MANGALORE REFINERY & PETROCHEMICALS LTD.

(A subsidiary of Oil & Natural Gas Corporation Ltd – ONGC)

Regd. Office: Kuthethoor P.O., Via: Katipalla, Mangalore-575030 (India)

TENDER FOR

PACKAGE A	**DEVELOPMENT OF SECURITY INFRASTRUCTURE FACILITIES AT** 1. MRPL MAIN GATE 2. CARGO GATE 3. LP GATE
PACKAGE B	**DEVELOPMENT OF SECURITY INFRASTRUCTURE FACILITIES AT** 1. PHASE III GATE

VOLUME-II of II

TECHNICAL SECTION

Tender No: 3200000698 dated 06.08.2023

TECHNICAL SPECIFICATION

Architectural, Civil & Structural

Fire Hydrant System

Electrical

Architectural, Civil & Structural

1.0 GENERAL SCOPE

1.1 The current project envisages the modernisation of civil and security infrastructure at various gates complexes and other locations of MRPL. The approximate summary of changes is as below:

PACKAGE A	Main Gate	Traffic laning from Chota Gate to Main Gate Development of open parking Construction of Main Gate plaza Construction of gate tunnel with overhead canopy Various Security equipment Lobbies for visitors, executives and contract labour
	LP Gate	Modification of existing security builring Construction of gate tunnel with overhead canopy Various Security equipment
	Cargo Gate	Relocation of existing security check cabins Relocation of gates Construction of cabins / pedestrian paths
PACKAGE B	Phase III Gate	Development of open parking Construction of Gate Plaza Construction of gate tunnel with overhead canopy Various Security equipment Lobbies for visitors, executives and contract labour Traffic Laning Construction of Boundary Wall

1.2 These specifications establish and define the material and constructional requirements for Civil, structural and architectural works.

1.3 Method of measurements is indicated in these Specifications. Where not so specified, latest version of IS: 1200 shall be applicable.

1.4 Providing and operating necessary measuring and testing devices and materials including all Consumables are included in the scope of work. No separate measurement or payment for testing

the work shall be made but rates quoted for various items shall be deemed to include the cost of such tests, which are required.

1.5 All materials shall be standard quality, manufactured by renowned concerns, conforming to Indian Standards or equivalent and shall have "IS" mark as far as possible unless otherwise approved by engineer-in-charge prior to procurement and use. The Contractor shall furnish manufacturer's certificates for the materials supplied by him when asked for. Further to that he shall get the materials tested from an approved Test House, if asked for by the Engineer-in-charge. The cost of all the tests and test certificates shall be borne by the contractor. No separate payment shall be made for the testing. The Engineer-in-charge shall have the right to determine whether all or any of materials are suitable. Any materials procured or brought to site and not conforming to Specifications and satisfaction of the Engineer-in-charge shall be rejected and the Contractor shall have to remove the same immediately from site at his own expense and without any claim for compensation due to such rejection.

1.6 Wherever referred to in this tender document, only the latest revision, which shall be in force till the completion of work, of specification, Codes of Practice and other publications of the Bureau of Indian Standards, shall be applicable.

1.7 Wherever Contractor executes civil and structural works involving building and equipment foundations, structural work or building pipe etc. the following works are deemed to have been included in the quoted rates for various works.

a. Mark of centerlines of foundations.

b. Marking of top levels of foundations, floors, etc. and establishment of reference lines, benchmarks on various floors, platforms etc.

c. Preparation of "as built" scheme of structural foundation and indicating designed and achieved levels, center lines and dimensions of pockets, position and level of anchor bolt etc.

1.8 In case of conflict amongst the provisions of Schedule of Rates, Specifications and drawings, all of them shall be read in conjunction with each other and clarification shall be obtained from the Engineer-in-charge whose decision shall be final and binding. Following procedure may generally be followed.

a. Description of items in Schedule of Rates shall be followed when provisions

b. Therein are different from those in Specification.

c. Where the description of item does not call out for some specific requirement but the same are given in specifications, the specification shall be followed in addition to the requirements given in description of items.

d. Where drawings call out for requirements different from or additional to those given in items description and specifications, the decision of the Engineer-in-charge shall be obtained as to what shall be followed.

In case of conflict amongst the provisions of Schedule of Rates, Specifications and drawings, all of them shall be read in conjunction with each other and clarification shall be obtained from the Engineer-in-charge whose decision shall be final and binding. Following procedure may generally be followed.

1.8.1 Description of items in Schedule of Rates shall be followed when provisions therein are different from those in Specification.

1.8.2 Where the description of item does not call out for some specific requirement but the same are given in specifications, the specification shall be followed in addition to the requirements given in description of items.

1.8.3 Where drawings call out for requirements different from or additional to those given in items description and specifications, the decision of the Engineer-in-charge shall be obtained as to what shall be followed.

2.0 TYPE AND MAKE OF MATERIALS TO BE USED

All the materials shall be got approved by Engineer in-charge prior to their use.

SL. No	NAME OF MATERIAL	APPROVED MAKE
1	Cement	ACC, Birla super, Ambuja, Ultra tech
2	Reinforcement & Structural Steel	TATA, SAIL, VIZAG (RINL), JINDAL, JSW
3	Glazed, Ceramic & Vitrified Tile	Johnson, Kajaria, Somany,
4	UPVC Window/Door	Venster, Fenesta, Adopenindia, Lingel windows, Wintech
5	Acrylic emulsion paints/Distempers/Synthetic enamel paint/thermoplastic road marking paint	Asian, Berger, Dulex, Nerolac
6	Water proofing / Construction chemical admixture	BASF, Pedelite, Fosroc
7	Glazing/ Glass	Saint Gobain, Modi, Tata float
8	Paver block	Aeons, Hicon, Malu, Vibrant besser, Basant Paver or locally made meeting the tender requirement.
9	Sanitary fixtures	Jaquar, Hindustan sanitaryware, Grohe
10	Sanitary fittings	Jaquar, Hindustary& Grohe.
11	PVC/ UPVC/ CPVC Pipe & Fittings	Supreme, Prince, Finolex, Ashirvad, Astral
12	GI Pipe/ MS pipe	TATA, Zenith, GST, Jindal
13	Gun metal gate valve/ Check valve	Leader, GG (ISI marked), Aidco, IVC, Fludiline

14	PVC water tank	Sintex, Polycon, Rotex
15	Locks	Godrej, Europa
16	G.I. Fittings	R-Brand, K-brand, Unik
17	Stone ware pipe & Gully trap	Mysore, Perfect Potteries, Barrow's & CC
18	Brass hardware	Saifee, Tube & Hardware
19	Water pumps & motors	Kirloskar, groundfous, Crompton
20	HDPE Pipe	Supreme, Sangir, Oriplast
21	Rolling shutter	Avians, JaibharaniEngg., Srisai Ganesh Structurals.
22	Aluminium Composite Panel Sheets	Alstrom, Eurobond, Redbond
23	FRP door	SSTAR doors, ASTRAL windows, Rawji industrial Corporation.
24	Plywoods& laminates	Duro, Greenply, Century, Kitply, Archid
25	Zincalume / Gelvalume Sheet	Jindal, JSW, Tata Bluescope
26	Stainlees steel works	Jindal, Bhawani
27	Pest control	PCI / equivalent
28	Door Hardware	Yama, Yale Godrej, Suzu steel, Dorma, Hardwyn
29	Lifts (Elevators)	Kone, Johnson, Otis
30	Traffic Signals	Keltron, CMS, Nucleonics
31	Gypsum Board	India Gypsum, Saint Gobain

32	Grid Ceiling Tiles	Armstrong, Gyproc, saintgobin
33	Glass	Saint Gobain, Asahi
34	Cupboards	Godrej, Ikea, Nilkmal, Durian
35	Vertical blinds for windows	D'décor, Elegant Décor or equivalent
36	Truss less (Self-supported) Roofing	Proflex, Kalzip, Safintra, Mercury, Kailash Roofing
37	Lockers	Godrej, Nilkmal
38	Gate Automation	Faac, Came, Nice, Armstrong, Samarth

Note:

a. Above maker of materials are approved subject to meeting the tender specification & site requirement.
b. The sample of the materials shall in either case have to be got approved from Engineer in charge before procurement.
c. Material where no make/brand has been mentioned, in that case ISI marked sample shall be submitted by the contractor for approval of Engineer in charge.
d. For any item not covered in the list, the contractor shall get the make & sample approved from EIC before procurement. The final choice of make to be used in the works will rest with MRPL & the decision of EIC shall be final & binding on the contractor in this respect.
e. Contractor will be responsible to ensure the quality of products listed in approved list of makes/brands. Contractor will have to replace the defective & sub-slandered materials at his own cost.

3.0 BUILDING MATERIALS

3.1 SCOPE

The scope for the Section is to specify the properties, storage and handling of common building materials unless otherwise mentioned in drawings or schedule of items.

3.2 MATERIALS

3.2.1 Stone

All Stones shall be from approved quarries, hard, tough, durable compact, drained, uniform in texture and color and face from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean and sharp and shall show uniformity of textures, without loose grains and fee from any dull, chalky or earthy appearance. Stone showing mottled colors shall not be used for face works. A stone shall not absorb more than 5 percent of its weight of water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for Comparison of bulk supply.

3.2.2 Laterite stone

The stone blocks shall be without any soft veins, cracks, cavities, flaws and similar imperfections. The blocks shall be exposed preferably for a period of three months before being used in the construction of masonry to ensure adequate stabilization However, exposure to rains should be avoided. Compressive strength not less than 3.5 N/mm2 (saturated dry samples.) IS: 1121 (Part I)-1974.

3.2.3 Earth

For filling and terracing shall be free from all rubbish organic or vegetable growth including roots, weeds etc. All clods shall be first broken down.

3.2.4 Cement

Cement used shall be ordinary Portland cement conforming to Code for ordinary cement in IS: 8112 and shall be fresh when delivered. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If the cement is procured by the Owner and issued to the Contractor, the Contractor shall satisfy himself at the time of taking delivery that the quality, quantity and freshness of cement are upto the specified standards No. shall be entertained and all

rectification work on this account shall be done by the Contractor at his own expense. If at any time, the Engineer feels that the cement being used by the Contractor is not upto specification may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall else have no claim for this type of suspension of work.

3.2.5 Coarse Aggregates

Coarse aggregates shall be as per IS: 383 latest edition, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc, and any other materials liable to effect the strength durability or appearance of concrete. Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer. Washing of aggregates by approved means shall be carried out, if desired by the Engineer. Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete of the specified proportions and strength and of consistency that will work readily into position without segregation.

Grading of aggregate

40mm gauge

The grading shall be such that not more than 75% shall exceed 40mm and not less than 25% smaller than 20. No piece shall in any case be larger than 45mm. It shall be screened free from dust or other foreign materials.

20mm nominal gauge

It shall be given in RCC specifications. If proper gauge of aggregate is not being obtained sieving may be insisted upon in which case the contractor shall supply.

3.2.6 Sand

Sand shall be hard, durables, clean and free from adherent coating or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrities, alkalis, salts, coal, mica, shale or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability of appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded. Unless otherwise directed by the Engineer all sand shall pass through IS Sieve No.240 and 15% to 35% of

sand for masonry mortar and 5 to 50% of sand for plaster shall pass through IS Sieve No.30. Sand for concrete shall conform to IS: 383.

3.2.7 Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

3.2.8 Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall conform to IS: 226. Mild steel and medium tensile steel bars and hand drawn steel wire for concrete reinforcement shall conform to IS: 432. Cold twisted steel bars shall conform to IS: 1786. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10mm diameter shall be of tested quality. All wire netting shall be galvanized.

3.2.9 Scaffolding

Scaffolding shall consist of Steel and necessary battens and planks. All the scaffolding members before installation shall be checked for their strength and stiffness and tied up properly steel scaffolding if available may also be used. Where scaffolding is necessary, it shall be erected on double supports. Holes shall not be made in wall for support. Planks shall be fixed and tied together. In case of finishing work such as plastering, painting and distempering, no part of the scaffolding should touch the structure. Where ladders are used, gunny bags shall be tied up at the ends to prevent any damage to work by sliding or tipping.

3.2.10 Timber

Timber shall be of type as stated in schedule and the best kind available, perfectly dry, well seasoned, free from sapwood, sound, straight, free from knots, cracks, shakes and other defects and any appearance of rot.

3.2.11 Mild Steel / Tor Steel

It shall comply with the Indian Standard specifications for construction work. The surface shall be free from rust. All steel shall be of Tata's, H.S.L. or other approved Indian manufacturers. Untested steel shall not be used unless otherwise specified.

3.2.12 Steel Doors

Steel doors shall conform to the Indian Standards specification NO. IS: 1038 read in conjunction with IS: 1080 and 1081. They may be side, top or center hung, vertically or horizontally pivoted or fixed and of composite sizes as detailed on the drawings, joined together side by side or on top of one another by fabricated mullions (vertical coupling members) or transom (horizontal coupling members) as may be required and as shown on the drawings. The size of section shall be such as to be adequate for the specific type shown on the drawings. The contractor must include in his rates for additional strengthening members for large size of doors wherever necessary. All sizes shown on the drawings are over all heights and width of the outside frames of steel doors. The sizes indicated on the drawings shall vary plus or minus 1.5mm.

3.2.13 Glass

Sheet or plate glass shall be of approved Indian make of thickness as stated in the schedule of quantities and visually clear when viewed from any direction. It shall be free from bubbles, waves and other defects.

3.2.14 Special Materials

If materials of a particular brand are specified in the schedule of quantities, these shall be procured accordingly from the particular manufacturer. These shall include materials such as bitumen and bituminous compounds, water proofing compounds, hardening compounds, special paints, acoustic and insulation boards and other finishing materials of approved makes. The responsibility for the use of these materials lies with the contractor and should avail himself of necessary guarantee from the manufacturers. Such guarantee as may be required by the employer shall be obtained by the contractor and given to the employer.

3.3 STORAGE AND HANDLING OF MATERIALS

3.3.1 General

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realized from the Contractor's dues. The Contractor shall maintain upto date accounts of receipts, issue and balance (stack-wise) of all materials. Storage of materials shall conform to IS: 4082.

3.3.2 Bricks

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

3.3.3 Stones

Stones shall be stored at site in manner approved by the Engineer. Dressed stone for wall facing, paving etc. shall be stored with special care to avoid defacement of faces and edges or damp and rust stains.

3.3.4 Cement

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal of first in first out basis. Any material considered defective by the engineer shall not be used by the contractor and shall be removed from the site immediately.

3.3.5 Coarse and Fine Aggregates

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass or any other injurious substances at any stage. Aggregate of different size shall be kept in separate stacks. If so desired by the engineer aggregate from sources shall be stacked separately with proper care to prevent intermixing.

3.3.6 Reinforcement

Reinforcement bars shall be stored off the ground and under cover if so desired by the engineer. If necessary a coat of cement wash shall be given to the bars to guard against rusting.

EARTH WORK IN EXCAVATION AND BACKFILLING

4.1. SCOPE

This specification covers site clearance and excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring blasting, shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc relevant to structures and locations covered under the scope of this contract.

4.2. GENERAL

4.2.1. Codes and Standards

All works under this specification, unless specified otherwise shall conform to the latest revision and/or replacement of the following or any other Indian Standard Specification and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed.

IS: 3764	Indian Standard for Safety Code for Excavation Work.
IS: 1200	Indian Standard Method of Measurement of Building and Civil Engineering work (Part-I) Part-I: Earthwork.
IS: 4701	Indian Standard Code of Practice for Earthwork on Canals.

4.2.2. Conformity with Designs

The Contractor is to carry out the work as per the drawings issued to him and/or Contractor's drawings, which are approved, by the Engineer and /or Engineer's instructions.

4.2.3. Materials to be used.

All materials required for the work shall be of best commercial variety and approved by the Engineer.

Borrow Material

Borrow material required for back filling shall be excavated from approved locations and levels and shall consist of material, approved by the Engineer, free from roots, vegetation,

decayed organic matter, harmful salts and chemicals, free from lumps and clodes. If specified, clean graded sand free from harmful and deleterious material from approved quarries shall be used as fill material.

4.2.4. Quality control

The contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipments used. The quality control operation shall include but not limited to the following items of work.

(a) Lines, levels and grades: (i) Periodic surveys

(ii) Establishment of markers, boards etc.

(b) Back filling: (i) Checking the quality of fill material

(ii) Checking moisture content of the backfill

(iii) Checking the degree of compaction

4.3. EXECUTION

4.3.1. Setting out

Within 15 days of award of Contract, the Contractor will prepare and submit to the Engineer detailed drawings of the excavation work as proposed to be executed by him showing the dimensions as per drawings and specification adding his proposals of slopes, shoring, approaches, dewatering sumps, berms, etc. On receiving the approval from the Engineer with modification and corrections, if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be fixed at intervals prescribed by the Engineer and checked by the Engineer and certified by him after which the Contractor will proceed with the work. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the contractor of his responsibility of carrying out the work to true lines and levels and grades as per drawing and subsequent corrections, if necessary, free of cost to the Owner in case any errors are noticed in the Contractor's work at any stage.

4.3.2. Initial Levels

Initial levels of the ground either a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for crosschecking the depths obtained from tape measurements.

All records of levels, measurements etc. and also any drawing, cross section etc. made there from, shall be jointly signed by the authorized representative of the contractor and the engineer before the commencement of work and they shall form the basis of all payments in future.

4.3.3. Clearing and Grubbing etc.

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc., and leveled up. Trees upto300mm girth shall be uprooted. Trees above 300 mm girth to be cut, shall be approved by the Engineer and then marked. Felling of trees shall include taking out roots upto 600 mm below ground level or 150mm below formation level whichever is lower. After the tree is cut and roots taken out the pot-holes formed shall be filled with good earth in 250 mm layers and consolidated unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer.

Before earth work is started, all the spoils and unserviceable materials and rubbish shall be burned or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed. Useful materials, saleable timber, firewood etc. shall be the property of the Owner and shall be stacked properly at the work site in a manner as directed by the Engineer.

4.3.4. Classification

All earthworks shall be classified under the following categories:

a) Ordinary Soil

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud pet, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging

implement. Removal or any other modular material having diameter in any one direction not exceeding 75mm occurring in such strata shall be deemed to be covered under this category.

b) Hard Soil

This shall include

i) Stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and chovel, closely applied.

ii) Gravel and cobble stone having maximum diameter in any one direction between 75mm and 300 mm.

iii) Soling of roads, paths, etc, and hard core

iv) Macadam surfaces such as water bound, and bitumen/tar bound

v) Lime concrete, stone masonry in lime mortar and brickwork in lime/cement mortar, below ground level.

vi) Soft conglomerate, where the stones may be detached from the matrix with picks; and

vii) Generally any material, which requires the close application of picks or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil, mentioned in (i) and (vi) above.

c) Soft and Decomposed Rock

This shall include;

i) Limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock, which may be quarried or split with crowbars.

ii) Unreinforced cement concrete, which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level.

iii) Boulders which do not require blasting having maximum diameter in any direction of more than 300 mm found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin; and

iv) Any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) **Hard Rock (requiring blasting)**

This shall include

i) Any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is requiring.

ii) Reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and

iii) Boulders requiring blasting

e) **Hard Rock (blasting prohibited)**

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

4.3.5. Excavation for Foundations and Trenches

4.3.5.1. General

All excavations shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor, in each individual case, for the method he proposes to adopt for the excavations including dimension, side slopes, shoring, dewatering, disposal etc. This approval however shall not in any way make the Engineer responsible for any consequent loss and damage. The excavation must be carried out in the most expeditious and efficient manner.

