing specified, the same shall be done 36 hours after laying when the surface has hardened sufficiently. It shall be polished with polishing stone, in se quence of different grades of carborundum stones (first No. 60, then No. 80 & then No.120) till a smooth shiny surface to the satisfaction of the Engineer is achieved. After final polishing, the finished areas shall be rubbed with oxalic acid and then wax polished.

7.10 Terrazzo Flooring & Facing

General

The terrazzo work shall be done by approved firm or specialists. Marble chips used for facing coat of terrazzo work shall be of best quality (from Dehradoon or other approved source) and of uniform tint and colour and shall be approved by the Engineer before using in the work. All terrazzo work shall be polished on completion followed by a final wax polish of approved quality.

Terrazzo work shall be done either cast-in-situ or with precast tiles as specified in the Schedule of Quantities Unless otherwise specified thickness for cast-in-situ terrazzo work shall be 25 mm including base course and for tiles 20 mm excluding mortar bed.

7.10.1 Cast-in-situ terrazzo flooring

It shall consist of an underbed and a topping laid over an already matured concrete subgrade.

7.10.1.1 Thickness

Unless specified otherwise, the total thickness of the finished flooring shall be either 25 mm or 40 mm of which the topping shall be minimum 6 mm (net) for 25 mm and minimum 10 mm net for 40 mm flooring. A minimum allowance of 2 mm in the topping shall be kept for grinding and polishing so as to achieve the minimum specified thickness of topping. All junctions of vertical with horizontal planes shall be rounded neatly to uniform radius of 25 mm or as shown in the drawings.

7.10.1.2 Mix

i) Underbed course

The underbed for floors and similar horizontal surface shall consist of a mix of 1 part cement, 2 parts sand and 4 parts stone chips by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only minimum water to be added to give a workable consistency.

ii) Topping

Topping shall consist of cement (grey or white) as specified with or without colour pigment, marble powder and marble chips. The proportion of cement and marble powder shall be 3 parts of cement to one part of marble powder by weight. The proportion shall be inclusive of any pigments added to the cement. The proportion to which pigments are mixed with grey or white cement to obtain various shades for the binder, shall be as specified in Table-I of IS : 2114-1984.

The proportion of marble chips and cement marble powder mix shall be 7 parts of marble chips to 4 parts of cement marble powder mix mixed by volume. Care shall be taken to ensure an even and uniform disposition of the marble chips.

7.10.1.3 Laying

i) Laying of underbed

The underbed shall be laid in panels in the same manner as that for artificial stone flooring. The panels shall not be more than 2 sq.m. in area of which no side shall be more than 2.0 m long. Cement slurry @ 2.75 kg/sq.m. shall be applied before laying over cement concrete/RCC surface/ plastered surface.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping. In case of in-situ dado work, the sections shall not be more than 60 cm x 60 cm and the aluminium, glass or any other material strips provided similarly.

ii) Laying of topping

After laying, the underbed shall be leveled compacted and brought to proper grade with screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat 'green' but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The terrazo surface shall be tamped, troweled and brought true to the required level by straight edge and steel floats in such a manner that maximum amount of marble chips come up and are spread uniformly over the surface and no part of the surface is left without the chips. Excessive troweling should be avoided in early stages lest too much cement may come up the surface leading to surface cracking and requiring more grinding to expose marble chip.

7.10.1.4 Curing

The surface shall be left dry for air curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for seven days.

7.10.1.5 Grinding & polishing

Grinding and polishing shall be done either by hand or by machine. In case of manual grinding, the process of grinding shall begin after 2 days while in case of machine grinding the process shall start after seven days after completion of laying. First grinding shall be done with carborundum stone of 60 grit size. The floor shall then be washed and cleaned to remove mud and grindings, a grout of cement and colouring pigment in same proportion of the topping shall be applied to cover the pin holes. The surface shall be cured for 5 to 7 days and then ground with machine fitted fine grit blocks (No. 120). The surface shall be again cleaned and repaired as mentioned above and shall be cured for 3 to 5 days. Finally the third grinding shall be done with machine fitted with fine grit blocks (No. 320) to get even and smooth surface without pin holes. The finished surface should show the marble chips evenly exposed.

Where use of machine for polishing is not feasible/ possible rubbing and polishing by hand shall be done in the same manner as specified for machine polishing except that carborundum of coarse grade (No. 60, 80 and 120) for first, second & final polishing. After the floor is polished to the satisfaction of the Engineer, it shall be rubbed with oxalic acid and finally wax polished with 'Mansion' or similar approved floor polish to the entire satisfaction of Engineer. For good result, wax polishing shall be applied on the surface with the help of soft linen over a clean and dry surface and then the polishing machine fitted with bobs shall be run over it. Clean saw dust shall be spread over the floor surface and the polishing machine again operated so as to remove excess wax and leave glossy surface. Floor shall not be left slippery.

7.10.2 Terrazzo cast-in-situ facing, skirting and dado

The work shall be carried out in the same manner as that for terrazzo cast-in-situ floors except that the base or bedding course shall consist of 1:3 cement mortar (1 cement & 3 medium sand) of 12 mm or 15 mm or 20 mm thickness for total thickness 18 mm or 21 mm or 26 mm respectively. As specified earlier, the bedding course shall be laid in

panel (not more than 60 cm x 60 cm) divided by glass/ aluminium strips. The topping shall be of 6 mm thick finished and shall be laid when the backing plaster is still green. Special care shall be taken to see that the surface are properly cured.

7.10.3 Terrazzo tile finished flooring/facing

The work will consist of manufactured terrazzo tile and an underbed.

7.10.3.1 Thickness

Unless otherwise specified, the total (net) thickness including the underbed shall be 40 mm for flooring and other horizontal surface and 32 mm for vertical surfaces like dado/skirting. The necessary allowance for cutting and grinding shall be kept to have the specified finished thickness.

7.10.3.2 Tiles : Tterrazzo

The tiles shall, unless specifically permitted in special cases, be machine made under quality control in a shop and shall be subjected to minimum hydraulic pressure of 140 kg. per sq. cm.

The tiles shall be composed of a backing and topping. The finished thickness of upper layers shall not be less than 5mm for size of marble chips upto 6m size and not less than 6mm for size of marble chips upto 20mm size.

The ingredients for topping shall be same as cast-in-situ terrazzo. The thickness of the topping, as specified above, shall be net after grinding & polishing. First grinding shall be given to the tiles at the shop before delivery.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles.

7.10.3.3 Mix : Underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 1 part coarse sand or 1 part cement : 3/4 parts coarse sand mixed with sufficient water to form a stiff workable mass. The thickness of underbed for the flooring shall be 20mm unless

otherwise specified. For skirting and dado and all vertical surface it shall be about 12 mm thick and composed of 1 part cement 3 parts coarse sand.

7.10.3.4 Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The base surface shall be roughened for better bond. Before laying the underbed, over the base/subgrade, a coat of cement slurry shall be applied over the sub-grade. Before the underbed has time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or cement slurry applied at 4.4Kg of cement per sq.m. and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect. When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moistened allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed. If desired dividing strips as specified under Cl. 7.10.1.3 may be used for dividing the work into suitable panels.

7.10.3.5 Grinding and polishing

Procedure shall be same as in-situ terrazzo finished flooring. Grinding shall not commence earlier than 14 days after laying of tiles.

7.11 Glazed Tile Finished Flooring & Facing

This finish shall be composed of glazed earthen tiles with an underbed laid over a concrete or masonry base.

7.11.1 Thickness

Unless specified the total thickness shall be 21 mm for flooring & 18 mm for dado/skirting for the underbed.

The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

7.11.2 Tiles : Glazed

These shall conform to the requirement of IS : 777. The tiles shall be of earthenware, covered with glazed white or coloured, plain or with designs, of 149 mm x 149 mm or 99mm x 99mm nominal sizes and 5,6 & 7 mm thick unless otherwise specified. Specials like internal and external angles, beads, covers, cornices, corner pieces etc., shall match. The top surface of the tiles shall be glazed with a gloss or matt unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform, and fractured section shall be fine grained in textures, dense and homogeneous.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

7.11.3 Mix : Underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand mixed with sufficient water or any other mix if specified and shall be 12mm thick minimum or as specified.

7.11.4 Laying & finishing

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. Before laying the underbed, over the base/subgrade a coat of cement slurry shall be applied over the subgrade. Before the underbed has time to set and while it is still fairly moist but firm, cement shall be hand dusted over it and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The joints shall be practically invisible and filled with non-staining white cement/white cement mixed with pigment for coloured tiles. Internal angles shall be provided with `specials'. Drains shall be provided with `specials'. The tiles shall be thoroughly cleaned after completion. The tiles shall be laid to the slope specified in the drawings and truly vertical on walls when used as skirting.

7.11.5 Curing & cleaning

After flush pointing the joints, the surface shall be cured for 7 days by keeping it wet. The surface shall be then cleaned with soap or suitable detergent, washed fully and wiped with soft cloth to prevent scratching before handing over.

7.12 Marble Flooring

7.12.1 Thickness

Unless specified otherwise the underbed shall be average 20 mm for flooring and 12 mm thick for vertical surfaces. The slabs may be 20 mm, 25 mm, 30 mm or 40 mm thick as specified.

7.12.2 Marble slab

The slabs shall be made from selected stock which are hard, sound, homogeneous and dense in texture and free from flaws, angles and edges shall be true, square, free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of plus or minus 5 mm in dimensions and plus or minus 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm. The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

7.12.3 Mix : Underbed

The underbed, unless specified otherwise for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 1 part coarse sand or 1 part cement : 4 parts coarse sand mixed with sufficient water to form a stiff workable mass and shall be on 20mm thick bed. For skirting and dado and all vertical surfaces it shall be 12 mm thick and composed of 1 part cement and 3 parts coarse sand.

7.12.4 Laying

The sides and top surface of the slabs shall be machine rubbed with coarse sand stone and washed clean before laying. The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, a thick cement slurry at 4.4 Kg of cement per sq.m. shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, grey/ white/mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

7.12.5 Polishing, finishing

Fine chiseling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under terrazzo flooring. However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

7.13 Marble in Facia or Dado

Marble tiles of approved shade, variety, size and thickness as specified in the item shall be used. They shall be of selected quality, dense, uniform and homogeneous in texture and free from cracks or other structural defects. The exposed face shall have no unsightly stains, veins and defects. They shall have uniform milky white or coloured shade or patterns of colours approved by the Engineer before ordering the tiles. The surface shall be fine polished and sides machine cut, true to square.

When a single course of marble slab is to be fixed as in dado etc., the slabs shall be fixed as described below :

Mortar pads of 1:3 C.M. (1 cement : 3 coarse sand) of uniform width shall be stuck on to the wall at close intervals and the marble slabs shall be pressed on to them firmly. The remaining cavities if any shall then be filled with thin grout of cement mortar of the same proportion. The sound coming, on gently tapping of the slab, will indicate if there are hollows. When the hollow cannot be filled with grout and the finished slab continues to give a hollow sound on tapping, the slab shall

be removed and reset. For the facia work where more than one course is required the marble slabs shall be of matching stand and veins to form architectural pattern as per drawings and shall be fixed in the same way as described above except for the horizontal joints of the slabs, where adjacent slabs shall be held together by a brass pin passing through a hole drilled into the slabs. In addition, wrought iron/dowels shall be provided to anchor the slabs to the wall. The metal cramps shall be counter sunk into the joints of the slab and it shall be located about a metre apart subject to a minimum of one for each slab for each horizontal joint.

The facing shall be fixed truly in plumb and in perfect line or curves as shown on the plans. The courses and joints shall be as directed by the Engineer. The surface shall be protected from sun and rain and cured for 10 days and shall be finally polished with carborundum stones as for skirting & dado of cast-in-situ terrazzo.

7.14 Flooring/Paving with Hardener like Ironite

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is 'Green'.

7.14.1 Thickness

Unless otherwise specified in the Schedule of Items, the total thickness of the floor with metallic hardener finish shall be 40 mm or 50 mm of which the topping shall be 10 mm (net) for 40 mm & 12 mm (net) for 50 mm

7.14.2 Material (metallic hardener)

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the Engineer, actual samples shall be tested.

7.14.3 Mix

Unless otherwise specified, the mix for underbed shall be of 1:2:4 concrete and stone chips shall be 12 mm down grade. For topping the proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry with 4 parts cement, by weight.

To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

7.14.4 Laying & finishing

The under bedding course of base course shall be laid as per specification of laying underbed for Red artificial stone flooring. The surface shall be roughened by wire brush as soon as possible. The finish top coat shall be laid while the concrete base is still fairly 'green' within about 3 hours of laying of the later. The finish shall be of uniform and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smooth with steel trowel.

7.14.5 Curing

The finished floor shall be cured for 7 days by keeping it wet.

7.15 Chemical Resistant Tiles Flooring / Facing (Either of natural stone or prepared tiles)

This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry. The Contractor shall get it done by specialised manufacturer & get guarantee of its performance.

7.15.1 Tiles

The chemical resistant tiles as detailed in the Schedule of Items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform non-fading colour and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 kg/cm2. The surface shall be abrasion resistant and durable.

7.15.2 Laying

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have same chemical resistant properties as that of tiles. Jo ints shall be pointed if so desired. The se tting and fixing shall be according to the manufacturer's specification approved by the Engineer.

7.16 Chemical Resistant in Situ Finished Flooring/Facing

Chemical resistant in situ finish shall be as called for in the Schedule of Items. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. Th e Contractor shall get it done by a spe cialised manufacturer, get guarantee of performance from the organisation and pass it on to the owner in addition to his own guarantee.

7.17 Acceptance Criteria

The Contractors shall satisfy the Engineer specially for the workmanship of the following finished floor :

(a) Level, slope, plumb as the case may be

(c) Alignment of joints, dividing strip etc.

(d) Colour, texture

(e) Surface finish

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

(g) Details at edges, junctions etc.

(h) Performance

(i) Precautions specified for durability.

(j) Effluent treatment plant

8.0 WOOD WORK

8.1 General

Wood work shall be neatly and truly finished to exact dimensions and details as per drawings, without patching or plugging of any kind. Rebates, roundings and mouldings as shown in dr awings shall be

made before assembling. Exposed work shall be finished smooth with well planed faces.

All assembly of shutters of doors, windows, ventilators and frames thereof shall be exactly at right angles. In the case of frames, the right angle shall be checked from the inside surfaces of the respective members.

All door and window frames shall be clamped together so as to be square and flat at the time of delivery. Door frames without sills shall be fitted with temporary stretchers.

Horns of frames and other parts that go into or butt against the masonry, shall be protected against moisture and decay with two coats of coal tar or other approved protective material.

All surfaces of the door, window and ventilator frames and shutters which are required to be painted ultimately shall be covered evenly by brush with a priming coat of approved primer. In the case of doors to be polished or varnished, a priming coat of approved polish or varnish shall be given before delivery. No primer shall be applied to the wood work until it has been inspected and passed by the Engineer.

8.2 Joinery

All heads, posts, transoms and mullions etc., of doors, windows and ventilators shall be made out of single pieces of timber only. The heads and post shall be through- tenoned into the mortices of the jamb posts to the full width of the latter and the thickness of the tenon shall be not less than 1.25 cm. The tenons shall be close fitting into the mortices and pinned with corrosion resisting metal pins not less than 8 mm diameter or with wood dowels not less than 10 mm diameter. The depth of rebate in frames for housing the shutters shall in all cases be 1.25 cm and the rebate in shutters for closing in double shutter doors or windows shall be not less than 2 cm. Unless otherwise specified, all joints shall be mortice and tenon joints with the ends of the tenons exposed to view. Joints shall fit truly and fully without fillings. The contact surfaces of tenons and mortices shall be treated, before putting together, with an approved adhesive conforming to I.S :848- 1974 and 851-1978.

8.3 Shrinkage & Tolerance

The arrangement, joining and fixing of all joinery work shall be such that shrinkage in any part and in any direction shall not impair the strength and appearance of the finished work.

The tolerance on overall dimensions shall be within the limits prescribed in IS : 1003 (Part 1 & 2)-1983 to 1991.

8.4 Fixing

Door and window frames shall generally be built in at the time the walls are constructed. Alternatively, where permitted by the Engineer, the frames may be subsequently fixed into prepared openings for which purpose holes to accommodate the holdfasts shall be left at the time of construction. Where the frames are subsequently fixed into prepared openings in the wall such openings should be 25 mm more than the overall width of the door, window or ventilator frame to allow minimum 12mm plaster on each jamb. The height of the unfinished opening shall depend upon whether a threshold is required or not. While fixing the door care shall be taken to see that at least 6 mm space is left between the door and the finished floor. The M.S. clamps fixed to the frame shall be inserted in the holes and jammed in cement concrete M-15 or (1:2:4 mix) with 20 mm down graded stone chips after holding the frame in proper position to the line, level and plumb.

The size of the concrete block shall be 250 x 125 x 85mm unless otherwise specified.

8.5 Tarring

Timber in contact with earth, concrete, plaster or masonry shall be treated with boiling coal tar or 2 coats of wood preservative treatment like hot solingnum or creosite oil etc. before fixing the frame in position.

8.6 Fittings

Unless otherwise specified, three holdfasts shall be fixed on each side of a door frame, one at the centre point, and the other two at 30 cm from the top and the bottom of the door frames. In the case of windows and ventilators, a pair on each side shall be fixed at quarter points of the frames. Unless otherwise specified the hold-fasts shall be of mild steel plate 40 x 3 x 225 mm long, fish tailed at one end and screwed to the frame in the formed rebates.

Generally, each door shutter shall be fixed to the frame with three hinges of approved manufacture, one at the centre and the other two approximately 24 cm from the top and bottom of the shutter. Each window shutter shall be fixed to its frame with two hinges at the quarter points.

Locks, handles, door closers, stoppers etc., shall be fitted as shown in drawing or described in the Schedule of Items.

8.7 Doors, windows & ventilators etc.

Dimensions of the various components of doors, windows and ventilators shall be in accordance with IS : 1003 (Part 1&2)-1983 to 1991 Table- III or as shown on the drawings. The work shall be carried out as per detailed drawing. The wooden members shall be planed, smooth and accurate. They shall be cut to the exact shape and size without patching or plugging of any kind. Mouldings, rebates, curves and roundings etc. shall be done as shown in the drawing before the pieces are assembled into the shutter.

The thickness of stiles and rails etc shall be as per IS: 1003 (Part 1&2)-1983 to 1991 unless otherwise specified in the item of works. These shall be properly and accurately mortised and tenoned. Rails which are more than 180mm in width shall have 2 tenons. Stiles and rails shall be made out of single piece upto 200mm in width. In case more than one piece of timber is used for members exceeding 200mm width, they shall be joined with a continuous tongued and grooved joint, glued together and reinforced with rust proof metal dowels or headless pins. The tenons shall pass clear through stiles. the stiles and rails shall have a 12mm groove, unless otherwise shown in the drawing, to receive the panel. In case of double shutters the rebate at the closing junction of the two shutters shall be as per clause 5.5 of IS: 1003-1991 or as shown in the drawing. Primer coat shall not be put before shutters are passed by the engineer.

8.8 Panelled Shutters

These shall conform to IS: 1003 (Part I)-1991. Timber panelled shutters shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, hard board or asbestos cement board.

Stiles, rails and panels in door shutters shall be of the same species of wood.

Timber panels shall be of minimum width of 150mm. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. No single panel shall exceed 0.5 m2 in area. Timber panels shall be fixed only with grooves but additional beadings may be provided either on one side or both sides.

Unless otherwise specified thickness of panel for 35mm thick shutter shall be 15mm and for 40mm and above thick shutter, it shall be 20mm. For 25mm thick shutter, panel thickness shall be 12mm.

Apart from timber panels other materials like plywood, Block board, particle board, Hard board and Asbestos cement may also be used for panelling purpose and shall be fixed with grooves or beading or both as per provisions made in IS:1003 (Part-1)-1991.

Timber suitable for manufacture of door shutter have been grouped under class a,b,c & d in Table 1 of IS: 1003 (Part-1)-1991.

8.9 Glazed Shutters

The openings for glazed shutters shall be rebated and moulded out of solid timber. Plain sheet glass for panels shall be of approved quality as specified. Wherever specified, ground glass or frosted glass of approved quality shall be used in place of plain sheet glass. Unless otherwise specified glass panes shall be fixed by means of moulded beads and suitable MS panel pins. A thin layer of putty shall be applied between glass panes and sash bars and also between glass panes & beading.

8.10 Flush Door Shutters

Unless otherwise specified, flush door shutters shall have a solid/cellular core, a teak wood frame, and shall be faced with approved quality of plywood on both faces. The core and stock shall be made from well seasoned approved timber and treated with approved preservatives. The plywood faces shall be glued on to the solid/cellular core with waterproof glue under pressure and heat. The construction of flush doors shall be such that no difficulty should arise in fixing mortice locks, hydraulic door closers etc. The shutters shall

be rebated in the case of the double leaf doors. Where specified flush doors shall be provided with vision panels, rectangular/ round or louvered.

If specified so, the flush door shall be solid block board core or solid particle board core construction. The workmanship and overall finish shall be of very high standard and shall conform to IS:2191 (Part 1&2)-1983 & 2202 (Part 1&2)-1983 to 1991. The shutters shall be procured from approved manufacturer bearing IS certification mark only.

8.11 Other types of shutters

8.11.1 Wooden hand rails

Wooden hand rails shall be of approved quality teak wood fixed to concrete or metal balustrade with concealed steel or metal lugs and bolts as per drg. Joints will be made with concealed crews and dowels. All bends, mitres, coves, moulds etc. will be strictly to proper profile and finally smoothened by sand paper. The hand rail shall be finished with wax or french polish or painting as per direction of the engineer.

8.11.2 Hardware fittings for door, windows & ventilators

All mortice or rim locks, latches, cabinet and wardrobe locks, hydraulic door closers, floor springs etc. shall be of Godrej, Everite make or of similar approved make. The rate shall include for all necessary screws, other adjuncts, fixing in position and is for the completed work. the finish shall be as specified in the schedule of quantities. Door, window and ventilator fittings shall be as per specifications already described. The rates for doors, windows and ventilator shutters shall include the cost of fixing the fittings, with the necessary screws to the shutters and the frame. The cost of fittings only shall be paid separately. Where specified in the schedule of quantities, the cost of fittings shall be included in the rates for doors, windows and ventilators shutters. In such case the contractor shall supply and fix the various fittings strictly to the standard laid down in the schedule of hardware fittings and no separate payment for this shall be made.

8.12 Inspection

The Contractor shall provide all facilities to the Engineer for the inspection of the goods at his premises. No primer shall be applied until the wood work has been inspected and passed by the Engineer.

The Engineer shall have the option of rejecting any article or asking for replacement of any article found to be defective or not complying with the requirements of this specification and the relevant Schedule of Items.

9.0 METAL DOORS, WINDOWS AND ROLLING SHUTTERS

9.1 General

Doors, windows and ventilators etc., shall be truly square and flat, i.e. free from twist and warp. The general fabrication shall co nform to IS:1038-1983 & IS : 1361-1978 as applicable.

9.1.1 Frames shall be constructed of sections which have been cut to length and mitred. They shall be morticed, reinforced, drilled and tapped for hinges and lock and bolt strikes. W here necessary, frames shall be reinforced for door closers. Flash butt welding or any other suitable method which gives the desired requirement, with mitred corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Fr ames shall f inish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties/weather bars installed in p lace. All frames shall be square and flat. Do or thresholds shall be provided as shown on drawing. Doors without threshold shall have bottom tie of approved type.

9.1.2 The Contractor shall first submit for the approval of the Engineer, the name and address of the manufacturer whose metal casements and doors and windows he intends to use, together with typical drawings and specifications, describing the details of construction for each type of door/window/ventilator etc.

9.1.3 All steel doors, windows and ventilators shall be either galvanised or painted. All steel surfaces shall first be thoroughly cleaned free of rust, scale or dirt and mill scale by pickling or similar process and then shall be painted with one coat of an approved primer conforming to IS : 102-1962 before despatch. Alternatively they may be galvanised by t he "Hot Dip" zinc spray or electro- galvanizing process as described in IS : 1361-1978.

9.2 Fixing

Doors, windows and ventilators shall not be built in at the time the walls are constructed but shall be subsequently fixed into prepared openings, as laid down in IS : 1081-1960. Holes to accommodate the fixing lugs are to be left or cut, and the casements fixed after all the rough masonry and plaster work have been finalised. The lugs of the casement shall be jammed in cement concrete (15C Mark)/(1:2:4) mix after holding the casement in proper position, line and level.

The width of the clear unfinished opening in the wall should be 25 mm more than the overall width of the door frame to allow for plaster on each jamb. The height of the unfinished opening shall depend upon whether a threshold is required or not. While fixing the door, care shall be taken to see that at least 6 mm space is left between the door and the finished floor.

9.3 Fittings

Hardware shall be fixed as late as possible, preferably just before the final coat of paint is applied. It shall be fitted in a workmanlike manner, so that it may not work loose and in such a way that screws and pins are not marked and mutilated by hammers and screw drivers. It shall be tested for correct operation. Where specified, doors shall be fitted with a three-way bolting device which can be operated from outside as well as inside, and a locking system, which can similarly be operated from either side. Solid steel bolt handles shall be provided, one on the outside and one on the inside of each shutter. In case of doors provided with a service door, the lock shall be fitted on the service door. All materials shall be the best procurable and shall be approved by the Engineer.

9.4 Normal Steel Plate Doors

Steel doors may be of the hinged type or sliding/ folding type, single shutter or double shutter, and of single-walled or double walled construction, as specified on the drawings or Schedule of Items. All doors shall be provided with a sturdy frame and hold fasts for fixing into the wall. Unless otherwise specified, the frame shall be prepared from mild steel angles of size not less than 65 x 65 x 6 mm electrically welded at the corners and the shutter shall be made from flat steel sheet of 18 gauge or 1.25mm thickness with a frame of mild steel angles not less than 50 x 50 x 6 mm all round, suitably braced. The whole shutter shall be of welded construction and shall be hung at the sides by means of three or four hinges as specified.

9.4.1 Double Plate flush door shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of two outer sheets or 18G or 1.25mm thick steel sheets, rigidly connected and reinforced inside with continuous vertical 20G or 0.99mm thick stiffeners, spot welded in position at not more than 150 mm on centres. Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and head, shall have proper level on lock stiles and rails and shall be reinforced at corners to prevent sagging or twisting. Pairs of double doors shall have meeting style edges bevelled or rebated. Where shown on drawing, or in the Schedule of Items, the doors shall be sound-deadened by filling the inside voids with mineral wool or other suitable approved materials. Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push-plates and other surface hardwares where necessary. Any drilling and tapering required for surface hardware shall be done at site. Where shown in drawing, provisions, shall be made for fixing glazing, vision panels, louvres etc. Glazing mouldings shall be of 18G or 1.25mm thick steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louvre blades shall be V or Z shaped sections.

9.4.2 Single sheet door shutters

Single sheet doors shall be made from best quality 18g/1mm mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with a semi-tubular edge and central stiffening rail which shall convey the lock and other fixture. The frames shall be made from best quality steel sections. Wherever required or shown on drawings, provision for fixing glass panes, louvres etc., shall be made.

The manufacturing shall done as specified in "Double Plate Flush Door Shutters".

9.5 Pressed Steel Doors

All pressed steel doors shall be obtained from an approved manufacturer. The frame and shutters shall be fabricated from cold

rolled or pressed steel sections. Unless otherwise specified, the thickness of all sheets used for frames shall be not less than 5 mm. The shutters shall be made of sheet steel of 2 mm thickness for single shutter doors and double shutter doors with or without service door. The plates shall be adequately stiffened with suitably placed stiffeners

The double-walled door shutter shall consist of two plates each 2.5 mm thick, separated by a gap of 33 mm in between making an overall thickness of 38 mm or as shown in drawing. The plates shall be adequately stiffened by means of suitably spaced horizontal steel stiffeners.

9.6 Steel Windows, Sashes, Ventilators, etc.

These shall conform to IS : 1038-1983 and IS : 1361-1978 as appropriate and as shown in drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc.

9.6.1 Where composite unit openings are shown in drawings, the individual window units shall be joined together with requisite transoms and mullions. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown in drawings.

All welds at the corner of casement shall be done by flash butt welding process or any other suitable method which gives the desired requirement and dressed flush on all exposed and contact surfaces.

9.7 Collapsible Gate (Steel)

Mild steel collapsible gates shall be obtained from an approved manufacturer. These shall be of mid bar type made out of double channels each 20 x 10 x 2 mm with 20 x 5 mm diagonals and shall be top hung with roller bearings, and fitted with locking arrangement.

Collapsible gates under 3.0 metre height shall generally have 3 sets of lattices and those over 3.0 metre height, 4 sets of lattices. Guide tracks shall be fitted at the top and bottom, of T-iron 40 x 40 x 6 mm with 40 mm dia bearings in every fourth double channel

9.8 Steel Rolling Shutters and Grills

9.8.1 Unless otherwise specified the shutters shall conform IS:6248-1979. Laths for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 3.5 M wide and not less than 1.25 mm thick for shutters above 3.5 M wide and machine rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

9.8.2 Rolling grills shall be constructed out of 6/8 mm dia rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated laths of approved design reinforced with 6 mm dia rods. End locks shall be heavy type and shall be provided at each end of alternate laths unless specified otherwise. Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown in drawings, a flexible weather strip shall be applied to make tight contact with the floor. Guides shall be of such depth as to retain the shutter under a wind pressure of 150 kg/sq.m. or as specified. Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360 th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.Hoods shall be formed of not less than 20 gauge or 0.90 mm thick sheet mild steel, suitably, reinforced to prevent sag. Locks shall be slide bolt and hasp, or cylinder lock operable from both sides. Provision for securing hand chain with padlock, removable handle for hand cranks etc, shall be made as described in scheduled of items and as directed by the Engineer.

9.8.3 Laths for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 3.5 M wide and not less than 1.25 mm thick for shutters above 3.5 M wide and machine rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load. Rolling grills shall be constructed out of 6/8 mm dia rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated laths of approved design reinforced with 6 mm dia rods.

9.8.3 End locks shall be heavy type and shall be provided at each end of alternate laths unless specified otherwise. Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters.

When shown in drawings, a flexible weather strip shall be applied to make tight contact with the floor. Guides shall be of such depth as to retain the shutter under a wind pressure of 150 kg/sq.m. or as specified. Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360 th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation. Hoods shall be formed of not less than 20 gauge or 0.90 mm thick sheet mild steel, suitably, reinforced to prevent sag. Locks shall be slide bolt and hasp, or cylinder lock operable from both sides. Provision for securing hand chain with padlock, removable handle for hand cranks etc, shall be made as described in scheduled of items and as directed by the Engineer.

9.8.5 Manually operated shutters/grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 0.3 metres per second. In general, manually operated shutters shall be push pull type for openings upto 9 sqm in area. Larger shutters shall be either chain and gear operated or crank and gear operated. The crank/handle shall be removable. All shutters shall be lockable from one or both sides as described in Schedule of Item or as desired by the Engineer.

9.8.6 Priming coat of shop coat

Shutters shall be painted with one coat of red lead or zinc chromate primer after they are inspected and found in order and acceptable. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

9.8.7 Erection

Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc., shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with prevailing Indian Electricity Rules.

9.8.8 Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

9.8.8.1 Field inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.

9.9 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

9.10 Aluminium Doors, Windows, Frames

9.10.1 Anodised tubular aluminium doors shall be of approved make and shall be of size and design as per relevant drawing. Unless otherwise specified, the door frame shall be of 101.4mm x 44.6mm and shutter of 50mm tubular extrusions, 3mm thick. The opening arrangement shall be single action or double action as shown in drawing with spring hinges in floor. The glazing shall be 5.5mm thick plain glass panes fixed with necessary gaskets and aluminium beading strip. The door shall be provided with one security lock. The shutters shall be provided with 1.6mm thick 300x150mm push plates and 1.6mm thick 300mm wide kick plate of anodised aluminium for full width of door inside and outside.

The door frames shall be polished and anodized with approved colour. The average thickness of anodic coating shall not be less than 15 microns as per IS: 1868-1982. Door frame shall be provided with approved anchors @ 90 cm c/c maximum for fixing.

9.10.2 Aluminium windows

Aluminium windows and ventilators shall conform to IS:1948-1961 or equivalent as approved by the Engineer. Fixed frame shall be

manufactured from aluminium alloy conforming to ISS-HE-9 WP. The fixtures like handles, stoppers, stays, etc., shall also be anodized aluminium and shall be of approved make. Glazing shall be 4mm thick plain glass and shall be fixed with glazing clips and metal putty. It shall conform to IS:1081-1960. Average anodizing coating to windows, ventilators and fixtures shall not be less than 15 microns as per IS : 1868 - 1982.

9.10.3 All work shall be fitted and shop assembled to a first job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce a uniform colour throughout the work. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be shape fit type without visible screws and shall be of sizes to accommodate glazing. All work shall be ad equately braced and reinforced as necessary for strength and rigidity.

10.0 GLAZING

10.1 General

Glazing shall be done with plain, frosted, ground glass or wired cast glass, laminated safety glass or toughened glass etc. as shown on drawings, described in the Schedule of Items or approved by the Engineer. The method of glazing adopted shall be such that movement of the structure, to which the securing is done, does not transmit strain to windows, doors or ventilators as the case may be. The work shall generally conform to IS:1081-1960 "Code of Practice for Fixing and Glazing of Metal Doors, Windows & Ventilators". The material for putty shall consist of whiting and linseed oil, raw-mixed in such proportion as to form a paste conforming to IS : 419-1967.

10.2 Doors, Windows and Ventilators

Windows and ventilators shall be designed for putty glazing fixed from outside and glazed doors for fixing from inside. In addition, spring type glazing clips shall be provided at intervals of 30 cm, or as shown otherwise on drawings or described in the Schedule of Items. These shall be inserted into holes drilled in the shutters or frames as the case may be.

All glazing shall be puttied to the shutters of frames with good quality putty in addition to glazing clips. Glass pa nes shall not be placed directly against the metal/timber. A thin layer of putty shall be even spread over the glazing rebate and the glass pressed firmly against it. It shall be secured in position by m eans of teak wood beads for wooden shutters. Glass panes shall be set without springing & shall be bedded in putty and back puttied, except where moulding or gasket are specified. Putty etc. shall be smoothly finished to even lines. Figured glass shall be set with smooth side out. After completion of glazing work, all dirt stains, excess putty etc., shall be removed and the glass panes shall be left in perfectly acceptable condition. All broken cracked or damaged glass s hall be replaced by n ew ones at the Contractor's cost.

10.3 Northlight Glazing

This shall consist of aluminium or steel glazing bars as shown on drawings or described in the Schedule of Item and be subject to approval of Engineer.The glazing parts shall be securely fixed in their frame and shall be weather-proof. All glazing shall be flashed to the surrounding so as to be weather-proof. Glass shall be fixed to the a astragals with glazing clips and putty.

11.0 WHITE WASHING, COLOUR WASHING AND PAINTING

11.1 Scope

This chapter deals with white washing, colour washing, distempering, cement washing, emulsion painting, silicate painting etc., to concrete and masonry surfaces and painting to the wood works and steel works. For the items which have not been completed or partly covered in this chapter, specifications suggested by the manufacturers for the materials, surfaces preparation, workmanship and all bye works shall be strictly followed and shall be carried out as p er direction of the Engineer.

11.2 Materials

Materials shall conform to Part - I

11.3 White Washing, Colour Washing

11.3.1 General

Wherever scaffolding is required/necessary, it shall be erected on double support tied together by horizontal pieces, over which the scaffolding planks shall be fixed. No part of it shall rest on or touch the surface which is be ing washed/painted. Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls. For white washing the ceiling, proper stage scaffolding shall be erected. The surface on which wash is to be applied shall be thoroughly brushed free from mortar droppings and foreign matter.

11.3.2 White Wash

The wash shall be prepared from fresh stone white lime of approved quality and shall be thoroughly slaked on the spot mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for 24 hours and then shall be screened through a clean coarse cloth. 4 Kg of gum dissolved in hot water shall be added to each cubic metre of the cream.

The approximate quantity of water to be added in making the cream will be 5 litres of water to 1 Kg of lime. Indigo/ultramarine blue upto 3 gm per kg of lime dissolved in water shall then be added and wash stirred well. Water shall then be added at the rate of about 6 litres per kg of lime to produce a milky solution. The white wash shall be applied with approved brushes to the specified number of coats. The operation for each coat shall consist of stroke of brush given from the top downwards, another from the bottom upwards over the first stroke and similarly one stroke horizontally from the right and another from the left before it dries. The white washing on ceiling shall be done prior to that on walls.

Each coat shall be allowed to dry before the next one is applied and shall be subjected to inspection and approval by the Engineer. No portion of the surface shall be left out initially to be patched up later on.

The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed. Doors, windows, floors and such other parts of the building not to be white washed shall be protected from being splashed upon.

11.3.3 Colour Wash

A priming coat of white wash with lime shall be applied before applying two or more coats of the colour wash (as specified). Entire surface should represent a smooth and uniform finish. Sample of colour wash shall be duly approved by the Engineer before application. Same specification as that of white wash shall be followed for colour wash also using necessary amount of colouring ingredient of approved tint.

11.3.4 White Washing with Whiting

Whiting (ground white chalk) shall be dissolved in sufficient quantity of warm water and thoroughly stirred to form a thin slurry which shall then be screened through a clean coarse cloth. 2 Kg of gum and 0.4 Kg of copper sulphate dissolved separately in hot water shall be added for every cum. of slurry which shall then be diluted with water to the consistency of milk so as to make wash ready for use. Other specification remains same as per white washing with lime.

11.4 Cement Primer Coat

The surface shall be thoroughly cleaned of dust, mortar, droppings etc., and shall be allowed to dry for at least 48 hours. It shall then be rubbed thoroughly be sand paper to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry. The cement primer shall preferably be applied by brushing and not by spraying. Horizontal strokes shall be given first and vertical strokes shall be applied immediately, afterwards. This entire operation will constitute one coat. The surface shall be finished as smooth as possible, leaving no brush marks.

11.5 Water-proof cement paint

The prepared surface shall be thoroughly wetted with clean water before water proof cement paint is applied. The paint shall be prepared strictly as per manufacturer's specifications, in the absence of which it shall be mixed in two stages. The first stage shall comprise of 2 parts of water proof cement paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform

consistency. The paint shall be mixed in such quantities as can be used up within an hour of its mixing.

Paint shall be applied with brushes or spraying machine The solution shall be kept well stirred during the period of application. It shall be applied as far as possible on the surface which is on the shady side of the building so that direct heat of the sun on the surface is avoided. Painted surfaces shall be sprinkled with water 2 or 3 times a day. This shall be done between coats and for at least 2 days following the final coat. The curing shall be started as soon as paint has hardened so as not to damage by sprinkling of water say about 12 hours after the application. A uniform shade should be obtained after application of paint. Cement paint shall not be applied on surfaces already treated with white wash, colour wash, distemper, varnish paint etc., and on gypsum, wood and metal surfaces.

11.6 Synthetic washable distemper

The surface shall be prepared as for Cement Primer Coat. A primer coat of cement or distemper primer shall be applied as specified in the description of the item. Unevenness in the plaster shall be made good by applying plaster of Paris putty mixed with distemper of the colour to be used on the entire surface including filling up the undulations. The surface shall then be rubbed down with a fine grade sand paper and made smooth. After the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth, taking care not to rub the priming coat out. All loose particles shall be dusted off. One coat of distemper properly diluted with thinner, shall be applied with brushes/rollers in horizontal strokes followed immediately by vertical ones which together constitute one coat. The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied to obtain an even shade. A time interval of at least 24 hours shall be allowed between consecutive coats. The brushes shall be of 15 cm. double bristled type. They shall be maintained in proper condition and those that are dirty or caked will not be allowed to be used. The finished surface shall be even and uniform without patches, brush marks, distemper drops etc. Sufficient quantity of distemper shall be mixed to finish one room for applying one coat in one operation.

11.7 Dry Distemper

The surface shall be prepared in the same manner as for synthetic washable distemper. A primer coat using approved whiting shall be applied over the prepared surface. Distemper prepared as per manufacturer's direction shall be applied and each coat shall be allowed to dry before subsequent coat is applied. The finished surface shall be free from chalking when rubbed, even, uniform and shall show no brush marks.

11.8 Plastic emulsion paint

The surface on which plastic paint has to be laid must be thoroughly cleaned and prepared and all defects rectified and finally prepared in the same manner as for synthetic washable distemper. The surface shall be dry and rubbed smooth by means of sand paper to the satisfaction of the Engineer. One coat primer and two coats of plastic emulsion paint are to be applied. The work is to be carried out under direct guidance and instructions from the manufacturers whose expert advise and supervision are to be made available in order to achieve the high grade finish. The painters employed for this work must be capable of producing the highest standard of workmanship required. If the finish is of doubtful nature, the contractor shall have to rectify at his own cost to the entire satisfaction of the Engineer.

11.9 Bitumen painting

Bitumen painting to concrete surface shall be done as follows :

(i) Hot application

The surface shall be cleaned of all mud etc., before painting. The honey-combs and other defects of concrete surfaces to be painted shall be rectified properly. Any projection of binding wire shall be cut to keep it 10 mm inside the concrete surface and then filled with mortar. Before application the surface shall be absolute dry.

Bitumen of standard quality as specified shall be heated to the temperature specified by the maker and then applied hot with brushes on the prepared surface. The surface shall be allowed to cool before applying the second coat.

(ii) Cold application

The surface shall be prepared in the same way as for hot application. The bitumen emulsion of approved quality shall be applied with special brushes. Where acid resistant treatment is specified such surface shall be covered with approved acid resisting coating to the satisfaction of the Engineer. Before the coating is applied, the surface shall be properly cleaned and prepared in the manner described above.

11.10 Tarring

(i) Timber surfaces in contact with earth/concrete/ plaster shall be treated with one coat of hot tar or as specified in schedule before fixing.

(ii) If required steel work in holdfasts and the like shall be treated as above and sanded in addition before being fixed in position.

11.11 Painting to Timber & Steel Surface

11.11.1 General

The priming coat for steel/wood work shall be applied after the surface has been prepared. After the priming coat has dried, all nails, screw holes and cracks shall be filled with putty and surface smoothened with sand paper.

All surfaces must be thoroughly dry before painting work is started and painting in exterior/exposed parts shall not be taken up in wet/humid or otherwise unfavourable weather.

All stains of paint to glasses, walls, fittings and fixtures etc. shall be cleaned thoroughly by applying required turpentine or thinner. The contractor's rate shall include all these.

11.11.2 Painting to timber

(i) Unless otherwise specified, all timber surfaces shall be treated with one priming coat, one under coat and one finishing coat. Under coat and finishing coat shall be synthetic enamel or as specified. Priming coat shall be of approved primer. In case the surface is to be polished or varnished, a priming coat as approved or specified shall be given. No primer shall be applied to wood work until it has been inspected and passed by the Engineer.

(ii) Polishing

The surface to be polished shall be prepared in the same manner as specified under painting.

(iii) French Spirit Polish

After preparation of the surface it will be well dusted and then the pores of the wood shall be filled up with a filler made of a paste of whiting in water or methylated spirit with a pigment if so required. The spirit polish shall be prepared by dissolving pure shellac in methylated spirit, @ 0.75 Kg of shellac to 5 litres of spirit, with the addition of pigment if so required.

The polish shall be applied with a pad consisting of cotton wool inside a clean white cloth. Several coats shall be applied with light sand papering from time to time and cleaning the dust before applying next coat except the final coat. The final coat of the polish shall be rubbed thoroughly until the wood feels perfectly dry when touched and gives a satisfactory smooth shining.

(iv) Wax Polishing

After preparation of surface wax polish will be applied. The polish shall be prepared by heating together 2 parts of pure bees wax and boiled linseed oil each over a slow fire. When the wax is completely dissolved the mixture shall be cooled till it is just warm and one part of genuine turpentine is to be added and entire mixture shall be well stirred.

Polish shall be applied in the same manner as specified for spirit polish.

11.11.3 Painting to Steel Surface

11.11.3.1 General

All surfaces shall be thoroughly cleaned of all dirt, grease, rust and mill scale. Areas which become inaccessible after assembly shall be painted before assembly after cleaning the surfaces as described above. The surfaces shall be perfectly dry before painting.

Wherever shop primer painting is damaged, the surfaces shall be thoroughly cleaned and touched up with corresponding primer.

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

11.11.3.2 Steel Structures

Unless otherwise specified all structures shall be painted with two coats of primer. One coat shall be applied at shop and the second coat at site. All structures after erection shall be given two coats of finishing paint and shall be of synthetic enamel of approved colour. The under coat shall have different tint to distinguish from the finishing coat.

11.11.3.3 Galvanized Iron Sheets

All plain and CGI sheets requires surface pre-treatment or use of other patented primer to ensure adhesion of paint to zinc coated surfaces. Such pre-treatment shall be as per manufacturer's specifications. Where pre-treatment is adopted one coat of primer paint of suitable quality shall be applied. Unless otherwise specified the finishing coats shall consist of an under-coat of an aluminium paint having blue tint and a second coat of aluminium paint having aluminium colour.

11.11.3.4 Structures embedded

Exposed surfaces of embedded parts shall be given two coats of red lead graphite primer at shop and finished with two coats of anti-corrosive paint at site after embedment. Type of paint and procedure of painting shall be as per manufacturer's specification. Surfaces to be field welded shall have no paint applied within 100 mm of the welding zone.

12.0 INTERNAL WATER SUPPPLY PLUMBING, DRAINAGE & SANITATION

12.1 Scope of Work

The work comprises supply, laying testing, commissioning etc. of water supply, plumbing, drainage & sanitation.

The work includes the following activities connected with the job :

i) Supply and delivery of all required pipes and other materials.

ii) Earthwork in excavation for trenches, pits/chambers/manholes etc.

iii) Civil works connected with the laying/erection of pipe lines such as making holes in the wall etc. and repairing them after pipe erection, construction of pipe supports, valve chambers, manholes, bedding and covering of pipe laying wherever required.

iv) Laying and jointing of pipe lines as specified in this chapter

v) Testing of pipe lines after laying as per standard tests specified in this chapter.

vi) Back filling of trenches after successful and satisfactory testing.

vii) Disinfection of the complete piping system in the case of water supply.

viii) Commissioning of entire network.

ix) Safe custody of the pipes/materials/equipment/work and other obligation stated elsewhere in the specification.

x) Any other activities which are not mentioned above but essential and required.

12.1.1 Materials

The materials shall conform to Part-I of this series.

12.2 Water Supply & Plumbing

12.2.1 General

12.2.1.1 General Requirements

The Contractor shall lay all the pipes and fittings in the best workman like manner by skilled workmen and licensed plumbers in conformity with the regulations and requirements of the local appropriate authorities and to the satisfaction of the Engineer. Unless otherwise specified water supply works in buildings shall be carried out in

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

12.2.2 Installation

All works like earth work, masonry, concrete, steel work, cutting holes, chases in brick, concrete & RCC works, cutting of roads, repairs and rectifications associated directly with the installation of water supply system shall come under the scope of the contractor and shall be governed by the specification of the relevant chapter.

12.2.3 Laying

Before lowering down for laying in the trenches, the pipes shall be checked against crack by means of light hammering and for any other damage. All fixing shall be carefully aligned and spaced at a distance from the main structure to give reasonable all round access for maintenance and inspection and laid true to line plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface holder or on reliable supports at least one near each joint and spacings as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. If situation requires, pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer. Pipes embedded in floors and wall shall be securely bound so as not to allow any movement due to expansion and contraction. adequate width shall be provided to lay the pipes as per standard practice.

Excavation below the required level is not permitted. The contractor shall make good any excess excavation as directed by the Engineer.

Soft spots in the bottom of beds for pipe lines in rock shall be leveled with sand or soft soil or concrete as approved by the Engineer and the thickness of the layer shall not be less than 100mm.

12.2.4 Excavation for pipe lines in trenches

Excavation shall comply with chapter 2. The sides of pits and trenches shall be adequately supported at all times, except where otherwise directed by the Engineer.

12.2.5 Underground piping in and around building

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable, and as shown in the drawing and instructed by the Engineer. The thrust blocks shall be provided wherever required.

The size and depth of the trench shall be as approved by the Engineer. Backfilling in trenches shall be done with selected fine earth, unless otherwise permitted, in 150mm layers and carefully consolidated and well treated so that it does not set as a drainage channel. Special care shall be taken while filling in the vicinity of the pipe to avoid damages. Before backfilling the laid pipe shall be fully tested and approved.

12.2.6 Concealed piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the adjoining structure by making chases in walls/floors and these shall be secured by hooks and the chases filled with concrete 1:2:4 (1 cement, 2 sand and 4 aggregate). The contractor will rectify, if required the chases, openings and pipes, supplement and make good after laying and testing of the concealed pipelines.

12.2.7 GI.Piping

12.2.7.1 The pipes shall be fixed in longest lengths possible with all necessary bends, tees, couplings, reducing ockets, short piece, jamnut and tees etc. in perfect straight lines both vertically and horizontally.

12.2.7.2 All exposed GI pipes shall be fixed at least 15mm clear of wall face with holder bat clamps at suitable places not exceeding (2.5 metres) centre to centre. Where the pipes are laid in chases in walls as shown in the drawing, these shall be secured to walls by hooks. Chases in walls and floors shall be filled in with cement concrete 1:2:4. Where the pipes are to be run underground these may be laid at least 60 cm below ground level.

12.2.7.3 The joints of pipes and fittings shall be sealed with red lead paint and fine spun yarn. Joints must be perfectly water tight when put under maximum test pressure.

12.2.7.4 Unless otherwise specified the exposed portion of pipes and fittings shall be given two coats of approved synthetic enamel paint over a coat of approved priming. Pipes laid underground or concealed in walls/floors shall be treated with two coats of bituminous paint.

12.2.8 Jointing of pipes

The interior of all pipes and joints shall be cleaned before jointing commences. Jointing of pipes shall be done in such a manner as to render them completely leakproof and durable. Instruction of the manufacturer shall be followed unless desired otherwise by the Engineer. However, the general norms and recommended practices for different types of pipes are given below for guidance :

(a) Cast Iron

i) Spigot and socket joints :

Interior surface of bells and exterior surface of smooth ends of pipes shall be cleared of redundant insulating cover and other foreign materials particularly of oil, burning off materials from bells and smooth pipe ends. Sharp rises on interior bell surface shall be smoothed out.

Bells should be lined up, in compliance with direction of pipe. Laying work shall be started from lower points.

ii) Lead and Flanged Joint :

Lead joints shall be made as per Sl. 15.4.6.1 and flanged joints as per Sl. 15.4.6.2 of chapter 15.

b) Steel Pipes

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove

burring from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer.

c) G.I Pipes

Threads shall be cut with, sharp tools, and before jointing all scale shall be removed from pipes by suitable means. The screw threads of the pipe shall be cleaned out and the joint made by screwing the fitting after treating the threads with approved pipe jointing compound. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

d) Asbestos cement pipes

Socket and spigot ended pipes shall be jointed by caulking with tarred gaskets and grouted with 1:3 cement sand mortar.

12.2.9 Precautions

a) All water supply pipes shall be so laid and so fixed and maintained as to be and remain completely water tight.

b) During installation open ends of each pipe shall be protected by suitable covers or plugs so that the ends, thread, sockets or spigot are not damaged and no foreign materials can make its way into the pipe line.

c) Due care should be taken to ensure that there shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting containing impure water or water liable to contamination or of an uncertain quality of water which has been used for any other purposes.

d) Fittings and fixtures liable to be stolen shall be fitted and fixed just before testing and handing over.

12.2.10 Painting

When mentioned in the schedule of item underground steel and cast iron pipes shall be treated with 2 coats of anticorrosive bituminous paint on the outside surface after cleaning the surface from soil, dust,

moisture, rust, scales soot etc. When painting is to be done for pipes above ground, G.I. pipes shall be given a coat of zinc chromate primer, C.I. & M.S. pipes shall be given one coat of red lead or zinc chromate primer over which at least 2 coats of paint of best quality and manufacture as approved by the Engineer shall be provided or as specified in the schedule of item.

12.2.11 Ferrule and stop cock box with chamber

Square cast iron surface box 15 cm square and 22.5 cm deep weighing not less than 4.54 Kg with hinged lid shall be provided in masonry chamber. Top of box shall be made flush with the finished level of the chamber. The chamber 25cm x 25cm inside shall be with half brick wall in cement mortar 1:4 over a cement bed concrete of 75mm thick in proportion 1:4:8 with stone chips. The in side wall faces shall be plastered with 12mm thick cement mortar 1:4 finished smooth with a floating coat of neat cement.

The exposed surfaces of cast iron box and cover shall be treated with two coats of bituminous paint.

12.2.12 Inspection, Testing and Acceptance

12.2.12.1 Pipes, fittings and fixtures before laying

All pipes, fittings and appliances shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be

inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

12.2.12.2 Testing of pipes after laying

General

a) The contractor shall ensure the safety of the pipe work under test and provide all necessary stoppers, testing apparatus etc. that are required for testing.

b) The contractor shall be responsible for any damage done to pipe work and ancillary work while testing and shall replace any pipe or fitting which does not satisfactorily withstand the test.

c) The contractor shall give written notice of the times at which tests are to take place. On completion of each test two copies of the complete records shall be given to the Engineer.

d) The work will not be considered complete until the tests are found satisfactory and a certificate issued by the Engineer.

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits and then tested under pressure. The test pressure shall be 6Kg/cm2 or double the maximum working pressure, whichever is greater The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or a large diameter, by a power driven test pump, provided that pump is not left unattended. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been re-calibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable loss for at least five minutes. The end of the main shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

12.2.12.3 Testing of service pipes and fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely watertight. All pipings, fittings and appliance shall be checked for satisfactory support and protection from damage, corrosion and frost.

12.2.13 Storage Tank

12.2.13.1 Pressed steel tank

Pressed steel water storage tanks shall be of nominal size and capacity as mentioned in the Schedule of Item and fabricated with all flanges external / internal or bottom flange internal and side flanges external, as shown on drawings or schedule of items. Inlet, overflow, vent pipes and manholes shall be arranged and provided as shown in drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50mm above the bottom of the tank and there shall be 150mm free board at the top of the tank. The fabricator shall supply 5 prints of fabrication drawing to the Engineer for prior approval showing thickness of plates, method of jointing the plates. All supports, stays, gussets etc. Pads, cleats etc., required for supporting the tanks shall also be supplied by the manufacturer.