All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders projecting out of the excavated surface shall be removed, if in opinion of the Engineer they are likely to be hindrance to the workers.

Method of excavation shall be in every case subject to the approval of the Engineer and the Contractor shall ensure that stability and safety of the excavation, adjacent structures, services and works.

The Contractor shall have full responsibility of the stability of the excavation and safety of the workmen. If any slip occurs, the Contractor shall remove all slipped material from the excavated pit.

All loose boulders, semi-detached rocks not directly in excavation but so chose to the area to be excavated as to be liable in the opinion of the Engineer to fall or otherwise endanger the workmen, equipment of the work etc., shall be stripped off and removed away from the areas of excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion, which was originally sound and safe. Any materials not requiring removal as contemplated in the work, but which, in the opinion of the Engineer, is later to become loose or unstable shall also be promptly and satisfactorily removed as directed by the Engineer.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

Information of rock requiring blasting, those over cuts which are unavailable will be made up by ordinary cement concrete 1:2:4 which will be paid for under appropriate rate, provided this over cut is not due to negligence of the contractor. The decision of the Engineer as to the admissibility of such over cut for payment will be final. All excavated materials such as hard rock, boulders, bricks, dismantled concrete blocks etc, shall be stacked separately as directed by the Engineer and shall be the property of the Owner.

4.3.5.2. Excavation in ordinary Soil, hard Soil and Soft and Decomposed Rock

The excavation in ordinary soil, hard soil, soft and decomposed rock will be carried out as per the approved proposal, modified and connected where necessary by the Engineer. The work

will be carried out in a workman like manner without endangering the safety of nearby structures/services or works and without causing hindrance to their activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly and the balance work will be carried out carefully to avoid any over-excavation. On completion, the work will be finally checked and approved by the Engineer. In certain cases, where deterioration of the ground, upheaval, slips etc., are expected, the Engineer may order to suspend the work at any stage and instruct the Contractor to carry out the balance work just before the foundation work of the structure can be started. No extra will be paid to the Contractor for such unavoidable temporary suspension of work.

4.3.5.3. Excavation in Hard Rock

In case where excavation, both in ordinary soil and hard rock are involved, the ordinary soil comprising of soft, hard and dense soils (including laterite formations) and rock including weathered rocks, lateritic rocks, etc., which can be excavated without blasting, shall be completely stripped off and the levels of the hard rock surface wall be taken to enable measurements. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props bracing or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 meters steel mesh anchored to the lower edge of excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiseling, wedging or any other approved method and payment appropriate to blasting shall be made, unless otherwise mentioned in the Schedule.

4.3.5.4. Disposal

The excavated spoils will be disposed of in any or all the following manners;

a) By using it for back filling straightway

b) By stacking it temporarily for use in back filling at a later date during execution of the Contract.

c) I) By either spreading, or

ii) Spreading and compacting at designated disposal areas.

d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in back filling by some other agency.

4.3.5.5. Disposal of Surplus

All surplus material from excavation shall be carried away from the excavation site to be designated disposal area selected by the Engineer.

All good and sound rock excavated from the pits and all assorted materials of dismantled structure shall be the property of the owner and if the Contractor wants to use it, he shall have to obtain it from the Engineer at a mutually agreed rate for the same.

All sound rock and other assorted materials like excavated bricks, etc., shall be stacked separately and shall be measured in stacks deducting 50% volumetric measure for voids.

4.3.5.6. Protection

The Engineer shall be notified by the contractor as soon as the excavation is expected to be completed within a day so that it may be inspected by him at the earliest. Immediately after approval of the Engineer, the excavation must be covered up in the shortest possible time. But, in no case the excavation shall be covered up or worked on before approval and measurement by the Engineer. Excavated material shall be placed beyond 1.5 meters from the edge of the pit or trench or half the depth of the pit or trench whichever is more or further away if directed by the Engineer.

Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken.

Adequate fencing is to be made enclosing the excavation. The contractor shall protect all under-ground services exposed by excavation. The contractor shall also divert all surface drains, etc, affected by the excavation to maintain the working area neat and clean.

4.3.5.7. Dewatering

All excavations shall be kept free of water and slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep the trench dewatered until the construction of foundation structure and backfilling are complete in all respects (except where such dewatering would need installation of well points or deep wells for which separate payment will be made). Sumps made for dewatering must be kept clear of the foundations. Method of pumping shall be approved by the Engineer but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping.

4.3.5.8. Timber Shoring

Timber Shoring made out of approved quality of timber shall be 'close' or 'open" type, depending on the nature of soil and the depth of pit or trench and the type of timbering shall be determined by the Engineer. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

4.3.6. Back Filling

3.6.1.1 General

The material used for back-filling shall consist of material, approved by the Engineer obtained directly from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoins or from borrow pits from selected areas designated by the Engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials etc.

In certain locations, the Engineer may direct sand fillings, the sand should be cleaned, well graded and be of quality normally acceptable for use in concrete.

3.6.1.2 Filling and Compaction in pits and Trenches around Structures

As soon as the work in foundations has been accepted and measured, the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc, and filled with earth in layers not exceeding 250 mm in loose thickness each layer being watered, rammed and properly compacted to the satisfaction of the Engineer. Earth shall be rammed with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and leveled to proper profile as desired by the Engineer.

Since the degree of compaction depends on the moisture content of the soil, a close watch should be kept on it and corrections done to optimize the moisture content.

3.6.1.3 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250mm in loose thickness, watered and compaction machine or manually, if specifically permitted by the Engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slope intended to be given to the floor.

3.6.1.4 Filling in Trenches for Water pipes and Drains

Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling.

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed.

Where the trenches are excavated in soil, the filling shall be done with earth on the side and top of pipes in layers not exceeding 150 mm watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of excavation of trenches in rock, the filling upto a depth of 300mm or the diameter of the pipe whichever is more, above the crown of pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash according to the availability at site. The remaining filling shall be done with rock filling of boulders of size not exceeding 150 mm mixed with fine material as available to fill up the voids watered, rammed and compacted.

3.6.1.5 Approaches and Fencing

The Contractor should provide and maintain proper approaches for workmen and for inspection, the roads and approaches around the excavated pits should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of filling at the surplus disposal area where dumping from a high bench is in progress.

4.4. TESTING AND ACCEPTANCE CRITERIA

4.4.1. Excavation

On completion of excavation, the dimensions of the pits will be checked as per the drawings after the pits are completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations filled back to required lines levels and grades by placing ordinary concrete of 1:3:6 proportion and /or richer and/ or by compacted earth, as directed by the Engineer at the Contractor's cost. The choice of grade of concrete will be a matter of unfettered discretion of the Engineer. Over excavation of the sides will be made good free of cost by the Contractor while carrying out the back filling. The excavation work will be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.4.2. Back Filling

The degree of compaction required will be as per the stipulation laid down in IS 4701, if not otherwise mentioned in the Schedule and the actual method of measuring the compaction achieved will be decided by the Engineer. The work of back filling will be accepted after the Engineer, is satisfied with the degree of compaction achieved.

If it is required to use clayey soil exhibiting swelling properties for filling around foundations and under pavement and floor slabs due to non-availability of suitable filling material nearby, then the back filled clayed swelling soil should be well compacted and a layer of not less than 750mm thick cohesive non-swelling (CNS) soil shall be placed on top of the clayey soil and well compacted. Very broad specifications for soil to be considered as CNS material is given Annexure F3-1 enclosed at the end of the section.

4.5. MEASUREMENTS

4.5.1 Clearing and Grubbing

No separate measurement shall be done for this item for the purpose of payment in general except for cutting of trees having girth more than 30cms and works connected to this.

4.5.2 Excavation

The excavation below PCC is required to suit soil condition. The excavation under such circumstances shall be paid as per the PCC line only.

Actual quantity of excavation required and approved by the Engineer shall be measured in Cu.M. No extra shall be paid for keeping the excavations dewatered as required for completion of the structure to come in. Necessary disposal of the spoils as described in the schedule of items shall be included in the quoted rate.

4.5.3 Back Filling

4.5.3.1 With Assorted Earth from Excavations for Foundations, Trenches etc.

Actual quantity of consolidated back-fill shall be measured in Cu.M. The cost of lead, lift etc shall be as per schedule of items and included in the rate quoted.

4.5.3.2 With Earth from borrow pits and stacks

Actual quantity of consolidated back-filling or actual quantity of excavation in the borrow pits or the excavated volume of the stack with a deductions of 30% for voids, in case filling is done by earth from stack, whichever is less, shall be paid in Cu.M. The lead, lift etc as mentioned in the Schedule of Item shall be included in the rates quoted.

4.5.3.3 **Sand Filling**

Actual quantity of consolidated sand filling shall be measured in Cu.M. The rate shall include cost of sand and all necessary works for execution of the items.

4.5.4 **Leads and Lifts**

The leads for excavation and/or back filling will be measured between the centroid of the actual disposal area and that of the plan of the pit. The distance between these two points will be measured along the shortest practicable haulage path as decided by the Engineer.

Lifts will be measured vertically between the average ground level from where the pit excavation was started and the bottom level of the excavated pit. Level lines corresponding to the stages where lifts become payable will be drawn on the cross section of the pit and the volumes of excavation contained between these horizontal planes will be computed and paid according to the corresponding rates.

4.5.5 **Transportation of Surplus Earth**

4.5.5.1 Payment shall be made only for the lead beyond 5 kms from construction area rate shall include reexcavation, loading, transportation, dumping, stacking or spreading (as per directions of the engineer-in-charge) the surplus earth and the soil in the area demarcated by the Engineer-in-Charge. Payment shall be made on cubic meter (M^3) basis on the difference of measurements of the volumes of the excavated pits and the measurement of the back filling. Quantity generated due to voids in back filled volume of earth shall also be removed by the Contractor at no extra cost and this disposal of earth shall not be measured and paid under any item.

4.5.5.2 In exceptional circumstances the Engineer-in-Charge may direct the Contractor to remove surplus earth, concrete of debris or any other waste material from site to the area of disposal

on the basis of truck measurement. In such case volume of material shall be calculated on the basis of truck volume reduced by 30% for voids in case of soft/hard soil sand, 50% for soil/hard rock. All other provisions of disposal such as spreading, leveling, grading shall apply in this case also.

4.0 ROAD WORK

4.1 SCOPE

This specification establishes the material and construction requirements for the flexible pavement with bituminous and bitumen premix carpet.

4.2 CODES & STANDARDS

IRC: 27 tentative specifications for bituminous macadam (Base & Binder Course)

IS: 73 paving bitumen

IS: 8887 Specification for Bitumen Emulsion for Roads

MORT & H Specification for road and bridge works

NOTE:- Latest Edition of all Codes and Standards shall be followed.

4.3 BITUMINOUS MACADAM

Bituminous Macadam shall consist of construction of one or more courses of compacted crushed aggregates, pre-mixed with a bituminous binder, laid immediately after mixing on a previously prepared base

4.3.1 Material

4.3.1.1 Aggregates

The aggregates shall consist of crushed stones of clean, hard, tough, durable rock of uniform quality and shall be clean, free excess of dist, flat or elongated pieces, soft or disintegrated stone, clay or other deleterious matter.

The aggregates shall satisfy following physical requirements:

Property	Test	Specification
Cleanliness	Grain size analysis	Max 5% passing 0.075 mm sieve
Particle size	Flakiness & Elongation Index (Combined)	Max30%
Strength	Los angeles Abrasion value or Aggregate Impact value	Max40% Max 30%

Durability	Soundness Sodium sulphate Magnesium sulphate	Max12% Max18%
Water Absorption	Water Absorption	Max2%
Stripping	Coating & stripping Bitumen Aggregate mixtures	Max retained coating 95%
Water sensitivity	Returned tensile strength	Max80%

4.3.1.1 Grading of Aggregates

The aggregate of bituminous macadam shall conform to the grading as specified below.

Mix designation	Grading 1	Grading2
Nominal Aggregate size	40mm	16mm
Layer thickness	80-100mm	50-75mm

IS sieve mm	Cumulative % weight of aggregate passing	
45	100	
37.5	90-100	
26.5	75-100	100
19		90-100
13.2	35-61	56-88
4.75	13-22	16-36
2.36	4-19	4-19
0.30	2-10	2-10
0.075	0-8	0.8
Bitumen content % by weight of total mixture	3.1-3.4	3.3-3.5

4.3.1.1 Bitumen

The bitumen shall paving bitumen of penetration grade 60/70 or 80/100 complying with IS specification for paving bitumen IS : 73.

Prime coat: The primer shall be bitumen emulsion complying with IS 8887 and slow setting type (SS).

Tack coat :: The tack coat primer shall be bitumen emulsion complying with IS 8887 rapid setting type (RS).

4.3.2 Construction Methods

4.3.2.1 Weather and Seasonal Limitation

Bituminous primer shall not be applied to a wet surface or during a dust storm or when the temperature in the shade is less than 10 C. Surfaces which are to received emulsion primer should be damp, bit no free or standing water shall be present

4.3.2.1 Equipment

All equipment necessary for the proper construction of work shall be on the site of work in good condition.

4.3.2.1 Preparation of Underlying Course

The underlying course on which bituminous macadam id to be laid shall be prepared, shaped and conditioned to a grade and section as specified. Any depressions or pot-holes should be properly made up and thoroughly compacted sufficiently in advance. The surface of the underlying course shall be thoroughly swept and clean and free from dust and foreign material, care taken not to disturb the interlocked aggregate.

4.3.2.1 Application of prime coat

The bituminous primer shall be sprayed uniformly using a self propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly. Hand spraying of small areas and inaccessible areas shall be sprayed with a pressure hand sprayed. The primer cost shall be applied at the rate of 1.0 Kg/m2 on WMM or WBM surfaces

4.3.2.1 Curing of Primer:

A primed surface a tack shall be allowed to cure for at least 24 hours before any subsequent surface treatment or mix is laid. A primed surface shall not be allowed to traffic other than that necessary to lay the next course.

4.3.2.1 Tack Coat

Over the primed surface a tack coat should be applied uniformly at 0.3Kg/m2 using self propelled or towed pressure sprayer. Hand spraying of small areas, inaccessible areas or in narrow gaps shall be sprayed with a pressure hand sprayer. The tack coast shall be left to cure until all the volatiles have evaporated any subsequent construction is started.

4.3.2.1 `Mixing, Transporting & laying

Premixed bituminous materials shall be prepared in a mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. Manufacturing, Laying & rolling temperatures of bituminous course shall be as given below:

Bituminous	Bitumen	Aggregate	Mixed material	Rolling	Laying
Penetration	Mixing C	Mixing C	C	C	C
35	160-170	160-175	170max	100min	130min
65	150-165	150-170	165max	90min	135min
90	140-160	140-165	155max	80min	115min

The difference in temperature between the binder and aggregate should at no time exceed 14 C

Bituminous materials shall be transported in clean insulated vehicles and shall be covered while in transit.

Bituminous materials shall be spread & leveled by an approved self propelled paving machine except in areas where a mechanical paver cannot access. In inaccessible areas, spreading, rolling & leveling shall be close with hand tools by experienced staff.

The laying thickness shall be so adjusted such that the required compacted thickness is obtained after rolling is completed.

4.3.3 Compaction

Compaction of bituminous shall commence as soon as possible after laying. Compaction shall be completed before the temperature falls below the specified minimum rolling temperature Rolling shall be done with 8-10 tones smooth wheeled rollers. Rolling shall commence at the edges and progress towards the center longitudinally except that on super elevated and unidirectional cambered portions. Rolling shall continue until all roller marks have been removed from the surface. The roller wheels shall be kept damp to prevent the mixture from adhering to the wheels.

4.4 BITUMEN PREMIX CARPET

5.4.1 Material

5.4.1.1 Coarse aggregate

The arrogate shall consist of crushed stones of clean, hard, durable rock of uniform quality and shall be clean, free from excess of dust, flat or elongated pieces, soft or disintegrated stone, clay or other deleterious matter. The size of aggregate shall be as mentioned in the schedule of quantities.

5.4.1.2 Sand

The sand shall consist of clean, hard, durable, uncoated dry particles and shall be free from injurious amounts of dust, soft or flaky particles, organic matter or other deleterious substances.

5.4.1.3 Binder

The binder shall be bitumen of penetration 80/100 or60/70 conforming to IS : 73. The bitumen shall be collected on road side drums. Any leaking or damaged drum shall not be accepted.

5.4.2 Quantities of material (premix carpet)

5.4.2.1 For Premix Carpet 50mm thick

Sl.No	1	2	3
i)	Coarse aggregate 25mm and down size	5.5m3	

ii)	Coarse aggregate 12mm and down size (For 15 mm thick carpet layer	2.0m3	
iii)	Bitumen For 35 mm thick Carpet (1 layer) For 15mm thick Carpet (II layer)	269kg 110kg	68.3kg
iv)	Coarse aggregate 2.5 mm and down size (For 50mm thick, 1 layer)		0.6m3

5.4.2.3 For Premix Carpet 75 mm thick

Sl No	1	2	3
i)	Coarse aggregate 25mm and down size (For 50mm thick 1 layer	805m3	
ii)	Coarse aggregate 12mm and down size (for 25mm thick, II layer	3.5 m3	
iii)	Bitumen For 50 thick I layer For 25 thick II layer	375kg 185kg	68.3kg
iv)	Coarse sand as sealing aggregate		0.6m3

5.4.3 Laying

5.4.3.1 Preparation of Road Surface

The surface on which tack coat is to be applied shall be clean and free from dust, dirt and any extraneous material. Immediately before the application of the tack coat the surface shall be swept

clean with a mechanical broom and high pressure air or by other means as directed by Engineer-in-Charge.

If pot binder used for tack is found on the bituminous surface, these irregularities must be filled in with premix chipping and well rammed about a week before the carpet is laid.

5.4.4 Tack Coat

The binder used for tack coat on bituminous surface shall be bitumen emulsion complying with IS 8887 rapid type (RS). The coat should be applied uniformly at the rate of 0.3kg/m2, using self propelled or towed pressure sprayer. Hand spraying of small areas, inaccessible areas or in narrow gaps shall be sprayed with a pressure hand sprayer. The tack coat shall be left to cure until all the volatiles have evaporated before any subsequent construction is started.

The tack coat shall be applied just ahead, keeping pace with laying of premix carpet.