All tanks shall be supplied with mosquito-proof top with manhole not less than 450mm diameter. Tanks deeper than 1.00 Metre shall be provided with M.S. internal access ladder adjacent to the manhole. Meter level indicator shall be provided if asked for. Two coats of anticorrosive paint over a suitable primer shall be applied to both internal a external surface of tanks. The paint shall be so selected as not to impart any taste or odour of water and be of lead free composition.

12.2.13.2 G.I. Water Tank

G.I. water tanks shall be procured from a reputed manufacturer. The design shall be good enough to withstand the loads safely. Galvanized iron water storage tank shall be made of minimum 16 gauge galvanized iron sheet. Unless otherwise specified plain sheets shall be fixed at the corner to angle iron frames by means of 6 mm rivets at 40 mm pitch for tanks upto 1000 litres capacity and 8 mm rivets at 35 mm pitch for tanks above 1000 litres capacity. Tanks above 1000 litres shall have 20 mm dia. galvanised iron stays, one fixed to angle framing at topand two in the body of the tank for extra strength. Holes for rivetting shall be drilled and not punched. Lead shall be applied to the joints before rivetting.

Tanks shall have 400 mm dia. holes at the top with hinged covers. The covers shall be made of galvanised iron sheet with angle iron frame. The cover shall be just loose but close fitting to keep out dust and

mosquito and will not be airtight. It shall be complete with lockable arrangement.

Tanks unless otherwise specified shall be provided with rising main inlets of 40 mm dia. galvanised iron pipe or as shown on drawing and 40 mm dia. G.I. overflow pipe and 25 mm washout with plug. If specified the rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing.

The ball valve shall permit the entry of water when the tank is empty and disconnect the supply when the tank is full. It consists of a hollow floating ball made of copper, plastic or hard rubber, 110 mm in diameter attached to an arm which is so pivoted that the end near the pivot close the orifice of the main when the ball is raised to the required height of water in the tank and opens the main as soon as the ball drops with the fall of water level as it is drawn off through the distribution. The ball valve shall be fixed to the tank in such a position that the body of the ball valve submerge when the tank is full upto the water line. The ball valve shall be so adjusted as to limit the level of the water in the tank below the lip of the over-flow pipe, and above the maximum water filled level shall be as per the standard norms for GI water tank.

12.2.13.3 Water reservoirs made of concrete or masonry shall be governed by the specification in the relevant chapter. It shall have, inlet, outlet, overflow and wash out with plug and a top MS/CI cover as per schedule of items and drawings.

12.3 Drainage and Sanitation (Internal)

12.3.1 Scope

This section covers the layout and construction of drains for waste water, surface water and sewage together with all fittings and fixtures inclusive of ancillary works, such as connectins, manholes and inspection chambers used within and around the building and the connection to a public sewer upto treatment work, septic tank and soak pit. All sewerage and drainage works shall be executed in accordance with specifications given for different works. All sewerage and drainage works shall be executed by a licensed plumbing supervisor or a licensed plumber and in accordance with IS : 1742-

1983 "Code of Practice for Building Drainage" unless otherwise specified.

12.3.1.1 Installation

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumbs, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and shall be located so as to allow easy maintenance.

All pipelines, fittings and fixtures shall be installed leakproof; when the works under scope of this specification are linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gasses.

12.3.2 Rainwater Downcomers

Rainwater downcomers shall be standard cast iron or asbestos cement pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paint over a coat of primer. Rain water downcomers shall run along and be secured to walls columns, etc. Where desired by the Engineer these may have to be installed in chases cut in the structure. All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clamp type, split ring type or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed. Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings. All horizontal pipes shall have a minimum fall of 1 in 100.

12.3.3 Gutter

The gutters shall be made of G.I. or A.C. Gutters shall be supplied by reputed specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. GI gutters shall have the edges strengthened by suitable means. The joints may be made by rivetting, bolting or soldering.

Unless specified otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no deflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated of MS brackets. All junctions shall be thoroughly watertight. The joints may be made by rivetting, bolting or soldering. All joints between successive lengths of gutters shall have an overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater downcomers shall be made fully watertight and secured.

12.3.4 Soil and Drainage Pipes

12.3.4.1 Gradients

If not specified the minimum gradients of soil and drainage pipe line shall be as follows :

100 mm nominal dia	:	1 in 35
150 mm nominal dia	:	1 in 65
230 mm nominal dia	:	1 in 120
300 mm nominal dia	:	1 in 200

12.3.4.2 Relation with water supply pipe lines

Unless specifically cleared by the Engineer, under no circumstances shall drainage and soil pipes be allowed to come close to water supply pipelines.

12.3.4.3 Laying

Each separate pipe shall be individually set for lines and levels. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 16 m apart. The excavation shall be boned in at least one in every 2 m. The foot of the boning rod shall be set on a block of wood of the exact thickness of the wall of the pipe.

Each pipe shall be separately and accurately boned between sight rails.

12.3.4.4 Support and protection on pipelines

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointings.

Where pipes are not bedded on concrete, the bed shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of sand or gravel as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows :

a) When cover is less than 1 metre and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased surrounded with concrete as per IS:4127-1983.

b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipes, the sewer shall be bedded on concrete 1:4:8 mm with 20mm down aggregates as per IS:4127-1983.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched with concrete 1:4:8 mm with 20mm down aggregates as per IS:4127-1983.

d) Where maximum water table is likely to rise above the top of the barrel the pipe sewers shall be completely encased/surrounded with 1:4:8 concrete with 20mm down aggregate as per IS:4127-1983.

Vitrified clay pipes shall be laid on a bed of 150mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The support shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

12.3.4.5 Entry into structures

For entry of the pipes lines into any building or structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. Where openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline, the openings and chases shall be mended.

12.3.4.6 Traps and Ventilating pipes

a) Pipes carrying the sewage from water closets and waste water and overflow water from baths, wash basins, sinks shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap. Ventilating pipes shall be carried up vertically from the drain to a height of at least 600mm above the outer covering of the roof top of the building or as shown on drawings. All vertical ventilating, anti-siphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer.

Connecting to existing sewer lines shall be through a manhole.

b) Sand Cast Iron Spigot and Socket pipe and fittings

All soil waste and vent pipes and fittings used in the work shall be cast iron and shall conform to IS:1729-1979. The pipes shall have spigot and socket ends, with bead on spigot end and shall be with or without ears. The pipes shall be free from cracks and other flaws. The interior. of the pipes and fittings shall be clean and smooth and painted inside and outside with Dr. Angus Smith's solution or other approved anticorrosive paint. Fittings shall include bends, offsets, branches of various types, junctions etc. as required for the work which shall be provided according to drawings and directions of the engineer.

The fittings shall be provided with access doors where so specified or directed by the engineer. The access door fittings shall be of proper design so as not to form cavities in which the filth may accumulate. Doors shall be provided with 3mm thick rubber insertion packing, and when closed and bolted they shall be watertight. The access doors shall have MS studs and bolts or screws or bolts and nuts.

Fixing

The pipes and fittings shall be fixed to wall by means of MS holder bats clamp of approved type and steel bolts or by pipe nails, bobbins etc. as the case may be, keeping the pipe clear from the finished surface of the wall. The holder bat nails shall be fixed to the wall in wooden block. The soil pipe shall be supported at the foot upon a bed of cement concrete of proportion 1:3:6 and firmly attached to the wall.

The pipes shall be laid truly vertically or along the line as shown in the drawing. Connection between main pipe and branch pipe shall be made by using branches and bends with access door for cleaning.

All vertical soil waste, ventilating and anti-siphonage pipes shall be carried up above the roof and provided with suitable C.I. cowl on top.

Pipes outside the building shall be laid underground for which trenches shall be excavated as required for the work. The trenches shall be back-filled with excavated material after the drainage system has been tested and passed.

Jointing (Lead Caulked Joint)

Unless otherwise specified, the pipes and fittings shall be jointed with lead joints as described below :

The annular space between the socket and spigot will be first well packed in with tarred gasket or hemp yarn leaving 25mm from the lip of the socket for the lead. The joint may be leaded by using proper leading rings or if they are not available by wrapping a ring of hemp rope covered with clay round the pipe at the end of the socket, leaving a hole through which lead shall be poured in (for pipes with sockets facing a upwards 15mm high small clay band on socket edge may be used).

The lead shall be rendered thoroughly fluid and each joint filled in one pouring. Before caulking, the projecting lead shall be removed by flat chisels and then the joint caulked round with proper caulking tools and a hammer of 2 to 3 pounds in weight in such manner as to make the joint quite sound. After being well set up the joint is to be left flush neat and even with the socket.

Lead for caulking shall conform to IS:782-1978.

Painting

All the exposed CI pipes and fittings shall be painted to match the colour of the surroundings. The surface of the pipes and fittings to be painted shall be cleaned thoroughly and painted 2 coats with approved paint over and including 1 coat of approved primer. Pipes laid underground shall be painted with 2 coats of anti-corrosive paint.

12.3.4.7 Cutting of pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

12.3.4.8 Jointing

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and man- holes shall be gas tight when above ground and watertight when underground. Method of

jointing shall be as per instructions of the manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

(a) Sand Cast Iron Pipes

Jointing of cast iron pipe shall be done as described in Sl. No. 12.3.4.7(b).

(b) Concrete pipes

i) Spigot & Socket Joint

The opening of the joint shall be filled with stiff mixture of cement mortar 1:2 (1 cement : 2 fine sand) which shall be rammed with caulking tool.

ii) Collar Joint

Joint shall be done by slipping the collar over and clear of the end of the pipe. The recess at the end of the pipe shall be filled with jute braiding dipped in hot bitumen. Care shall be taken that no off-set of the jute braiding shall be visible either outside or inside the pipe. The collar shall be then set up over the joint covering equally both the pipes and leaving an even caulking space all round. cement and sand mortar (1:1.5) shall then be well punched or pressed home with a caulking tool.

(c) Glazed stoneware pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the socket. The reminder of the socket shall be filled with a stiff mixture of cement mortar of 1:1 proportion. When the socket is filled, a fillet shall be formed round the joint with a trowel,

forming an angle of 45 degree with the barrel of the pipe. The newly made joints shall be protected, until set, from sun and rain and shall be cove red with damp sacking or other suitable materials.

12.3.5 Trenches and other excavations

Excavation shall be carried out according to chapter-2, Earthwork.

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench. The spoil bank shall not be allowed to endanger the stability of the excavation. Sp oil may be car ted away and used for filling the trench behind the work. Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement. All e xcavations shall be properly timbered, where necessary. Ef ficient arrangements for dewatering during excavation and keeping it dry till back filling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the contractor from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. The se when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken for packing with selected material in areas 300 mm around the pipe. At least 300 mm over the pipe shall also be filled with soft earth or sand.

Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All s ettlements shall be mad e good regularly to minimise inconvenience or traffic where applicable.

12.3.6 Installation of fittings & fixtures

12.3.6.1 General

All fittings & fixtures shall be laid out as per drawings and in proper line, level and shall be firmly secured to floors with screws and ditto fix and to walls with wall plugs and screws. Unless otherwise specified only C.P. Brass screws shall be used for fixing sanitary fittings to wall plugs and floors.

12.3.6.2 European pattern WC

Water closet shall be fixed with floor by means of 75 mm long, 6.5 mm diameter counter sunk bolts & nuts embedded in floor using rubber or fibre washers so as not to allow any lateral displacement.

12.3.6.3 Indian Patttern W.C.

The water closet pan shall be sunk into the floor and embedded in a cushion of average 150 mm cement concrete 1:4:8 (1 cement, 4 sand and 8 broken brick ballast of 40 mm size). The concrete shall be left about 125 mm below the top level of the pan so as to allow for flooring and its bed concrete. The joint between the pan and trap shall be made with C.M. 1:1 and joint between trap and CI soil and waste pipe to be made with lead. All the joints shall be leak proof. The WC floor shall slope towards the pan. The foot rest shall be set in cement mortar 1:3 (1 cement : 3 sand).

The cast iron cistern, brackets and flush pipe etc. shall be painted with two coats of approved paint, over and including a coat of approved priming.

12.3.6.4 Wash basin

Wash basin shall be fixed to C.I./R.S. brackets fixed in cement mortar 1:3 (1 cement :3 sand). The brackets shall be fixed to approved wooden wall plugs with screws. C.P. brass trap and union shall be connected to waste pipe if specified.

12.3.6.5 Urinals

The urinal shall be fixed to the walls with C.P. Brass screws fixed to wooden wall plugs. Urinal partitions shall be fixed to walls by making chases in walls and grouting the same in 1:2:4 cement concrete.

12.3.6.6 Mirror

Fixed type mirror shall be screwed to wall plugs with CP brass screws and shall have a backing of asbestos or similar material as specification in the item.

Swivel type mirror shall be fixed with C.P. brackets which shall be fixed to wall plugs with CP brass screws

12.3.6.7 Soap tray / toilet paper holder

This shall be of flush mounting design and shall be housed in walls by making chases and grouting the same in cement mortar 1:3 unless otherwise specified. All other fittings shall be fixed with screw or as per manufacturer's specification

12.3.6.8 Towel rail & Toilet glass-shelf unit

This shall be fixed with CP Brass screws which shall be fixed to wall plugs.

12.3.6.9 Gully trap

This shall be fixed on 100 mm thick bed and encasement of size 600mm x 600mm x full height of trap shall be provided with cement concrete of proportion 1:4:8 with 40mm stone aggregate. The gully outlet shall be jointed to the branch drain as specified or directed by the Engineer.

12.3.6.10 Masonry chamber for Gully Trap

After fixing and testing gully and branch drain, a brick masonry chamber 300mm x 300mm x 450mm deep or as specified (internal dimensions) in cement mortar 1:4 (1 cement and 4 sand) shall be built with half brick thick wall round the gully trap from the top of the concrete. The internal faces of the chamber shall be finished smooth with 15 mm thick cement plaster (1:4) and neat cement finish. Brick wall exposed to outside shall be finished with 12 mm thick cement plaster 1:4. P.C.C. (1:2:4) band 100 mm thick shall be provided over the brick work with suitable grooves for accommodating R.C.C. cover

to be supplied as per drawing and made water tight by providing suitable beading in the band.

12.3.6.11 High level flushing cistern - (fixing flush pipe & cistern)

The W.C. pan shall be connected to the cistern by G.I. 32mm dia or 40mm (O.D) high density polythene flush pipe with holder clamp and brass coupling.

12.3.6.12 Low level flushing cistern

Unless otherwise specified, it shall be connected to the closet by means of 40mm dia white porcelain enameled flush bend using rubber adaptor joints.

12.3.7 Septic tank and effluent disposal

12.3.7.1 Septic tank

Septic tank shall consist of the tank itself with inlet and outlets therefrom complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawing. This item shall also include ventilating pipe of at least 100mm dia whose top shall be provided with a suitable mosquito proof wire mesh and cowl. Generally ventilating pipe shall extend to a height of about 2 metres when the septic tank is at least 15 metres away from the nearest building and to a height of 2 metres above the top of building when it is located closer than 15 metres. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

12.3.7.2 Effluent disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed S.W pipes laid in a trench filled with broken bricks.

12.3.7.3 Soak Pit

Shall be complete as shown on drawing. In absence of a detailed drawing it shall consist of a 900mm dia pit 1000mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or

concrete blocks with dry open joints backed with at least 75 mm of clean coarse aggregate. The lining above the inlet level shall be set in cement mortar (1:6). The pit shall be filled with brick bats. Inlet pipe shall be taken down to a depth of 900mm from the top as an anti-mosquito measure.

12.3.7.4 Open jointed S.W pipes

Minimum dia of the S.W pipes shall be 200mm nominal. The trench for laying the pipes shall be minimum 600x600mm. The joints of the pipes shall be left unsealed.

12.3.7.5 Commissioning septic tank

After the septic tank has been proved water-tight and the sewage system is checked, the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow dung may be introduced.

12.3.8 Manhole/Inspection chambers

Necessary excavation as required for the manhole shall be done true to dimensions and levels as shown in the drawing. The manhole chamber shall be built with brick work in C.M. 1:4 with minimum one brick thick on a base of 100mm thick cement concrete 1:4:8 with 40mm down aggregate or as specified. The concrete bed shall extend beyond the external face of brick work on all sides by at least 75mm . The thickness of wall shall be as indicated. The work shall be carefully built in English bond, the jointing faces of each brick being wall buttered with cement mortar before laying so as to ensure a full joint.

The inside of the walls shall be plastered with 15mm thick cement mortar 1:4 and finished with a floating coat of neat cement and outside shall be plastered with 12mm thick C.M. 1:4.

The channels and benching shall be done in cement concrete 1:2:4 with 20mm down stone aggregate and finished with 12mm thick cement plaster in C.M. 1:3. The channels shall be semicircular in the bottom half and of diameter equal to the sewer. Above the horizontal diameter the top edge shall be suitably rounded off. The Branch channels shall also be similarly constructed with respect to benching

but at their junction with the main channel an appropriate fall suitably rounded off in the direction of flow of the main channel shall be given. The benching at the sides shall be carried up in a slope of 1 in 3.

All angles shall be rounded to 75mm radius with cement mortar 1:4 and shall be rendered smooth. The internal surfaces shall have a hard impervious finish obtained by using a steel trowel.

The manhole chamber shall be covered on top with RCC (1:2:4) slab with necessary reinforcement as per drawings. Unless otherwise specified circular type light duty M.H. cover with single seal weighting 25 kg. will be provided in each RCC cover.

12.3.9 Testing and acceptance

12.3.9.1 Inspection before installation

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

12.3.9.2 Testing of pipelines

Comprehensive tests of all pipe lines shall be made by simulating conditions of use. The method of actual test shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below :

12.3.9.3 Smoke Test

Soil, waste, vent and all other pipes, when above ground, shall be tested for gas tightness by a smoke test conducted under a pressure of 25mm water gauge and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

12.3.9.4 Water Test

For pipes other than cast iron Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimetre of diameter per kilometre may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the end of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in funnel which could be raised or lowered till required head is obtained and fixed suitably for observation.

Subsidence of test water may be due to one or more of the following causes :

a) Absorption by pipes and joints.

b) Sweating of pipes or joints

c) Leakage at joints or from defective pipes

d) Trapped air

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut and made good.

12.3.9.5 For cast iron pipes

Cast iron sewers and drains shall be tested as for glazedware and concrete pipes. The drain plug shall be suitably strutted to prevent their being forced out of the pipe during the test.

12.3.9.5.1 For straightness

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball will roll down the invert of the pipe and emerge at the lower end and;

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

12.3.9.6 Testing septic tank

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15mm.

12.3.9.7 Fixtures etc.

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

13.0 EXTERNAL SEWERAGE & DRAINAGE

13.1 Scope of Work

The work comprises supply, laying, testing, commissioning etc., of sewerage & drainage network as specified.

The work includes the following activities connected with the job.

i) Supply and delivery of all required pipes and other materials including erection.

ii) Earth work in excavation for trenches and pits/ manholes.

iii) Civil works connected with the laying/erection of pipe lines such as making holes in the walls etc., and repairing them after pipe erection, construction of pipe supports, brick / concrete manholes, preparation of concrete bedding and covering for pipe laying wherever required etc.

iv) Laying and jointing of the pipelines as specified in this chapter

v) Testing of the pipelines after laying as per standard tests as specified in this chapter.

vi) Back filling of the trenches after successful an d satisfactory completion of tests for the pipeline laid.

vii) Cleaning, painting/coating and wrapping etc of pipes and fittings etc.

viii) Commissioning of entire network laid.

ix) Safe custody of pipes/material/equipment/work and other obligations stated elsewhere in the specification.

x) Any other activities which are not mentioned above but essential and required.

xi) If specified, at road crossing the pipe shall be laid in encasing pipes, wrapped & coated M.S pipes shall be used as encasing pipes. The encasing pipe shall project beyond the berm or both sides of the road. The encasing pipe sh all be supported on P.C.C saddles if the site condition warrants so.

13.2 Materials

The materials shall conform to part-I of this series. Sewerage net work in Township shall generally be of R.C.C/S.W.G pipes, R.C.C pipes being used normally for pipe sizes of 400mm dia and above. In plant area, at road crossings etc Cast Iron Pipes may be used.

13.3. Excavation of trenches & pits

Excavation shall be carried out according to Chapter of Earthwork.

Before starting earth work in excavation, temporary drainage arrangement shall be provided to prevent surface water entering the trenches and pits at the cost of Contractor.

Excavation of trenches and pits for pipelines shall be carried out in shortest possible time so as to avoid sinking of ground and consequent damage to the pipelines.

Excavation of trenches for pipelines and surface drains, shall be in exact accordance with the plans and section, alignment, levels and gradients as indicated on the drawings or as directed at site by the Engineer. The final bed must be dressed, levelled or trimmed to proper

gradient and rammed with sprinkling of sand and got passed by the Engineer. No excavation shall be made below the specified levels without written permission of the Engineer. Should any excavation be taken below the specified level due to carelessness of the Contractor, he will fill in such excavation at his own expense as specified in clause 2.12.

13.4 Cast Iron Pipes

I.S 3114-1985 has to be followed in general for Laying and jointing of pipes unless otherwise specified.

13.4.1 Back filling

For the purpose of back filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench to its top.

ZONE-"A" **From the bottom of the trenches to the level of the center line of the pipe.**

ZONE-"B" **From the level of the center line of the pipe to a level 300 mm above the top of the pipe.**

ZONE-"C" **From a level 300 mm above the top to the top of the trench.**

Trenches shall not be back filled until the pipe joints have been tested, alignment and gradient passed by the Engineer but back filling shall be done, at least from the bottom of the trench to the level of the center line of the pipe (ZONE "A") leaving 450 mm on either side of the joints uncovered, with earth till testing is completed. These joints should however be kept covered with mats, gunny, straws etc., to avoid damage to joints by temperature effects.

While back filling care should be taken to ensure that no damage should be done to the pipeline. All back fill materials shall be free from cinders, ashes, slag, refuse, rubbish, vegetables or organic material, lumpy or foreign material, boulders, rocks or stones or other materials which in the opinion of the Engineer is unsuitable or deleterious. However, materials containing stones upto 20 cm as the greatest dimension may be used in Zone-"C" unless specified otherwise herein.

Backfilling in Zone-"A" shall be done by hand with sand, fine gravel or other approved material placed in layers of 80 mm and compacted by

tamping. The back filling material shall be deposited in the trench for its full width of each side of the pipe, fitting and appurtenances simultaneously.

Backfilling in Zone-"B" shall be done by hand or approved mechanical methods. Special care being taken to avoid injuring or moving the pipes. The type of back fill materials to be used and the method of placing and consolidating shall be prescribed by the Engineer to suit individual locations.

Back filling in Zone-"C" shall be done by hand or approved mechanical methods. The type of back fill materials and method of filling shall be as prescribed by the Engineer.

Paving and metaling shall be reinstated in as good order as before removal and the Contractor shall do adequate ramming and watering of under layers to guard against subsequent settlement all at his cost.

13.4.2 Custody of pipes

The Contractor shall remain responsible for the safe custody of pipes, specials and other materials supplied by him/issued to him either free or on cost recoverable basis till these are laid installed, tested, back filled etc., and handed over to the Engineer.

The Contractor shall verify the conditions of the pipes, specials etc., at the time of receipt from sources and shall be responsible for all damages during handling, transporting, laying, installing, testing etc., and the cost of such damages shall be borne by the Contractor.

13.4.3 Erection/laying of pipelines

i) Erection of all equipment shall be carried out with highly skilled workers.

ii) The pipelines shall be laid and supported properly and it shall be deemed as a contractual obligation that the lines are not thrown out of alignment or lifted off during commissioning and subsequent operation.

13.4.4 Pipeline erection

All the underground pipelines shall be laid in accordance with IS : 3114-1985.

13.4.5. Handling of pipes & fittings

Unloading of pipes & fittings

While unloading, pipes shall not be dropped down from trucks on hard surface. This should be done with the help of a steadying rope and timber skids. Pipes should not be dragged, specially to the spigot end along hard surface.

Lowering of pipes & fittings

Proper implements, tools etc. shall be provided and used by the contractor while lowering pipes & fittings in the trenches and in no case these should be dropped. Pipes over 300mm dia shall be handled with the help of chain pulley blocks with tripod supports.

Detection of cracks in pipes and fittings

The pipes and fittings shall be inspected for defects and cracks by ringing with a light hammer preferably while suspended. Smearing the outside with chalk dust helps location of the crack. If doubt persists, pouring a little Kerosene on the inside of the pipe at the suspected spot will confirm it as it will seep through.

Cleaning of pipes and fittings

All foreign materials shall be cleaned from the socket and spigot ends both from inside and outside. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being laid. When pipe laying is not in progress, the open ends of the pipe shall be closed suitably.

Cutting of pipe

The cutting of pipe for inserting valves, fittings or closure pieces shall be done in a neat manner without damage to the pipe. Pipe cutting machine may be used for this purpose and in case it is not available, for large diameter pipes electric arc cutting method using a carbon or steel rod may be adopted. The pipes can be cut by using chisels also depending on the circumstances.

Permissible deflection at socket and spigot joints

Direction

On level ground the socket ends should face the upstream. When the line runs uphill the socket ends should face the upgrade.

Permissible deflection

In case it becomes necessary to deflect pipe from a straight either in the vertical or horizontal plane, due to obstructions or where long radius curve is permitted, the following norms shall be adhered to:- Lead joint 2.5 degrees Rubber joints

for nominal bore	80 to 300mm	5 degrees
for nominal bore	350 to 400mm	4 degrees
for nominal bore	450 to 750mm	3 degrees

Anchor and thrust blocks

Suitable concrete thrust blocks shall be installed, wherever the thrust is appreciable, specially at dead ends and bends. In case of unbalanced also this may be required. In case of steep gradients and under influence of temperature change also thrust blocks may be required for rigidly joined pipes.

It is advisable to avoid sharp bends above 45 degrees. In soft ground as far as possible two bends should not be put together and be separated by at least one length of straight pipe.

Anchor or thrust blocks s hall be generally as per IS : 5330-1984 and thrust resistant design pressure shall be equal to the test pressure.

13.4.6 Pipe jointing

The type of jointing will be defined in the detailed working drawing and Schedule of items i.e. whether they should be (i) socket and spigot with molten lead or lead wool joint or (ii) flanged joint.

13.4.6.1 Socket & spigot joints

a) Molten lead joints

Unless otherwise specified, socket and spigot joints shall be done with molten lead.

The spigot shall be cleaned of the coating, carefully entered in the socket of the adjacent pipe by one or more laps of white hampen spun yarn, sufficient yarn only being driven into the socket to leave the depth of the lead specified. The proper depth of each joint shall be tested before running the lead by passing completely round it a wooden gauge, notched out to the correct depth of lead, the notch being held close up against the face of the socket. The pipes shall be carefully packed underneath so that they shall bear properly throughout their whole length.