5.4.5 Preparation of Premix

Mechanical mixers shall be generally used for preparation of premix. Improvised hand mixing drums may be used, if permitted by the Engineer-in-charge.

Stone chippings of specified size shall be thoroughly mixed dry in the mixer at the rate indicated above. Binder heated at temperature suitable for the grade of bitumen is added to the mixer drum at the specified rate per 100m3 of surface and thorough mixed till the stone chips are completely coated with the binder.

The premix shall be emptied on to wheel barrows or stretchers and carried to work site.

5.4.6 Spreading of Premix

Immediately after applying the tack coat, the premix shall be spread with rakes to the required thickness and distributed evenly by means of a drag spreader. The camber shall be checked by means of camber board and the unevenness shall be rectified.

5.4.7 Rolling

When the premix has been laid for a length of 15-20 meters, rolling shall be commenced with tandem rollers (8 to 10 tonnes). Rolling should commence from edges and proceed towards center longitudinally.

The wheels of roller shall be continuously moistened to prevent the premix adhering to the wheel and being picked up.

After the preliminary rolling and honeycombing, high spot or depression shall be rectified by adding or removing the premix as per requirement and the surface shall be rolled again to compaction. Camber shall be checked at every stage and any defects found shall be rectified. Excessive rolling shall be avoided.

Seal Coat (For low rainfall areas – under 150 cm/yr).

A premix seal coat, mix preferably in a mechanical mixer after heating the sand should be applied immediately after laying the carpet and rolled. Materials required for this seal coat are as per clause 4.

Seal Coat (For high rainfall areas – over 150 cm/yr)

The material requirement for seal coat in high rainfall areas is as under:

Binder 80/100 or 60/70 Coarse aggregate 6.3mm passing IS 10mm	98 kg/100m2 of road surface
Square mesh retained on IS sieve 2.36mm	0.9m3/100m3 of road surface

A liquid seal coat, preferably with chipping as above (though coarse sand can also be used) should be applied after laying the carpet. The binder after being heated to permitted temperature, should be applied to the cleaned surface, blinded with chippings and rolled. Traffic may be allowed on the road preferably 24 hours providing the seal coat.

PAYMENT

Payment shall be made on sq.m. basis of finished surface including all labour& materials as per above specifications.

REMOVAL OF SURPLUS EARTH

Surplus earth and soil from excavation shall be removed from construction area to the area demarcated by the Engineer-in –Charge.

Payments shall be made only for lead beyond initial 50m from construction area. Rate shall include loading, transportation, dumping, stacking the surplus earth and soil in the area demarcated. Payment shall be made on cubic meter basis by measurement of number of trucks.

The contractor shall furnish the detailed scheme and sequence of erection to match with the project schedule and get the same approved by the Engineer-in-charge.

5.0 PLAIN AND REINFORCED CEMENT CONCRETE

5.1 SCOPE

6.1.1. General

This specification covers all the requirements described hereinafter for general use of Plain and Reinforced Cement Concrete work in structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

This specification shall also supply to the extent it has been referred to or applicable with the special requirements of structures covered in SCOPE of IS: 456

IS: 456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by these code, appropriate IS Code, specifications and /or replacement by an International Code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS Codes and Standards is enclosed hereinafter for reference.

6.1.2. Work to be provided for by the Contractor

The work to be provided for by the contractor unless otherwise specified shall include but not be limited to the following:

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, mids construction equipment, tools and plants, transportation etc., required for the work.

b) Except where it is excluded from the Scope of Contract, Contractor shall prepare progressively and submit for approval detailed drawings and Bar Bending Schedules for reinforcement bars showing the position and details of spacers, supports, chairs, hangers etc.

c) Design and prepare working drawings of formworks, scaffolds, supports, etc. and submit for approval.

d) Submit for approval shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedment, hangers, openings, frames etc.

e) Submit for approval detailed drawings of supports, templates, hangers etc., required for installation of various embedment like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

f) Submit for approval detailed schemes of all operations required for executing the work. Eg. Material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, approaches etc.

g) Design and submit for approval concrete mix designs required to be adopted on the job.

h) Furnish samples and submit for approval results of tests of various properties of the following:

    i) The various ingredients of concrete

    ii) Concrete

    iii) Embedment

    iv) Joint seals

i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings, specifications and schedule of items.

j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved, proforma for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor jointly and severally.

6.1.3. Information to be submitted by the Tenderer

6.1.3.1 Design Mix

Design mix as per clauses 6.2.1(g) &6.3.4 of this specification giving proportions of the ingredients, sources of aggregates and cement, along with accompanying test results of trial mixes as per relevant I.S. is to be submitted to the Engineer for his approval before it can be used on the works.

6.1.3.2 Detailed Drawings and Bar Bending Schedules

Detailed working drawings and Bar Bending Schedules in accordance with clause 2.1(b) and 3.16.1 of this specification.

a) Detailed Drawings and Designs of Formworks to be usedDetailed design data and drawings of standard form works to be used.

b) Detailed Drawings for Templates & Temporary Supports forEmbedments

c) Mill Test Report for Cement & Reinforcing Steel Mill Test Reports for cement and reinforcing steel in case these materials are supplied by the Contractor.

d) Inspection Reports

Inspection Reports in respect of Form work and Reinforcement and any other items of work as may be desired by the Engineer in charge

e) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification.

f) Any other data, which may be required as per this specification.

6.1.3.3 Conformity with Design

The Contractor will prepare checklists in approved proforma, which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer sufficiently in advance whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the Engineer will give written permission the same "Pour Card" allowing the Contractor to commence placement of concrete. Details of all instructions issued by the Engineer and records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. These sheets, termed as "Progress Cards', will be prepared by the contractor on approved proforma. The pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the engineer, the choice being dictated by the requirements of design and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

5.2 Materials to be used

5.2.1 General requirements

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless stated otherwise and be of best approved quality.

5.2.2 Cement

Generally cement shall be ordinary Portland cement conforming to IS: 8112. In special cases Rapid hardening Portland cement, Low heat cement etc., may be permitted or directed to be used by the engineer.

5.2.3 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries and conforming to IS: 383 will be allowed to be used on the works.

5.2.4 Fine Aggregate

Aggregates smaller than 4.75mm and with in the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or sand. Only fine aggregate from approved sources and conforming to the above IS specifications will be allowed to be used on works.

5.2.5 Water

Water for use in concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities. Normally potable water is found to be suitable. Generally IS: 3550 will be followed for routine tests. In case of doubt the acceptance test for water shall be as per IS: 3025 and Table-I of IS: 456

5.2.6 Admixture

Only admixture of a quality will be used when directed or permitted by the engineer. The admixture shall conform to IS: 9103.

5.2.7 Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the contract/drawing/instructions. All bars above 10 mm dia shall be tested quality.

5.3 Quality Control

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirement and maintain

and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work:

a) Admixture:

Type, quantity, physical and chemical properties that affect strength, workability and durability of concrete.

For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits.

b) Aggregate:

Physical, chemical and mineralogical qualities grading, moisture content and impurities.

c) Water:

Impurities tests

d) Cement:

Test of satisfy relevant IS Specifications (only association with Owner's tests, if the supply is made by Owner).

e) Formwork:

Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.

f) Reinforcement:

Shapes, dimensions, length of splices, clearances, items and supports.Quality and requirement of welded splices.

Material tests or certificates to satisfy relevant IS Specification (if contractor's supply).

g) Grades of concrete:

Usage and mix design, testing of all properties.

h) Batching & Mixing

Types and capacity of plant, concrete mixers and transportation equipment.

i) Joints

Locations of joints, water stops and filler materials. Dimension of joints, quality and shape of joint material and splices.

j) Embedded and Anchorage items:

Material, shape, location, setting

k) Placing:

Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.

l) Compaction:

Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand – spreading, rodding and tamping.

m) Setting of base & beaming plates:

Lines, elevations and bedding mortar

n) Concrete Finishes:

Repairs of surface defects, screening, floating, steel toweling and brooming , special finishes

o) Curing:

Methods and length of time.

Copies or records and tests for the items noted above, as well as records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

5.4 INSTALLATION

5.4.1 Washing and Screening of Aggregates

Washing and screening of coarse and fine aggregates to remove fines, dirt or other deleterious materials shall be carried out by approved means as desired by the Engineer.

5.4.2 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will in turn affect the workability and quality of the concrete. Admixtures may be permitted to be used in accordance with IS: 456 to modify the rate of hardening, to improve workability or an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data or other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

5.4.3 Grades of Concrete

Concrete shall be in any of the grades designated in IS: 456 Grades of concrete to be used in different parts of work shall be as shown on the drawing or as per the Engineer's instructions. In case of liquid retaining structures, IS: 3570 will be followed.

5.5 CONCRETE

5.5.1 General

Proportioning of ingredients of concrete shall be made by any of the two following methods as directed by the Engineer.

a) With preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".

b) Without preliminary tests adopting nominal concrete mix. Such concrete shall be called "Normal Mix Concrete".

As far as possible, design mix concrete shall be used on all concrete works. Ordinary concrete, in grades permitted in accordance with IS: 456 may be used if shown on drawings or approved by the Engineer. In all cases the proportioning of ingredients and works control shall be in

accordance with IS: 456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

5.5.2 Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability and workability necessary for the job by the most economical use of the various ingredients. In general, the design will keep in view the following considerations:

a) Consistent with various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) The finished concrete should have adequate durability in all conditions to withstand satisfactorily the weather and other destructive agencies, which it is expected to be subjected to in actual services.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete by the Engineer. The Contractor will strictly abide by the same in his design of concrete mix installation.

Not withstanding anything mentioned in various tables given in IS: 456 giving specific values and degrees of workability for different conditions of concrete placing, minimum cement content and maximum water cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different conditions of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete, the following tables in the specification are included. For identical condition is values given in the tables shown herein below are different from those mentioned in IS: 456 the values as indicated in the table shown herein below shall prevail.

TABLE – I

STRENGTH REQUIREMENT OF CONCRETE

Grade of Concrete	Specific Characteristic CompressiveStrength of 15 cm cubes at 28 days Conducted in accordance with IS: 516 (N/Sq.mm)
M – 10	10
M – 15	15
M – 20	20
M – 25	25
M – 30	30

Note: 1. Notwithstanding anything mentioned above, the cement/total aggregate ratio is not to be increased beyond 1:9:0 without specific permission of the Engineer.

Note: 2. It should be noted that such high aggregate cement ratio will be required for concretes of very low slump and high water cement ratio which may be required to be used in mass concrete work only.

Note: 3. The above figures are for guidance only, the actual cement/aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

5.5.3 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per Table-II of IS: 456. All other relevant clauses of IS: 456 shall also apply.

5.5.4 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as shown below:

TABLE – II

MINIMUM CEMENT CONTENT SPECIFIED

FOR DIFFERENT GRADES OF CONCRETE

Grade of Concrete	Minimum Cement Content/Cu.M Of Finished Concrete
M – 15	300 Kg
M – 20	340 Kg
M – 25	350 Kg
M – 30	370 Kg

The minimum cement contents mentioned above are for average conditions.In case the cement content can be reduced due to continuous and consistentfavourable conditions, on account of better quality of cement control, then theEngineer may instruct lower cement content and the Contractor shall abide by the stipulations laid down hereunder.

a) The Contractor shall design the mixes for 10% (Ten percent) higher strength over and above those specified in Table-I under clause 6.3.4,for the various grades of concrete and different slump requirement.

b) Sufficient number of trial mixes will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.

c) All tests will be done in presence of consultant Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The contractor will

always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.

d) The consultant Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

In case there is a downward revision of the minimum cement content from that specified in the contract, the particular unit rate of concrete will be reduced by an amount equal to the cost of cement saved, calculated at the issue rate. The relevant cost of wastage and handling on the cement saved which is inherent in the total cost of structure, will not be deducted from the unit rate and will thus pass on to the Contractor.

5.5.5 Water-Cement Ratio

The choice of water-cement ratio in designing a concrete mix will depend on:

a) The requirement of strength

b) The requirement of durability

5.5.6 Strength Requirement

In case of "Design Mix Concrete", the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary test in the laboratory to the satisfaction of the Engineer. Frequent check on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above, the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of ordinary concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-III of IS: 456 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS: 456.

TABLE-III

MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVEDIFFERENT DEGREES OF WOKABILITY WITH DIFFERENTVALUES OF WATER – CEMENT RATIO(FOR GUIDANCE)

CEMENT/TOTAL AGGREGATE RATIOS

Workability	Water Cement Ratio	Ratio by Weight of Cement To Gravel Aggregate		Ratio by Weight of Cement To Crushed Stone Aggregate	
		20 mm size	30 mm size	20 mm size	38 mm size
Very low slump 0-25mm	0.4	1:4:8	1:5:3	1:4:5	1:5:0
	0.5	1:7:2	1:7:7	1:6:5	1:7:4
	0.6	1:9:4	1:10	1:7:8	1:9:6
	0.7	1:10	1:12	1:8:7	1:10:6
Low slump 25 – 50 mm	0.4	1:3:9	1:4:5	1:3:5	1:4:0
	0.5	1:5:5	1:6:7	1:5:0	1:5:5
	0.6	1:6:8	1:7:4	1:6:3	1:7:0
	0.7	1:8;0	1:8:5	1:7:4	1:8:0
Medium slump 50 – 100 mm	0.4	1:3:5	1:3:8	1:3:1	1:3:6
	0.5	1:4:8	1:5:7	1:4:2	1:5:0
	0.6	1:6:0	1:7:3	1:5:2	1:6:2
High slump 100 –175mm	0.4	1:3:2	1:3:5	1:2:9	1:3:3

	0.5 0.6 0.7	1:4:4 1:5:4 1:6:2	1:5:2 1:6:7 1:7:4	1:3:9 1:4:7 1:5:5	1:4:6 1:5:7 1:6:5

NOTE: 1. Notwithstanding anything mentioned above, the cement/Total aggregateRatio is not be increased beyond 1:9:0 without specific permission of the Engineer.

5.5.7 Durability Requirement

Table 19 & 20 of IS: 456 give the maximum water cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks and contact with harmful chemical impermeability may also be an important consideration.

Whenever the water cement ratio dictated by Durability consideration is lower than that required from strength criterion, the former should be adopted.

However, water-cement ratio, from the point of view of durability as well as from strength consideration, should meet the requirement given in Table No. IV

Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of Formwork and around the reinforcement and embedments and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:-

5.5.8 LIMITS OF CONSISTENCY

Degree of Workability	Slump in mm with standard Cone as per IS:1199		Use for which concrete is suitable
	Min	Max	

Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads and like
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion or reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts structures

NOTE: Notwithstanding anything mentioned above, the slump to be obtained forWork 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. The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS: 1199 and Clause 6 of IS: 56 shall be carried out.

5.5.9 Mixing of Concrete

Concrete shall always be mixed in mechanical mixer unless specifically approved by the Engineer for concrete to be used in unimportant out of the way locations in small quantities. Water shall not normally be charged in to the drum of the mixer until all the cement and aggregates consisting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in color and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set of remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixes shall be thoroughly cleaned and when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant where used shall conform to IS: 4925.

When hand mixing is permitted by the Engineer, it shall be carried out on a watertight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in color and consistency. In case of hand mixing, 10% extra cement shall be added to each batch at no extra cost to the Owner.

5.5.10 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial settings of cement starts. Concrete should be conveyed in such a way as will prevent segregation of loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, inspite of all precautions, segregation does occur during transport, the concrete shall be properly remixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers, which will reduce the rate of loss of water evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipments shall be kept free from set concrete.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed and cement slurry will be spread thoroughly on the rock

foundation or construction joint just prior to placement of concrete. The cost of application of such element slurry and mortar will be deemed to be included in the unit rate of concrete.

After concrete has been placed it shall be spread if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for purchasing concrete in to adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of practice. In thin members with heavy congestion of reinforcement or other embedment where effective use of internal vibrator is, in the opinion of the engineer, doubtful, in addition to immersion vibration the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structure the contractor will additionally employ screed vibrators as per IS: 2506. Hand tamping may be allowed in rare cases subject to the approval of the engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always-green concrete, which is still plastic and workable. No concrete shall be placed in open during rains. During rainy seasons no placement in the

open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rain before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

Slabs, beams and similar members shall be poured in one operation unless otherwise instructed by the engineer. Moulding, throating, drip course etc., shall be poured as shown on the drawings or as directed by the engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the engineer. Any deviation there from shall be set right by the contractor at his own expense as instructed by the engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits the engineer may direct to remove the portion or reconstruct or repair the same at the contractor's expense.

5.5.11 Placing and Compacting Concrete

Where specifically covered the relevant IS Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes repairs and maintenance of concrete. If, however, there is no specific provision in the relevant IS Code for any particular aspect of work, any other standard Code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following type of surfaces.

a) Earth foundation
b) Rock foundation
c) Formwork
d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance etc., are to be removed by the air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed will be rammed and consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be disturbed.

5.5.12 Repairs, Finishes and Treatment of Concrete surfaces

Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork appropriate methods of handling, placing and consolidation by experience workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the contractor's cost. The Engineer may at his sole discretion, allow to retain concrete with minor deflects provided the contractor is able to repair it by approved methods at no extra cost to the Owner. The Contractor shall inspect all concrete work immediately after the forms are removed and he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations: -

a) Sack rubbing with mortar and stoning with carborundum stone

b) Cutting away the defective concrete to the required depth and shape.

c) Cleaning of reinforcement and embedments

d) Roughening by sand blasting or chipping

e) Installing additional reinforcement/welded mesh fabric

f) Dry packing with stiff mortar

g) Plastering, guniting, shotcretingetc

h) Placing and compacting concrete in the void left by cutting out defective concrete

i) Grouting with a cement sand slurry of 1:1 mix.

5.5.13 Finishing unformed Surfaces

The requirement of finishes of formed surfaces are given separately under clause 3.20.7 of this specification. The Contractor is to include in his quoted rate for concrete, the provision of normal finishes in unformed surface which can be achieved by screeding, floating, trowelling etc., as and where required by the Engineer without any extra cost to the Owner. A few typical and common cases of treatment of concrete surface are cited below:-

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface shall be done as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked without any extra cost to the Owner to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed preferably a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by

wooden floats and procedure a dense surface free from blemishes, ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beams, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brick work or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form it stripped off so that proper bond can develop Pattern, adequacy and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surface before they are covered up.

5.5.14 Protection and curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation of flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials etc. that may impair the strength and durability of the concrete.

If it is so desired by the Engineer, the contractor shall prepare before commencement of actual work, designs and working drawings for formwork and centering and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centering shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rekers are to be used where forms are to support inclined members The forms shall be satisfactorily strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the working load, in case the Contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified free of charge as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Right care shall be exercised in ensuring that all column forms are plumb and true thoroughly cross-braced to keep them so. All floor and beam centering shall be crowned not less than 8mm in all directions for every 5 meters span. Unless specifically, described on the drawings or elsewhere to the contrary, bevelled forms 25 mm by 25 mm shall be fixed in the form-work at all corners to provide as soon as the concrete has hardened sufficiently, it shall be

covered either with sand, hession, canvas or similar materials and kept continuously wet for at least 14 days after final setting. curing by continuous sprinkling of water will be allowed if the engineer is satisfied with the adequacy of the arrangements made by the contractor.

The contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. Incase any lapse on the part of the contractor is noticed by the engineer, he will inform the contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the contractor within 3 hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the contractor, or pay for the part where adequate curing was noticed at a reduced rate, entirely at the discretion of the Engineer.

5.6 REINFORCEMENT

Mild steel round bars, cold twisted and deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc. will be used as reinforcement as per drawings and directions.

5.6.1 Bar Bending Schedules

The contractor shall submit the Engineer for approval Bar Bending Schedules with working drawings in triplicate, showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, within one month of receipt of the Letter of Intent or of the receipt of the relevant design drawings, whichever is later. Upon receipt of the Engineer's final approval of the Bar Bending Schedule and drawings, the Contractor shall submit 6 (six) prints of the final drawings with one reproducible print after incorporating necessary modifications or corrections for final record and distribution. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the Contract.

5.6.2 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

5.6.3 Bending

Unless otherwise specified reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding to the approved Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not not exceeding R45 Deg.C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

5.6.4 Placing in position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like tor steel chairs and/or concrete spacer blocks, irrespective of whether such supports are payable or not . Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No.20 (annealed soft iron wire of by tack welding in case of Bar larger than 25mm 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 tor steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

5.6.5 Welding

Normal bond laps in reinforcement may be placed by lap or butt-welding reinforcement bars, if asked by the Engineer under certain conditions. The work should be done with suitable

safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. Welded mesh fabrics conforming to IS: 1566 may also be used if specified in the Schedule of items and drawings.

5.6.6 Quality Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary connections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as for as practicable and as that reinforcement in position do not have to bear extra load and get disturbed.

The cover for concrete over the reinforcement shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

5.7 Form Work

5.7.1 General

Chamfering of the finished concrete edges without any extra charge. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

5.7.2 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete,

chippings, shavings, sawdust etc shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and /or water jet along with wire brushes, brooms etc, shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

5.7.3 Design

The formwork shall be so designed and erected that the form for slabs and the sides of beams, columns and walls are independent of the soffits or beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork. Removing any props or re-propping shall not be done except with the specific approval of the Engineer. If formwork for column is created for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedger, spacer, bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

5.7.4 Inspection of Forms

Casting of concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval form the Engineer shall be obtained.

5.7.5 Removal of Forms

Before removing any formwork, the Contractor must modify the Engineer well in advance to enable him to inspect the concrete if he so desires.

The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there

from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner. The Engineer may however instruct to postpone the removal of formwork if he considers if necessary.

Form for various types of structural components shall not be removed before the minimum periods specified herein and the removal after the minimum periods shall also be subject to the approval of the Engineer in each case.

TABLE - VI

SCHEDULE OF REMOVAL OF FORM

Part of Structure	**Ordinary Portland Cement Concrete**				**Rapid Hardening Portland Cement Concrete**			
	Temperature °C				Temperature °C			
	Above 40°C	40° 20°	- 20° 5°	-Below 5°	Above 40°C	40° 20°	- 20° 5°	-Below 5°
	Days	Days	Days	Days	Days	Days	Days	Days
a)Column & walls	2	1	1	Do not remove forms until site cured	1	1	1	Do not remove forms until site cured test
b) Beam sides	3	2	3		2	1	1	
c) Slabs 125mm	10	7	8		7	4	5	

d) Slabs over 125mm thick and soffit of minor beams	18	14	16	test specimen develop at least 50% of the specified 28 days strength	12	8	9	specimen develop at least 50% of the specified 28 days strength
e) Soffit of main beams	24	21	22		14	10	12	

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40°C can be reduced to those of the temperature range of 20°C to 40°C subject to approval of the Engineer.

Construction joints in beams, if required to be provided, will be located at the middle of span according to clause 3.13.1(b) of this specification. In such cases however entire span of beam shall have to be kept supported by formwork till its removal for the portion of beam, cast at a later date, is due and so approved by the Engineer.

5.7.6 Tolerance

The form work shall be so made as to produce a finished concrete true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this Specification or drawings or directed by the Engineer.

For a) Sectional dimension - ± 5mm

b) Plumb - 1 in 1000 of heights

c) Levels - ±3 mm before any deflection has taken place.

The tolerance given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

5.7.7 Re-use of Forms

Before re-use, all forms shall thoroughly scraped, cleaned, joints and planes examined and when necessary repaired and inside surface treated as specified here in before. Formwork shall not be used /re-used if declared unfit or unserviceable by the Engineer.

5.7.8 Classification

Generally, the 'ordinary' class formwork shall be used unless otherwise directed by the Engineer.

a) Ordinary

These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

b) Plywood

These shall be used in exposed surfaces, when a specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the ordinary class, if it is still in good condition.

5.7.9 Ornamental

These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timber or of plywood which can be shaped correctly.

5.7.10 Opening, Chases, Grooves, Rebates, Blackouts etc.

The Contractor shall have all openings, grooves, chases etc, in concrete work as shown on the drawings or a specified by the Engineer.

Anchor bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and Other Miscellaneous Embedded Fixtures

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as directed and secure the same as may be required. The materials, if required to be supplied by the Contractor shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surface of embedded materials are to be painted with one coat of approved anti-corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc, shall be used as may be required or directed by the Engineer, free of cost to the Owner.

Items to be embedded

a) Inserts, hangers, anchors, frames around openings, manhole covers, frames, floor clips, sleeves, conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structural to be left embedded for future extension, special connection etc.

d) Dowel bars, etc. for concrete work falling under the scope of the contractors.

e) Lugs or plugs for door and window frames occurring in concrete work.

f) Flashing and jointing in concrete work

g) Any misc. embedments and fixture as may be required

Correct location and alignment as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

5.8 Expansion and Isolation Joints

5.8.1 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 herein after. In case of liquid retaining structures, additional precaution 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 materials, 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 of the method of forming the joints should be obtained from the Engineer before starting the work.

5.8.2 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.

5.8.3 Isolation Joints

Strong and tough alkathene sheet or equivalent about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet care being taken not to damage the sheet in any way.

5.8.4 Rubber Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer. The

rubber shall have a unit weight of 1,500 Kg/Cu.m, a shore hardness –65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any earth or any other deleterious material expected under normal conditions.

5.9 Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose.

This yard shall be dry, properly leveled and have a hard and even surface. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1: 2 proportions) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc, shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (twenty eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in concrete position of the units to facilitate erection even though they may not be shown on the drawings and shall be burnt off and finished after erection.

Precast concrete units when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, leveling and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as directed by the Engineer. If centerings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen)

days. The joint between precast roof planks shall be pointed with 1: 2 cement: sand mortar where called for in the drawings.

5.10 Water proofing of Concrete Structures

5.10.1 General

Waterproofing of concrete structures shall be done by either suitable extraneous treatments like applying paints, fixing bitumen felts etc. or internally by suitable design of the concrete mix. Addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints.

The design, material and workmanship shall conform to the relevant I.S. Codes where applicable; the Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

5.10.2 Water Bar/Seal

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be either metallic rubber or P.V.C. The materials and installation will be as described under Clause 3.23.3.

5.10.3 Waterproofing Admixtures

a) In Concrete:

The admixtures shall be procured from reliable and reputed manufactures and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to the Owner to supervise the work, if desired by the Engineer.

b) In Plaster:

The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement and sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved water proofing admixture and laid in appropriate thickness and in layers not exceeding 15mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's representative at no extra cost to the Owner. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

5.10.4 Admixture

5.10.4.1 Air Entraining Agents

Initially, before starting to use A.E.A.relationship between the percentage of air entrained and the cylinder cube crushing strength vis-à-vis quantity of A.E.A used for all types of concrete will be established by the Contractor free of charge by carrying out sufficiently large number of tests. After then, at regular intervals and whenever directed by the Engineer, the Contractor will check-up free of charge, the actual percentages of air entertained and corresponding crushing strengths to correlate with earlier test results.

5.10.4.1 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the contractor free of charge to the Owner.

5.10.5 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc., shall be in accordance with IS: 516 and IS: 1199 the size of specimen being 15 cm cubes. Normally only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516

Sampling procedure, frequency of sampling and test specimen shall conform to Clause 14 of IS: 456

To control the consistency of concrete from every mixing plant slump tests and/or compacting factor tests in accordance with IS: 1199 and as mentioned in Clause 3.6 of this specification shall be carried out by the contractor every two hours or as directed by the engineer. Slumps corresponding to the test specimens shall be recorded for reference.

The acceptance criteria concrete shall be in accordance with Clause 15 of IS: 456. However in exceptional circumstances the Engineer may, at his discretion, accept a concrete of lower strength than specified and which is otherwise unacceptable according to IS: 456.

Payment for concrete, which is normally unacceptable, as per the criteria laid down in IS: 456 but which the Engineer has accepted shall be made at a reduced rate to the strength obtained.

Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures etc., wasted in the dismantled portion shall be made. In the course of dismantling if any damage is done to the embedded items of adjacent structures the same shall be made good, free of charge by the Contractor to the satisfaction of engineer.

5.10.6 Load Test

Load tests of structural members may be required by the Engineer, when the strength of test specimen results fall below the required strength, as per 'Load Test on parts of structures", Clause 16.5 of IS; 456. If load testing is decided by the Engineer, the member under consideration shall be subjected to a test load equal to 1.25 (one and quarter) times the specified live load used for design and this load shall be maintained for a period of 24(twenty four) hours before removal. The detailed procedure of the test is to be decided by the Engineer. Load tests shall not be made until the structure is at least 56 days old.

If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made by the Contractor free of cost to the Owner. Alternatively, if permitted under Statutory Regulations and at the discretion of the Engineer, the structure under test or a portion thereof may be retained as such without any modification by de-rating its load bearing capacity, provided the design criteria allows such de-rating.

A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 16.5 of IS: 456.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor. If in the course of dismantling, any damages done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

5.10.7 Rates

The rate for any item in the schedule, unless specifically excluded in the contract, shall be deemed to include the cost of all materials consumed or used in the work or incidental to it as well as labour, tools, plants, equipment, templates, supports, scaffolds approaches, security and safety measures, power, fuel, lubricants, storage, handling transport, testing, insurances, taxes, royalties and other revenue expenses, accommodation, services, supervision, overheads, profits etc, the various items of work which are to be provided are mentioned under Clause 2.1 and else where in this specification. If no separate item is provided for any such work in the schedule of items, it is implied that the contractor shall not claim for any of the connected items of the schedule viz. detailed drawings and drawing of formwork in the items of form form work of concrete etc., rate for R.C.C. items shall include for carrying out specimen tests as per specifications.

5.11 Method of Measurement

5.11.1 Concrete

a) Actual volume of work as executed or as per drawings issued, whichever is less, shall be measured in Cu.M. Deductions for openings, conduits, pipes, ducts pockets, chases etc, shall be made, provided they are larger than 0.1 Sq.M in area each. No deduction shall be made for embedded fixtures including reinforcements, sleeves, anchor bolts and similar items.

b) Precast concrete work shall be measured in the same way as specified in foregoing paragraph. No separate payment shall be made for formwork. Lifting hook where required in the design, shall be treated as reinforcement steel and paid accordingly. Payment shall be due only after erection, grouting and curing of the precast units in proper position unless otherwise provided for in the contract. All breakages and damages of the precast units will be to the Contractor's account and shall be replaced free of charge to the Owner.

5.11.2 Admixture

Admixture will be measured on the basis of theoretical requirement or actual consumption, whichever is less.

5.11.3 Reinforcement

a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc, for reinforced concrete shall be measured by weights in tones. The weight will be arrived at by multiplying the actual or theoretical length; whichever is less, by the sectional weights. In case, the Owner issues the reinforcing steel, the sectional weights will be the same as were applied at the time of issue. In case the steel is to be supplied by the contractor, the sectional weight to be adopted will be the I.S. Sectional weight or as per actuals which will be arrived at by accurately measuring representative samples as directed by the Engineer whichever is less.

b) Standard hooks, cranks, bonds, authorized laps etc, shall not be measured.

c) Lap welding or butt-welding if permitted will be measured diameter wise per joint. The actual length of steel in lap will be measured separately in case of lap welding. The rate quoted for the smaller size bar will be applied in case of joint between two bars of different diameters.

d) No payment shall be made for binding wires, spacer block, supports, chairs, hangers etc. of height 300 mm and less required of keeping the steel in position unless otherwise specified in the contract. For supporting horizonal reinforcement at height larger than 300 mm support drawings will be prepared by the Contractor and payment will be made for the

supports as approved by the Engineer or as actually placed, whichever is less, at the same rate as for reinforcement.

e) No extra will be paid for modification of already embedded reinforcement, if required due to faulty fabrication or placement.

f) Dowels neither shown on the drawings not instructed by the Engineer, but required for construction facilities and/or sequence, shall not be measured.

5.11.4 Form Work

a) Formwork shall be measured as the actual surface in contact with the concrete and paid in Sq.M unless included in the rate for concrete.

b) Formwork shall not be measured separately for precast concrete work, which shall be included in the concrete rates.

c) No payment for formwork or any other requirements in construction joints shall be made.

d) Openings upto 0.4 Sq.M shall be neglected as if non-existent for the purpose of formwork measurement.

e) No extra measurement or payment shall be made for making the formwork waterproof or for supports, scaffolding, concreting, approaches etc.

f) No measurement shall be taken for the formwork in pockets, openings, chases etc, in concrete if the cross-sectional area is less than or equal to 0.4 Sq.M in each case. If the cross-sectional area of any opening exceeds 0.4 Sq.M the formwork shall be measured under appropriate classification.

g) Fixing and removing pockets and openings of sectional area less than 0.4 Sq.M shall be measured on number basis and paid separately.

5.11.5 Anchor Bolts, Anchor Sleeves, Inserts, Hangers, Conduit Pipes and Embedded Fixtures.

a) These will be measured on theoretical weight basis of the complete insert handled by the Contractor irrespective of the amount of insertion. Where theoretical weight cannot be

assessed satisfactorily, the actual weight shall be allowed under certification of the Engineer.

b) No extra shall be to be paid for templates and other arrangements required to secure these in position. The protection of these materials with proper anticorrosive paints/grease and covering with gunny bags against any damages till the structure is handed over, shall be the responsibility of the Contractor at no extra cost.

c) Any 'boxing' left for inserts, etc, during construction, for facility of the Contractor's work and later on filled in by the same Contractor after placing the insert shall be considered for measurement purpose, as if the inserts etc, were placed before concreting.

d) No extra payment shall be made for cleaning of the inserts, etc, required for bond with the concrete.

5.11.6 Water proof Plaster

The measurement will be no finished square area basis. The thickness, method of applications, waterproofing additive to be used etc, will be specified in the specification/drawings/schedule of items.

The waterproofing additive will be measured and paid separately under admixtures. Deductions will be made for all openings.

5.11.7 Plinth Protection

All building shall be provided with 1000mm wide and 100mm thick PCC of grade 1:2:4 for Plinth protection all round with surface drain of required size and slope to suite storm water quantity. Plinth protection shall be laid over prepared subgrade and base formed with broken brickbats or rubble laid to a thickness of 150 mm .

5.11.8 LIST OF IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian

Standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed;

IS: 73 - Indian Standard Specification for paving Bitumen

IS: 216 - Indian Standard Specification for Coal Tar Pitch

IS: 226 - Indian Standard Specification for Structural Steel (Standard Quality)

IS: 269 - Indian Standard Specification for 33 Grade ordinary Portland cement

IS: 383 - Indian Standard Specification for Coarse and Fine Aggregates

IS: 432 - Indian Standard Specification for mild Steel and Medium Tensile Steel Bars

IS: 455 - Indian Standard Specification for Portland Slag Cement

IS: 456 - Indian Standard Code of practice for plain and ReinforcedConcrete

IS: 457 - Indian Standard Code of practice for General Construction PCC & RCC

IS: 516 - Indian Standard Specification for Methods of Test forStrength of concrete

IS: 1139 - Indian Standard Specification for Hot rolled Mild Steel and Medium Tensile Steel Bars and High yield Strength Steel; Deformed Bars for concrete Reinforcement.

IS: 1199 - Indian Standard Specification for Methods of SamplingAnd Analysis

IS: 1200 - Indian Standard specification for Method of measurement CC work

IS: 1200 - Indian Standard Specification for Method of MeasurementForm Work.

IS: 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing

IS: 1489 - Indian Standard Specification for Portland-Pozzolana Cement

IS: 1566 - Hard drawn steel wire fabric for concrete reinforcements

IS: 1609 - Code of Practice for laying Damp-proof Treatment usingBitumen Felts

IS: 1786 - High strength deformed steel bars and wires for Concrete Reinforcement

IS: 1791 - Indian Standard Specification for Batch Type Concrete Mixers

IS: 2185	-	Indian Standard specification for Hollow and solid Concrete Blocks.
IS: 2386	-	Indian Standard Specification for methods of Test for aggregates
IS: 2502	-	Indian Standard Code of Practice for Bending and Fixing Of Bars
IS: 2505	-	Indian Standard Specification for concrete Vibrators, Immersion Type
IS: 2506	-	Indian Standard Specification for Screed Board Concrete Vibrators.
IS: 2514	-	Indian Standard Specification for Concrete Vibrating Tables
IS: 3370	-	Indian Standard Specification for Code of practice forConcrete Structures for Storage of Liquids.
IS: 3590	-	Indian Standard Specification for Load Bearing light Weight Concrete Blocks.
IS: 3696	-	Safety Code for Scaffolding and ladders
IS: 4082	-	Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site.
IS: 4090	-	Indian Standard Specification for Design of Reinforced Concrete Archs.
IS: 4634	-	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes
IS: 4656	-	Indian Standard Specification for Form Vibrators for Concrete.
IS: 4925	-	Indian Standard Specification for Concrete Batching and Mixing plant
IS: 4926	-	Indian Standard Specification for ready mixed concrete
IS: 4990	-	Indian Standard Specification for Plywood for Concrete Shuttering work
IS: 4995 Part I & II	-	Indian Standard Specification for Design of Reinforced Concrete Bins for the Storage of granular and powdery Materials.
IS: 4998	-	Indian Standard Specification for Design of Reinforced

		Concrete Chimneys.
IS: 5512	-	Indian Standard Specification for Flow Table for use in Tests of hydraulic Cement and Pozzolanic Materials
IS: 5513	-	Indian Standard Specification for Vicat Apparatus
IS: 5515	-	Indian Standard Specification for Compaction Factor Apparatus
IS: 5751	-	Indian Standard Specification for Precast Concrete Coping Blocks
IS: 5816	-	Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders.
IS: 5891	-	Indian Standard Specification for Hand Operated Concrete Mixers
IS: 6452	-	Indian Standard Specification for High Aluminum Cement For Structural use.
IS: 6923	-	Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators
IS: 6925	-	Indian Standard Specification for Method of Test for Determination of water soluble chloride in concrete Admixtures.
IS: 7242	-	Indian Standard Specification for Concrete Spreaders
IS: 7246	-	Indian Standard Specification for Table vibrators for Consolidating concrete
IS: 7251	-	Indian Standard Specification for Concrete Finishers
IS: 7320	-	Indian Standard specification for Concrete Slump Test Apparatus
IS: 7861	-	Indian Standard Specification for Recommended Practice For Extreme weather concreting
IS: 7969	-	Safety Code for Handling and storage of Building Materials
IS: 8041	-	Indian Standard Specification for Rapid Hardening Portland Cement
IS: 8112	-	Indian Standard Specification for 43 Grade Ordinary Portland Cement

IS: 8142	-	Method of test for Determining Setting Time of concrete by Penetration Resistance.
IS: 8989	-	Safety Code for Erection of Concrete Framed Structures
IS: 9103	-	Indian Standard Specification for Admixtures for Concrete.