The lead shall be carefully skinned of all scale when melted in a cast iron pot or patent melting machine. The joints must be perfectly dug before being run with lead. The pipes shall again be examined for line and level and the space left in the socket shall be filled in generally by pouring in melted lead. This may be done best by using proper loading rings or if these are not available, by wrapping a ring or hemp rope, covered with clay round the pipe at the end of the sockets leaving a hole into which lead shall be poured. For large pipes, it is also necessary to leave one or more air vents around lower half of the joints. The lead shall be rendered thoroughly fluid and each joint shall be filled at one pouring. If the pipe is too large for the joint to be filled from one ladle, two or more ladles shall be used. It is to be noted that the lead should be heated to such a temperature as will ensure that it flows completely around the joint. Overheating of lead shall be avoided.

After a section of convenient length has been laid, lead caulking shall be commenced. The lead shall be freed from the loading pipe outside the socket of the other pipe with a flat chisel, and then caulked around 3 separate times, with proper caulking tools of increasing thickness and a hammer 2 to 3 kg in weight in such a manner as to make the joints sound and water tight. After being well and evenly set, the joint is to be left flush neat and even with the socket. The approximate weight of lead and spun yarn for different size of cast iron pipe socket and spigot joints, as per IS : 3114-1985 are given in the Table-I.

TABLE – I

QUANTITY OF LEAD AND SPUN YARN FOR DIFFERENT SIZES OF PIPES

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

Note : The quantities of lead given are provisional and a variation of 20% is permissible either way.

b) Lead wool joint

In the event of the Engineer specifying or permitting the use of lead wool the joint shall be made as follows :

Hempen spun yarn shall be driven into the socket and thoroughly caulked with suitable caulking tools. Lead wool shall then be introduced and this caulking shall be repeated with each turn of lead wool under which the socket is full within 3 mm and the wool of the lead wool is compressed into dense mass. The joint shall then be finally pressed with finishing tool. The table giving the quantity of lead wool and yarn to be used in different sizes of pipes is given in the Table-2

TABLE – 2

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

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

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

13.4.6.2 Flanged joints

Flanged joints should be made by painting the facing of the flanged with graphite or red lead freely. Packing should be of rubber insertion sheet or compressed fibre board and of approved thickness. The packing should be of full diameter of the flange with proper pipe hole and bolt holes cut out and even at both the inner and outer edges. All the bolts shall be tightened up evenly on all sides keeping the longitudinal axes of adjoining pipe in exactly the same straight line.

The interior of the pipe must be checked carefully so as to be free from all dust and other foreign matters as the work proceeds. For this purpose a disc plate or brush sufficiently long to pass two or more joints from the end of the pipe last laid shall be continuously drawn forward as the pipes are laid. The ends of the pipes must be securely protected preferably with wooden plugs during the process of the work. The pipes laid must not be made receptacles either for tools, cloth or any other material during progress of the work.

13.4.7 Inspection & testing

a) If required all materials shall be inspected by the Engineer before dispatch to site. All the tests shall be carried out in the manufacturer's works and necessary test certificates shall be furnished as proof of such testing. The Contractor shall intimate the Engineer at least two weeks in advance for any such

inspection / testing. All facilities for inspection / testing including necessary test certificates shall be provided by the Contractor at his own cost.

b) After completion of erection all pipe lines shall be inspected by the representative of the Contractor and the Engineer. Any discrepancy, defect pointed out during this inspection shall be made good by the Contractor to the entire satisfaction of the Engineer without additional cost.

c) All pipes with valve and fittings shall be tested to 1.5 times maximum working pressure. The pressure should remain constant for a period of 8 hours. All arrangements for testing shall be done by the Contractor. Any defect found during testing shall be made good by the Contractor to the entire satisfaction of Engineer and the test shall be repeated till acceptable results are achieved. Any special tools, instrument or equipment required for these tests shall be provided by the Contractor for tests only.

d) All oils, lubricants and other consumables required during tests and trials of different equipment shall be supplied and arranged by the Contractor at his own cost.

13.4.8 Painting

i) All equipment, valves and other exposed steel parts shall be given a coat of red oxide, zinc chromate or red lead and two coats of final approved quality paint according to the colour scheme of the Purchaser.

ii) All the exposed pipes and fittings shall be painted with two coats of paints of approved quality.

13.4.9 Commissioning

After pressure testing the main, it should be flushed with water of sufficient velocity to remove all dirt and foreign materials.

The system shall be commissioned after all necessary tests have been conducted successfully. All lubricants, oils, and other consumables required for commissioning of the system shall be supplied by the

Contractor at no extra cost. Commissioning of the equipment to be supplied, if any, by the Owner, shall be carried out by the Contractor under guidance of the representatives of the supplier of these equipment and Engineer. Any adjustment and/or changes/ rectifications that may be found necessary during commissioning of these equipment shall be carried out by the Contractor at his cost.

13.5. Stoneware Glazed Pipelines (S.W.G)

13.5.1 Back filling

Trenches shall not be back filled until the pipe joints have been tested, alignment and gradient passed by the Engineer, but back filling shall be done at least for a depth equal to the diameter of the pipe or 300 mm whichever is greater over the pipes leaving 450 mm on either side of the joints uncovered with earth till the testing is completed. These joints should however be kept covered with mats, gunny bags, straws etc., to avoid damage to joints by temperature effects.

While back filling care should be taken to ensure that no damage is done to the pipelines. The first 300 mm of filling material immediately over and around the pipe should be of soft material free from clods and stones etc. The remainder of the filling materials shall be watered and rammed in layers not exceeding 250 mm at a time.

Paving and metalling shall be reinstated in as good order as before laying of the pipelines.

Unless otherwise required by the Engineer, there shall be a minimum cover of 700 mm over the pipes and at road crossing etc., it shall not be less than 900 mm.

13.5.2 Laying of pipes

The laying of the pipelines shall commence only after the levels of the bottom of the trench at various points have been checked by the Engineer. Cracked pipes whether at the socket or in the body shall be rejected. All SW pipes shall be fitted together on the surface of the ground to ensure a proper fit before they are lowered. The spigots and sockets shall be properly cleaned and brushed, if necessary & then lowered by hand to the bottom of the trench.

The pipes shall be carefully laid to the alignment, levels and gradients shown on the plans and sections, and great care shall be taken to prevent, sand, earth or other matter from entering the pipes during laying. As it is not permitted to rectify errors of grade by packing up underneath with earth, care should be taken in excavating and slight scraping, if necessary, done to bring to grade. The pipes between manholes shall be laid truly in straight lines without vertical or horizontal undulations.

Bedding, haunching or encasing of the pipes during laying shall be in accordance with IS : 4127-1983 and shall be done with cement concrete in proportion (1:4:8) to prevent ground water from entering the pipelines.

All inverts shall be laid from site rail fixed at the true levels, with proper boning rod. The sight rails and boning rods shall be provided, fixed and maintained by the Contractor at his own expense.

The pipes shall be laid, sockets facing up the gradient, beginning at the lower end, and with the sockets, resting in the socket rest holes cut in the trench bottom. Each pipe shall be laid singly and no pipe shall be laid until the trench has been excavated to its required depth to a distance of twenty yards in front of the pipes to be laid.

No pipes of any description shall be covered until they have been passed by the Engineer.

13.5.3 Jointing of pipes

(a) Cement joint

The stoneware pipes shall be cement jointed normally. In case, if specified so, bituminous joints shall be used. In each joint, spun yarn soaked in neat cement slurry or gasket of tarred yarn shall be passed round the joint and inserted in it by means of suitable jointing tools. More skeins of spun yarn or gasket shall then be added and well rammed home. The yarn shall be moistened to avoid absorbing moisture from cement mortar.

The yarn should be so placed as to centre the spigot of one pipe within the socket of the other and shall prevent the jointing mortar penetrating inside the pipe where it might set and interfere with the flow of sewage.

Yarn or gasket (cemented or tarred) so rammed shall not occupy more than one-fourth of the depth of socket.

The cement shall be thoroughly mixed with medium sand in the proportion of 1:1 (1 cement : 1 sand) and then just enough water shall be added to make the mix plastic. On no account, the mortar shall be made soft or sloppy. The mix shall then be carefully inserted by hand into the joint.

Special care shall be taken for inserting the mortar into the portion of the joint underneath the pipe. When the cement mortar has been inserted, it shall be punched or caulked into the joint with wooden caulking tools, and more cement mortar shall be added until the space of the joint has been filled completely with tightly caulked cement. No fillet of cement shall be added.

No mortar which is older than 30 minutes shall be permitted for jointing. The cement mortar joints shall be cured at least for seven days before testing.

The inside of each pipe shall be carefully wiped out with a mop or scrapper sufficiently long to pass two joints from the end of the pipe and any projecting cement shall be removed.

All pipes entering the manholes should be set in cement mortar 1:3 and a completely watertight junction effected.

(b) Bituminous joints

If specified so this joint will be used. Asphalt and sand in the ratio of 1:7 shall be boiled together and filled into the socket in a molten state with the aid of special moulds.

13.5.4 Testing of pipes

Testing of pipes shall be done wholly at contractor's expense inclusive of apparatus, provision of water etc., and/or as per IS : 4127-1983.

After cement has had time to set, the pipes shall be tested in lengths between manholes in the following 'manner'. In the lowest manhole a plug shall be inserted in the pipe. The disc in the pipe and at the upper manhole shall be fitted with a filling pipe with a right angle bend and an

air cock. The length of pipe shall then be filled with water by means of the pipe connection on the upper disc. The air cock in the upper disc shall be kept open, while the pipeline is being filled to permit the escape of air.

When the pipes have been filled with water and air excluded, the air cock shall be shut and water shall be poured into a conical "Filler" attached to the testing and filling pipe of the disc in the upper manhole until water remains in the filler. The testing or filling pipe shall then be raised and fastened so that the height of the pipe is six feet, which will be the usual test pressure for stone ware pipe joints.

The test will be for an hour or such longer period as may be set by the Engineer. If the water level does not fall more than 25 mm in the length of 90 metre, the test may be considered satisfactory.

If it is found that certain pipe joints are leaking, the water shall be run off and joints recaulked with cement mortar and the test repeated till it is proved by the Contractor that the joints are leak-proof.

13.5.5 Concrete bedding, haunching & encasing

Unless otherwise specified in the Schedule of Quantities, all SW pipes shall be laid in accordance with IS: 4127-1983 As per site condition haunching or/and encasing of pipes with cement concrete may be required as per clause 4.2 & 4.3 of IS 4127-1983. The concreting shall be done with 1:4:8 cement sand concrete.

Where sewers have less than 1.2 m cover at places of heavy traffic, these shall be surrounded with mass concrete if directed by the Engineer.

13.5.6 Handling of pipes

While unloading, pipes shall not be dropped from the trucks/carts on the ground. Timber skids and steadying rope should be used while unloading or lowering in trenches. To avoid damage specially to spigot end, pipes should not be dragged on the hard surface.

13.6 Manholes

All manholes shall be of the size and type as given in the Schedule and shall be provided as per drawing or as directed by the Engineer. All the manholes shall be circular or other shape as shown in drawing. The bed shall be in cement concrete of Mark-10B (or 1:3:6 mix) (Size of coarse aggregate 40 mm and down) of 100 mm thickness or as shown in the drawing and shall be projected out 75 mm from the outside face of the wall all round. or as shown in the drawing. The working part including channeling, benching etc., made of P.C.C. shall be of grade-15C (or 1:2:4 mix). All manholes shall be plastered inside with 1:3 cement plaster 20 mm thick and finished with a floating coat of neat cement unless otherwise specified.

Concrete used for precast RCC cover slabs shall be of grade 20C (or 1:1.5:3 mix)and shall be constructed as per drawing.

The top level of manholes shall be generally 100 mm above the surrounding ground levels or as directed by the Engineer. Channeling inside the manhole shall be done in smooth bends.

The end of pipe shall be neatly built in and finished in cement mortar 1:3.

Circular medium duty Cast iron water sealed manhole cover and frames, 560 mm dia (clear opening) and nominal weight 128 kg shall be provided for each manhole and shall be in accordance with IS:1726-1991 Manhole covers with double seals (Light duty) with wt. as specified in schedule of item shall be provided within compound near the buildings if specified so. If specified heavy duty cover and frames, either circular or double triangular type, shall be provided. Step irons shall be provided with two coats of bituminous paint and shall be as per drawing.

In cases where branch pipe sewers enter the manhole or main pipe sewer at a level more than 1m, from the main sewer, a drop connection shall be provided. The extra pipe length required for this connection will be paid under item for pipelines. No other extra payment will be allowed.

All exposed surfaces of cast iron frame and cover shall be painted with two coats of bituminous painting

13.7 Marker plates

Marker plate indicating the particular service installed shall be provided along the routes of pipes laid below ground. These shall be of mild steel, with the type of service and direction of flow, painted on it. The markers shall be set firmly in a concrete base and installed at all corners and turning points. Over straight runs markers shall be spaced at 100 m intervals generally.

14.0 ROAD WORK

14.1 General

Road works in general shall be constructed according to the requirements to the various specifications and codes of practices of the Indian Roads Congress.

Works such as earthwork, masonry, concreting and the like, wherever they occur in association with construction of roads, shall be governed by the respective specifications of these series.

14.2 Trenching and Preparation of Subgrade

The surface of the formation of width equal to that of soling coat shall first be cut to a depth below the proposed finished level equal to the combined depth of soling and wearing coat, (due allowance being made for consolidation), and dressed parallel to the finished profile. Any roots of bushes, trees etc., shall be taken out to the full depth and the cavities thus formed shall be filled up and rammed by the contractor at his cost.

In slushy soil or in areas where water logging is frequent, adequate arrangement shall be made for drainage of the area so that the sub-soil water level is kept as low as possible.

The sub-grade shall then be consolidated with a power road roller of 8-10 tonne capacity by rolling with minimum of 5 numbers of passes till it is densely consolidated to the satisfaction of the Engineer.

Surplus earth shall be disposed of as directed by the Engineer and the areas where it is disposed of shall be neatly dressed.

All undulations of the sub-grade surface that might develop due to rolling shall be made good with earth and sub-grade re-rolled.

14.3 Ash / Moorum Carpet

Wherever the ground is so ft and slushy, ash carpet consisting of common boiler ash shall be laid to 5 cm thickness over the subgrade and then rolled. In firm ground no ash carpet is necessary and boulder soiling shall be laid directly over the sub-grade. If decided by the Engineer, a bed of moorum of specified thickness shall be provided for to form a sub-grade.

14.4.1 Boulder Soling

The width of the soling coat shall be 30cm (15cm on either side) more than that of the wearing coat. Its depth shall be 15cm in cutting and 23cm in f illing and made up soil, unless otherwise specified in the schedule of quantities or shown in the drawing.

The edges of the soling shall be marked out by str ings and stakes. Soling stone shall be hand packed and set on edge with greatest length across the road. This shall be laid closely in position on the sub-grade, firmly set with their broadest side downwards. The joints shall be staggered. All interstices between the stones shall be wedged in with locking smaller stones well driven into gaps to ensure tight packing and complete filling of interstices. Such filling shall be carried out simultaneously with the placing in position of soling stones and shall not lag behind.

After packing, surface shall be checked with template of approved shape and high and low spots corrected by removing soling and re-packing. The top surface of the soling coat shall be perfectly true to camber and grade.

The soling shall then be thoroughly consolidated with power roller of 8-12 tonne weight depending upon the type of soling stones, starting at "edges" and working towards the centre. In case of super-elevated curve the rolling shall commence from the inside edge of the curve to the outside edge. The roller shall run over the same surface of soling at least 10 times or more till the soling coat is well consolidated to the satisfaction of the Engineer. The surface shall be checked by templates and any disturbance in grade or camber corrected after every rolling and finally consolidated. After that, at least 50mm thick moorum shall be laid on top of soling coat and rolled with water to proper compaction so that the top surface seems smooth. The rate for soling coat shall be

inclusive of the cost of the moorum as blinding materials for which no separate payment shall be made.

14.4.2 Laterite soling

In case of laterite soling the thickness of soling shall be as follows :

(i) For road width of 7m and above the sub-base shall consist of two layers of laterite stones 150mm maximum size. The sub-base shall be rolled to a thickness of 230mm after compaction.

(ii) For road width of 4m to 7m,the sub-base shall consist of one layer of laterite stone of 150mm maximum size consolidated to 115mm thick.

(iii) A layer of moorum,33.3 % in volume of laterite, shall be spread over the laterite to a uniform thickness and rolled with 8 tonne roller with constant watering until the mixture penetrates into the voids of laterite layer. Care shall be taken to maintain the camber and slopes.

Other steps for laying, compacting etc. of the laterite soling shall be same as given under clause 14.4.1 "Boulder soling".

14.5 Kerbs

Concrete or stone kerbs, where shown in drawings, shall be fixed in position after laying and consolidation of soling. They shall be fixed true to line and level and secured in position by approved means.

14.6 Water Bound Macadam Surfacing

The construction of water bound macadam shall be carried out according to IRC : 19-1981 "Standard Specification and Code of Practice for Water Bound Macadam".

14.7 Preparation of Base and Shoulders

The subgrade shall be reshaped to the required grade and camber. Where water bound macadam is to be laid over existing black top surface, 50 mm x 50 mm furrows shall be cut in the existing surface at 1 m intervals inclined 45 degree to the centre line of the carriageway, before laying of coarse aggregates. Necessary arrangements shall be

made for the lateral confinement of aggregates by constructing shoulders in the form of two parallel mud walls 20 x 15cm which shall be made along the outer edges of the wearing course.

14.8 Spreading Coarse Aggregate

The coarse aggregates shall be spread uniformly and evenly upon the prepared base in required quantities from stock piles along the roadside or directly from vehicles. In no case shall these be dumped in heaps directly on the base. The aggregates shall be spread to proper profile by using templates placed across the road about 6m apart. Where possible, mechanical devices shall be used to spread the aggregates uniformly.

The water bound macadam course shall be constructed in layers of not more than 75 mm thickness. However, the Engineer may permit courses of 100 mm compacted thickness to be constructed in a single layer. Each layer shall be tested by depth blocks. No segregation of large or fine particles shall be allowed.

14.9 Rolling

The coarse aggregates spread as described above shall be compacted to full width by rolling with either three wheel power roller of 6 to 10 tonnes capacity or an equivalent vibratory roller. The weight of roller shall depend on the type of coarse aggregate.

The rolling shall begin from edges and after the edges have been compacted, progress gradually towards the centre, parallel to the centre line of the road, uniformly lapping each preceding rear wheel track by one half width. On super elevated portions, rolling shall commence from the lower edge. Where screenings are to be applied, rolling shall be discontinued when the aggregates are partially compacted with sufficient voids to permit application of screenings. Where screenings are not to be applied, as in the case of crushable aggregates compaction shall be continued until the aggregates are thoroughly keyed, with no creeping of stones ahead of the roller. Slight sprinkling of water may be done during rolling, if necessary.

Rolling shall not be done when the subgrade is soft or yielding nor when it causes a wave like motion in the base course. If irregularities develop during rolling, and exceed 12 mm when tested with a 3m straight edge, the surface shall be loosened and aggregates added or

removed before rolling again. Th e surface shall be checked by template for camber. In no case shall screenings be used to make up depressions.

14.10 Application of Screenings

After coarse aggregates have been rolled, screenings to fill t he interstices shall be applied gradually over the surface in thin layers. Dry rolling shall be done when the screenings are being spread, so that the jarring effect of roller causes them to settle into the voids of the coarse aggregates. Damp and wet screenings shall not be used and the spreading, rolling and brooming of screenings shall be taken up on sections which can be completed within one day's operation.

14.11 Sprinkling and Grouting

After application of screenings, the surface shall be copiously sprinkled with water, swept and rolled. The sprinkling, sweeping and rolling operations shall be continued and additional screenings applied where necessary until the coarse aggregates are well blended and firmly set and a grout of screenings and water forms ahead of the wheels of the roller.

14.12 Application of Binding Material

After the application of screenings, approved binding material, where it is required to be used, shall be applied at a uniform and slow rate in two or more successive thin layers to a thickness of 2.5 cm. After each application of binding material, the surface shall be copiously sprinkled with water and the resulting slurry swept in with brooms, so as to fill the voids properly. This shall be followed by rolling with a 6-10 tonne roller, during which, water shall be applied to the wheels to wash down the binding material that may get stuck to them. The spreading of binding material, sprinkling of water, sweeping with brooms and rolling shall continue until the slurry of binding material and water forms a wave ahead of the wheels of moving roller.

14.13 Setting and Drying

After final compaction the road shall be allowed to cure overnight. Next morning, hungry spots shall be filled with screenings or binding

material, lightly sprinkled with water and rolled. No traffic shall be allowed till the macadam sets.

14.14 Surface Evenness

The surface evenness of completed water bound macadam course in longitudinal direction shall be within 12 mm when tested with a 3 m straight edge and in cross profile within 8 mm whe n checked with a template.

14.15 Bituminous Pavements

14.15.1 Bitumen premix carpet with seal coat

The consolidated thickness of this type of treatment shall be 2cm/2.5cm/4cm or as specified.

14.15.1.1 Surface preparation

Water bound macadam surface on which black topping is to be provided shall be thoroughly cleaned of dust, loose materials, caked mud and other foreign material with the help of wire brush, chisel, picks etc. Cleaning shall be such as to expose the stone metal to a depth of about 6mm without dislodging the interlock of the metal. All du st and other materials thus removed shall be thrown away at a suitable place as directed by the Engineer.

Any potholes, depressions and undulations found after cleaning shall be made good with premixed chippings, and well rammed.

14.15.1.2 Tack coat

Just before the application of tack coat, the surface shall be thoroughly cleaned by brooms and then by fanning with gunny bags.

Bitumen of specified grade heated to a temperature of 177 to 188 degree 'C' shall be spread on the prepared surface uniformly at the rate of 0.75 kg/sq.m. by means of sprayers. It shall be applied just ahead of and keeping pace with, laying of premix carpet.

14.15.1.3 Preparation of mix, laying & consolidation

The stone grit (aggregate) shall be surface dry and contain not more than 2% moisture before use. It shall be first screened of dust and measured in boxes and then loaded into the drum mixer according to the capacity of the mixing drum in the proportion given in the table below. The aggregate shall be heated to facilitate mixing with the binder in cold weather, where so directed by the Engineer.

The binder heated in boilers, to a temperature of 149 to 177 degrees C or as specified for the grade used and maintained to that temperature, shall be drawn off from the boiler into a suitable container or in bucket gauged to show the weight of bitumen in it. This shall then be poured over the aggregate in the mixer at the correct rate of 64 Kg /cum of aggregate or as specified and mixing started and continued till aggregate is uniformly coated with bitumen.

Immediately after applying the tack co at, the hot mix shall be discharged from the mixer, carried to the road surface and spread to a thickness sufficient to achieve after consolidation the specified thickness. Rakes or dr ag spreaders shall be used for spreading the mixture.
When the premix has been laid for a length of 15-20 metres it shall be rolled. Rolling shall commence from edges and proceed towards the centre. The roller wheels shall be moistened continuously so as to prevent metal chips sticking to it. Any high spot or de pression which become apparent shall be corrected by add ition or removal of premix materials.

Further the prepared finished surface shall be protected from the traffic for 24 hrs or such period as may be specified by the Engineer.

14.15.1.4 Materials

Quantity of materials required per 100 sqm of road surface shall be as given in the table below, unless otherwise specified.

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

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

14.15.2 Seal coat

In dry areas where rainfall is under 150cm per year a premix sand seal coat shall be applied immediately after laying the carpet. The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen. The aggregates shall be dry and suitably heated to a temperature directed by Engineer before the same are placed in the mixer of suitable design. Mixing of binder with aggregates to the specified proportions shall be continued till the latter are thoroughly coated with binder. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with premix materials, the surface shall be rolled with 6 to 8 tonne power roller. Rolling shall be continued till the premix material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

In wet areas where rainfall is above 150cm per year a liquid seal coat with chippings (not sand) shall be applied after laying the carpet. The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen and spread on the surface preferably using mechanical sprayers. Immediately following the application of the binder, stone chippings in a perfectly dry condition shall be uniformly spread on the surface. Immediately after the application of the cover material, the entire surface shall be rolled with 8-10 tonne road roller.

14.15.3 Surface dressing

The surface shall be prepared in the same way as that for premix carpet work as per 14.15.1.1. Depression or pot holes, if any, shall be repaired as indicated.

After the surface has been prepared and is in perfectly dry condition, bitumen heated in the same manner as for premix carpet, shall be sprayed over the surface preferably using mechanical sprayers. It shall be ensured that there is even and uniform distribution of bitumen on the surface. Spraying shall be carried out parallel to the centre line of the road.

Immediately following the application of bitumen, stone chippings in a perfectly dry condition, shall be uniformly and evenly spread as specified in the item, over the entire sprayed surface. Spreading may be done preferably by means of mechanical gritter. Finally the entire surface shall be broomed to ensure perfect uniform spreading.

The final surface shall be checked by means of camber board etc. The spread surface shall be rolled with 6 to 8 tonne roller till there is sufficient boundage of chippings with bitumen. The finished surface shall be thrown open to traffic on the following day.

14.15.4 Premixed Bitumen Concrete

14.15.4.1 General

In this type of road carpet a mixture of sand and stone aggregate is used as aggregate producing a dense mixture. Seal coat is not necessary as the sand used in the mix works up to the surface and forms a seal by itself. The consolidated thickness of this type of treatment shall vary from 4cm to 7.5cm as specified.

14.15.4.2 Surface Preparation

Same as in para 14.15.1.1 above.

14.15.4.3 Tack Coat

Same as in para 14.15.1.2 above.

14.15.4.4 Preparation of Mix, Laying & Consolidation

Para 14.15.1.3 shall generally apply except that the mixing shall be done in two stages. The stone aggregate of the the correct specified size and in the proportion shown in the table above shall be fed into the mixer to which 2/3rd of the total specified quantity of bitumen heated to the appropriate temperature shall be added. When the stone metal is well coated, the sand in the specified proportion and the balance 1/3rd quantity of total bitumen shall be fed into the mixer. Mixing shall be continued until a homogeneous mix is produced and all particles are uniformly coated with bitumen.

The premix shall be emptied on to wheel barrows or stretchers and carried to the site of work. It shall then be spread uniformly on the road surface with rakes or drag spreaders immediately after applying the tack coat to a thickness sufficient to achieve after consolidation the specified thickness. When the premix has been laid for a length of 15-20m it shall be rolled. Rolling shall commence from edges and proceed towards the centre.

The roller wheels shall be moistened continuously so as to prevent metal chips sticking to it. After preliminary rolling, all honeycombs, any high spot or depression which become apparent shall be corrected by addition or removal of premix materials. Camber and grade shall be checked at every stage to ensure correctness and any defect found shall be rectified.

14.15.4.5 Materials

Quantity of materials required per 100 sqm of road surface shall be as given in the table below unless otherwise specified.

BINDER

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

Aggregate

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

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

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

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

14.15.5 Surface evenness

The finished surface of premix carpet and bituminous concrete shall be tested with a straight edge 4.5 m long and any irregularity greater than 6mm shall be corrected.

14.16 Berms

Shoulders and berms shall be prepared as shown on the drawings. Work on making berms shall not lag more than 100 metres behind the water bound macadam consolidation. Suitable drains shall be cut on the berms so that the water bound macadam surface is kept drained till bituminous macadam is laid.

14.17 Kerbs

Kerbs shall be laid and set in place before completing the bituminous or concrete wearing surface as well as t he wearing surface of footpath. Setting shall be done in mortar where so specified with Schedule of Items. They shall be laid and set in such a way as to obtain straight lines in the finished work, the top surface matching with the finished surface of footpath.