6.0 MASONRY AND ALLIED WORKS

6.1 SCOPE

This specification covers furnishing, installation, repairing, finishing, cutting, protection, maintenance and handling over of masonry and allied works of use in structures and location covered under the scope of the Contract.

6.2 INSTALLATION

6.2.1 Masonry

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

6.2.2 Mortar

Mix for mortar shall be specified in the Schedule of items.

6.2.3 Laterite Stone Masonry. `

The stone blocks shall be without any soft veins, cracks, cavities, flaws and similar imperfections. The blocks shall be exposed preferably for a period of three months before being used in the construction of masonry to ensure adequate stabilization However, exposure to rains should be avoided. Compressive strength not less than 3.5 N/mm2 (saturated dry samples.) IS: 1121 (Part I)-1974.

Supplying , providing and laying first class laterite stone masonry in CM 1:5 for wall in sub structure & super structure, using approved quality laterite stones including double scaffolding with pipes, payment of all applicable royalty & ROW payments and for all leads & lifts. Rate to include dressing of stones, watering prior to laying, providing and laying as per is code specifications. Curing the masonry after construction, providing scaffolding require if any, etc., complete in all respect as per tender specification/scope of work etc., complete in all respect as per IS-3620-1979 specification/scope of work etc. and as directed by MRPL Engineer-in-charge. The stones must be properly dressed and laid to plumb and must give a square cut appearance at the pillars.

a) Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

b) Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

c) Encasing of Structural Steel

This shall be done by masonry work round flanges, webs etc. and filling the gap between steel and masonry by minimum 12mm thick mortar. Encased members shall be wrapped with cheeked wire-mesh when shown on drawings or instructed by the Engineer. The minimum lap is cheeked wire mesh shall be 50 mm.

d) Damp proof Course

Unless otherwise specified Damp-proof course shall be 40mm thick artificial stone in proportion 1:11/2:3 cement sand stone chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

e) Sealant

Silicone sealant or polyurethane shall be used in all expansion joints exposed to weather. All joints around exterior doors, windows and expansion joints shall be sealed for proper water tightness.

f) Roof Drainage and Water proofing

Roof drainage system shall be provided for quick and efficient draing of rainwater from roof to avoid seepage and damage to roof. The runoff gradient for the roof shallnotbe less than 1 in 100. Roof drainage system shall consist of roof drain heads, rain water down comer and fixtures. The

down comer pipes shall be suitably concealed with masonry work, cement concrete or sheeting to match with the exterior finish.

g) Rain water down comers shall be of PVC pipe.

Sumps

In case of underground structures, sumps with pumping arrangement shall be provided at suitable location to collect and pump out any incidental water collection to nearest storm water drain.

6.2.4 RANDOM RUBBLE STONE MASONRY

a) Dressing

Stone shall be hammer dressed on the face, the sides and the beds to enable it to come in proximity with the neighboring stone. The "bushing" (projection) on the face shall not be more than 40mm on an exposed face and 19mm on the face to be plastered. It shall not have depression more than 10mm from the average wall surface. It shall also conform to the general requirements for dressing of stones covered in IS: 1129.

b) Laying

All stones shall be wetted before laying to prevent absorption of water from mortar. The stones shall be laid so that the pressure is always perpendicular to the natural bed. The courses (if any) shall be built perpendicular to the pressure which the masonry will bear. In case of battered walls, the base of stone and plan of courses (if any) shall be at right angles to the batter.

The walls shall be carried up truly plumbed or to the specified batter. Every stone shall be carefully fitted to the adjacent stones, so as to form neat and close joints. Vertical joints shall be staggered as far as possible.

Stone may be brought to level course at plinth, Window sills and roof level. Leveling up at plinth level, window sills and roof level shall be done with concrete comprising of one part of the mortar as used for the masonry and two parts of graded stone aggregate of 20mm nominal size.

The bond shall be obtained by fitting in closely the adjacent stones. Transverse bonds shall be provided by the use of bond stones extended from the front to the back of the wall. At angular junctions the stones at each alternate course shall be well bonded into the respective courses of the adjacent wall.

Face stones shall extend and bond well in the back. These shall be arranged to breaked joints as much as possible, and to avoid long vertical lines of joints. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face.

Where there is a break in the masonry work, the masonry shall be raked in sufficiently long steps for facilitating joining of old and new work. The stepping of the raking shall not be more than 45 degrees with the horizontal. The masonry work shall not be raised more than 1.2 meter per day. Toothed joints in masonry shall not be permitted.

c) Hearing of Chips

The hearting or interior filling of the wall shall consist of rubber stones which may be of any shape but shall not be less than 150mm on any face. These shall be carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar. The hearting should be laid nearly level with facing and backing, except that at about one meter intervals, vertical bonds stones shall be firmly embedded to form a bond between successive courses.

d) Insertion of Chips

The chips and spalls of stones shall be used wherever necessary to avoid thick mortar beds or joints and it shall also be ensured that no hollow spaces are lefty anywhere in the masonry. The chips shall not be used below their hearting stone to bring these up to the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and this shall in no case exceed 20% of the quantity of stone masonry.

e) Bond Stone

Bond or through stone running across the thickness of wall shall be provided in the walls having thickness up to 600mm, two or more bonds stones overlapping each other by at least 150mm shall be provided in a line from face to back. At least one bond stone or a set of bond stones shall be provided for every 0.5 sq.m courses and shall be staggered in subsequent course. An identification mark for the bond stones shall be given on both faces.

f) Quoins

The quoins shall be of selected stones neatly dressed to the required angle and shall be of the same height as the course in which they occur and laid header and stretcher alternately. The quoin shall not be less than 0.03 cubic meters in volume.

g) Jointing

Stones shall be so laid that all joints are fully packed with mortar. Face joint shall be minimum 20mm thick. The joints shall be struck flush and finished at the time of laying; when plastering and pointing is not required. If walls are to be plastered or pointed, joint shall be raked to a minimum depth of 20mm during the progress of work when the mortar is still green. For the faces of the wall which are not to be plastered, stone surface shall be cleared of mortar splashing to give uniform stone appearance.

6.2.5 RATES

Rates shall be unit rate for the complete work as detailed out in the Specification unless any particular portion is specifically excluded in the schedule of items.

6.2.6 METHOD OF MEASUREMENT

6.2.6.1 Soling

Soling of different types as enumerated in the Schedule of items shall be measured on actual area basis. Deductions shall not be made for areas less than 0.1 Sq.M

6.2.6.1 Masonry

Thickness of brick walls shall be measured in nominal brick sizes.

For masonry work exceeding 150 mm in thickness, actual volume of work shall be measured and deductions for openings, lintels, sills, conduit ducts, pipes etc., shall be made.No opening less than 0.1 Sq.M in area shall however be deducted.No deduction shall be made for embedded fixtures nor any extra be paid for the mortar used for fixing or for necessary cutting of bricks.

No extra payment shall be made for cutting of masonry units.

Walls 150 mm in thickness or less shall be measured for actual area of works and deductions made

Exposed brick work using selected ordinary brick or face bricks for the exposed face shallbe measured in area as an extra over the ordinary brick work if not provided in the schedule of items. It shall be measured by volume including the composite backing if so provided in the schedule.

Reinforcements shall be measured and paid separately under relevant items in the schedule unless included in the items for masonry work.

Laps in wire-mesh reinforcement shall not be measured. Reinforcing mesh shall be measured on actual area basis. Reinforcing bars shall be measured by weight.

6.2.7 I.S. CODES

The following codes, standards and specifications are made a part of this specification. All standards, tentative specifications, specifications, codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions.

In case if discrepancy between this specification and those referred to herein, this specification shall govern

IS: 1077	-	Common burnt clay-building bricks
IS: 3102	-	Classification of burnt clay solid bricks
IS: 2180	-	Heavy duty burnt clay-building bricks
IS: 3495	-	Method of test for burnt clay building bricks

IS: 2691	-	Burnt clay facing bricks
IS: 2212	-	Code of practice for brick work
IS: 2185	-	Hollow and solid concrete blocks
IS: 5498	-	Lime cement cinder hollow concrete blocks
IS: 3115	-	Lime based blocks
IS: 1597	-	Code of practice for construction of stone masonry (part I)
IS: 2394	-	Code of practice for application of lime plaster finish
IS: 2645	-	Integral cement water proofing compounds
IS: 1443	-	Code of Practice for laying and finishing of cement Concrete flooring tiles.
IS: 2114	-	Code of practice for laying in situ terrazzo floor finish
IS: 777	-	Glazed Earthen ware wall tiles
IS: 4021	-	Timber door, window and ventilator frames
IS: 2202	-	Wooden flush door shutters (Solid Core type) Part I
IS: 1003	-	Timber paneled and glazed shutters (Part I & II)
IS: 4020	-	Door shutters- Methods of test
IS: 1761	-	Transparent sheet glass for glazing and framing Purposes
IS: 4351	-	Specification for Steel door frames
IS: 1038	-	Steel doors, windows and ventilators
IS: 1081	-	Code of practice for fixing and glazing of metal (Steel and aluminum) doors, windows and ventilators.

IS: 5807	-	Method of test for clear finishes for wooden Furniture (Part I to III)
IS: 1477	-	Code of practice for painting of ferrous metals in Buildings (Part I & II)
IS: 2338	-	Code of practice for finishing of wood and wood Based materials (Part I)
IS: 427	-	Distemper, dry, color as required
IS: 428	-	Distemper, oil emulsion, color as required
IS: 2395	-	Code of practice for painting concrete, masonry And plaster surfaces
IS: 3384	-	Bitumen primer for use in waterproofing and damp proofing.
IS: 1580	-	Bituminous compounds for water proofing and Caulking purposes
IS: 1322	-	Bitumen felts for water proofing and damp proofing
IS: 1346	-	Code of practice for water proofing of roofs with bitumen felts.
IS: 1127	-	Recommendations for dimensions and workman-ship Of natural building stones for masonry work
IS: 1609	-	Code of practice for laying damp proof treatment using bitumen felts
IS: 2250	-	Code of practice for preparation and use of Masonry Mortars

IS: 5134 - Bitumen Impregnated Paper

7.0 PLASTERING

Plastering shall be generally conform to IS:1661.

7.1 Sand Faced Plastering

Surface preparation – The joints shall be raked out properly and dust and loose mortar shall be brushed out. Efflorescence, if any shall be removed by brushing out and scrapping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

Application of Plaster – Plaster shall be applied in two coats namely, 12mm undercoat and 8mm finishing coat. Ceiling plaster shall be completed before commencement of wall plastering shall be started from top and worked down towards the floor.

12mm Thick Undercoat – First, plaster of 12mm thick and 150 x 150mm shall be applied horizontally and vertically at not more than 2m intervals over entire surface to serve as gauges. The plaster shall be applied in a uniform surface slightly more than 12mm thick and then brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upwards and sideways movements at a time. The surface shall be left rough and furrowed 2mm deep with scratching tool diagonally both ways to form key for finishing coat. The surface shall be kept wet till finishing coat is applied.

Mortar – Mortar for undercoat shall be one cement+ five sand (1:5) by volume.

8 mm Finishing Coat – The Finishing coat shall be applied after the undercoat has sufficiently set but not dried and in any case within 48 hours. Sand to be used for second coat shall be sieved. Sand passing through 3mm sieve shall be taken for the second coat. The sand shall be of uniform size so that when sieved through a sieve of 50 mesh not more than 10 shall pass through. The second coat shall be struck uniformly over the first coat and firmly pressed and leveled using a batten. The surface then shall be firmly troweled and sponge floated to remove excess moisture and bring the sand to the surface. The surface thus prepared shall be uniformly roughened for texture, by running a fine wire brush lightly over the surface, if necessary.

Mortar – Mortar to be used for this coat shall be 1 cement + 2 sand, by volume.

The surface of plaster shall be kept wet for at least seven (7) days and shall be protected from the sun.

General – All corners, angles, and junctions shall be truly vertical and horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, arises, angles etc. where required shall be done without any extra cost. Such rounding or chamfering shall be carried out with proper templates to the size required.

In suspending work at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically. When recommencing the plaster, the edge of the old work shall be scraped, cleaned and wetted areas. Plastering work shall be closed at the end of the day on the body of the wall and not nearer than 150mm to any corners. It shall not be closed on the body of features like bands, cornices, etc. and nor at the corners. Horizontal joints in plaster work shall also occur on parapet top and coping.

The thickness of the plaster specified shall be measured exclusive of the thickness of the key, i.e. grooves or open joints in the masonry. The average thickness of the plaster shall not be less than the specified thickness. The minimum thickness over any portion of the surface shall not be less than specified thickness by more than 3mm.

The curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered. The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the Contractor's expenses by means as the Engineer may approve. The dates on which plastering is done shall be legibly marked on the various sections plastered to help watching of curing period.

For plastering work, double scaffolding having two sets of vertical supports shall be provided so that scaffolding is independent of walls. The Contractor shall be responsible for providing and maintaining sufficiently strong scaffolding so as to withstand all loads coming upon it.

7.2 Rough Cast Plaster

The surface preparation, application and curing shall be same as described for sand faced plaster for the undercoat. Mortar for the finishing coat shall consist on one part of gravel of 3 mm to 6 mm size. Mortar shall be thrown on the wall by means of a skipper of plasterer's trowel. The thickness of the coat shall be about 10 – 12mm. Curing shall be carried out for 7 days.

7.3 Neat Cement Punning

Before starting application of punning, the surface to be credited shall be brought to a true surface, all the putlog holes, crevices, etc. shall be filled in properly. Then the entire area shall be uniformly treated with a neat paste of cement and rubbed smooth, so that entire surface is covered with neat cement coating. The quantity of cement applied shall be 1 kg / sq.m.

Smooth finishing shall be completed with trowel immediately and in no case later than half an hour adding water to the plaster mix.

7.4 Waterproof Plaster

The integral cement waterproofing compound of approved make and manufacture and as specified in the drawings shall only be used for plastering.

Material shall be brought to the site in its original packing. The containers shall be opened and contents shall be mixed with dry cement in the proportion and manner as specified by the manufacturer. Care shall be taken in mixing to see that water proofing material gets well and integral mixed on addition of water.

8.0 PAINTING

8.1 SCOPE

This specification covers requirements regarding material, surface preparation, workmanship and finish for painting, varnishing, polishing and lining to various surfaces.

8.2 GENERAL

The surfaces for painting covered under this specification broadly consist of the following:

1) Structural Steelwork,
2) Steel Doors, Windows, Ventilators,
3) False Ceiling and A/C sheeting,
4) Concrete and masonry surfaces,
5) Cast Iron Covers, Pipes, Gratings

Hardware and accessories thereof, lighting fixtures, grills, etc. shall be removed during painting and refixed after painting. Removal and refixing shall however be done on instructions from the Engineer to that effect.

8.2.1 SAND- BLASTING AND SHOT- BLASTING

The process of sand-blasting or shot-blasting is the most thorough system of cleaning steel. Is to imping under pressure of air, the principle a jet of sharp sand or granulated steel (steel grit) on to the metal surface, removing in the process any rust and scale, including firmly-adhering mill scale. A steel surface properly cleaned by sand-blasting may be immediately recognized by its silver-grey surface and the criterion for good sand-blasting or shot-blasting is the even colour of the surface so cleaned. An air compressor with a displacement of 4.5 m3 will suffice for the work, but a compressor giving about 5.5 m3 of air would give faster results. Many of these are either readily available or may be built locally. Sandblasting is injurious to the labour carrying out this work. Suitable spray masks shall, therefore, be worn by workmen to prevent them from inhaling silica sand dust, which may lead to silicosis. River sands which are hard and sharp are most suitable for sand-blasting. The criterion shall be that the sand is free from loam and mud, and is sharp and hard. The high cost of steel shot restricts its application to a shop where shot-blasting or sand-blasting cabinets can be used. The cost of sand-blasting is approximately equivalent to the cost of a first class 4-coat paint job but this extra expense is fully ,justified as with a reasonable cycle of repainting the finishing coat only, it will not be necessary to clean the steel to bare metal

at a subsequent date, and the protection against corrosion will be optimum. Precautions shall be taken when sand- or shot-blasting light gauge steel to see that buckling does not occur as a result of continuous impingement of sand or steel shots under high velocity.

In areas, where presence of inflammable vapours is a possibility, such as near petrol tanks in oil terminals or refineries, special non-sparking wire-brushes, chipping hammers and scrapers shall be used. Precautions with regard to sand-blasting operations in inflammable areas shall be observed.

8.2.2 MATERIAL

Material shall be of highest quality of well known manufacturer and shall be delivered to the job site in unbroken packages, bearing the brand and name of the manufacturers with labels intact and seals unbroken and shall be subject to inspection and approval.

Samples of all colors shall be submitted before any work is started.

Except white-wash and color-wash, all approved shades to be used in painting shall be ready made and not prepared at site by mixing two or more colors.

8.2.3 SCAFFOLDING

Scaffolding where required shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to surfaces.

8.2.4 PROCEDURE

The procedure of painting shall be as per the specification of the paint manufacturer. When no specifications are furnished the procedure of painting shall be as specified below. Plastered and concrete surfaces shall be at least 60 days old before painting.

8.2.5 PRECAUTIONS

All furniture, lightings, fixtures, sanitary fittings, glazing, floors etc. shall be protected by covering and stains, smears, splashing, if any shall be removed and any damage done shall be made good by the contractor at his cost.

8.3 WATER PROOFING CEMENT BASED PAINT

8.3.1 Material:

Cement based paint (IS:5410-2002) of approved manufacture, quality, shade and colour only shall be used.

8.3.2 Preparation of surfaces:

The surface shall be thoroughly cleaned off all mortar dropping, dirt, dust, algae, grease and other foreign matter by brushing and washing the surfaces. The surface shall be thoroughly wetted with clean water before the water proof cement paint is applied. The prepared surface shall be got approved before painting is commenced.