Where the road edge forms a curve, the kerbs shall follow such curve. Gaps shall be left as shown in d rawings or as ma y be required to provide for drainage.

14.18 Bridges and Culverts

Bridges and culverts shall be constructed according to the specifications of Indian Roads Congress. Relevant chapters of earthwork, concrete, masonry etc., of these series shall apply.

14.19 Boulder Pitching

Wherever specified, boulder pitching shall be provided at the inlet and outlet of pipe culverts, or for embankments of bridges. The subgrade shall first be dressed to level or slight slope as indicated. The transverse slope of the pitching shall be made strictly in accordance with the drawings or as directed by the Engineer.

14.20 Scarifying & Dismantling

Where a new carriage-way abuts or includes an existing carriage-way and the Engineer so directs, the surface of the latter shall be scarified, adjusted and reshaped to conform with the existing and new camber or crossfall. Materials from the existing road shall be used or disposed off as directed by the Engineer.

Where dismantling of the existing road has been specified, the various layers of the road viz., bituminous macadam, water-bound macadam and soling shall be scarified separately. Scarifying can be done either by hand picks, or by means of scarifiers fixed to the roller. When a roller is used for scarifying, crushing of the metal shall be avoided by moving the metal clear of roller wheels after the scarifier has passed over it. The loosened material shall then be combed by means of rakes to bring out most of the larger stone. If necessary, the larger stones thus collected shall be screened to separate fine particles if any.

The remaining metal shall then be removed and screened to recover reusable metal. Different grades of metal shall be stacked separately and measured.

14.21 Diversions

Where the construction of the road or culvert or bridge is in progress, the road shall be closed to traffic and a suitable diversion shall be provided for traffic by the Contractor, as directed by the Engineer.

The road shall be closed by the erection of barriers and suitable sign boards at both ends which shall be provided with lights at night. Both during night and during day, one man shall be posted at each barrier to suitably divert the traffic and to keep the light burning during the night.

15.0 WATERPROOFING TO ROOFS & WATERPROOFING PAINTS

15.1 Scope

This chapter deals with different types of waterproofing on roof.

15.2 Material

The materials shall conform to Part-I.

15.3 General Workmanship

The waterproofing to roofs being specialised works the Contractor shall get these done by specialised firms/agencies.

15.4 Painting with Hot Bitumen

The surface to be painted shall be thoroughly dried and then cleaned, with wire brushes and cotton or gunny cloth, of all loose materials and scales. The surface shall further be cleaned with a piece of cloth lightly soaked in kerosene oil. Bitumen shall be brought to the site in its original container and this shall not be removed from site till the painting job is completed. Before applying the main coatings of hot bitumen paints, one coat of bituminous primer shall be applied. The number of coats of hot bitumen shall either two coats or as specified in the Schedule of Items. The bitumen of approved quality (either of grade 80/100 or 30/40) or as specified shall be applied to the surface after heating it to the manufacturer's specifications. Care shall be taken to see that no blank patches are left and the quality of bitumen to be spread shall be as specified and shall be to the satisfaction of the Engineer.

15.5 Painting with Bitumen Emulsion

Before applying, the surface shall be cleaned thoroughly. Generally two coats of Bitumen Emulsion are provided over a coat of emulsion primer. Since the painting is with emulsion, the surface need not be made dry.

15.6 Waterproofing of Roof

15.6.1 With bitumen felt

Prior to laying the insulation, roof gradient shall be checked. If necessary, the roof shall be re-graded by screed to ensure everywhere a run off gradient of not less than 1 in 120. The screed shall consist of one part cement and four parts medium to coarse sand by volume. The screed shall be cured for 7 days. The surface shall then be cleaned of all foreign matter by wire brushing and dusting.

Waterproofing unless specified otherwise in drawings shall be the "heavy treatment type" with primer coat as described in IS : 1346-1991. The method of laying roofing treatment, surface finishing with pea gravels, special mode of treatment for drain outlets, projecting pipes, parapet walls, expansion joints, gutters, timber roofs etc., shall conform to IS : 1346-1991. The number of layers of felts shall be as specified in the drawing or Schedule of Items. The bonding bituminous material shall be of grade 30/40 or as specified and the minimum quantity of hot bitumen to be applied, shall be 1.2 kg/m2. Unless specified otherwise, the bituminous felts shall be hessian bases of Type-3 Grade-2. Pea gravel finish may be substituted by a coat of bituminous aluminium paint, where so specified in the Schedule of Items.

The cement mortar used for filling the chases shall be of mix 1:4 and the cement concrete for fillets shall be of the same grade as the roof slab.

Where special surface finish with precast concrete or clay tiles is specified, it shall be in accordance with the relevant chapter of this series.

15.6.2 With bitumen mastic

The work shall be carried out generally in accordance with IS : 4365-1967 "Code of Practice for Application of Bitumen Mastic for Waterproofing of Roofs" or according to the manufacturer's specifications. The work shall be carried out by a firm of specialists in the trade.

The type of underlay or primer, thickness of application, surface finish etc., shall be as shown on drawing or described in the Schedule of Items. Bitumen melting shall be done in a mechanical mixer by gradu-

ally heating to about 200 degree 'C'. Coarse aggregate where required shall be added to the hot bitumen and stirred.

Each coat shall be spread evenly and uniformly by means of a float to the required thickness. Timber gauges shall be used to regulate the thickness. Particular care shall be taken to tuck the mastic into grooves on vertical surfaces, at joints, around pipes or other projections and at junction of adjoining bays.

15.6.3 Waterproofing of RCC roof with Lime concrete and Pressed clay titles.

Lime concrete shall consist of broken brick aggregates and lime. Proportion of brickbat coba shall be 2.5 parts of brick jelly to one part of lime. The brick jelly shall be hard, well burnt and of size varying from 12mm to 25mm.

The lime concrete is then laid over roof to slope to give specified thickness and in slope of 1 in 80 or as shown on the drawing for proper roof drainage as per roof drainage plan. The lime concrete is then to be beaten in the manner approved by the Engineer for 48 hours or as directed with hand beaters.

If the surface during the process of compaction becomes so uneven that water lodges in pools, the surface shall be pricked up, and fresh concrete

spread and consolidated as necessary to obtain an even surface.

The concrete shall then be cured by sprinkling water and allowed to harden for a period of not less than six days before laying the roof finish.

Roof shall be finally finished with one coarse of machine pressed clay titles 20 mm thick laid over a 12mm thick of 1:3 mix cement mortar mixed with 5% crude oil by weight of cement mixed in mortar. The pressed clay tiles shall be immersed in water for two hours before being used. The side joints of the tiles shall be more than 60 mm thick set full in mortar. Before the work dries up completely, the tile joints shall be raked out and pointed with cement mortar 1:3 mixed with crude oil which shall be 5% by mass of cement. The joints shall be well rubbed over with thin bar trowel and excess of mortar scrapped off until the surface of the pointing attains a black polish and becomes hard. As

the work proceeds, it shall be kept thoroughly wetted until the mortar has set firm and hard. Watering shall be continued for three weeks after construction.

Lime concrete and tiles shall be taken up the parapet walls to a height of 150 mm or as shown in the drawing.

The specification of pressed clay titles shall be as given in IS:2690-1975 (Part-I). The specification of crude oil shall be as per IS:2119-1980.

The areas around drain pipes shall be properly finished with provision of adequate slope.

The contractor shall give guarantee for any/all types of waterproofing for a period of 7 years against bad of faulty material and construction and shall rectify the same at his own cost during the guaranteed period.

15.7 Waterproofing for Basement

15.7.1 The specification covers the requirements of waterproofing of basements, tunnels, ducts, pits, bunkers, etc.

The material used shall be bitumen felt type-3 of grade-2 conforming to IS : 1322-1982, together with the specified bonding material and primer.

Waterproofing shall be provided on the outside of walls and top of the floors and shall be carried 150 mm above ground level.

The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be :

i) For depths upto five metres below ground : 2 layers.

ii) For depths beyond five metres : 3 layers.

The method of laying the bitumen felts and workmanship shall in general conform to IS : 1609-1991.

Waterproofing work shall be taken in hand only when the sub-soil water level is at its lowest, the site shall be kept dry by adequate

arrangements for pumping out water till the work has been completed. For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps. In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area. Adequate arrangements shall be made to prevent the sides of excavation from slipping while the work is in progress.

The base concrete of mud-mat shall be rendered smooth by a 20 mm thick sand-cement plaster (6:1). Any sharp corner over which the waterproofing course is to be laid shall be eased out by means of cement mortar fillets 7.5 cm in radius.

The surface must be dry before the next operation is carried out. Blown bitumen conforming to IS : 702-1988 shall be applied hot over the prepared surface at the rate of 1.5 kg/m2 for the first layer and for every other subsequent layer(s). The laying of felt over the bitumen so applied shall always commence on the floor, and shall be carried to the walls only after treatment of the floor is complete. The minimum overlapping of joints at sides and ends of felts shall be 10 cm. Joints for subsequent layers of felt shall be staggered. All joints shall be completely sealed by blow lamp.

A protective flooring of either flat bricks in cement mortar 1:3 or 6 cm thick cement concrete type M15B or a coat of cement sand plaster (1:3) 4 cm thick shall be constructed over the waterproofing treatment to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way, the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth, where necessary with a coat of cement plaster 1:5, the felts shall be laid as for the floor ensuring that the surface to be treated is dry and then a protective brick wall, half-brick nominal thickness shall be built in cement mortar 1:6 over the projecting mud-mat, the space between the wall and felt being grouted with cement slurry. Sufficient care shall be taken to ensure a perfect bond between the waterproofing on the floor and that on the walls.

The treatment on the wall shall be carried 150 mm above the surface of ground and tucked into a grove 6.5 cm. wide and 7.5 cm deep, the chase being filled with cement mortar (1:4).

Where waterproofing is done to the roof of an underground structure, such as a tunnel, it shall be done in a similar way. The structural concrete shall be rendered smooth, hot bitumen and bitumen felts applied in the same way as for the floor and walls, and over this shall be laid a protective layer of cement concrete grade M10C, 7.5 cm thick.

15.7.2 With epoxy based emulsion

Over the mud-mat a 20 mm plaster is to be provided to make the surface even.

On the plastered surface of the mud-mat, three coats of epoxy based leakproof emulsion shall be applied with reasonable gap between each coat in order to permit sufficient drying time.

Precaution should be taken that during the process of rod binding if any damages happens it should be immediately rectified by making patch painting on the affected portion only and as such a complete vigilance is to be kept to rectify the defect.

After the rod binding is over the concreting should be done with high polymer based, chloride and sulphide free cement waterproofing additive/admixtures @ 2% by weight of cement all through the floor area and all through the vertically raised walls of four sides which shall remain underground upto a depth of 8 metre and above from ground level.

After the concreting and immediately after de-shuttering cleaning of the concrete surface on the external faces of the walls are to be done and then three coats of epoxy based leakproof emulsion shall be applied with a reasonable gap between the each coat before back filling. If the back filling is with hard material again a protective layer of plaster shall also be applied on the external faces of walls in order to avoid damages on the painted surface.

If the back filling is with soft sandy or alluvial soil there is no necessity for protective layer of plastering as mentioned above.

Epoxy based paint can be applied on the wet surface hence there shall be no stoppage of the normal progress of the project works.

15.8 Surface Application

Waterproofing done by surface application of bitumen based or epoxy based material shall conform strictly to the recommendations of the manufacturer. The work shall be carried out by a firm of specialists in the trade.

15.9 Guarantee

For the waterproofing on the roof as well as for underground basements the Contractor shall give guarantee in writing for the period of 7 to 10 years as specified in the Schedule of Item. For such guarantee the Contractor shall get guarantee from the manufacturer/specialised firms and forward the same to the Engineer. However, the Contractor shall be fully responsible for the serviceability of the waterproofing treatment throughout the guarantee period and any leakage during that guarantee period shall be stopped by the Contractor at no cost to the Owner and without disturbing working facility of the Owner.

15.10 Water proofing course with Fibre glass R.P. tissue

15.10.1 Scope

This section covers the furnishing of all labour, equipment and performing all operations necessary to complete to p rovide water proofing course of Fibre glass R.P. tissue all in accordance with the drawing and these specifications.

15.10.2 Terminology

For the purpose of these specifications the following definitions detailed hereinafter shall apply.

15.10.3 Preparation of surfaces

Surface to receive waterproofing shall be dry, free from dirt, loose particles and foreign materials. Projections which might puncture the membrane shall be removed and voids and crevices shall be filled in prior to the start of work.

Adequate covering shall be provided during this work to avoid splashing or staining of the adjacent work and surfaces. Any work or surface splashed or stained shall be thoroughly cleaned to the satisfaction of the Engineer. Joints in the tissue felt in the different layers shall be staggered.

15.10.4 In built-up roofing

Application

i) Suitable slope shall be provided in the roof as per manufacturers specifications. Heat insulation may also be provided if necessary.

ii) Prime the plastered surface primer at the rate of 0.4 Kg/sqm. This should properly impregnate the surface and should be left till the time it is touch-dry.

iii) Apply first coat of hot bitumen @ 1.8 Kg/sqm.

iv) Embed first layer of fibre glass RP tissue. Overlaps shall be 100mm between the layers in either direction.

v) Apply second coat of hot bitumen @ 1.8 Kg/sqm.

vi) Embed second layer of fibre glass RP tissue after the surface of the first layer has become dry.

vii) Apply third coat of hot bitumen @ 1.8 Kg/sqm.

viii) Embed third layer of fibre glass RP tissue.

ix) Apply fourth coat of hot bitumen @ 1.8 Kg/sqm.

x) Finish with gravel grit @ 0.006 cum per sqm.

Guarantee

A written guarantee for the water tightness shall be taken for a minimum period of 10 years.

15.10.5 Specification

Water proofing medium

i) By impregnation into the fibre glass reinforcement membrane forms a monolithic mass.

ii) Prevents the penetration of water/moisture.

iii) Acts as a top dressing.

Layer

A single thickness of fibre glass tissue impregnated with bituminous compound.

Multiple layer

2 or more layers of fibre glass tissue laid consecutively with overlapping joints and impregnation with bitumen.

Bitumen/primer

A liquid bitumen of low viscosity which penetrates into a prepared surface upon application.

Half-brick masonry shall be of approved quality 50 class brick work in cement mortar 1:4 (1cement : 4 sand). Plaster should be in cement mortar 1:4 (1cement : 4 sand). Sand should be fine sand conforming to IS 383

Application

Suitable slope may be provided in lean concrete, if necessary. Over this, 12mm thick plaster with cement mortar 1:4 (1cement : 4 coarse sand)is to be laid.

Prime the plastered surface with primer at the rate of 0.4 Kg/sqm. This should properly impregnate the surface & then should be left till the time it is touch dry.

Water proofing shall be as follows :-

i) Apply first coat of hot bitumen @ 2.4 Kg/sqm.

ii) Embed first layer of fibre glass RP tissue. Overlaps shall be 100mm between the layers in either direction.

iii) Apply second coat of hot bitumen @ 2.4 Kg/sqm.

iv) Embed second layer of fibre glass RP tissue after the surface of the first layer has become dry .

v) Apply third coat of hot bitumen @ 2.4 Kg/sqm.

vi) Embed third layer of fibre glass RP tissue after the surface of the second layer has become touch-dry.

vii) Apply fourth coat of hot bitumen @ 2.4 Kg/sqm.

viii) Embed fourth layer of fibre glass RP t issue after the surface of the third layer has become touch-dry.

ix) Apply fifth coat of hot bitumen @ 2.4 Kg/sqm.

x) A layer of 12mm thick fine sand is to be laid after completing the above operations. The layer of sand will n ot be applied on vertical walls.

The surface should be finished with half-brick maso nry in cement mortar 1:4 (1cement : 4 coarse sand).

Guarantee

A written guarantee for the water tightness shall be taken for a minimum period of 10 years.

General

The work will be carried out by specialists in the trade. Workers shall be provided with gum boots and hand gloves. There shall be no air pockets. Corners shall be treated flush without any air pockets or voids.

Measurement

The unit will include supply of materials, transport, preparation of surface, application of water proofing treatment, plastering, masonry work etc., as specified herein. The measurement of the item will be in square metres nearest to the second decimal of the concrete surface which is to be damp-proofed.

15.11 Water proofing course with P.V.C sheets/ membranes

15.11.1 Jointing

The adjacent lengths of the P.V.C sheets shall be jointed by giving an overlap of 25mm, one over another by sealing with the approved adhesive. A minimum width of the sheet, as specified in the item, shall be used without any joint. Jointing of the sheets, to the extent possible and practicable, shall be done at the site workshop.

15.11.2 Laying

i) Horizontal areas: The base concrete shall be rendered smooth by cement sand plaster 1:6 mix of 20mm thick unless otherwise specified. It shall be ensured that there are no sharped crivices, projections etc which may puncture and damage the sheet. P.V.C sheets shall then be evenly laid over the smooth rendered surface while it is green.

After laying of sheets a protective cover shall be laid over it. This cover may be of 1:6 cement sand mortar bed of thickness 20mm and above, flat brick/tile soling over cement sand mortar bed, any other suitable layer or thermal insulation cover as specified in the item. However care is to be taken that sheets do not get damaged while laying the protective cover. The horizontal layer of P.V.C sheets shall be carried over to a minimum of 150mm height and tucked in to the connecting vertical walls as in the case of roof parapets, if there is no provision of continuous laying of the sheets in the adjacent vertical surface.

ii) Vertical surfaces

On vertical concrete surfaces the P.V.C sheets shall be fixed along with the form work with the knobs projecting toward concrete. The sheets shall be clamped on the top of the form work to keep it in position. Concrete is then poured and knobs are locked in it. After the forms have been stripped off, all the tie bolt holes, cuts and other damages are sealed with additional patches of sheets as per manufacturer's specification.

In case good quality of soil, completely free from foreign materials like stone piece, hard lumps and rubbish etc, is available, it can be used directly as a back fill. Otherwise a half brick wall or any other measure as specified shall be provided as a protection barrier over the projecting base of the concrete/mud mat. The top edge of the sheet shall be tucked into a chase to be subsequently sealed with cement sand mortar of 1:4 mix.

In case of sheets being laid both on horizontal and adjacent vertical surfaces, the horizontal sheets shall be carried on the vertical portion as one monolithic layer.

15.11.3 Agency

The execution work including jointing, laying and testing etc. shall be done by a specialised agency duly approved by the Engineer.

15.11.4 Testing

After laying is complete, the sheets shall be tested by an Electronic Pin hole detector for pin holes, cuts and other damages etc. All such portions shall be patched suitably with additional sheets as directed and again test checked.

15.11.5 Expansion joints

All Expansion Joints etc of dimensions as specified, shall be filled up by Polymer Sealant of pourable grade as per manufacturer's specification on the P.V.C sheets locked in the joint.

15.11.6 Guarantee

The contractor shall guarantee the water tightness and leak proofing of the structure for a period of ten years after certified completion and

handing over of the jobs by furnishing a free maintenance guarantee as per prescribed format and as specified.

15.12 Waterproofing with Non-Shrink Polymeric Waterproof Grouting Compound

15.12.1 Work Included

The Contractor shall furnish materials, labour, plant, equipment and tools to complete the work as specified and/or as shown in drawings.

15.12.2 Materials

Cement

Ordinary portland cement shall conform to IS : 269-1989 and portland blast furnace cement shall conform to IS : 455-1989.

Aggregates

All aggregates shall conform to IS : 383-1970 Fine aggregates shall be approved river or pit sand.

Cement waterproofing compound

All cement waterproofing compound shall conform to IS : 2 645-1975 and shall be of approved quality.

Solvent less resin

High build polymeric surfacing which forms a thick resilient and flexible membrane on concrete with high resistance to oil and water.

Nozzle

15 mm dia threaded G.I. pipes of suitable length plugged at both ends.

Super plasticiser

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

15.12.3 Waterproofing of underground structures

Waterproofing shall be carried out as per the approved manufacturer's specification and as stated below:

15.12.3.1 Raft

The sub-base (PCC) of the underground structure shall be cleaned of all dirts and kept dry by continuous pumping of water. 20 mm thick plaster with cement-sand mortar (1:3) mixed with approved cement waterproofing compound as per manufacturer's specification shall be laid on top of the sub-base. The plaster shall be finished smooth with a steel trowel.

The plastered surface shall then be painted with two (2) coats of approved solvent less resin to form a thick resilient and flexible resinous membrane over the plastered surface.

Threaded nozzles of 15 mm dia and of suitable length shall be placed and fixed in a grid pattern of maximum 1.5 m centre to centre over the whole raft, prior to casting of RCC raft. similar nozzles will also be placed along the construction joint, if any, at regular intervals not exceeding 1.5 m c/c. Adequate precaution shall be taken to keep the nozzles plugged at both ends to prevent them from getting clogged by concrete. Similar nozzles shall also be post fixed at critical points, if required. Approved super plasticiser-cum-cement waterproofer shall be added to the concrete which shall be at least M20 grade as defined by IS : 456-1978 and the water cement ratio of the concrete shall not exceed 0.45. Adequate precaution shall be taken to keep the nozzles vertical while concreting.

Approved non-shrink polymeric waterproof grouting compound mixed with cement slurry shall be injected through the nozzles under pressure by pump as per the instructions of the manufacturer. When the injection operation is over the nozzles shall be sealed with a sealing compound as per manufacturer's specification and instruction.

15.12.3.2 Vertical wall

15 mm dia threaded nozzle of suitable lengths shall be placed and fixed in a grid pattern of maximum 1.5 m centre to centre over the entire surface prior to concreting of the vertical wall. Similar nozzle are to be also fixed at construction joints, if any, y, at regular intervals not exceeding 1.5 m c/c. Adequate precaution shall be taken to keep the nozzles plugged at both the ends to avoid clogging of the nozzles by concrete. Similar nozzles shall also be post fixed at critical points, if required.

The concrete for the vertical wall shall be at least M20 grade as defined by IS:456-1978 having a maximum water cement ratio of 0.45. Approved super plasticiser-cum-cement waterproofer shall be added to the concrete as per the manufacturer's specification. Adequate precaution shall be taken to keep the nozzles horizontal during concreting. The exterior surface of the concrete shall be plastered with 12 mm thick cement sand mortar (1:3) mixed with approved cement waterproofing compound conforming to manufacturer's specification. The plastered surface shall then be finished smooth with a neat coat of cement slurry and painted with two coats of approved solventless resin to form a thick resilient and flexible resinous membrane over the plastered surface. Approved non-shrink polymeric waterproof grouting compound mixed with cement slurry shall be injected through the nozzles under pressure by pump as per the manufacturer's specification and shall be sealed with a sealing compound as per manufacturer's specification and instruction.

16.0 MISCELLANEOUS

16.1 False ceiling

16.1.1 Scope

This chapter deals with the specification for various types of false ceiling as listed below :

a) Wooden ceiling (solid wood) and decorative ply.

b) Ceiling with insulating Building Board/Particle Boards etc.,

c) A.C. Sheet and ply wood ceiling.

d) Plaster of Paris (Gypsum Anhydrous) ceiling over wooden frame.

e) Plaster of paris (Gypsum Anhydrous) Tiles ceiling.

f) Wooden cover, fillets, beading for ceiling.

16.1.2 General

16.1.2.1 Materials

All materials shall be in accordance with the general specifications of materials, Part-I, Schedule of items and as shown in drawings.

Special finishing materials as specified in schedule of item shall be procured from the specified source and got fixed by employing skilled worker in the trade under direct supervision of the manufacturer.

16.1.3 Openings for installation of light fittings

Openings in the ceiling for installation of A/C grills, light fittings shall be provided as per drawings.

16.1.4 Recess for pelmet

Recess for the installation of pelmets shall be provided where shown in drawings along the windows/ doors.

16.1.5 Grills

Grills made of wooden, M.S., Aluminium, PVC or any other material as necessary shall be provided as indicated in the drawing.

16.1.6 Frame work

The type of frame to receive the ceiling material may be of wood, aluminium or M.S. as specified in the schedule of item and as mentioned in the drawing.

16.1.7 Wooden framing for false ceiling

Unless otherwise specified in schedule of items the wooden frame work shall be of following description :

The frame work for false ceiling shall be of approved quality teak wood scantlings, the runners shall be 75 x 50 mm size and shall be spaced at 1200 mm c/c and the battens shall be 50 x 50 mm size spaced at 600 mm c/c (approx) forming a grid of 600 x 600 mm or any other grid suitable for fixing the false ceiling material and its size. The runner and battens shall be joined by halving joint using counter sunk 6 mm bolt with washer of required length with soffit of runner and batten in perfect level. The heading joints between runners shall be made with lap joints using 2 nos. 6 mm dia counter sunk bolts with washer. Heading lap joints between battens shall be made with suitable size screws. The wall ends of the runner shall be embedded in the wall (50 mm deep) and shall be grouted with 1:2:4 cement concrete. The soffit of framework shall be made perfectly horizontal. The teak wood frames shall be treated with 2 coats of wood preservations treatment before fixing the tiles/boards as the case may be.

The main runners of frames shall be suspended by M.S. flat 40 x 3 mm /12mm dia M.S. round/T.S. hangers placed at 1200 mm c/c (approx), the top end of the hangers shall be hocked to R.C.C. reinforcement of slab or fixed to M.S. flat cleats installed in slab for the purpose or hooked to purlins of the trusses. The hangers may be twisted or ends of M.S. round/T.S. hanger flattened to allow for fixing the same with T.W. frame or M.S. cleats with bolts of suitable size.

For teak wood framings of shaped ceilings the spacings of frames and hangers levels of false ceiling etc., shall be required to obtain the shapes/drops and profile of the ceiling and to the requirement of ceiling material. The frames shall be locally adjusted to create openings of required sizes for installation of light fittings, grills of air conditioning system.

16.1.8 Metal framing

16.1.8.1 Galvanised pressed steel framing system

Galvanised pressed steel framing system for false ceiling shall be procured from reputed manufacturer and installed by specialist agencies under technical guidance of the manufacturer and strictly as per their specifications. Unless specified otherwise these shall consist of G.I. rectangular pipes at 900 mm c/c suspended by M.S. hanger fixed to R.C.C. slab with M.S. cleats and cross channels fixed to rectangular pipes at 450 mm c/c as per "Galvolock" system of M/s

Eastern Interior Pvt Limited or equivalent. Ceiling materials shall be fixed to cross channels as per specifications of the manufacturer.

Framing shall be adjusted to provide openings for the light fittings and air-conditioning grills but these shall be supported independently and not on the framing.

16.1.8.2 Aluminium grid ceiling framing system

Framing for Aluminium grid false ceiling system shall be of reputed manufacturer Bestlok, Eezilock or equivalent. It shall consist of aluminium main tee and cross tee's suspended by adjustable hangers fixed to R.C.C. floor with cleats. The grid may be 600 x 600 mm, 1200 x 600 mm or as per drawings. Ceiling materials, shall be fixed to frames strictly as per manufacturers specification.

16.1.9 Fixing of Ceiling

16.1.9.1 Wooden ceiling with planks

These shall be of class of wood and thickness as specified in Schedule of items. Unless specified otherwise the width of the ceiling board shall be 100 mm to 150 mm and shall be planed true on the exposed surface. The maximum length of the finished board shall be 1800 mm. The boards/strips shall be joined with tongue and grove joints and heading joints in adjacent board of the same strip shall be square butt type neatly finished. These joints shall be staggered in alternate strip or line. The boards shall be fixed to T.W. battens by headless brass pins. Moulding beads at junctions with walls and other locations as per drawings shall be provided. Necessary opening for installation of light fittings and A/C grill shall be provided and junctions if required shall be finished with moulded beads.

The false ceiling shall finally be checked for line and level, sand papered and polished with colourless polish to achieve matt satin natural finish.

16.1.9.2 Decorative ply ceiling

These shall be with decorative selected group matched ply of Teak Ply, white cedar ply or any other approved class of veneer ply in strips, square or rectangular panel matching the ply of wall panelling, if any, in the same room and of thickness as per schedule of item and drawings.

The strip ply, square/rectangular panels shall be fixed to T.W. framework with panel pins. Moulded beads of same wood as that of ply of matching shade shall be provided at junctions with walls and as specified in drawings.

Where specific pattern of grains and shade is required the ply cut into shapes as per design may be pasted on a backing ply with adhesive and such made panels shall be fixed to framing.

The ceiling shall be checked for line, and levels and exposed surfaces shall be sand papered and finally polished with colourless polish to achieve matt satin natural finish.

16.1.9.3 Ceiling with insulation board/particle boards

Insulation boards shall be of approved manufacturer, shade, design and thickness as specified in schedule of items and drawings. These may be plain, textured, perforated with natural finish or with white finished surface.

The boards shall be cut to suit the panel sizes of ceiling with special tools and by skilled workmen strictly as per manufacturers specifications. The board shall be fixed to T.W. frames with brass screws or as per manufacturers recommendation and in case of metal frames as per recommendations of the manufacturer of the ceiling system. The joints where exposed shall be of uniform thickness (3 mm to 6 mm) and pattern as shown in drawings.

The ceiling shall be checked for line and level and exposed surfaces prepared appropriately to receive the paint as specified in schedule of item and drawing.

16.2. Wooden partitions

16.2.1 Scope

All materials for the wooden partitions shall be of respective class as specified in the part (I) and as mentioned in schedule of items.

16.2.1.2 Frame work

Unless otherwise specified in the schedule of items, framing for partitions shall be made of approved quality teak wood scantlings of

sizes as mentioned in schedule of items and drawing. The spacing of frames shall not exceed 1200 mm c/c in both direction. The joints of the frame shall be made as per standard joinery practice using standard adhesive as described in wood work chapter. The faces of the frames to receive ply/wooden board shall be true to line, level and plumb. The frames shall be firmly secured to walls, ceilings, floors by making chases and grouting the frames in 1:2:4 cement concrete or fixing the frames with metal clamps/flats screwed to above elements. The frame shall be treated with 2 coats of wood preservative. Where the panelling material is of decorative ply of 3.5 mm to 4 mm thickness, commercial ply of 6 mm thickness shall be fixed to the frame work for backing purpose. Where sunk (coffered) panels are to be made, combination of single and double layers ply shall be used for backing to achieve level difference for sunk panels.

16.2.3 Boarding/facing for partition

a) Wooden plank/board

These shall be of class of wood and thickness as specified in the schedule of item and drawings. These shall be fixed to backing wooden frame work with counter sunk brass screws in pattern and designs, with groves, joints, beads, fillets, cover moulds as shown in drawings. The exposed surfaces shall be sand papered and polished as specified.

b) Decorative ply wood facing

These shall be with decorative teak wood/rose ply/white cedar 3.5 to 4 mm thickness of selected pieces with matching colour, texture and grains and shall be fixed to the backing ply with panel pins in pattern, design, with uniform width of joints, beads, fillets, cover mould as shown in drawings. The exposed surfaces shall be lightly sand papered finished with colourless polish to achieve matt satin finish.

c) Jolly pan (laminated) board

Where specified Jolly pan boards shall be fixed to teak wood frame work strictly as per manufacturer's specification. The boards after fixing shall be cleaned of all adhesives etc.

d) Formica facing

Formica facing shall be fixed to the backing ply with standard adhesive as described for panelling works.

16.3 Expansion and Isolation Joints

16.3.1 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved-laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval, for the method of forming the joints, should be obtained from the Engineer before starting the work.

16.3.2 Bitumen impregnated board

Bitumen impregnated fibre board of approved manufacturer as per IS: 1838 (Part 1)-1983 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

16.3.3 Joint sealing strips

16.3.3.1 General

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water. The sealing strips will be either metallic like G.I., Aluminium or Copper, or Non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. If desired by the Engineer, joints in rubber seals may have to be vulcanised.

16.3.3.2 Metal sealing strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U-shaped, Z-shaped or any other shape and of thickness as indicated in the drawing and schedule of items and/or as instructed by the Engineer.

The transverse joints will be gas welded using brass rods and approved flux. In case it is found that the joints cannot be made leak proof, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor without any additional cost to the Owner. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

a) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The Strips shall be strong, durable, without any rust or crease. At the joints, the overlapping should be for a minimum length of 50mm

b) Aluminium strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS : 737-1986. A minimum lap of 50 mm length is required at the joints.

c) Copper strips

The copper strips shall be minimum 18 SWG in thickness and 300 mm width.

It should be cleaned thoroughly before use so as to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

16.3.3.3 Non-metallic sealing strips

These will be normally in Rubber or PVC Rubber or PVC joint seals can be of shape having any combination of the following features :

a) Plain

b) Central bulb

c) Dumb-bell or flattened ends

d) Ribbed and corrugated wings

e) V-shaped

Transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The actual size and shape shall be as shown in drawings/Schedule of Items and or as directed by the Engineer.

The method of forming these joints, laps etc., shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

a) Rubber sealing strips

The minimum thickness of rubber sealing strips shall be 3 mm and the minimum width 100 mm. The material will be natural rubber and be resistant to corrosion, abrasion and attacks from the acids, alkalies and chemicals normally encountered in service. The physical properties will be generally as follows :

Specific Gravity : 1.1 to 1.15

Shore Hardness : 65A to 75A

Tensile Strength : 25 - 30 N/mm2

Maximum Safe Continuous Temperature : 75 Degree 'C'

Ultimate Elongation : Not less than 350%

b) P.V.C. sealing strips

The minimum thickness of P.V.C sealing strips will be 3 mm and the minimum width 100 mm. Th e material should be of good quality Polyvinyl Chloride highly r esistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows :

Specific Gravity : 1.3 to 1.35

Shore Hardness : 60A to 80A

Tensile Strength : 10 - 15 N/mm2

Maximum Safe Continuous Temperature : 70 Degree 'C'

Ultimate Elongation : Not less than 275%

16.3.4 Bitumen compound

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834-1984.

16.4 Barbed Wire Fencing

16.4.1 Materials

16.4.1.1 Galvanised barbed wire

Barbed wire shall be properly galvanised and shall be obtained from the approved manufacturer as specified in detail in Part-1.

16.4.1.2 Other materials

The specifications of materials, for angle iron posts, concrete works, plasters, if any, and for other works, shall conform to the requirements as specified in Part-I.

16.4.2 Workmanship

The work shall comprise of the following :

a) Excavation in ground of required dimensions with all sides vertical in any type of soil including soft rock and removing the soil and dressing it neatly.

b) Filling the holes in full with cement concrete 1:3:6 mix, well packed, after erecting the posts in correct line, level and plumb. In case of any post coming at local depression, the hole may not be of full depth but the depth of concrete will always be made 60 cm raising it above ground level with necessary shuttering.

c) Where the angle iron posts are specified in the item these shall be 50 mm x 75 mm x 6 mm unless mentioned otherwise. 10 mm dia holes with saw cuts for inserting the wires shall be made as per the spacings of barbed wire shown in drawing or as directed by the Engineer. The foot of the post shall be provided with base plate for anchorage. The spacing shall be 2.5 m or as per drawing. After inserting the wire into holes the socket is to be pressed back.

d) Straining bolts are to be provided 15 m apart from each row of wire for maintaining proper tension in the wire and without any sag or looseness.

e) Posts are to be painted as directed by the Engineer.

16.5 Chain link fencing

16.5.1 Scope

The work under this specification covers the supply and fixing of galvanised steel chain link fencing with galvanised steel posts chain link fabric.

16.5.2 Material

Galvanised steel chain link fabric and galvanised steel pipe posts shall be obtained from the approved manufacturer as specified in detail in Part - I .

16.5.3 Workmanship

The GI pipe posts shall be embedded in plain cement concrete not leaner than 1:4:8 foundations. The height of posts above top of foundations and spacing of post shall not be more than 3 m. The chain link fabric shall be fixed to the fencing posts with the help of stretcher galvanised bars (25 x 6 flats) which will be bolted to the lugs welded to the posts. The stretcher bars shall be provided in the lapping of fabric also.

16.6 Concertina Coil fencing

The spacing of posts and strut shall be 3.0m apart centre to centre, unless otherwise specified or as pe r Engineer-in-charge to suit the dimension of the area to be fenced. Every 15 th last but one end posts and corner posts shall be strutted on both sides and end posts on one side only.

Fixing of posts and struts shall be as specified in clause 4.21.8 Part II of specification.

Concertina coil fencing shall be fixed on angle iron shaped with 9 horizontal reinforced barbed tape (RBT) stud tied with GI staples and GI clips to retain horizontal including necessary bolts or GI barbed wire tied to angle iron all complete as per direction of Engineer-in-charge with reinforced barbed tape.

SPECIFICATION FOR CIVIL WORKS

PART – III NORMS OF CEMENT CONSUMPTION

CONTENTS

1. MASONRY WORK

2. PLAIN/REINFORCED CONCRETE WORK

3. FINISHING WORK

4. FLOORING WORK

5. MISCELLANEOUS ITEMS

6. WATER SUPPLY/DRAINAGE & SANITARY WORKSS

GENERAL

For calculating the requirem ents of cement in various items of work the following standards will be adopted. Over the above theoretical quantity of cement, additional allowance upto plus or minus 3% shall also be allowed as certified by the engineer.

For items not covered in th is standard, CPWD standards s hall be followed or calculated as per uses/requirement in absence of st andard norms. Cement required for enabling work and cement required for testing purposes will be taken into account for consumption purpose. However, in no case such quantity should exceed 5% of the total cement used in the work or as certified by the engineer based on actual observation whichever is less.

Sl.No.	Description of Item	Cement Requirement

MASONRY WORK

1.	Random rubble masonry with	CM 1:4	1.255 quintals per cum
2.	Random rubble masonry with	CM 1:6	0.825 quintal per cum
3.	Coursed rubble masonry in	CM 1:6	0.75 quintal per cum
4.	Brick work in	CM 1:4	0.950 quintal per cum of BW
5.	Brick work in	CM 1:6	0.625 quintal per cum of BW
6.	Half brick work in	CM 1:3	1.43 quintals per 10 sqm of area
7.	Half brick work in	CM 1:4	1.06 quintals per 10 sqm of area
8.	75mm thick brick in	CM 1:4	0.65 quintal per 10 sqm of area
9.	75mm thick brick in	CM 1:3	0.81 quintal per 10 sqm of area

10.	Projected brick bands, Drip course etc. in CM 1:6 finished with 12mm thick cement plaster		0.165 quintal per 10 RM
11.	Half brick thick, Honey combed brick work in	CM 1:4	0.064 quintals per sqm

PLAIN/REINFORCED CONCRETE

1.	RCC/PCC of nominal mix 1:5:10 complete (excluding finishing with CP)	1.30 quintals per cum of concrete
2.	RCC/PCC of nominal mix 1:4:8 complete (excluding finishing with CP)	1.70 quintals per cum of concrete
3.	RCC/PCC of nominal mix 1:3:6 complete (excluding finishing with CP)	2.23 quintals per cum of concrete
4.	RCC/PCC of nominal mix 1:2:4 complete (excluding finishing with CP)	3.18 quintals per cum of concrete

Controlled Concrete - Plain and Reinforced

5.	Concrete grade	(i)	M -5A	To be mutually agreed based on mix design to be prepared by contractor & approved by the Engineer
		(ii)	M -5B	
		(iii)	M -7.5A	
		(iv)	M -7.5B	
6.	Concrete grade	(i)	M -10A	
		(ii)	M -10B	
		(iii)	M -10C	
7.	Concrete grade	(i)	M -15B	
		(ii)	M -15C	
		(iii)	M -15D	

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

FINISHING

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

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

FLOORING

1.	Brick on edge flooring in cement mortar 1:4	1.100 quintal per	10 sqm area
2.	Brick on edge flooring in cement mortar 1:6	0.800 quintal per	10 sqm area
3.	25mm thick (IPS) cement concrete flooring 1:2:4 (1 cement : 2 sand : 4 graded stone chips 12mm nominal size) finished with a floating coat of neat cement.	1.020 quintal per	10 sqm area
4.	40mm thick (IPS) cement concrete flooring 1:2:4 with 20mm and down stone chips finished with a floating coat of neat cement.	1.500 quintal per	10 sqm area
5.	25mm thick (IPS) flooring with base coat 19mm thick 1:2:4 using stone		

	chips 10mm nominal size and 6mm topping coat 1:1 (1 cement : 1 stone chips 3mm size) with a floating coat of neat cement.	1.370 quintal per	10 sqm area
6.	40mm thick (IPS) flooring with base coat 30mm thick 1:2:4 using stone chips 10mm nominal size and10mm topping coat 1:1 (1 cement : 1 stone chips 3 to 6mm size) with a floating coat of neat cement.	2.320 quintal per	10 sqm area
	25mm thick cast-in-situ grey terrazzo flooring, under layer 19mm thick cement concrete 1:2:4 with 10mm nominal size chips and 6mm thick topping laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in pr oportion of 4:7 (4 cement marble powder mix : 7 marble chips) by volume.	1.370 quintal per	10 sqm area
8.	40mm thick cast-in-situ grey terrazzo flooring, under layer 30mm thick cement concrete 1:2:4 with 10mm nominal size chips and10mm thick topping laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in pr oportion of 4:7 (4 cement marble powder mix : 7 marble chips) by volume.	1.575 quintal per	10 sqm area
9.	40mm thick cast-in-situ terrazzo flooring, under layer 31mm thick cement concrete 1:2:4 with 10mm nominal size chips and top layer 9mm thick with marble chips of size 4 to 7mm nominal size laid in cement		

	marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 4:7 (4 cement marble powder mix : 7 marble chips) by volume.		
	a) Dark or light s hade pigment with grey cement	1.583 quintal per	10 sqm area
	b) Light shade pigment or without any (grey cement) pigment with white cement	1.010 quintal per (grey cement) 0.580 quintal per (white cement)	10 sqm area 10 sqm area
	c) Medium shade pigm ent with 50% grey cement and 50% white cement	1.295 quintal per (grey cement) 0.290 quintal per (white cement)	10 sqm area 10 sqm area
10.	40mm thick cast-in-situ terrazzo flooring, under layer 28mm thick cement concrete 1:2:4 with 10mm nominal size chips and top layer 12mm thick with marble chips of size 7 to 12mm nominal size laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 2:3 (2 cement marble powder mix : 3 marble chips) by volume.		
	a) Dark or light s hade pigment with grey cement	1.705 quintal per	10 sqm area
	b) Light shade pigment or without any (grey cement) pigment with white cement	0.895 quintal per (grey cement) 0.810 quintal per (white cement)	10 sqm area 10 sqm area
	c) Medium shade pigm ent with 50% grey cement and 50% white cement	1.300 quintal per (grey cement)	10 sqm area

		0.405 quintal per (white cement)	10 sqm area
d)	White cement without any pigment	0.895 quintal per (grey cement)	10 sqm area
		0.810 quintal per (white cement)	10 sqm area
11.	Terrazzo cast-in-situ skirting and dado, top layer 6mm thick marble chips laid in cement marble powder mix 3:1 (3 cement : 1 marble powder) by weight in proportion of 4:7 (4 cement marble : 7 marble chips) by volume.		
(A)	18mm thick with under layer 12mm thick cement plaster 1:3		
a)	Dark or light s hade pigment with grey cement	1.490 quintal per	10 sqm area
b)	Light shade pigm ent or without any pigment with white cement.	1.090 quintal per (grey cement)	10 sqm area
		0.400 quintal per (white cement)	10 sqm area
c)	Medium shade pigm ent with 50% grey cement and 50% white cement	1.290 quintal per (grey cement)	10 sqm area
		0.200 quintal per (white cement)	10 sqm area
(B)	21mm thick, with under layer 15mm thick cement plaster 1:3		
a)	Dark or light s hade pigment with grey cement	1.640 quintal per	10 sqm area
b)	Light shade pigm ent or without any pigment with white cement.	1.230 quintal per (grey cement)	10 sqm area
		0.400 quintal per	10 sqm area

		(white cement)	
c)	Medium shade pigment with 50% grey cement and 50% white cement	1.430 quintal per (grey cement) 0.200 quintal per (white cement)	10 sqm area 10 sqm area
12.	Precast terrazzo tiles 20mm thick with marble chips of sizes upto 6mm laid in 25mm thick bed of lime mortar, jointed with neat cement slurry mixed with pigment		
a)	Dark shades using grey cement	0.88 quintal per	10 sqm area
b)	Light shade using white cement.	0.44 quintal per (grey cement) 0.44 quintal per (white cement)	10 sqm area 10 sqm area
c)	Medium shade using 50% grey cement and 50% white cement	0.66 quintal per (grey cement) 0.22 quintal per (white cement)	10 sqm area 10 sqm area
13.	Precast terrazzo tiles 20mm thick with marble chips of sizes upto 6mm in skirting or on walls, laid on 12mm thick cement plaster 1: 3 jointed with neat cement slurry		
a)	Dark shades using grey cement	1.395 quintal per	10 sqm area
b)	Light shade using white cement.	1.175 quintal per (grey cement) 0.22 quintal per (white cement)	10 sqm area 10 sqm area
c)	Medium shade using 50% grey cement	1.285 quintal per	10 sqm area

	and 50% white cement	(grey cement) 0.11 quintal per (white cement)	10 sqm area
14.	White glazed tiles 5, 6 or 7 mm thick in flooring, skirting and dado on 12 mm thick cement plaster 1 : 3 in base and joined with white cement, slurry etc.	0.942 quintal per (grey cement) 0.25 quintal per (white cement)	10 sqm area 10 sqm area
15.	Marble stone slab flooring over 20mm thick base of lime mortar 1:1:1 (1 lime : 1 surkhi : 1 sand) and jointed with white cement slurry etc.		
a)	20 mm thick / 30 mm thick / 40 mm thick	0.075 quintal per (white cement)	10 sqm area
16.	Marble stone slab flooring over 20mm thick base of cem ent mortar 1:4 & jointed with white cement slurry etc.		
a)	20 mm thick	1.275 quintal per (grey cement) 0.075 quintal per (white cement)	10 sqm area 10 sqm area
b)	30 mm thick	1.290 quintal per (grey cement) 0.075 quintal per (white cement)	10 sqm area 10 sqm area
c)	40 mm thick	1.310 quintal per (grey cement) 0.075 quintal per (white cement)	10 sqm area 10 sqm area
17.	Marble tiles 18 to 24 mm thick in risers	1.16 quintal per	10 sqm area

	of steps, skirting, dado, walls and pillars laid on 12mm thick cement mortar 1:3 (1 ce ment : 3 sand) and jointed with white cement slurry	(grey cement) 0.075 quintal per (white cement)	10 sqm area
18.	Extra for each additional thickness of 5 mm granolithic layer of 1:2:4 for flooring	0.016 quintal per	10 sqm of area
19	12mm thick cement plaster skirting, dado risers of steps and edges of ground sink with CM 1:3 finished with a floating coat of neat cement.	0.800 quintal per	10 sqm of area
20	15mm thick cement plaster skirting, dado risers of steps and edges of ground sink with CM 1:3 finished with a floating coat of neat cement.	0.995 quintal per	10 sqm of area
21.	19mm thick cement plaster skirting and dado with 12mm thick backing with CM 1:3 and 7mm topping 1:1 (1 cement : 1 stone chips 3mm size) finished with a floating coat of neat cement.	1.35 quintal per	10 sqm of area
22.	25mm thick cement plaster skirting and dado with 18mm thick backing with CM 1:3 and 7mm topping 1:1 (1 cement : 1 stone chips 3mm size) finished with a floating coat of neat cement.	1.85 quintal per	10 sqm of area

MISCELLANEOUS

1.	Marble work for wall lining (Veneer work) 1.8 to 2.4 cm thick in CM 1:3 including pointing with white cement mortar 1:2 (1 white cement : 2 marble	0.715 quintal per (grey cement) 0.170 quintal per (white cement)	10 sqm of area 10 sqm of area

	dust)		
2.	Marble work for wall lining (Veneer work) 4 cm thick in CM 1:3 including pointing with white ce ment mortar 1:2 (1 white cement : 2 marble dust)	1.020 quintal per (grey cement) 0.170 quintal per (white cement)	10 sqm of area 10 sqm of area
3.	Grading roof for water proofing treatment with :-		
a)	CC 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20mm nominal size)	3.2 quintal per	cum of Concrete
b)	CM 1:3	5.1 quintal per	cum of mortar
c)	CM 1:4	3.8 quintal per	cum of mortar
4.	Providing and fixing MS fan clamps of standard shape and size in existing RCC slab including cutting chase and making good.	0.016 quintal	each
5.	Making plinth protection 50mm thick of CC 1:3:6 (1 cement : 3 sand : 6 graded stone aggregate 20mm nominal size) over 75mm bed of dry brick ballast 40mm nominal size well rammed and consolidated and grouted with fine sand including finishing the top smooth.	1.1 quintal per	10 sqm of area
6.	Grouting with		
a)	CM 1:2	7.18 quintal per	cum
b)	CM 1:3	5.40 quintal per	cum

7.	DPC 25mm thick (1:2:4)	0.81 quintal per	10 sqm of area
8.	Making plinth protection with bricks on edge in CM 1:6 over 7.5cm bed of dry brick aggregate 40mm nominal size rammed, consolidated and grouted with fine sand and top of bricks pointed with CM 1:2.	0.86 quintal per	10 sqm of area
9.	Providing and fixing 25mm dia GI pipe outlet in CM 1:3 including cutting and making good the walls.	0.05 quintal per	10 RM
10.	Providing and fixing 40mm dia GI pipe outlet in CM 1:3 including cutting and making good the walls.	0.075 quintal per	10 RM
11.	Providing chases 75mm wide 50mm deep in walls for conduit pipe and filling the same with CC 1:3:6	0.075 quintal per	10 RM
12.	Fixing steel windows with 1:2:4 concrete blocks	0.40 quintal per	10 sqm of area
13.	Cement-sand mortar :		
a)	1:1(1cement :1sand)	10.2 quintals per	cum
b)	1:2(1cement : 2sand)	6.8 quintals per	cum
c)	1:3(1cement : 3sand)	5.1 quintals per	cum
d)	1:4(1cement : 4sand)	3.8 quintals per	cum
e)	1:5(1cement : 5sand)	3.1 quintals per	cum
f)	1:6(1cement : 6sand)	2.5 quintals per	cum

DRAINAGE/SANITARY & WATER SUPPLY INSTALLATIONS

1.	100mm dia AC rain water pipe l/c fittings with CM 1:2	0.725 quintal per	100 RM of pipe
2.	150mm dia AC rain water pipe l/c fittings with CM 1:2	0.82 quintal per	100 RM of pipe
3.	Fixing IWC pan with traps, pair of footrests, and flushing cistern complete	0.125 quintal	each
4.	Fixing EWC pan with trap and flushing cistern complete	0.01 quintal	each
5.	Fixing wash basin and kitchen sink	0.025 quintal	l each
6.	Fixing urinal cistern including pipes	0.025 quintal	each
7.	Fixing & finishing floor trap	0.015 quintal	each
8.	Fixing HCI pipes and specials, 100mm dia and 75mm dia including making good the walls	0.135 quintal per	10 RM of pipe
9.	Fixing GI pipes of all dia with clamps (for inside work only)	0.015 quintal per	10 RM of pipe
10.	Jointing glazed stoneware pipe with CM 1:1		
	a) 100 mm dia	2.17 quintals per	10 RM of pipe
	b) 150 mm dia	3.23 quintals per	10 RM of pipe

11.	Laying cement concrete 1:5:10 all round SW pipe including bed concrete as per standard design		
	a) 100mm dia SW pipe	19.24 quintals per	100 RM of pipe
	b) 150mm dia SW pipe	23.53 quintals per	100 RM of pipe
12.	Gully chamber as per specification.	0.385 quintal	each
13.	Stopcock chamber as per specification	0.185 quintal	each
14.	Inspection chambers as per specification		
	a) 600x600x600mm deep	1.43 quintals	each
	b) 750x600x600mm deep	1.435 quintals	each
	c) 900x900x600mm deep	1.885 quintals	each
15.	Extra depth of inspection chambers as per specification		
	a) 600x600mm	0.805 quintal per	RM of depth
	b) 750x600mm	1.295 quintal per	RM of depth
	c) 900x900mm	1.460 quintal per	RM of depth
	d) 1200x900mm	1.835 quintal per	RM of depth

SPECIFICATION FOR CIVIL WORKS

PART – IV DIMENSIONAL TOLERANCE

GENERAL

The materials used in construction shall, bes ides conforming to the specifications and standards mentioned, be t he best of the existing ki nds obtainable. Where a particular 'Brand' or 'Make' of material is specified such 'Brand' or 'Make' of material alone shall be used.

A high standard of workmanship and accuracy shall be achieved in all sections and parts of the work. The workmanship shall be in accordance with the latest and the best civil engineering practice.

The Contractor shall ensure that all sections of t he work are carried out with utmost care to achieve the dimensions shown in drawings or specifications. Where special and close tolerances are required in any particular section of work, these will be shown in the drawing and such toler ances shall be met. In the absence of such specific mention in drawings t he following dimensional deviations may be tolerated, provided they do not impai r the appearance or r ender the particular section of work unacceptable to the purpose for which it is intended. Tolerance for materials and workmanship not covered in this part as mentioned hereinafter will be in accordance with the relevant IS code.