The water proof cement paint shall be mixed in such quantities as can be used up with in an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Water proof cement paint shall be mixed with water 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 water proof cement 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 liquid of workable and uniform consistency. In all cases the manufacturers instruction shall be followed meticulously.

8.3.3 Application:

The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. To avoid direct heat of the sun during painting, the cement based paint shall be applied on the surface which is on the shady side. Cement based paint shall not be applied on the surfaces already treated with white wash,

colour wash, dry or oil bound distemper, varnishes, paints etc. It shall not be applied on gypsum, wood and metal surfaces.

8.4 SYNTHETIC ENAMEL PAINT

8.4.1 Paint

Synthetic enamel paint of approved brand, manufacture and shade shall be used. The surface preparation shall be as described earlier, for oil bound distemper.

8.4.2 Application

a) Under coat:

One coat of the specified paint of shade shall be applied and allowed to dry, overnight. It shall be rubbed next day with the finest grade of wet abrasive paper.

b) Top coat:

Top coats of specified paint of the desired shade shall be applied after the under coat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure proper, uniform glossy surface.

8.5 PAINTING WITH ACRYLIC EMULSION/PLASTIC EMULSION PAINT

8.5.1 Paint: This shall be polyvinyl based Acrylic/plastic emulsion paint of approved manufacture of the required shade, conforming to I.S.15489-2013 (Type-1).

8.5.2 Primer: The primer to be used for the painting with acrylic emulsion on cement concrete surfaces/ plastered surfaces shall be of approved brand and as recommended by paint manufacturer.

8.5.3 Putty: Plaster filler to be used for filling up (putting) uneven surfaces, small cracks and holes etc. shall be of approved compound and as per recommendations of the manufacturers. No oil based putty shall be used. The putty should be made from a mixture of whiting and plastic emulsion paint or as per manufacturers recommendations.In the event of separate provision of application of wall care putty over concrete/ plastered surface inthe work application of plaster filler (Putty) as mentioned above is not required.

8.5.4 **Finishing coats:** All the finishing coats shall be of matt finish or any other finish as required by the Engineer-in-charge. The number of finishing coats shall be as specified in the item.

8.5.5 Mode of Measurement: All the measurements for payment shall be taken on net surface area actually painted, unless otherwise specified. Deduction will be made from the areas for fixtures, grills, ventilation, outlets, electrical boxes and such obstructions not painted, if they are individually more than 0.05 sqm.

8.6 EXTERIOR ACRYLIC PAINT

8.6.1 Material: The paint shall be (Textured exterior paint/Acrylic smooth exterior paint/premium acrylic smooth exterior paint) of approved brand and manufacture conforming to IS:15489-2013 (Type-2)

This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and Engineer-in-Charge.

8.6.2 Preparation of Surface: For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer in charge after inspection before painting is commenced.

8.6.3 Application: Base coat of water proofing cement paint: All specifications in respect of base coat of water proofing cement paint shall be as described under 10.7.

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-in-charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust.

Paint shall be applied with a brush on the cleaned and smooth surface. 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 uniformly as possible leaving no brush marks.

The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described here-in before.

8.7 EPOXY PAINT

8.7.1 Epoxy Polyamide Primer: Epoxy primer shall be a two component polyamide cured epoxy primer of M/s Asian paints or of approved/specified manufacturer.

8.7.2 Epoxy Finish coat Paint: Epoxy paint shall be a two component polyamine adduct cured epoxy paint of M/s Asian Paints or of approved manufacturer.

8.7.3 Surface Preparation - Non-Ferrous Substrate: Surface should be dry and clean. Any visible oil/grease should be removed. Cleaned surface should be abraded or sweep blasted using low pressure and non - metallic abrasives, then primed with a coat of wash primer/self-etch primer (Apconyl WP 636).

8.7.4 New concrete or masonry surface: Must be allowed to cure at least 30 days before coating. The moisture content of the concrete/masonry should be less than 6%. In case of large areas and for severe exposure conditions, the surface has to be prepared by light blasting. In less critical areas where blasting is not practical, wire brushing has to be adopted to remove laitance, followed by treating with dilute hydrochloric acid (10%)and neutralizing the acid etched areas by washing with 5% solution of soda ash.

8.7.5 Old concrete surface: Remove the surface contaminants like grease, oil, etc., by solvent wipingor by 10% caustic solution. Preferably the surface has to be prepared by light blasting. In case, blasting is not practical, etch the surface to get a good profile by treating white dilute hydrochloric acid (10%) and neutralizing the acid etched areas by washing with 5% solution of soda ash.

Remove acid and contaminants by liberal wash with water. Ensure that acid solution does not retain on the surface and joints. Allow the surface to dry thoroughly before applying primer. Any cracks should be cut out and filled with suitable epoxy based toweling compound filler prior to painting.

8.7.6 Film Thickness: The recommended dry film thickness of the primer shall be 50 microns or as specified.

8.7.7 Application of Paint: Over the base coat of epoxy primer of specified thickness two or more coat of approved epoxy paint shall be applied strictly as per manufacturer specification to get desired thickness of paint 150micrn or as specified.

The contractor has to provide Elcometer sampling sheets for testing dry film thickness.

8.7.8 Other Details, Mode of measurement and Rate: These shall be as for Painting (General) mentioned here-in-before as far as they are applicable.

9.0 FLOORING & PAVING

9.1 SCOPE

This specification covers the requirements of laying different types of flooring laid over base concrete, encountered in Township Structures.

Flooring in any township Structure may have to be done in discontinuous strips or areas to suit the equipment erection. The flooring shall be done in close coordination with other agencies and shall keep pace with demands in respect of erection. No claims for extra shall be enable for reasons of discontinuity of work or delay in having areas available for work.

9.2 MATERIAL

For specification of materials, refer BOQ items.

9.3 VITRIFIED TILES

Polished vitrified tiles shall be 600 x 600mm x 9.50mm thick in flooring in different sizeswith water absorptions less than 0.07% and flexural strength not less than 47.3 N/mm2, in all colours, shades and sample asapproved by PMC, laid on 20 mm thick cement mortar

1:4 (1 cement: 4 coarse sand) including grouting the joints with whitecement and matching pigments etc. these are proposed in the following area hall, bed room, dining area etc., complete as directed by PMC.

9.4 CERAMIC TILES

Anti skid ceramic tiles with matt finish shall be used in toilets, passage, staircase, etc., The tiles shall be 300 x 300 x 7 mm of approved shade brand and colour.

9.5 GLAZED WALL TILES

Glazed wall tiles shall be 300x450x 6mm thick, in vertical surfaces over CM 1:3 mix 12mm thick and jointed in neat cement slurry, pointed in white or coloured cement as specified. Those are proposed in the following area toilets, kitchen dado etc., shall be provided of 2100 mm heightand directed by PMC.

9.6 SKIRTING/ DADO

150 mm skirting matching with floor finish shall be provided in all areas unless specified otherwise elsewhere.

9.7 GRANITE STONE SLAB

Granite shall be of approved color and quality. The stone shall be hard, even, sound regular in shape and generally uniform in color. It shall be without anby soft veins, cracks of flows.

The thickness of the stone shall be as specified in the items.

All exposed face shall be double polished to tender truly smooth and the even reflecting surface. The exposed edges and corners shall be rounded off as directed. The exposed edges shall be machine cut and shall have uniform thickness.

9.8 INTERLOCKINGTILES

Inter locking tiles shall be 60mm thick factory made rubber coated anti-skid cement concrete interlocking paver block of M-30 grade made by block making machine with strong vibratory compaction and of approved size and design/ shape laid in required colour and

pattern over and including 50mm thick compacted bed of course sand, filling the joints with coarse sand etc. all complete as per the direction of Engineer-in-charge.

10.0 DOORS, WINDOWS & VENTILATORS

10.1 GENERAL

This specification lays down requirements regarding material, sizes, construction, workmanship, finish and installation of frames, shutters and glazing for doors, windows, ventilators and MS doorin accordance with these specifications & drawings.

10.2 STANDARDS

IS: 287	Recommendations for maximum permissible moisture content of timber
IS: 401	Code of practice for preservation of timber
IS:451	Technical supply conditions for wood screw
IS: 851	Specification for synthetic resin adhesives for construction work in wood
IS:1411	Code of practice for seasoning of timber
IS: 1200 (part-XXI)	Method of measurement of building and civil engineering works (wood work & joinery)
IS: 1708 (part 1 to 18)	Method of testing of small clear specimens of timber
IS: 7196	Specification for hold fast
IS: 204 (part-I)	Specification for tower bolts (ferrous metal)
IS: 204 (part-II)	Specification of tower bolts (non ferrous metal)

IS: 208	Specification for door handles
IS: 1341	Specification for steel butt hinges
IS: 1659	Specification for block boards
IS: 2202	Specification for wooden flush door shutters (solid core type)
IS: 2209 (part-I)	Specification for mortise lock of timber
IS: 3564	Specification for door closers
IS: 4531	Specification for steel door frames
IS: 6760	Specification for slotted counter sunk head wood screws
IS: 12896	Indian timber for doors and windows shutter and frames- classifications
ISO: 1163	Plastics-Unplasticized polyvinyl chloride (uPVC) molding and extrusion materials Part 12: Preparation of test specimens and determination of properties (ISO 1163-2:1995)

10.3 TEAKWOOD DOOR

10.3.1 SCOPE

The works covered under this specification consist of providing, making and fixing of wooden frames for doors in accordance with these specifications and drawings.

10.3.2 GENERAL

Door frames shall be of 2nd quality timber of C.P. teak wood or as specified in the BOQ and Brought and put up to section as indicates on the drawings or as directed by the PMC.

It shall be perfectly dry, well-seasoned, free from sap wood, sound, straight free from large and loose knots, crack,shakes and other defects. Defective wood is liable to be rejected even after it is fixed inposition.

All scantlings, planks etc. shall be sawn in straight lines and planes in the direction of grains and of uniform thickness.

They shall be properly framed and mortised and tongued together at right angle and set correctly in the masonry or concrete.

The tolerances in the dimensions shall be allowed at the rate of 1.5 mm. per face to be planed.

10.4 FLUSH DOOR

10.4.1 SCOPE

The works covered under this specification consist of providing, making and fixing of block flush door shutter in accordance with the specifications and drawings.

10.4.2 GENERAL

Flush door shutter shall have a solid core and may be of the decorative or non-decorative type conforming to IS: 2202

The thickness and type of shutter shall be as specified in item of schedule of quantities.

The shutter shall be free from twist or wrap in its plane. The moisture content in timber used in the manufacture of flush door shutters shall be not more than 12 percent when tested according to IS: 1708

The tolerance in size of solid core type flush door shall be as under in Normal thickness + 1.2 mm in Normal height + 3 mm.

The thick of the shutters shall be uniform throughout with a permissible variation ofnot more than 0.8 mm. when measured at any two points.

10.5 FRP DOOR

Fiberglass reinforced plastic (FRP)molded shutter 30mm thick to fit in above frame, shutter with depressed panel design, with fireretardant grade unsaturated polyester resin, moulded to 3mm thick FRP laminate all around, with suitable wooden blocksinside at required places for fixing of fittings and polyurethane foam (PUF) / Polystyrene foam to be used as filler materialthroughout the hollow

panel, casted monolithically with testing parameters of F.R.P. laminate conforming to table - 3 ofIS: 14856 : 2000, complete with necessary hinges, handle, tower bolts, aldrop, etc., and necessary screws as per direction ofEngineer-in-charge.

10.6 UPVC FRENCH DOOR/WINDOW, WINDOWS, VENTILATORS

The works covered under this specification consist of providing, making and fixing of UPVC Window, Ventilators in accordance with these specifications and drawings.

10.6.1 GENERAL

The profiles are hollow, multi-chambered and steel reinforced with an outer wall thickness of 2. 2 mm.

10.6.2 CONSTRUCTION

The window unit is designed with all corners, transom/mullion joints mitered and fusion welded. The entire window is steel reinforced, which further increases the structural integrity of the frame. The window unit is designed such that water drainage does not pass through the reinforcement chamber. The product is free from all sharp edges and blurs.

10.6.3 HARDWARE AND FITTING

All hardware including its fixings is of materials resistant to or protected against atmospheric corrosion. Where hardware is fixed through the reinforcement, all screws penetrate the reinforcement by at least 2 mm. The windows incorporate a large variety of security devices such as multi-point locking including espagnolettes with mushroom headed catch. Handles and locks are designed so that they cannot be released from the outside by any mechanism.

10.6.4 INSTALLATION

The Window Systems can be fixed directly to the brickwork or surrounding structure using proprietary fixings and silicon sealant. Alternatively, a variable fixing plug fixed to the outside of the frame can be simply fixed to the structure, no matter what the cavity width, no timber or other sub frames are necessary.

10.6.5 GLAZING

The Window System can be internally or externally glazed with single glazing in 4mm, 5mm, 6mm and double-glazing upto 30mm.

10.6.6 WATER DRAINAGE

Water drainage is made in the profile to ensure that if any water comes due to an open window then it is immediately drained out.

10.7 MS DOOR SHUTTER

Supplying and fixing MS door shutters consisting of MS box section, flats, tubes, sheets, meshes etc., double/single hung including lugs, locking arrangements as per drawing and painting steel works with two coats of approved synthetic enamel paint over and including a coat of priming complete with all by works as per specification and direction of the Engineer.

10.8 FITTINGS AND FIXTURES

The fixtures and fastenings, that is butt, hinges, tee and strap hinges, sliding doorbolts, tower bolts, door latch, bath room latch, handles, door stoppers, casement window fasteners, casement stays and ventilators catch shall be made of the metal as specified in the item or its specifications.

The fixtures shall be heavy, medium or light type. The fixtures and fastenings shallbe smooth finished and shall be such as will ensure case of operation.

The samples of fixtures and fastenings shall be got approved as regards quality and shape beforeproviding them in position.

10.8.1 BUTT HINGES

Railway standard heavy type but hinges shall be used when so specified. Tee and strap hinges shall be manufactured from M. S. Sheet.

10.8.2 TOWER BOLTS

Tower bolts as specified in the item shall be used and shall be got approved.

10.8.3 DOOR LATCH

The size of door latch shall be taken as the length of latch.

10.8.4 ALDROPS

The aldrops as specified in the item shall be used and shall be got approved.

10.8.5 DOOR HANDLES

The size of the handles shall be determined by the inside grip length of the handles. Handles shall have a base plate of length 50 mm. more than the size of the handle.

10.8.6 DOOR STOPPER

The floor door stopper shall conform to IS: 1823. This shall be made of cast brass of overall size as specified and shall have rubber cushion.

10.8.7 MORTISE LOAC & LATCH

This should generally conform to IS: 2209. Handles shall conform to IS: 4992. Mortise lock with latches and pair of level handles shall be 6 levels, with zinc alloy pressure die cast/brass or as specified body of approved quality, and shall be right or left handed as specified.

10.9 PAYMENT

10.9.1 The measurement of doors, windows and ventilators shall be on the basis of the area of the overall frame size suitable for the shutter. Any projections beyond overall frame size such as horn or projection of frame below the floor shall not be measured.

10.9.2 The rate for doors, windows and ventilators shall include

10.9.3 Cost of provision of vision panels, ventilations cover molds, architrave, etc. if provided.

10.9.4 Cost of providing a coat of coal tar to the back side of the frames, a suitable priming coat of paint or varnish or polish to the front side of frames and shutter for timber doors, windows and ventilators.

10.9.5 Cost of providing 2 coats of zinc chromate red oxide primer to steel doors, windows and ventilators. Cost of all the materials, labour, transport, tools and equipment.

11.0 ROLLING STEEL SHUTTERS AND GRILLS

11.1 SCOPE

This specification covers the design, supply of materials, fabrication, delivery and erection of rolling shutters/Grills with motor drive and/or mechanical operation including all accessories as herein after specified.

11.2 INSTALLATION

11.2.1 COMPONENTS

(a) Slots for rolling shutters shall be made from tested bright cold rolled, annealed, M.S. Strips not less than 0.90mm thick for shutters up to 3.50m wide and above, machine rolled at 75mm rolling centers interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

(b) Rolling grills shall be constructed out of 6mm dia rods at 35mm on centers running horizontally flexible connected with vertical links spaced not more than 200mm centers. Alternatively rolling grills shall be made from perforated slots of approved design reinforced with 6mm dia rods.

(c) End locks shall be heavy type M.C.I/C.I and shall be provided at each end of alternate slots unless specified otherwise in the schedule.

(d) Bottom bars shall be finished with two angles not less than 6mm thick for external shutters. When shown on drawings a flexible weather strip shall be applied to make tight contact with the floor.

(e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 kg/sq.m or as specified in the schedule.

(f) 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.

(g) Hoods shall be formed of not less than 20 gauge steel suitably reinforced to prevent sag

(h) Locks shall be slide bolt and hasp or cylinder lock operable from one side or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc., shall be made as described in schedule or as described by the engineer.

(i) Power unit shall be suitable for 3 phases, 50 cycle 400 volts A.C. Power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction as a speed of 0.30 meters per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built in over load protection, a geared limit switch and one push button station located inside the building unless otherwise stated in schedule or drawing.

(j) It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

(k) Operating chains shall be of tested quality, heavily galvanized and with all ends rounded to assure smooth operation and hand protection

(l) Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

11.2.2 MANUALLY OPERATED SHUTTERS/GRILLS

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 0.3 meters per second. In general manually operated shutters shall be push pull type for openings up to 9 sq. meters 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 or as desired by the engineer.

11.2.3 SHOP COAT

Shutters shall be painted with one coat of red lead zinc chromate primer. Where specified doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

11.2.4 ERECTION

Door shall be installed by the manufacturer or his authorized representative shall install door 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 the latest Indian electricity rules.

11.2.5 ACCEPTANCE CRITERIA

a) Shop 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.

b) 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.

c) 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.

11.2.6 RATES

Rates shall be unit rates for complete items for supply and/or erection of rolling shutters, including all drives, accessories, hardware etc. No extra payment shall be made for cutting, drilling, welding, grouting etc., to structure for the installation of the shutters.

The rates shall include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections.

11.2.7 MS VENTILATOR GRILL

Supplying, fabrication and fixing MS guard bars/grill made out of MS flats, rods, square bars, etc., to steel ventilators including two coats of synthetic enamel paint over primer

coat, all complete as per drawing/approved designs, specifications and directions of the Engineer.

11.2.8 I.S. CODE

I.S: 6248	-	Metal rolling shutters and rolling grills.

12.0 GLASS AND GLAZING

12.1 SCOPE

The work in general shall consist of supplying and fixing all glass and glazing including all clips, putty, mastic cement etc, whatever required as shown in drawings and specifications, supply of metal glazing beads and neoprene gaskets shall not be included in this scope.

This shall also include the fixing of all glass and glass supplied by the Owner at his site stores.