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

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

Description		Permissible tolerance
In thickness of barrel and socket between 500 to 600mm	:	Plus or minus 3mm
Glazed tiles, length of all 4 sides	:	Plus or minus 0.8mm
Individual dimensions and thickness	:	Plus or minus 0.5 mm
Metal doors, windows and ventilators - In overall dimension	:	Plus or minus 1.5 mm
Wooden doors, windows, v entilators Overall dimension of door, window, ventilators	:	Plus or minus 3 mm
All components of shutter except glazing bar		
Width	:	Plus or minus 3 mm
Thickness	:	Plus or minus 1 mm
Glazing bar, width & thickness	:	Plus or minus 1 mm

Mild steel tubes, tubulars and other wrought steel fittings

a)	Thickness			
	i)	butt welded light tubes	:	Plus not limited minus 8%
		medium and heavy tubes	:	plus not limited minus 10%
	ii)	seamless tubes	:	plus not limited minus 12.5%
b)	Weight			
i)	single tube (irrespective of the quantity)		:	+ 10% , - 8%

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

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

Earth work

Finished level of site levelling in hard rock : Plus or minus 50mm

Finished level of site levelling except for hard rock : Plus or minus 100 mm

Level of pits, trenches foundations : Plus or minus 50mm

Concrete & Reinforced concrete

Footings, plan dimension	:	Plus 50 mm Minus 12 mm
Eccentricity	:	0.02 times the dimension of footing in the direction limited to 50 mm
Thickness	:	Plus or minus 0.05 times the specified thickness
Foundations		
Deviation of planes and lines of their intersection from vertical or inclination along full height	:	Plus or minus 20 mm
Deviation of horizontal plane from horizontal line		
for 1 m of the plane in any direction	:	Plus or minus 5mm
for the whole plane	:	Plus or minus 20mm
Sizes of cross section	:	Plus or minus 8mm
Surfaces of inserts to support loads	:	Plus or minus 5mm
Length of elements	:	Plus or minus 20 mm

Equipment foundations :

Top level of bolt	:	Plus 20mm
Top level of foundation before grouting	:	Minus 20mm

Axes of anchor bolts in plan	:	Plus or minus 5mm
Axis of foundation in either direction	:	Plus or minus 10mm
Deviation in vertical line along height	:	Plus or minus 10mm
Sizes of pits in plan	:	Plus or minus 20 mm
Sizes of steps in plan	:	minus 20mm
Levels of steps, benches and pits	:	minus 20mm
Axes of inserts in plan	:	Plus or minus 10 mm
Basic dimensions in plan	:	Plus or minus 10mm
Deviation of horizontal plan from horizontal line		
for 1 m of plane in any direction	:	Plus or minus 5mm
for the whole plane	:	Plus or minus 20mm
Local deviations of top surface when checked with a 2 m long straight edge	:	Plus or minus 8mm

Buildings :

Surfaces when checked with a 2 m long straight edge	:	Plus or minus 8mm
Sizes of cross section	:	Plus 8mm Minus 0 mm
Length of elements	:	Plus or minus 20mm
Deviation from horizont al plane, for whole building	:	Plus or minus 10mm
Plumb in verticality	:	1 in 1000 of height

for columns supporting floor beams	:	Plus or minus 10mm
for framed columns linked with crane girders and beams	:	Plus or minus 10mm
Reinforced concrete walls	:	Length : Plus or minus 20mm
Flatness of surface w hen checked with a 2 m long straight edge	:	Plus or minus 8mm
Level of top surface to support assembled elements	:	Plus or minus 5mm
Deviation in planes and lines of intersection from vertical	:	Plus or minus 15mm
Size of cross section	:	Plus or minus 8mm

Placing of reinforcement :

Length of bar upto 75 cm long (Other than straight bars)	:	Plus 3 mm Minus 5 mm
75 - 150 cm long	:	Plus 5 mm Minus 10 mm
150 - 250 cm long	:	Plus 6 mm Minus 15 mm
250 cm long and above	:	Plus 7 mm Minus 25 mm
Straight bars, all lengths	:	Plus or minus 25 mm
Spacing of bars	:	Plus or minus 5 mm

Anchor bolts :

Shift in location in plan	:	Plus or minus 5 mm

Same, when bolts are located outside of structural columns	:	Plus or minus 10mm
Top level	:	Plus 20 mm
Threaded length	:	Plus 30 mm

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

Dimensions of openings for doors, windows etc	:	Plus 15 mm Minus 0 mm
Flooring, skirting, dado and plastering	:	
Insitu concrete floor	:	4 mm
Concrete tile and mosaic, in any 3 m length	:	3 mm
in large open area	:	15 mm
wall tiling - surface should not vary from general plane by more than 1 in 200. Marble and such superior work, in any 2 m length	:	1.5 mm
in any row	:	3 mm
Plastered surfaces, flatness when checked with a 2 m long straight edge	:	3 mm
Vertical surfaces, upto 1 storey	:	5 mm
Over full heights	:	10 mm
Metallic Inserts on assembled components length and width	:	Plus or minus 3 mm

Road work

The levels of the sub-grade and different pavement courses should not vary from those calculated with reference to the longi tudinal and cross-sections of the road as shown on the drawing beyond the tolerance given below :-

Sub-grade	:	plus or minus 25mm
Sub-base	:	plus or minus 20mm
Base	:	plus or minus 15mm
Wearing course	:	plus or minus 6mm

SPECIFICATION FOR CIVIL WORKS

PART – V METHOD OF MEASUREMENT

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1.0 GENERAL

2.0 EARTHWORK

3.0 ANTI - TERMITE TREATMENT

4.0 CONCRETE (PLAIN & REINFORCED)

5.0 MASONRY

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7.0 WHITE WASHING, COLOUR WASHING & PAINTING

8.0 FLOORING, PAVING & FACING WORKS

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10.0 METAL DOORS, WINDOWS & VENTILATORS

11.0 GLAZING

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13.0 WATER PROOFING, DAMP PROOFING

14.0 CEILING AND LINING

15.0 ROAD WORK

1.0 GENERAL

1.1 The method of measurement of the various items of work shall be in accordance with IS : 1200 (Part 1 to 28) - 1971 to 1993 unless otherwise mentioned in this part or in the schedule of items or in preamble or in the specification.

1.2 If there is any contradiction in meaning between any portion of this part and that of IS :1200 (Part 1 to 28) - 1971 to 1993, the stipulation of this part shall prevail.

1.3 The descriptions and explanations given herein have as much forces as though they are incorporated into the description of the items themselves in the schedule of items.

2.0 EARTH WORK & SAND FILLING

2.1 General

2.1.1 Each dimension upto 25 m shall be measured to nearest 0.01 m and to nearest 0.1 m for dimensions over 25 m. Areas shall be worked out to the nearest 0.01 m2 and cubical contents to the nearest 0.01 m3.

2.1.2 Shoring and strutting shall not be measured separately unless otherwise specified.

2.1.3 Dewatering for earth work and sand filling work shall not be measured separately unless otherwise specified.

2.1.4 For classification of soils, relevant clauses of Technical specification (workmanship and other requirements) is to be followed.

2.2 Requirements for particular works

2.2.1 Site levelling

2.2.1.1 For site levelling levels shall be ta ken jointly before start & after completion of work and the quantity computed bas ed on the levels. Measurements shall be made only for excavation and no separate measurement for filling shall be made except where earth, bo rrowed from elsewhere for site levelling work, will be measured separately only for that borrowed portion of earth.

2.2.1.2 In cases where it is not possible or convenient to take measurements from excavated cuts or borrow pits, excavation shall be worked out from filling based on the levels to be taken before and after completion of works. Deduction of 10 percent will be made for voids, however for consolidated fills done through heavy mechanical means, the deduction for voids shall be 5% in place of 10%.

2.2.1.3 In exceptional cases where the quantity is meas ured on the lorry measurement, loose stacks, boxes or any other similar method with the approval of the Engineer the deduction fo r voids shall be 20 per cent from the actual quantity.

2.2.2 Excavation

2.2.2.1 Before commencing excavation of foundations for buildings and structures, the initial ground levels shall be join tly recorded. The depth of excavation and the calculation of lift shall be bas ed on this. Normally the initial ground level shall be considered as the level of the site as handed over to the contractor. In case excavation is planned and approved to be taken up subsequent to terracing, the terrace le vel shall be treated as initial ground level.

2.2.2.2 Excavation of foundations, trenc hes, basements, pits etc., shall be measured to the dimensions shown in t he excavation plan, if any, or of the lowest concrete or masonry course, as the case may be and the actual depth. Working space and slopes shall not be measured.

2.2.2.3 Excavation of rock shall be measur ed from stacks of ex cavated rock with a deduction of 50 per cent for voids or measured in the solid based on levels.

2.2.2.4 In case of following works, no measurement will be recorded for the excavation beyond drawing / specification.

(a) In work which will be covered externally with damp proof covering.

(b) In work which requires formwork.

(c) In work which requires workmen to operate from the outside and for guniting and post tensioned concrete, ground beams etc.

However, if there is a specific provision otherwise in the item/specification/preamble, for authorised working, it shall be measured accordingly. This working space may be 60 cm. measured from the face of the structure at lowest level, unless otherwise mentioned.

2.2.2.5 Surface Dressing

Trimming of natural ground, excavated surface and filled up area to remove vegetation and/or small in equalities not exceeding 15 cm deep shall be described as surface dressing and measured in square metres unless otherwise specified in the schedule of items/ preamble.

2.2.2.6 Lead

The distance for removal shall be measured over the shortest practicable route and not necessarily the route actually taken.

The description of the item shall include loading and unloading.

For the purpose of the measurement of the lead, the area excavated shall be divided in suitable block and for each block the distance from the centre of the block to the centre of the placed earth pertaining to this block shall be taken as lead.

2.2.3 Back filling/filling

2.2.3.1 In foundations, trenches, basements, pits, etc. and in other like areas, the measurements shall be the theoretical volume of the filling computed from

drawings i.e. the volume measur ed under excavation minus the volume occupied by the structure and part filling if any, done otherwise.

2.2.3.2 In filling under floors the measurements shall be th e theoretical volume as per drawings after deducting the part filling if any, done otherwise.

2.2.3.3 In embankments, the work shall commence only after recording jointly the initial ground levels and the measurem ents shall be made on the basis of finished cross section and initial ground levels. Where controlled compaction by mechanical compacti on is done, 5% deduction for voids shall be made. In case controlled co mpaction by mechanical means is not done then deduction for voids shall be 10%.

2.2.3.4 Filling/Back filling shall not be measured separately for items of excavation, where filling/back-filling is a part of t he composite item and as such is included in excavation item itself.

3.0 ANTI-TERMITE TREATMENT

Measurement shall be the plinth area of the ground floor of the building treated. Dimensions shall be measur ed to the nearest 0.01 m and area to nearest 0.01 m2.

4.0 CONCRETE (PLAIN & REINFORCED)

4.1 Concrete

4.1.1 Dimensions shall be measured to near est 0.01 m except for the thickness of slab, which will be to nearest 0.005 m. Areas shall be worked out to nearest 0.01 m2 and cubic contents to nearest 0.01 m3.

4.1.2 The concrete shall be measured as per drawings except in the cases of approved variations which will be measured separately.

No deductions shall be made for the following :

i) Ends of dissimilar materials such as beams, rafters, purlins etc., upto 500 cm2 in cross section.

ii) Openings upto 0.1 m2 in area (In ca lculating area of an opening, the thickness of any separate lintel or sill shall be included in the height. No extra labour for forming su ch opening or voids shall be measured).

iii) Volume occupied by reinforc ement or other embedments such as anchors, inserts, conduits or vo lume occupied by pipes, sheathing etc. not exceeding 100 sq. cm. each in cross sectional area or as specified.

iv) Small voids not exceeding 40 cm2 each in cross section.

v) Moulds, drip moulding, chamfer, splay, beds, grooves and rebates upto 10 cm in width or 15 cm in girth.

4.1.3 Columns shall be measured from t op of column base to underside of first floor slab and from top of floor to under side of floor slab above thereafter. Beams shall be measured from face to face of columns and will include haunches. Depth of beam s hall be measured from bottom of slab and in the case of inverted beams from top of slab. Chajjas and other cantilevers shall be measured from the face of t he projection.Where vertical fins are combined with chajja, the latter shall be measured clear between fins. In case chajja is not combined with linte l, beam or slab, it shall be measured inclusive of bearing.

4.2 REINFORCEMENTS

4.2.1 Norms for Steel Consumption

The requirement of mild and high strength deformed bars for various works like reinforcement, guard bars, fan hooks etc. shall be calculated as mentioned below :

i) As per drawing including

(a) Authorised laps, bends, standard hooks and deviations etc.

(b) Spacer bars, chairs, hangers, supports, spacer blocks dowels etc. are to be considered for wa stage only and not to be measured for payment purpose.

ii) Quantity upto 0.5% of (i) above towards unaccounted wastages, plus

iii) Quantity upto 3% of (i) above towards cut pieces, which shall be pieces below 2m. length. These cut pieces shall not be taken back even though steel has been issued by the client/owner.

4.2.2 Reinforcements shall be measured in lengths to the nearest 0.01 m for various diameters of bar and converted in to weight in tonnes to the nearest kg. on the basis of standard weights as per IS : 1786-1986. No allowance shall be made in the weight for rolling margin.

4.2.3 Authorised laps, standard hooks, bends shall be measured.

4.2.4 Sapacer bars, chairs, hangers, supports, spacer blocks and unauthorised laps etc. shall not be measured unless otherwise specified.

4.2.5 Dowels neither shown on the drawi ngs nor instructed by the Engineer, but required for construction facilities shall not be measured for payment.

4.2.6 Modification of already embedded rein forcement, if required due to faulty fabrication or placement, shall not be measured for payment.

4.2.7 The measurements of reinforcem ents (including authorised laps, hooks, bends) shall be taken only from Bar bendi ng lists or from the drawings except in the cases of approved vari ations which will be measured as per 4.2.2.

4.2.8 Wire netting and fabric reinforcem ent shall be described (including meshes and wire/strands) and measured in s quare metre, unless otherwise specified in the schedule of item. Authorised laps shall be measured. Raking or circular cutting and waste s hall be included in the description of item.

4.2.9 Hoop iron shall be fully described and measured in running metres unless otherwise specified in the schedule of item.

4.2.10 Binding wire for the reinforcement shall not be measured separately and shall be included in the item of reinforcement.

4.3 ADMIXTURE

Admixture will be measured separately as specified or on the basis of the requirement as approved by the Engineer.

4.4 FORMWORK

Each dimension shall be measured to the nearest 0.01 m and area to the nearest 0.01 sq.m.

4.4.1 Formwork shall be measured as the ac tual surface in contact with concrete and paid in sq.m. unless included in the rate for concrete in specific item of work.

4.4.2 All the measurements shall be computed from the drawings except in the cases of approved variations which will be measured separately.

4.4.3 Formwork shall not be measured separately for precast concrete work, grouting and damp proof c ourse which shall be included in the concrete rates.

4.4.4 No measurement for formwork in construction joints shall be made.

4.4.5 Openings upto 0.1 sq.m . shall be neglected, as if non - existent, for the purpose of formwork measurement.

4.4.6 No extra measurement or payment shall be made for making the form work water proof or for supports, scaffolding, staging, centering, approaches etc.

4.4.7 No measurement shall be taken fo r the formwork in pockets, openings, chambers, chases etc., in concrete if the cross sectional area is less than or

equal to 0.1 sq.m. in each case. If the cross section area of any opening exceeds 0.1 sq.m. the actual area of the formwork shall be measured for payment.

4.5 EMBEDDED PARTS

4.5.1 These shall be measured on the basis of standard theoretical weight of the complete insert according to the drawing/direction.

4.5.2 Embedded steel, which are the integral parts of the embedment according to drawing and are required for anchoring the embedded parts in concrete shall be measured on the basis of the theoretical standard weight. In case of anchor bolts the theoretical weights of the nuts, lock nuts, check nuts and washers shall be added in the measurement for payment.

4.5.3 All bye-works such as jigs, fixtures, templates and other arrangements which are not integral parts of the embedded parts, but necessary to secure those (embedded parts) in position shall not be measured for payment.

4.5.4 Anti-corrosive paint over the exposed surfaces and protection of the anchor bolts with grease tc., shall not be measured for payment.

4.5.5 Modification works necessary to rectify the mistake of already placed embedded parts shall not be measured.

4.6 GROUTING

4.6.1 Grouting shall be measured in volume except in the cases of grouting by special cement compound or epoxy compound which will be measured by number.

4.6.2 Measurement shall be computed from the drawings except in the cases of approved variations which shall be measured separately and subsequently added to or deducted from.

4.6.3 Necessary formwork shall not be measured for payment.

4.7 DAMP PROOF COARSE

4.7.1 Measurement shall be in sq.m. st ating thickness and computed from the drawings except in the cases of approved variations which will be measured separately.

4.7.2 Necessary formwork shall not be measured for payment.

5.0 MASONRY

5.1 Dimensions shall be measured to nearest 0.01 m, areas to nearest 0.01 m2 and cubic contents to nearest 0.01 m3.

5.2 No deduction shall be made for :

(i) Ends of dissimilar materials such as joints, beams, posts, girders, trusses, lintels, purlins etc., upto 0.1 m2 in section.

ii) Openings upto 0.1 m2 in area.

(iii) Wall plates, bed plates, bearing of slab etc., thickness not exceeding 10 cm. and bearing not extending over the full thickness of wall.

(iv) Cement concrete blocks for holdfasts and the like.

(v) Iron fixtures such as pipes etc. upto 300 mm. dia. and hold fasts for doors and windows.

5.3 Dressed stonework such as in sills, cornices , column caps, copings etc., shall be measured as the smallest rectangular block from which the finished stone can be worked.

5.4 Honeycomb openings shall not be deducted from the area of honeycomb brickwork.

5.5 Brickwork of full brick width or more shall be measured in cu.m. while of thickness of half brick or less sha ll be measured in sq .m., unless otherwise specified.

5.6 Reinforcements for reinforced brick work shall be measured separately, unless otherwise specified and no deduction for reinforcement shall be made from brickwork.

6.0 PLASTERING & POINTING

6.1 All plastering and pointing shall be measured in sq.m. unless otherwise described. Dimensions shall be meas ured to nearest 0.01 m and areas to 0.1 sq.m.

6.2 Ceiling shall be measur ed between walls or partitions (dimensions before plastering) shall be taken. Measurem ent of wall plastering shall be taken between walls or partitions for length (dimension before plastering) and from top of floor or skirting to ceiling for height.

6.3 The methods of measurement in cluding the deductions for openings etc., shall be according to the relevant part of IS : 1200 (Part 1 to 28) - 1971 to 1993.

7.0 WHITE WASHING, COLOUR WASHING, PAINTING & OTHER FINISHES.

The method of measurement shall be according to the relevant part of IS : 1200 (Part 13 & 15) - 1987.

8.0 FLOORING, PAVING & FACING WORKS

8.1 The work shall be measured as a complete finished item including necessary underbed, adhesives, dividing st rips, joint sealing and necessary grinding, polishing and finishing where s pecified. The subgrade or the base course shall be measured separately against respective item unless otherwise specified.

8.2 All works shall be measured net, di mensions being measured to nearest 0.01 m and areas to nearest 0.01 sq.m. Any opening less than 0.1 sq.m. in area shall not be deducted nor any extra payment made for that.

8.3 Building paper or water proofing by bituminous felts/mastic asphalt treatment, where specified to be la id below floor, shall be measured separately for payment unless otherwise specified.

8.4 Laps and seams in sheet finishing (linoleum, cork, PVC, rubber & like) shall be deemed to be included in t he item itself even if not described explicitly and shall not be measured and paid separately.

9.0 WOODWORK

9.1 All work shall be measured net for fini shed dimensions as fixed, that is no extra measurement or allowance sha ll be made for shape, joints, wastage etc. subject to specific provision made in the IS : 1200 (Part 21) - 1973 and for dimensions supplied beyond those specified in the drawing.

9.2 Wooden frame

rought, finished and fixed shall be meas ured net for overall length nearest to 0.01 m, width and thickness to the nearest 2mm or as specified in the drawing and cubic contents calculated in cubic metres to the nearest three places of decimals.

Wooden shutters of all types

Length and width of the shutters sha ll be measured net as fixed to the nearest cm. in closed position coveri ng the rebates of the frame but excluding the gap between the shutter and the floor and the area calculated in square metre upto two places of decimal.

Over lap of two leaves of shutter shall not be measured separately.

Hand rails

Hand rails of finished width and depth as specified in the item shall be measured in running metres upto two places of decimal.

9.3 Painting and polishing, unless ot herwise described in the schedule of items, shall be measured separately for payment.

9.4 Builder's hardware and fittings fo r doors windows and ventilators shall be measured separately, unless stated ot herwise in the Schedule of Items. Hardware and fittings shall be measured according to IS : 1200 (Part-VII) - 1972.

9.5 Hold fasts for door, window and v entilator frames shall be measured separately.

9.6 Timber Partitions

This shall be measured in area calcul ated in sq. m. to the nearest two places of decimal.

9.7 Glazed shutters and glazed partitions (Wooden)

Glazed shutters/glazed partitions with wooden frames shall be measured as a single item in area calculated in sq.m. to the nearest two places of decimal. No separate measurement for glazing/glass panes shall be made.

9.8 Provision of making holes/opening/chas es in masonry/ concrete flooring etc. for fixing and making good of the same shall not be measured separately for payment.

9.9 Bitumen painting or approved wood pres ervative of the timber surfaces in contact with masonry/concrete floor etc. shall not be measured for payment.

10.0 METAL DOORS, WINDOWS & VENTILATORS

10.1 Door, window and ventilator/louvers as fixed, shall be measured net as clear width between jambs and clear height between floor/sill and underside of lintel, but excluding the gap bet ween door shutters and floor. Dimensions shall be calculated to the nearest 0.01 m., area calculated in sq.m. upto two places of decimal.

10.2 For MS collapsible shutter/gate, ro lling shutter sliding folding door, length and breadth shall be measur ed to the nearest cm. fo r the clear area of

opening as per drawing in which they ar e installed and calculated in sq.m. to the nearest two places of decimal.

10.3 M.S. Rolling grills, doors of steel pl ate, sliding door louvered ventilators, gates, grills, as fixed, shall be meas ured and computed to weight from the size as per drawing unless otherwise specified.

10.4 Glazed doors, windows, louvers, parti tions (both steel and aluminium) shall be measured in sq.m. to the nearest two places of decimal. No separate measurement for glazing/glass panes shall be made for payment.

11.0 GLAZING

11.1 Glazing shall not be separat ely measured for doors, windows and ventilators unless otherwise specified.

11.2 North light and roof glazing shall be paid as the area from outside to outside of glazing including frames, to the nearest 0.01 sq.m.

11.3 Glazing, where shown in the schedule of items as a separate item, shall be measured from edge to edge of glass as fixed.

12.0 WATER SUPPLY, DRAINAGE, SEWERAGE & SANITATIONS

12.1 All the pipelines buried under so il/masonry/floors/ concrete, laid over/underground/along masonry/along under floor shall be measured in metres along the centreline together with fittings/specials upto two places of decimal against respective schedule of items for different diameter (the diameter as specified shall mean nom inal bore except PVC pipe) unless otherwise specified.

12.2 All necessary earth work in trenches for laying pipe lines including dewatering, levelling and trimming to the gradient, sand filling in the trenches before laying the pipe, back f illing either by sand or by approved borrowed soil after laying the pipe lines including necessary compaction by spraying water and levelling/dressing the same shall not be measured separately for payment unless otherwise specified.

12.3 All required specials, i.e. bends tees, shoes cowls, plug, elbows, unions, caps, checkout and the like excludi ng valves shall not be measured separately for payment unless otherwise specified.

12.4 All fixing and supporting arrangement of the pipes like the supports, saddles, brackets, clamps, cleats, cove ring the pipes with concrete in case of pipes laid over ground, special arrangement for supporting the pipe like while coming out from the building to the trenches etc. shall not be measured separately for payment, unless otherwise specified.

12.5 All the arrangement in road crossing like cutting the road, diverting the road and drains, concealing the pipes with suitable approved measures, backfilling the area, covering and ma king good of the road with similar materials/design shall not be meas ured separately for payment, unless otherwise specified.

12.6 Septic tanks, inspection pits, m anholes etc., shall be considered as a composite single item including excavati on, dewatering, concrete, masonry, back filling, protection of other service lines and all the like works unless otherwise specified.

12.7 All the valves and all the bathroom/W .C./Kitchen fixures like bib tap, stop cock, shower, all sanitary wares, towel rails, mirrors etc., shall be measured separately under respective item in the schedule, unless otherwise specified.

13.0 WATER PROOFING, DAMP PROOFING

13.1 Water proofing for roofs

13.1.1 Length and breadth shall be measured in metre upto two places of decimal and area calculated in sq.m. upto two places of decimal.

13.1.2 Measurement shall be made for the net covered area. No measurement shall be made for overlapping for end and side joints and for bends around/along the corners, ends and for spec ial treatment around pipes, rain water gulleys, steel stru cture and the like etc. No deduction shall be made

in the measurement for the opening of area less than 0.1 m2 each and no extra payment shall also be made fo r any special works made around such openings.

13.1.3 Water proofing treatment shall be c onsidered as a single composite item including priming painting coat, wate r proofing felts, binding bituminous coats, top bituminous coat and pea size gravel or sand finishing etc.

13.1.4 For lime concrete terracing the cons olidated thickness shall be considered for measurement.

13.2 For Water proofing treatment in basement

13.2.1 With bituminous felts

13.2.1.1 Length and breadth shall be measured in metre upto two places of decimal and area calculated in sq.m. utp two places of decimal.

13.2.1.2 Measurement shall be made for the net covered area. Measurement shall be made from the drawing, except in certain special cases where it is impossible to compute from drawing and the measurement shall be made as executed. No measurement s hall be made for overlaps, special measures around projected pipes, s ealing the bends/rounds and in other cases, necessary projection/ overl ap for the connection between vertical and horizontal junction etc.

13.2.1.3 Water proofing treatment shall be considered as a single composite item, including priming painting coat, wate r proofing felts, binding bituminous coats and top bituminous coat etc.

13.3 Mastic Treatment

13.3.1 Length and breadth shall be measured in metres upto two places of decimal and area calculated in sq.m. upto two places of decimal.

13.3.2 Measurement shall be made for the net covered ar ea. No deduction in measurement shall be made for opening of area upto 0.1 sq.m. each and no extra payment shall be made for an y special treatment around such

openings. No measurement shall be made for extra payment for the special works necessary for junctions, corners, roundings, bends for the works around pipes and the like.

14.0 CEILING & LININGS

14.1 Dimensions shall be measured to the nearest 0.01 m., areas to be worked out to the nearest 0.01 sq.m.

14.2 Work formed to circular surfaces shall be measured separately unless otherwise specified.

14.3 All work unless otherwise described shall be measured as flat in sq.m.

14.4 No deduction in measurement shall be made for openings not exceeding 0.4 sq.m. and no extra measurement shall be made for forming such openings.

15.0 ROAD WORK

15.1 Dimensions shall be measured to nearest 0.01 m. Where the thickness is less than 20 cm., it shall be measured to nearest 0.005 m. Areas shall be worked out to nearest 0.01 sq.m. and cubic contents to the nearest 0.01 cu.m.

15.2 Where thickness is measured, it shall be the minimum thickness after compaction.

15.3 Cement concrete bases and roads shall be measured either in sq.m. or cu.m. as specified.

15.4 Unless otherwise specified, expansion and dummy joints shall be described and measured separately and given in running metres stating the thickness and depth of the joints.

SPECIFICATION FOR CIVIL WORKS

PART – VI SAFETY REQUIREMENTS FOR CONSTRUCTION WORKS

1.0 GENERAL

This specification deals with the subject matter of safety and protection to be observed in the Civil Construction. This shall be followed along with all related statutory requirements/obligation including Governmental byelaws, codes, ordinance of local or central authorities related to the construction work.

In case of complicated work like deep excavation, intricate shuttering and formwork, excavation in loose soil and below water table, stacking of excavated earth etc., work plan with necessary drawings and documents have to be prepared by the Contractor and got approved by the Engineer.

Necessary reference shall be made to the following Indian Standard Codes on safety requirements for various type of work :

Indian Standard

4081 - 1986	Blasting & Drilling.
5916 - 1970	Construction with Hot Bituminous Materials.
4130 - 1991	Demolition of Buildings.
3764 - 1992	Excavation Work
5121 - 1969	Piling & Other Deep Foundations.
4014 - (P-II) - 1967	Scaffolding, Steel Tubular.
3696 - (P-I & P-II) 1987 to 1991	Scaffolds and Ladders.
6922 - 1973	Structures Subject to Underground Blasts.
4756 - 1978	Tunneling Work.
5499 - 1969	Underground Air-raid Shelters in Natural Soil.