12.2 INSTALLATION

12.2.1 General

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louver , miscellaneous glazing and partitions, unless otherwise stated from approved manufacturer like Hindustan Pilkinton or equivalent having uniform refractive index and free from flaws, speeks and baubles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site. The cut edges shall be straight and free from chips, spalls or any other damages.

12.2.2 Materials

a) Glare reducing or heat absorbing glass shall be "Calorex" of Hindustan Pilkington or approved equivalent and special care shall be taken to grind smooth and round off the edge before fixing.

b) Clear glass shall be flat drawn sheet glass and shall be atleast 4mm thick. Sheet glass for doors shall be minimum 5.5 mm thick.

c) Wired glass shall be thick rolled glass with centrally embedded 24c wire mesh of Georgian type. This may be of clear or colored glass, as shown in drawings or schedules.

d) Obscure glasses shall have a cast surface in one side.

e) Colored and floured glass shall be as per approved sample.

f) In general, the party shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing. Quick setting putty glass is used where it shall be non-setting type.

g) Neoprene gaskets with snap-fit glazing heads, shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak-proof installation.

12.2.3 Glazing, Setting and Finish

All glazing, clips, bolts, nuts, putty mastic cement etc, as required shall be supplied by the contractor.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S.: Codes, four glazing clips shall be provided per glass pane, except for large panes were six or more clips shall be used as per Engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by the Contractor.

Glass panes shall be set without springing and shall be bedded in putty and back puttied except where molding or gasket are specified. Putty, mastic cement etc, shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Where glass will be supplied by Owner, the Contractor shall cut it to size and fix them in the same as specified above.

Necessary glazing clips, putty, mastic cement etc, shall be supplied by the Contractor. The Contractor shall be responsible for damage of Glass supplied by the Owner, during handling, transportation, fixing etc, Maximum wastage allowance shall be 5%.

After completion of glazing work, the Contractor shall remove all dirt stains, excess putty etc, clean the glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the Contractor's own cost.

12.2.4 ACCEPTANCE CRITERIA

a) All installation shall be free from cracked, broken or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked or underground edges.

b) Glazing shall be carefully done to avoid direct contact with metal frames.

c) All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak proof installation

d) At completion, the panes shall be free from dirt, stains, excess putty etc, to the complete satisfaction of the Engineer.

12.2.5 RATES

a) Rates shall be unit rates for supply and / or installation of different kinds of glass mentioned in the Schedule of items.

b) No separate payment shall be made for glazing clips, mastic cement, putty, nails etc, for drilling holes in frames for inserting glazing clips.

c) No separate payment shall be made for cutting of glass to require size, edge finishing etc, if the glass is supplied by the Contractor.

d) Payment shall be made for cutting of glass to required size edge finishing etc, if the glass is supplied by the Owner.

e) No separate payment shall be made for cleaning the glass after installation.

12.2.6 METHOD OF MEASUREMENT

a) All supply and / or installation of glass shall be measured for actual area of work done.

b) When glass is supplied by the Owner, the cutting of glass shall be measured for actual length of cut edges.

12.2.7 I.S. CODES

Following are some of the important I.S. Codes relevant to this Section.

IS: 3548 - Code of Practice for glazing in building

IS: 1081 - Code of Practice for fixing and glazing metal doors, windows & ventilators.

13.0 PLUMBING AND SANITARY INSTALLATIONS

13.1 GENERAL

The work under this chapter comprises the supply and installations of the complete plumbing and sanitary system and shall be carried out in compliance with all local rules and regulations for plumbing installation. All material for plumbing and sanitary installation shall be suitable for their intended purpose and appropriately matched to each other. All material and structural components shall be standardised and shall meet the respective quality and dimensional requirements. The Contractor shall submit samples, description, catalogues and/or drawings showing all technical details, type, manufacturer etc. of the offered materials for Consultant's approval.

All plumbing and sanitary works shall be executed by a licensed or authorised plumbing supervisor or a licensed or authorised plumber and shall be in accordance with the requirements of IS:1742 and other relevant codes.

For items such as earthworks, excavation, concrete, brick work, stonework, painting etc., relevant specifications for these shall apply, unless otherwise specified.

Unless otherwise specified, all exposed cast iron or mild steel components such as cisterns, brackets etc. shall be painted with one coat of red oxide paint and two coats of oil based paint of approved colour.

The diameter of pipes and fittings wherever mentioned shall mean the internal diameter or nominal bore, unless otherwise specified.

The job shall include the cost of making necessary chases, holes etc, in walls, floors and in other places and also making good on completion of the works. Any damage caused to floors, walls etc. during execution of the sanitary and plumbing works shall be made good by the Contractor to the satisfaction of the Consultant

13.2 STANDARDS

Unless otherwise specified herein, the following standards shall apply to the works covered by this chapter:

Roof Drainage System	
IS:1230	Cast iron rain water pipes and fittings
IS:1626	Asbestos cement building pipes, gutters and fittings (spigot and socket type)
IS:1729	Sand cast iron spigot and socket soil waste and Ventilating pipes, fittings and accessories.
IS:1742	Code of practice for building drainage.
IS:2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage
Pipes and fittings for sanitary plumbing and drainage	
IS:404	Lead pipes (All parts)
IS:405	Lead sheet and strip (All parts)
IS:458	Precast concrete pipes (with and without reinforcements)
IS:651	Salt glazed stoneware pipes and fittings
IS:771	Glazed fire clay sanitary appliances (All parts)
IS:774	Flushing cistern for water-closets and urinals (other than plastic cisterns)
IS:775	Cast iron brackets and supports for wash basins and sinks
IS:778	Copper alloy gate, globe and check valves for water

	works purposes.
IS:781	Cast copper alloy screw down bib taps and stop valves for water services
IS:782	Caulking lead
IS:783	Code of practice for laying of concrete pipes
IS:804	Rectangular pressed steel tanks
IS:1068	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium
IS:1172	Code of basic requirement for water supply, drainage and sanitation
IS:1239	Mild steel tubes and tubulars and other wrought steel fittings (All parts)
IS:1536	Centrifugally cast(spun) iron pressure pipes for water, gas and sewage
IS:1537	Vertically cast iron pressure pipes for water, gas and sewage
IS:1703	Copper alloy float valves (horizontal plunger type) for water supply fittings
IS:1711	Self-closing taps for water supply purposes
IS:1726	Cast iron manhole covers and frames

IS:1729	Sand cast iron spigot and socket soil waste and ventilating pipes, fittings and accessories
IS:1742	Code of practice for building drainage
IS:1795	Specification for Pillar taps for water supply purposes
IS:2064	Selection, installation and maintenance of sanitary appliances - Code of practice
IS:2065	Code of practice for water supply in buildings
IS:2104	Specification for Water meter boxes (domestic type)
IS:2326	Automatic flushing cisterns for urinals (other than plastic cisterns)
IS:2470	Code of practice for installation of septic tanks (All parts)
IS:2548	Plastic seats and covers for water-closet
IS:2556	Vitreous sanitary appliance (vitreous china) (All parts)
IS:2963	Specification for Copper alloy waste-fittings for wash basins and sinks
IS:3004	Specification for Plug cocks for water supply purposes
IS:3006	Specification for chemically resistant glazed stoneware pipes and fittings
IS:3076	Low density polyethylene pipes for potable water supplies
IS:3114	Code of practice for laying of cast iron pipes

IS:3311	Waste plug and its accessories for sinks and wash basins
IS:3486	Cast iron spigot and socket drain pipes
IS:3597	Methods of test for concrete pipes
IS:4127	Code of practice for laying of glazed stoneware pipes
IS:4346	Specification for washers for use with fittings for water services
IS:4984	High density polyethylene (HDPE) pipes for potable water supply
IS:4985	Specification for Unplasticized PVC pipes for potable water supplies
IS:5219	Cast copper alloy traps: Part 1, 'P' and 'S' traps
IS:5329	Code of practice for sanitary pipe work above ground for buildings
IS:5961	Specification for Cast iron gratings for drainage purposes
IS:7634	Code of practice for plastic pipe work for potable water supplies (All parts)
IS:8008	Injection moulded high density polyethylene (HDPE) fittings for potable water supplies (All parts)
IS:10124	Fabricated PVC fittings for potable water supplies (All parts)

IS:10592	Industrial emergency showers, eye and face fountains and combination units

13.3 MATERIALS

13.3.1 Sanitary Fittings

All sanitary fittings shall be procured from approved vendors and shall conform to the requirements of the relevant IS Codes listed above. The sizes shall be as specified in the drawings and where not specified, the same shall be as per Consultant's approval.

Glazed earthenware fittings shall be of reputed make, white colour and one piece construction. All metallic fixtures like taps, stop cocks, soap holders etc. shall be of Chromium Plated (CP) brass of approved make. All wall fittings shall be fixed with wooden cleats and CP brass screws and washers.

13.3.2 Pipes and Fittings

Cast iron pipes and specials shall be of standard quality conforming to IS: 3486.

Stoneware pipes shall conform to IS: 651.

RCC pipes for underground sewer shall be P1 class conforming to IS: 458.

Mild steel pipes shall conform to IS: 1239

Water supply lines of GI, PVC, HDPE shall conform to IS: 1239, IS: 4985 and IS: 4984 respectively. PVC fittings for water supply lines shall conform to IS: 10124.

13.3.3 INSTALLATION

All execution will be done on the basis of approved drawings / instructions given by the Consultant. Fittings shall be located and oriented to allow easy reach such that operation, maintenance, repairs and replacements of pipes, fittings and fixtures are conveniently possible.

13.3.4 Galvanized Steel Water Supply Pipes

Screwed galvanized steel pipes shall be jointed with screwed joints and screwed fittings of the same materials as that of the pipes. Any burrs remaining on the pipe ends after the threads are cut, shall be removed. An approved jointing compound together with a grommet of a few strands of fine yarn shall be used for jointing pipes and fittings. Any pipe threads exposed after jointing shall be painted, or in the case of underground piping, thickly coated with approved bituminous compound to prevent corrosion.

The depth at which the underground water supply pipe is to be laid shall be as shown on the drawings. The service pipe passing into or beneath the building shall be laid at least 200 mm below the ground floor level and accommodated in a previously laid sleeve in the structure where it enters the building. The space between the sleeve and the pipe at its entry into and exit from the building shall be filled with approved bituminous sealing material for a minimum of 150 mm at both ends.

Piping shall not be buried in walls or floors as far as possible. However, when unavoidable, piping shall be buried for the shortest distance necessary and adequate protection shall be provided against damage. Galvanized steel piping shall be secured by iron or steel clamps and hooks when fixed on walls.

All pipework shall be completely watertight and the joints shall be such that there are no projections of jointing materials or the like in the interior of pipes. Before the pipeline is commissioned, all piping and fittings shall be flushed clean.

13.3.5 High Density Polyethylene Water Supply Pipes

All high density polyethylene pipes shall have screwed ends and shall be jointed with screwed fittings of the same materials as that of the pipes. Any burrs remaining on the pipe ends after cutting threads shall be removed. If necessary, an approved jointing compound with a few strands of fine yarn may be used for jointing pipes and fittings. All exposed high density polyethylene pipes shall be installed with PVC saddles screwed on 25 mm thick wooden blocks securely fixed on walls at suitable intervals, not exceeding 1.0m. Pipe wherever installed in wall chasing, shall be fixed as in the case of galvanized steel pipes.

13.3.6 PVC Water Supply Pipes

All exposed pipes shall be installed with PVC saddles screwed on 25 mm thick wooden blocks securely fixed on walls at suitable intervals, not exceeding 1.0m. Pipe wherever installed in wall chasing, shall be fixed as in the case of galvanized steel pipes.

13.3.7 Sanitary Appliances

All sanitary appliances shall be fixed in position rigidly on floor and walls as indicated in the drawings or as directed by the Consultant. All appliances shall be from the approved manufacturer and of approved colour.

13.3.8 Indian Water Closet (IWC) - Squatting type

Squatting type water closet shall be fitted on trap and shall be jointed with gasket yarn and cement mortar. Rim of the pan shall be levelled properly and set flush with the finished floor. The pan shall be connected to PVC low level push button / lever type cistern of 10 litre capacity. The flushing cistern shall be supported on a pair of Cl cantilever brackets firmly embedded in the wall in cement mortar (1:4) or screwed to wall with suitable plugs. The flush pipe from the cistern shall be 32mm dia tested quality chromium plated (CP) pipe and connected to the pan inlet by means of hemp and putty joint.

13.3.9 European Water Closet (EWC) - Pedestal type

Pedestal type water closet shall be rigidly fixed on the finished floor by means of 75mm long brass screws with suitable plugs. The flushing cistern shall be PVC low level push button / lever type cistern of 10 litres capacity. The cistern shall be supported on a pair of cast iron or rolled steel cantilever brackets firmly fixed on wall with brass screws and suitable plugs. The flush pipe from the cistern shall be 40mm dia chromium plated with brass end cap / lining and fitted to the closet by means of rubber adapter. The closet shall be provided with double plastic seat cover conforming to IS: 2548 with chromium plated hinges.

13.3.10 Urinals

Standing type urinals shall be firmly fitted on finished wall by means of 50mm long brass screws and suitable plugs. Height of the lip from the standing point shall be as shown in the drawings. Urinals shall be fitted with automatic flushing cistern of 10/15 litres (2/3 urinals)

capacity. Flushing pipes shall be of CP pipes of 25mm dia and connected to the urinal with 15mm dia PVC connector fitted with brass cap and lining at one end. The joint to the inlet of urinal shall be neatly finished with putty.

The arrangement of waste pipes and discharge to the floor trap shall be as shown on the drawings or as directed by Consultant. For single urinal, the discharge may be directly to the floor trap through a 40mm dia waste pipe. For a range of urinals, the discharge may be collected in a common waste pipe of 50mm dia leading to the floor trap. Each urinal shall be connected to the common discharge pipe by 40mm dia waste pipes. Alternatively, the discharge from each urinal through 40mm dia pipe shall be lead to the 100 mm glazed stone ware / vitreous china / CI half round channel laid on the floor leading to the floor trap.

13.3.11 Wash basin

Wash basin shall be fitted in position true to level on a pair of cast iron brackets fixed to the wall with brass screws and plugs. The basin shall be fitted with 15mm dia approved quality CP pillar tap and 32 mm dia waste fittings. The type of waste pipe and their connections shall be as shown in the drawings or as directed by the Consultant.

13.3.12 Sink

Stainless steel sink shall be levelled properly and fitted in position on a pair of cast iron cantilever brackets firmly embedded in the wall in cement mortar (1:4). The sink shall be fitted with chromium plated brass waste fittings of standard size. The type of waste pipes and their connections shall be as shown on the drawings or as directed by the PMC.

Other miscellaneous fittings (e.g. mirror, towel rails, soap cases etc.)

All such fittings shall be of type and sizes specified in General Technical Specification / Specific Technical And Functional Requirements Of Civil Systems, and shall be fitted in position true to line, level and plane as shown on the drawings or as directed by the Consultant.

13.3.13 Water Tanks

Water storage tanks shall be food grade PVC tanks of SINTEX brand or approved equivalent make, unless otherwise specified.

In case large volume tank is to be constructed, the same shall be of Gl, Masonry or RCC. They shall be fitted with a ball valve of the inlet pipe. A mosquito proof overflow pipe shall be fixed to the tank with the pipe invert about 25 mm above the top of water line. Approved type of stop valve shall be provided for every outlet pipe. All outlet and inlet pipes shall be fixed as shown in the drawings. Inside surface of galvanized steel tanks shall be painted with anti-corrosive food grade paints.

All storage tanks, water supply fittings and pipes, before being put into commission, shall be disinfected with liquid chlorine by the Contractor.

14.0 FABRICATION OF STRUCTURAL STEEL WORK

14.1 SCOPE

This specification covers supply (as mentioned in BOQ items), fabrication, testing, painting and delivery to site of structural steel work including supply of all consumables, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steel work covered under the scope of the contract.

14.1.1 Codes and Standards

All work under this specification shall unless otherwise specified in the contract conform to the requirements of the latest revision and/or replacement of the following of any other relevant Indian Standard Specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard Specification, any other standard practice as may be specified by the engineer shall be followed.

IS 226 - Structural steel (Standard Quality)
IS 800 - Code of practice for use of structural steel in general building construction
IS 806 - Code of practice for use of steel tubes in general building construction
IS 808 -Rolled steel beams channels and angle sections
IS 813 - Scheme of symbols for welding
IS 814 -Covered electrodes for metal arc welding of structural steel
IS 817 - Code of practice for training and testing metal arc welders
IS 822 -Code of practice for inspection of welds
IS 9595 - Recommendations for metal arc welding of carbon and carbon manganese steel

IS 919 - Recommendations for limits and fits for Engineering

IS 961 - Structural steel (High tensile)

IS 1161 -Steel tubes for structural purposes

IS 1200 -Method of measurement of steelwork and iron work (Part-8)

IS 1239 - Mild steel tubes

IS 7215 - Tolerance for fabrication of steel structures

14.2 Materials to be used

14.2.1 General

All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales slag intrusions, laminations, pittings, rusts etc., that may impair their strength, durability and appearance all materials shall be of tested quality only unless otherwise permitted by the Engineer and/or consultant. If desired by the Engineer test certificates in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer a random sample shall be tested at an approved laboratory from each lot of 50 tones or less of any particular section.

The arc welding electrodes shall conform to the relevant Indian Standard Codes of Practice and specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric with each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (Polarity in case of D.C.supply) for which the electrodes are suitable.

14.2.2 Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable.

(1) IS 226	-	Structural steel (Standard quality)
(2) IS 961	-	Structural steel (High Tensile)
(3) IS 1977	-	Structural steel (Ordinary quality) st-42-0
(4) IS 2062	-	Structural steel (Fusion welding quality)

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

14.2.3 Electrodes

All electrodes to be used under the contract shall comply with any of the following Indian Standard specifications as may be applicable:

(1) IS 814 - Covered electrodes for metal arc welding of structural steel
(2) IS 815 - Classification and coding of covered electrodes for metal arc welding of structural steel
(3) IS 1442 - Covered electrodes for the metal arc welding of high tensile structural steel.

14.2.4 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian standard specifications IS 1367- Technical supply conditions for threaded fasteners.
Materials for bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard specifications as may be applicable.

(a) All mild steel for bolts and nuts when tested in accordance with the following Indian Standard specifications shall have a tensile strength of not less than 44 Kg/mm^2 and a minimum elongation of 23 per cent on a gauge length of 5.6 A , where A is the cross sectional area of the test specimen.The material used for the manufacture of high tensile steel bolts and nuts shall have a minimum tensile strength of 58 Kg/mm^2. Other mechanical properties shall conform to grade HT of IS 961.
(b) High Tensile steel (Special quality):
The material used for the manufacture of special quality high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel, as set out in IS 1367 or as approved by the Engineer.

14.2.5 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the contract.