4138 - 1977 Working in Compressed Air.

7293 - 1974 Working with Construction Machinery

8989 - 1978 Erection of Concrete Framed Structures.

2.0 BLASTING

2.1 Detonators and other explosive for blasting shall be taken to the blasting area in the original container or any separate non-metal container. This shall not be carried loose or mixed with other materials. Detonators and explosives must be kept separately.

2.2 No shot for blasting shall be fired except by persons licensed to do so.

2.3 Drilling shall not be resumed after a blast has been fired unless a thorough examination has been made to make sure that there is no unexploded charge.

2.4 Before firing a shot, sufficient warnings by means of whistling and/or otherwise shall be given to get men off the danger area. Blasting areas shall be cordoned off & red flags during day time and red lights during night time displayed prominently marking off the cordoned area.

2.5 All people except those who have actually to light the fuses must be removed to a safe distance of not less than 200 metres as a rule.

2.6 Wherever possible, blasting mats should be used.

2.7 Contractors doing blasting work must have licence and an approved magazine to store explosives.

2.8 Blasting operations shall be carried out during fixed hours of the day which shall be notified in writing.

2.9 Provisions in explosives Rules 1940 as amended from time to time, Indian Explosives Act 1844 (IV of 1884), and others shall be strictly followed.

3.0 EXCAVATIONS

3.1 Sides of all excavations must be sloped to a safe angle, not steeper than the angle of repose of the particular soil. If it is not possible to give a proper slope, the sides of the excavation where there is a danger of fall or dislodgement of earth or any material , shall be securely supported by timber or other type of shoring.

3.2 No excavation or earth work below the foundation level of an adjoining building shall be taken up unless adequate steps are taken to prevent damage to the existing structure or fall of any part.

3.3 Every accessible part of an excavation, pit or opening in the ground into which there is a danger of persons falling shall be suitably fenced with a barrier upto a height of one metre suitably placed from the edge of the excavation as far as practicable.

3.4 No material or load shall be placed or stacked near the edge of the excavation or opening in the ground. The excavated material shall not be placed within 1.5 m of the trench or half of the depth of the trench whichever is more.

3.5 Cutting shall be done from top to bottom. No undercutting of sides of excavation shall be allowed.

3.6 All narrow trenches 1.2 m or more depth, shall at all times be supplied with atleast one ladder for each 30m in length or fraction thereof. Ladder shall be extended from bottom of the trench to atleast one metre above the surface of the ground. The side of the trenches which are 1.5 m or more in depth shall be stepped back to give suitable slope, or securely held by planking, strutting and bracing so as to avoid the danger of side collapse.

3.7 Materials shall not be dumped against existing walls or partition to a height that may endanger the stability of the walls.

3.8 While withdrawing piled materials like loose earth, crushed stone, sand, etc., from the stock piles, no over hanging shall be allowed to be formed in the existing dump.

3.9 No material on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or public or any other agency at work.

4.0 DEMOLITION

4.1 On every demolition job, danger signs shall be conspicuously posted all round the structure and all doors, openings giving access to the structure shall be kept barricaded or marked except during the actual passage of workmen or equipment. However, provision shall be made for at least two independent exits for escape of workmen during any emergency.

4.2 During night, red lights shall be placed on or about all the barricades.

4.3 Where in any work of demolition it is imperative, because of danger existing to ensure that no unauthorised person shall enter the site of demolition outside working hours, a watchman should be employed. In addition to watching the site he shall also be responsible for maintaining all notices, lights and barricades.

4.4 All the necessary safety appliances as per IS ;4130 shall be issued to the workers and their use explained. It shall be ensured that the workers are using all the safety appliances while at work.

4.5 The removal of a member may weaken the side wall of an adjoining structure and to prevent possible damage, these walls shall be supported until such time as permanent protection is provided. In case any danger is anticipated to the adjoining structure the same shall be got vacated to avoid any danger to human life.

4.6 The power on all electrical service lines shall be shut off and all such lines cut or disconnected at or outside the property line, before the demolition work is started. Prior to cutting of such lines the necessary approval shall be obtained from the electrical authorities concerned. The only exception will be any power line required for demolition work itself.

4.7 All gas, water, steam and other service lines shall be shut off and capped or otherwise controlled at or outside the building line, before demolition work is started.

4.8 All the mains and meters of the building shall be removed or protected from damage.

4.9 If a structure to be demolished has been partially wrecked by fire, explosion or other catastrophe, t he walls and damaged roofs shall be shored or braced suitably.

4.10 Walkways and passage ways shall be provided for the use of the workman who shall be instructed to use them and all such walkways and passageways shall be kept adequately light ed, free from debris and other materials.

4.11 All nails in any kind of lumber shall be withdrawn, ha mmered or bent over as soon as such lumber is remov ed from the struct ure being demolished, and placed in piles for future cleaning or burning.

4.12 All the roads and open ar ea adjacent to the work site shall either be closed or suitably protected.

4.13 No electric cable or apparatus which is liable to be a source of danger or a cable or apparatus used by the operator shall remain electricity charged.

4.14 All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render it unsafe.

5.0 VEHICLE

5.1 No person shall board any vehicle or equipment when it is in motion.

5.2 Suitable blocks shall be placed against the wheels of a vehicle when it is used for tipping materials into excavati on or a pit or over the edge of any embankment or earthwork to avoid the danger of its running over the edge.

5.3 All workers shall stand clear of the vehicle while it is dumping. If the material being dumped is very heavy or sticky, dump hooks shall be used or dumper shall be clamped to prevent any danger of its tripping.

5.4 Materials shall not be allowed to be loaded in a vehicle so as to project horizontally beyond the sides of the body of the vehicle. All materials projecting beyond the front or rear shall be indicated by a red flag in the day and with red light in the night.

5.5 Driver of the truck or any heavy vehicle shall not reverse it unless assisted by a signal man who shall have a clear view of the driver and the area beyond the truck during reversing operation.

5.6 Maximum speed of a heavy vehicle must not exceed 15 km. per hour.

6.0 SCAFFOLDING, GANGWAYS, LADDERS & SHUTTERING

6.1 For all work that cannot be done from the ground level or from part of any permanent structure or from other available means of support, soundly constructed scaffoldings of adequate st rength shall be used as a safe means of access to places of work.

6.2 All scaffolding shall be securely supported or suspended and wherever necessary be properly braced to ensure stability.

6.3 Chains, ropes or other lifting materials used for the suspension of scaffoldings must be of adequate strength and shall be of tested quality.

6.4 All such chains and ropes used for the suspension of scaffoldings shall be properly fastened to safe anchorage points.

6.5 The platform of a suspended scaffolding shall be sufficiently wide. Suspended scaffolding shall have hand rail on 3 sides of about 1.0 m height.

6.6 All working platform and stages from which workers ar e liable to fall shall be of adequate width depending on the type of work done and closely boarded and planked.

6.7 Scaffolding or staging more than 3.5 m above the ground or floor, suspended from an overhead support or erected with stationary support shall have a guard rail properly atta ched, bolted, braced and otherwise secured atleast 1 m high above the floor or platform of such scaffolding or staging and extending along the entire l ength of the outside ends thereof with only such opening as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or struct ure. The platform shall also be provided with toe boards of atleast 150 mm high so placed as to prevent the fall of materials and tools from there.

6.8 All platforms or gangways, runways and the stairs sha ll be kept free from unnecessary obstructions, materials or junk.

6.9 Working platforms, gangways & stairways shall be so constructed that they shall not sag unduly or unequally, and if the height of the platform or the gangway or the stairway is mo re than 3.5 m above ground level or floor level they shall be closely boarded, shall be of adequate width and shall be suitably fenced.

6.10 Every opening in the floor of a building or in a working platform shall be provided with suitable fenc ing or railing whose minimum height shall be 1 m to prevent the fall of persons or materials.

6.11 Every ladder shall be securely fix ed at top and bottom. A ladder more than 5 m long shall have a prop.

6.12 All ladders used shall be of good construction, sound materials and adequate strength. Ladders with defective or missing rungs shall not be brought into use. The spacing of rungs shall not exceed 30 cms and these shall be recessed atleast 12 mm into rails.

6.13 All ladders or rungs used for vertical height of more than 10 m shall have an intermediate landing. All such in termediate landings shall be provided with guard rails to a height of atleast 1 m.

6.14 Every ladder shall be securely placed so that it cannot move either at the top or at the bottom and it shall rise to a height of atleast 1.2 m above the place of landing.

6.15 No portable single ladder shall be over 8 m in length.

6.16 Spacing between the side rails of the ladder shall not be less than 300 mm for ladders upto 3 m in length. For l onger lengths, this shall be increased at 6 mm for each additional 0.3 m of length.

6.17 Metal ladders must not be used for electrical work or near electric circuit of equipments.

6.18 All scaffolds, ladders and other safety devices mentioned or described herein shall be maintained in safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use.

6.19 Unfinished scaffolding which is under construction shall be prominently marked as unsafe and any access points shall be closed.

6.20 All Planking and Decking on walkways and scaffolds should be adequately supported at each end of the plank and intermediately if necessary. Planks should not be allowed to ca ntilever beyond the last support but should be overlapped if necessary on to the next plant.

6.21 Shuttering

The above remarks shall be applicabl e for this also. Shuttering, particularly for slabs, should be tr eated as a scaffold. Unfinished shuttering should be marked as dangerous similarly the finished formwork should be adequately supported, care bei ng taken to avoid trap door effects.

7.0 MOBILE LIFTING APPLIANCES

7.1 No mobile lifting appliances shall used on a sloping surface unless adequate precautions are taken to ensure stability.

7.2 Adequate precautions shall be taken to see that jib of the mobile crane does not come in contact with overhead electric transmission line.

7.3 Only one person shall give signals to the operator of mobile lifting appliances.

7.4 Maximum load to be lifted by li fting appliances shall be marked in a position where it can be clearly seen by the crane driver and the operator.

7.5 No load shall be raised, lowered or suspended fr om a chain or rope having a knot in any of the part.

7.6 No chain which is joined to another chain by means of bolt and nut shall be used for raising, lowering or suspending any load.

7.7 All chains, ropes and lifting gears shall be carefully examined and tested by a competent Maintenance Engineer atleast once in every quarter.

7.8 When the work is stopped or when the mobile lifting equipment is not in operation, the boom must be lowered to the horizontal position and tied securely in place to prevent accidental drop.

7.9 No person shall walk under a load which is swinging by a lifting equipment.

Guide rope must be attached to the load to prevent its swinging.

7.10 The foot blocks of the crane before starting work shall be securely supported and firmly anchored to prevent its movement in any direction.

7.11 Use of Hoisting machines and tackle including their attachments, anchorage and supports shall conform to the following standards of condition.

7.11.1 These shall be of good mechanical construction, sound material and adequate strength and free from defect and shall be kept in good working order.

7.11.2 Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable qua lity and adequate strength and free from patent defects.

7.11.3 Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years s hall be in charge of any hoisting machine or give signals to the operator.

7.11.4 In case of every hoisting machine and every chain ring hook shackle swivel and pulley block used in hoist ing or lowering or as means of suspension the safe working load shall be ascertained by adequate means, every hoisting machine and all gears referred to above shall be plainly marked with the safe working l oad. In case of hoisting machine having a variable safe working loadi ng, each safe working load of the conditions under which it is applicable s hall be clearly indicated. No part of any machine or of any gear referr ed to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing. Mobile cranes shall have the working load and the radius of jib for the load marked on it.

7.11.5 The top pulley for hoisting a load shall be opened monthly and the spindle inspected to see if any undue wear has taken place and for greasing.

7.11.6 In case of departmental machine, the safe working load shall be notified by the Engineer concerned. As r egards contractor's machines the Contractor shall notify the safe wo rking load of the machine to the Engineer whenever he brings any machin ery to site of work and get it verified by the Engineer concerned.

7.12 Motors, gearing, transmission, electric wiring and other dangerous part of hoisting appliances shall be provided wit h efficient safeguards. Hoisting appliances shall be provided with su ch means as will reduce to the minimum, the risk of accidental descent of the load. Adequate precautions shall be taken to reduce to the minimum, risk of any part of a suspended load becoming accidentally displaced.

8.0 RIVETTING, WELDING & GAS CUTTING & STEEL ERECTION

8.1 Rivetting

8.1.1 Bolts covered with wet or slippery compounds shall not be used in fabricating structural work.

8.1.2 The rivet heater must keep the rivet heating equipment as near as possible to the place of work.

8.1.3 A pail of water shall always be kept ready for quenching fire when stopping rivetting work.

8.1.4 Hot rivet shall not be thrown across aisles and shaftways.

8.1.5 Metal buckets for catching hot rivets must have false wooden bottoms to prevent rivets from rebounding.

8.1.6 All rivets, bolts, nuts, and other tools must be kept in boxes and not left loose, (For any further safety meas ures relevant I ndian Standards and safety specifications of structural section shall be referred to).

8.2 Welding & Gas Cutting

8.2.1 All cylinders must be used and stored in upright position only.

8.2.2 Cylinders must be stored away from open flames and other source of heat.

8.2.3 Oxygen cylinders must not be stored near other cyli nders containing gas or oil, grease or other combustible materials.

8.2.4 While the cylinder is in use, the cylinder valve key or wrench must be placed on the valve spindle.

8.2.5 Before a cylinder is moved, the cylinder valve must be closed.

8.2.6 Gas cutting torches must be lighted by means of friction flames or similar other methods and not with matches.

8.2.7 When torches are being changed or welding stopped for some time valves for all cylinders must be closed.

8.2.8 The coloured lenses used for welding or gas cutting must be of proper shade for the work being done.

8.2.9 Suitable eye protection equipment such as goggles, hand shields etc., must be used by persons engaged in welding or gas cutting operations.

8.2.10 Before any heavy structural member is gas cut, make sure that it is cleared and supported by ropes, cables, chains or any other means to prevent its dropping or swinging.

8.2.11 Cylinder valves and connections are not to be lubricat ed. All oily or greasy substances must be kept away from cylinders.

8.2.12 Substantial and incombustible screen must be used below or near the welding operations, if there is a po ssibility of a spar k falling on other workmen engaged in work closely.

8.2.13 All air pipe lines and air hoses must be frequently inspected. Air hoses shall not be used for dusting or for cooling purposes.

8.3 Steel Erection

8.3.1 All persons shall stand clear when a crane is sorting or shifting steel girders or other structural materials.

8.3.2 No person shall stand, walk or work beneath any suspended load.

8.3.3 Guide rope must be used for guiding lifting loads.

8.3.4 When guiding a beam or fabricated structure or erection it shall be so held that the employees hands do not get jammed against other objects.

8.3.5 Safety belts equipped with suitable life lines must be used by persons working at heights and standing on structur al members. Life line must be tied to an independent support. For any further safety measures, for Structural Steel Works, IS : 7205 - 1974 shall be referred to.

9.0 SAFETY APPLIANCES

9.1 Workers employed on mixing asphaltic materials, cement and lime mortars, shall be provided with protective footwear and protective goggles.

9.2 Those engaged in white washing and mixing or stacking of cement bags or any materials which is injurious to the eyes, shall be provided with protective goggles.

9.3 Those engaged in welding works shall be provided with welder's protective eye-shields.

9.4 Stone breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.

9.5 When workers are employed in sewers and manholes which are in use, the Contractor shall ensure that the manhole covers are opened and chambers are ventilated atleast for an hour before the workers are allowed to get into the manholes, and t he manholes so opened shall be cordoned off with suitable railing and provided wit h warning signals or boards to prevent accident to the public.

9.6 The Contractor shall not employ men below th e age of 18 and women on the work of painting with products cont aining lead in any form. Whenever men above the age of 18 ar e employed on the work of lead painting the following precautions shall be taken :

9.6.1 No paint containing lead or lead products shall be us ed except in the form of paste or ready made paint.

9.6.2 Suitable face mask should be supplied for use by them when paint is applied in the form of spray on a surf ace having lead paint dry rubbed and scraped.

9.6.3 Overalls shall be supplied by the Contractors to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.

9.7 The workers going into inspection chamber shall have gas masks, gum boots and rubber gloves while working insi de. After coming out they shall have some disinfectant from the first aid box for proper washing

9.8 All necessary personnel safety equipment such as safety helmets, safety boots, safety belts, leather gloves for welders, clear glass safety goggles etc., as considered adequate by the engi neer have to be kept available for the use of persons employed at t he site of work and maintained in condition suitable for immediate use and Contractor shall take steps to ensure proper use of equipment by the workers.

9.9 All the persons enteri ng the tunnel shall be provi ded with protective wear, such as helmets, steel toe safety shoe, gum boots or other suitable type of protective foot wear. In the case of steeply inclined tunnels and inshafts, safety belts shall also be provided.

9.10 Sign boards 1 x 1.5 m in size with the following wording shall be erected at the access to these areas. "CONSTRUCTION AREA, HELMET REQUIRED BEYOND THIS POINT"

9.11 No loose garments or ragged clothing shall be worn by the personnel engaged in tunneling operation.

9.12 A telephone system shall provided to ensure a positive and quick method of communication between all control lo cation inside tunnel and portal of the tunnels when longer than 500 m and for shafts when longer than 50 m

9.13 Irrespective of length and bends in the tunnel, arrangements shall be made for transmitting of warning si gnals by any one of the following means.

9.13.1 By electrically operated bells, operated by battery/dry cells with the bell placed outside the tunnel and the position of the switch shifting with the progress of the tunneling work. T he position of the operating switch although temporary shall be so chosen as to ensure proper accessibility and easy identification.

9.13.2 By the use of two field (magnet type) telephone.

9.13.3 Any other suitable arrangement like walkie-talkie.

9.14 Arrangement for rendering prompt and adequate first aid to the injured persons shall be maintained at every work site under the guidance of a medical officer-in-charge of the project. Depending upon the magnitude of the work the availability of an am bulance at a very short notice (at telephone call) shall be ensured.

9.15 First-aid arrangements commensurate with the degree of hazard and with the number of workers employed s hall be maintained in a readily accessible place throughout the worki ng hours. At least one experienced first-aid attendant with his distinguish ing badge shall be available on each shift to take care of injured per sons. Arrangements shall be made for calling the medical officer, when such a need may arise. It is recommended that foreman/assistant foreman/supervisor/ permanent workmen who are normally present at each working phase in each shift

are given adequate training on first-aid me thods to avoid employment of a separate attendant.

9.16 Stretchers and other equipment necessary to remove injured persons shall be provided at every shift.

9.17 Where there are more than 50 persons working in a shift, effective artificial respiration arrangements shall be provided, with trained men capable of providing artificial respiration.

10.0 ELECTRICAL

10.1 Only authorised persons shall handle or otherwise interf ere with electrical equipment. Any person detecting elec trical apparatus being handled by an unauthorised person or equi pment in unsafe condition must report the matter to the Engineer concerned.

10.2 No person shall work on any live electric conductor or apparatus and no person shall assist such person on su ch work, unless he is authorised in that behalf.

10.2.1 After isolating the equipment from the source of supply before the work begins, a sign 'DONT'T SWITCH ON' mu st be hung on or near the switch to avoid its being accidentally or i nadvertently switched on when persons are working.

10.2.2 Take out the fuses and keep in safe custody.

10.2.3 The switch may be locked if locking arrangement exists.

10.2.4 Earth the equipment, before work, to discharge it and short the terminals as a precautionary measure against accidental switching ON.

10.2.5 After the work is finished take out Earthing and shorting link.

10.2.6 Remove all tools and materials from the site of work. Replace the fuses and unlock the switch.

10.2.7 The switch shall only be put 'ON' by the person who switched it 'OFF' or by the person authorised by him in writing.

10.3 When working on live equipment use one hand only whenever possible, it is advisable to keep the other hand behind the back. Shocks from hand to hand are most dangerous.

10.4 All persons handling electrical gear in elevated position must use safety belts. Even a slight shock may cause loss of balance and fall.

10.5 No one shall attempt to extinguish a fire on or near a live electrical apparatus with water. Water is a good conductor of electricity. Use extinguishers wherever provided. Use sand and blankets etc., if available.

10.6 No person shall use any part of electrical equipment for storing or hanging clothes, umbrellas or other articles. Serious accidents occur from this practice.

10.7 For attending the work on O.H. lines or equipment use wooden ladders. Metallic ladders shall not be used.

10.8 Use insulated tools and ensure the insulation is in proper condition periodically at least once in three months. Use rubber gloves wherever possible.

10.9 As far as possible verbal instructions shall be avoided in case of pre-arranged shut-down of electrical apparatus.

10.10 When workers are employed for electrical installations which are already energised, insulating mats, wearing apparel such as gloves, sleeves and boots as may be necessary shall be provided. The workers shall not wear any rings, watches and carry keys or other materials which are good conductors of electricity.

11.0 MISCELLANEOUS

11.1 The Contractor shall provide necessary fencing and lights to protect the public from accident.

11.2 Fire extinguishers adequate in number shall be kept by the Contractor at the site of works where there is risk of fire hazard.

11.3 Adequate washing facilities shall be provided near the place of work.

11.4 When the work is done near any place where there is risk of drowning, all necessary equipments shall be provi ded and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provisions shall be made for pr ompt first aid treatment of all injuries likely to be sustained during the course of the work.

11.5 These safety provisions shall be brought to the notice of all concerned by displaying on a Notice Board at a prom inent place at the work spot. The persons responsible for compliance of the code shall be named therein by the Contractor.

11.6 To ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangements made by the Contractor shall be open to inspection by the Engineer and Owner.

11.7 Not withstanding the above clauses there is nothing in those to exempt the Contractor from the operat ions of any other Act or Rule in force in the Republic of India.

11.8 All storage, handling and use of flammable liquids shall be under the supervision of qualified persons. Fl ammable liquid shall not be stored inside the tunnel

11.9 All sources of ignition shall be prohibited in areas where flammable liquids are stored, handled and processed. Suitable warning and 'NO SMOKING' signs shall be posted in all such places. Receptacles containing flammable liquids shall be stacked in such a manner as to permit free passage of air between them.

11.10 All combustible materials shall be continuously removed from such areas where flammable liquids are stored, handled and proce ssed. All spills of flammable liquids shall be cleared up immediately. Containers of flammable liquids shall be tightly capped.

12.0 REPORTING OF ACCIDENT

All accidents, major or minor must be reported immediately. The Contractor, will provide first aid to the injured person immediately and the injured person shall report to the first aid station along with the 'INJURED ON WORK' form duly filled in quintuplicate and submit to the Medical Officer of the First Aid Station".

Serious Injury

In case of serious injury, the following procedure shall be adopted by the Contractor :

1. Provide First Aid at his own First Aid Station.

2. Take the injured person to the Hospital along with the "INJURED ON WORK" form duly filled in.

3. Reporting the accident to the Owner/Engineer by the Contractor.

Fatal Accident

Fatal accident must be reported immediately to the Engineer/Owner as well as to the Police.

Penalty

Failure to observe the Safety Rules will make the Contractor liable to penalty by way of suspension of work, fine and termination of contract.

SPECIFICATION FOR CIVIL WORKS

ANNEXURE- A

LIST OF IS & IRC CODES REFERRED

ANNEXURE - A

LIST OF IS & IRC CODES REFERRED

IS 383	:	Specification for coarse & fine aggregates from natural sources for concrete.
IS 2386 (Part 1 to 8)	:	Method of Test for aggregates for concrete
IS 456	:	Code of practice for plain and reinforced concrete.
IS 712	:	Specification for building limes.
IS 3182	:	Specification for broken brick (burnt clay) fine aggregate for use in lime mortar.
IS 269	:	Specification for 33 grade ordinary Portland Cement.
IS 455	:	Code of practice for Portland Slag Cement.
IS 1489	:	Specification for Portland Pozzolana Cement.
IS 8041	:	Specification for rapid hardening Portland Cement.
IS 8112	:	Specification for 43 grade ordinary Portland Cement.

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

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

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

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

workmanship of natural building stones for masonry work.

IS 2185 (Part-1)	:	Specification for concrete masonry unit Hollow and solid concrete blocks.
IS 2116	:	Specification for sand for masonry mortar
IS 1542	:	Specification for sand for plaster.
IS 2185 (Part-2)	:	Specification for concrete masonry unit- Hollow and solid light weight concrete blocks.
IS 2185 (Part-3)	:	Specification for concrete masonry unit - Auto claved Cellular Aerated concrete blocks.
IS 6041	:	Code of practice for construction of Auto claved Cellular concrete block masonry.
IS 6441 (Part 1 to 9)	:	Method of Test for Auto claved Concrete Products.
IS 3068	:	Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete.
IS 2114	:	Code of practice for laying in-situ terrazo floor finish.
IS 460 (Part 1 to 3)	:	Specification for Test Sieves.
IS 1237	:	Specification for cement concrete flooring

tiles.

IS 777 : Specification for glazed earthen ware wall tiles.

IS 1129 : Recommendation for dressing of natural building stone.

IS 1130 : Specification for Marble (blocks, slabs and tiles).

IS 809 : Specification for rubber flooring materials for general purposes.

IS 3462 : Specification for unbacked flexible PVC flooring.

IS 3461 : Specification for PVC asbestos floor tiles

IS 2818 : Indian Hessians.

IS 653 : Linoleum sheets and tiles.

IS 5389 : Code of pra ctice for laying hard wood parquet and wood block flooring.

IS 210 : Grey Iron Castings.

IS 2114 : Code of practice for laying in-situ terrazzo finish.

IS 1198 : Code of practice for laying of linoleum flooring.

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

hinges.

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

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

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

engineering purposes).

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

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

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

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

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

and ventilating pipes, fittings and accessories.

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

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

concreting. Recommended practice for cold weather concreting.

IS 2502 : Code of practice for bending and fixing of bars for concrete reinforcement.

IS 2751 : Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.

IS 800 : Code of practice for general construction in steel and deformed bars.

IS 816 : Code of practice for use of metal arc welding.

IS 814 : Covered electrodes for manual metal arc.

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

IS 2911 (Part 1 to 4) : Code of practice for design and construction of pile foundations.

IS 1343 : Code of practice for prestressed concrete.

IS 1785 (Part 1&2) : Specification for plane hard drawn steel wires for prestressed concrete.

IS 2250 : Code of practice for preparation and use of masonry mortars.

IS 1635: : Code of practice for field slaking of building

lime.

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

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

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

concrete pavement.

IS 1838 (Part 1)	:	Specification for performed filler for expansion joint in concrete pavements and structures.
IRC-43	:	Recommended practice for Tools, Equipment and appliances for concrete pavement construction.
IRC-15	:	Standard specifications and code of practice for construction of concrete road.
IS 3036	:	Code of practice for laying lime concrete for a water proofed roof finish.
IS 1346	:	Code of practice for water proofing of roofs with bitumen felts.
IS 1609	:	Code of practice for laying damp proofing treatment using bitumen felt.
IS 4365	:	Code of practice for application of bitumen mastic for waterproofing of roofs.
IS 9103	:	Specification for admixtures for concrete.
IS 2645	:	Specification for integral cement water proofing compounds.
IS 1834	:	Specification for hot applied sealing compound for joint in concrete.

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

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