(1) IS 226 - Structural steel (Standard quality)

(2) IS 961 - Structural steel (High tensile quality)

(3) IS 1977 - Structural steel (Ordinary quality) st-42-0

14.2.6 Paints

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS 2074 – Ready mixed paint, Red oxide – Zinc chromate painting.

14.2.7 Quality control

The contractor shall establish and maintain quality control procedures for different items of work and materials to the extent the deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the contractor's fabrication shop whether located at site or elsewhere. The contractor shall co-operative with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work:

(1) Steel : Quality, manufacture's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.

(2) Bolts, Nuts & Washers	:	Manufacturer's certificate, dimension checks, material testing.
(3) Electrodes	:	Manufacturer's certificate, thickness and quality of plus coating.
(4) Welders	:	Qualifying Tests.
(5) Welding sets	:	Performance tests.
(6) Welds	:	Inspection,
(7) Paints	:	Manufacturer's certificate, physical inspection reports.
(8) Galvanising	:	Tests in accordance with IS: 263 – Method for testing uniformity of coating of Zinc coated Articles and IS: 4759 – Specification for Hot-dip zinc coatings on structural steel and other allied products.

15.0 ROOF SHEETS

15.1 GENERAL

Galvalume is a high tensile steel sheet coated with aluminum and zinc alloy by hot dip method. In some countries this material is known as Zincalume. The basic material is cold rolled steel sheets of yieldstrength 550 Mpa. The coating for corrosion resistance is given at 150 gm/sqm , total on both sides. The alloy coating comprises of 55% aluminum, 43% zinc and 1.5% silicon. This coating combines the advantages of superior barrier protection of aluminum and the sacrificial cut edge protection of zinc.

The roof sheets shall be of truss less type (non supported) as per the specifications in the SOR.

15.2 COLOUR

The bare galvalume is fit to be used as a roofing material. However, for better aesthetics the materials can be given colour coatings of required shade with silicon modified polyester (SMP) at factory itself. The exterior coat of SMP is usually 20 microns thickness given over a 5 micron polyester back coat applied over 5 micron primer. Sheets with 20 micron exterior coat of PVF2 (fluropolymer) paint system containing 70% KYANAR 500 resins are also being imported. These colour coatings exhibit excellent life to first maintenance in excess of 20 years.

15.3 ASSEMBLY AND ERECTION

The panel forming and installation shall be a complete on-site process. The Mobile panel forming Units (roll-forming/panel fabrication equipment) along with crane, seaming and other equipments shall be transported to project sites with required manpower, enabling panel forming & installation.

The RCC sub-structure shall be designed considering the arch reaction data with suitable load combinations.

15.4 THICKNESS

Galvalume sheets are available in thickness ranging from 0.25mm to 0.8mm. The most commonly used thickness is 0.55mm for profiled sheets and 0.65mm for flashing and gutters. The approx. weight of 0.55mm sheet is 5kg/m2 and the coverage is 200sqm/tonne.

15.5 INSPECTION & TESTING

The contractor shall submit the manufacture's test certificate and all other documents relating to the procurement of galvalume sheets. The Engineer-in Charge at his discretion may get the samples tested to ensure that the material conforms to specification.

15.6 MEASUREMENT:

Length and breadth of completed work shall be measured correct to a cm and area shall be worked out upto two decimal of sqM.The area under the laps shall not be measured for payment.

15.7 ROOF SHEETS (TRANSPARENT)

15.7.1 Preparation of sheeting drawings, procurement, transportation and delivery at erection site of transparent polycarbonate sheets for roof. The sheets shall be laid for infusion of daylight in the gate tunnel at appropriate distances or as per approved construction drawing. Base thickness shall be 1.5 mm. fixing of sheets with all flashings, corners, ridges, cutting, bending of sheets to a required shape & size and erecting them in roof &sides with all fixing arrangement as per manufactures instructions and complete in all respect as per drawings and specifications.(net laid area to be measured)

16.0 MISCELLANEOUSSTEEL WORKS

16.1 M.S. Grating

16.1.1 Material: Gratings shall be fabricated, out of M.S. Flats. The steel shall conform to IS: 236 and shall be weldable quality. It shall be clearly rolled and shall be free from harmful surface defects.

16.1.2 Fabrication drawings: Based on the arrangement of supporting beams of design drawings, the contractor shall prepare shop fabrication drawings and get the same approved as per the procedure outlined for fabrication drawings for structural steel work.

16.2 GI Gratings: These shall be ready made bought out type and designed to carry specified loads with limits.

16.2.1 Unless otherwise mentioned in schedule of rates these shall be capable of carrying a uniformly distributed load of 500 kg per square meter or a concentrated load of 1000 kg at mid span

whichever is governing. The maximum span for the above loading condition shall be 1200 mm. The deflection shall not exceed span/200 or 6 mm whichever is less. The design shall be done as per IS: 800. Before fabrication or procurement the contractor shall submit the design calculations, drawings and manufacturers literature and get the same approved from engineer-in-charge.

16.2.2 The gratings for stair treads shall be provided with nosing of chequred plate of approved size and thickness

16.2.3 Payment: Gratings shall be paid on the basis of weight of the area of M.S.Grating and frame actually laid.

16.2.4 The rate shall include cost of preparation of fabrication drawings, calculations, cost of cutting to size, fabricating, welding, bolting, smoothing ends if necessary shop coat of red oxide zinc chromate primer, transporting and fixing in position by welding or clips as per the design drawings.

16.3 M.S.Tube handrails

16.3.1 All mild steel tubes and fittings shall conform IS: 1239 and shall be of medium grade. All screwed pipes shall have threads as per IS: 554. All fittings shall be malleable iron fittings as approved by engineer-in-charge.

16.3.2 All pipes shall either be directly welded or jointed with screwed couplings. Care shall be taken to remove burrs from the ends of the pipe and if required the vertical members should be grouted with cement mortar as specified. The pipe shall be fixed to pipe or angle uprights by means of suitable clamps or by means of welding. After fixing, the pipe shall be painted with two coats of white paint or aluminum paint over a coat of primer as directed by engineer-in-charge.

16.3.3 Payment :The payment shall be made on running meter basis of the actuals of handrail fixed and shall include the cost of pipes. Clamps and fittings, if any, transportation, cutting pipes as required, threading or welding, fixing, painting etc., all complete as per direction of the engineer-in-charge.

17.0 DEMOLITION AND DISMANTLING

17.1 SCOPE

This specification defines the demolition, dismantling of reinforced concrete, plain concrete, brickwork and structural steel work or any such other work. Any special requirement as shown or noted on the drawing shall govern the provision of this specification.

17.2 DEMOLITION

The term demolition implies breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown on the drawings.

17.3 DISMANTLING

The term dismantling implies carefully removing without damage (up or down). This shall consist of dismantling one or more part of the building as specified or shown on the drawings.

17.4 GENERAL

17.4.1 PRECAUTIONS

a) All materials obtained from dismantling or demolition shall be the propertyof the "Owner" unless otherwise specified and shall be kept in safe custody until handed over to the Engineer-in-charge.
b) The demolition shall always be planned before hand and shall be done in reverse order of those in which the structure was constructed. The scheme shall be got approved from the Engineer-in-Charge before starting the work.
c) Necessary propping and/or under-pinning shall be provided for the safetyof the adjoining work or property before dismantling and demolishing is taken up and the works shall be carried out in such a way that no damage is caused to the adjoining work or property. Whenever specified temporary enclosures or partition shall also be provided.
d) Necessary precautions shall be taken to keep down dust, nuisance
e) Dismantling shall be done in a systematic manner. All materials which are likely to be damaged by dropping from a height of demolishing roofs, masonry etc, shall be carefully removed first.

The dismantled articles shall be passed by hand, where necessary lowered to the ground (and not thrown) and then properly stacked as directed by the Engineer-in-Charge.

f) Where fixing is done by nails, screws, bolts etc, dismantling shall be done by taking out the fixing with proper tools and not by tearing or ripping off.

g) Any serviceable material, obtained during dismantling or demolition, shall be separated out and stacked properly as directed by the Engineer-in-Charge. All unserviceable materials rubbish etc, shall be disposed off as directed by the Engineer-in-Charge.

h) The Contractor shall maintain disconnected services whether temporary or permanent, if required.

17.4.2 PAYMENT

a) All work shall be measured in the decimal system, as fixed in its place, subject to the following limits unless otherwise stated hereinafter.

   a. Dimensions shall be measured correct to a cm.
   b. Areas shall be worked out correct to two places of decimal
   c. Cubic contents shall be worked out to the nearest 0.01

b) Parts of work required to be dismantled and demolished shall be measured separately.

c) Measurements of all works except hidden work shall be taken before demolition or dismantling and no allowance for increase in bulk shall be allowed.

d) Specification for deduction for voids, openings etc, shall be on the same basis as that employed for construction of the work.

e) The rate shall include the cost of all labour involved and tools used in demolishing including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing off unserviceable materials as directed by Engineer-in-Charge.

18.0 Self supported Roofing system

18.1 Self Supported Roofing system is where roofing sheets do not require intermediate support like purlins or trusses. The system comprises of profiled roofing sheets that are directly fixed to the supporting structure at the sides and provide stability due to its curved shape. The shape and size of roofing element is chosen to satisfy the general requirement of

strength and stiffness, lightness and economy, ease of handling and erection, proper seating and leak proof joints

18.2 Material

The materials should be High Quality, High Grade, Pre-Coated Galvalume Sheet of Thickness 1.3 mm to 1.6 mm. The sheet should be aluminum-zinc alloy-coated steel sheets with 55% aluminum, 43.5% zinc and 1.5% silicon coating. GALVALUME is a flat rolled steel sheet coated with alloy of Aluminum by a continuous hot dip process. Grade 550 Steel used is known as High tensile steel with a minimum tensile strength of 550 MPA.

18.3 Specification of galvalume sheet

BASE METAL	Cold Rolled Structural Quality Steel In Coil Form, Coil Width: 914 mm
STEEL GRADE	GRADE D: 350 MPa Yield Strength. Min.
STEEL THICKNESS RANGE	1.3 mm mm (Base Metal Thickness)
BARE GALVALUME COATING	AZ 150, 150 Gms./Sq. M. Alu-Zinc-silicon coating (55% Al. 45% Zn.)
COLOUR COATING & TESTING METHODS	Top Side – Suitable for Roll-Forming, 20 microns total dry thickness, NCCA Standard T-Bend Test method or ASTM D4 145 -83 Back Side – 12 microns total dry thickness, epoxy primer and polyester wash-coat.

18.4 FABRICATION AND PANEL FORMATION

i. The Panel formation is done as per the required length and curvature at the site itself.

ii. The Sheet from the roll is passed through a Hydraulic Profile machine (MIC Machine) to give it the

iii. Trapezoidal shape and cut to the required length.

iv. After the profiling, these panels are passed through another Hydraulic machine for Pre Curving asper the design.

18.5 MECHANICAL SEALING

i. Seaming is like 'zipping up' of a rolled metal peals together using a Mechanical Seaming machine.

ii. Three roofing panels are mechanically seamed (Interlocked) at site along with the light fixtures

iii. and hangers.

iv. Panels are free from holes, nuts/bolts, overlaps and sealants which ensures almost zero maintenance.

18.6 EXECUTION AND ERRECTION

i) Pre Curving and assembly of Sheets are done at Site.

ii) The process allows High Speed Erection of Roofing Sheets giving installation speed of around 1500 sq. m. in 12 hrs.

iii) After Erection, it is bolted with the supporting structure by Self Splitting screws or Nuts & Bolts.

18.7 FIXING OF SHEETS WITH MAIN STRUCTURE

iv) The Pre Curved Proflex Sheet, after launching is fixed at the supporting structure or eave with self-splitting High Tensile Screws or Nuts & Bolts.

v) In case of single span, side/End Support with gutters for collection and disposal of rainwater is needed.

vi) In case of multiple spans the center support with gutter is required.

vii) These supports with gutters can be RCC or Steel.

Fire Fighting System

1.0 SCOPE OF WORK:

Design & detailed engineering, procurement, fabrication & manufacture, supply, delivery at site, unloading at site, storage at site, erection, testing & commissioning as per the attached specifications.

2.0 BATTERY LIMITS:

- Inlet of Fire water – Tapped from existing network

3.0 STANDARDS:

The firefighting systems shall be designed, manufactured, erected, tested and commissioned as per the standards laid down in this specification. Detailed instructions on such aspects as are not included herein but it shall be as per the codes and practices adopted by the relevant Indian Standards and International Standards.

Bidder to note that MRPL or Consultant's approval is must for all designs and documentation of the bidder.

All equipment shall also conform to the provisions of statutory and regulations in force such as Indian Explosives Act, Indian Electricity Act and rules, Indian Factories Act etc. Including latest revisions if any.

INDIAN STANDARD	TITLE
IS 13039 – 1991	External hydrant systems – provision and maintenance.
IS 1641 – 1988	Code of practice for fire safety of building (General): general principles of fire grading and classification
IS 636	Non-percolating flexible fire fighting delivery hose
IS 1641	Code of practice for fire safety of buildings (general): General principles of fire grading and classification.
IS 2871	Specification for branch pipe, universal for fire fighting purposes.
IS10221-1982	Code for practice for coating and wrapping of underground mild steel pipe lines
IS:2190-2010	Selection, installation and maintenance of first-aid fire extinguishers

4.0 SPECIFICATION OF FIRE HYDRANT SYSTEM

The External hydrants shall be provided for plant area as per the layout attached with this specification for reference.

5.0 HYDRANTS:

All the external hydrants shall be as per the IS: 13039-1991.

All hydrants outlets shall be situated 1 m above ground level. The stand posts shall be 80 mm in diameter for single headed hydrants and 100 mm for double headed hydrants. The stand-posts shall be painted 'fire red' (shade No. 536 as IS-5) as per IS: 13039-1991 standards and shall be plate welded numbered for easy identification. Separate Isolator valve to be provided in the riser pipe.

One hydrant post shall be provided every 45 m as per IS 13039, since the area is classified as Light Hazard.

Hose is kept in hose boxes alongside external area hydrants as applicable area; each box shall contain two lengths of 15 m each.

Only oblique hydrants conforming to IS-5290, Type A with outlets angled towards ground shall be used. The hydrant couplings shall be used. The hydrant couplings shall be of stainless steel gun metal of the instantaneous spring –lock (female) type of 63 mm dia. and valves shall be of the screw down type.

Branch pipe/nozzle of monitor shall be of stainless steel. Aluminum, gun metal coupling, branch pipes and nozzles are prohibited.

Water shall be available immediately to all hydrants/fixed monitors at all times, with all cut-off valves being kept open. Before final inspection, the Hydrant system shall be flushed thoroughly.

Cut-off (Isolating) valves are necessary to obtain the best possible pressure at the seat of fire as they enables a damaged portion of the installation to be isolated whilst full pressure is available throughout the remainder. These valves are distributed according to the general layout of the installation and not according to fixed rules. For this reason, the proposed position of these valves shall have the prior approval of the Client / Consultant. Cut-off valves shall conform to IS 14846-2000.

Double headed hydrant shall consist of two separate landing valves. A single control valve shall not be permitted.

Type of hydrant to be considered are as follows:

Double headed hydrant

Single headed hydrant

The hydrants main shall be normally laid underground with a minimum earth cover of at least 1200 mm to the top of the pipe from ground level. Suitable RCC encasing pipes shall be provided at road crossings etc as required. For sizing of the mains shall be as per IS: 13039-1991.

Hydrant outlet and valve for the underground type hydrant and valves for the stand post type hydrant should be located as near the ground level as possible. The top of the outlet or spindle of the valve should be at a depth not exceeding 0.3 m.

The underground hydrant systems shall be as per IS:13039-1991 and IS: 909-1975

The hydrants should be covered by hinge cast iron covers as specified in IS 3950: 1979 with letters 'FH' embossed on them. Ordinary manhole covers of cast iron or reinforced concrete should not be used to cover underground hydrants or the valves of the stand post type hydrants.

Apart from painting the fire hydrants and their covers in distinctive colors, all fire hydrants should have suitable indicating plates fixed to the nearest wall or suitable post erected for the purpose to facilitate easy location. The indicating plates can be made of vitreous enameled mild steel, cast iron or aluminum alloy. The plates should be yellow in colour with letter 'H' in black, preferably with fluorescent colour paints. Where possible, size of the mains and the distance of the hydrant from the plate should be marked on the plate as per IS: 13039-1991.

The hydrants should be located according to the attendant fire hazard so as to facilitate the most effective service. They need not necessarily be equidistant from each other. In industries where they are to cover specific buildings, advantage should be taken of convenient doors or windows or both, to place hydrants so that only a minimum length of hose is required to reach the opening through which fires may be attacked. The location of hydrant landing valves on floors above the ground floor or a processing unit should be close to the staircase landings.

Hydrants should be located at a distance of not less than 2 m from the face of the buildings. This distance may suitably be increased up to maximum 15 m where hydrants are installed to protect processes so that the hydrants remain approachable and workable even in the case of a serious fire.

All hydrants should be readily accessible to the fire appliances and for fire fighting operations.

Hydrants located in situations where they are likely to be damaged by vehicular traffic should be 'suitably protected on all sides against possible damage.

Hydrant accessories, such as, hydrant stand pipes, hydrant key and bar suction collecting heads, delivery hoses, branch pipes and nozzles, etc, should be provided in sufficient quantities for quick operation of the hydrants.

MRPL having their own fire brigades, the hydrant accessories should be provided centrally on each of the fire appliance and at the fire station.

6.0 EQUIPMENT DATA SHEET:

The data sheet of various equipment's will be used in hydrants systems are as follows,

Sl.No.	Description	Technical Data
	HYDRANT VALVE	
	Type	Single / Double headed, female oblique type
	Code / Standard	IS : 5290, Type A
	End connection	Flanged and drilled to ANSI B 16.5, 150#
	Material of construction	Gun Metal to IS : 318 Gr.2
	Testing	As per IS : 5290
	Test pressure	Body - 21 kg/cm2 , Seat - 14 kg/cm2
	GATE VALVES	
	Sizes	Below 150 NB
	Type	Non - Rising spindle type
	Code / Standard	IS 780 / IS 14846
	End Connection	Flanged and drilled to ANSI 150# B16.5
	Material of construction	CI / MS Fabricated
	Rating	PN 1.6
	SLUICE VALVES	
	Size	Above 150 NB
	Material/ IS Code	IS 210 Gr FG 220 For Body & bonnet
	Valve Seat	13% Cr Steel faced Carbon Steel

Sl.No.	Description	Technical Data
	Manuf./Testing Std.	IS 780 / IS 14846
	Rating	PN 1.6
	CHECK VALVES	
	Type	Swinging disc type
	Material	As per IS 210 Gr FG 220
	Manuf./Testing Std.	IS 5312
	End Connection	Flanged and drilled to ANSI 150# B16.5
	Rating	Compatible with 10 kgs/cm2(g) working pressure
	BRANCH PIPE & NOZZLE	
	Size / Code / standard	IS : 903-1995
	Nozzle Type	Hexagonal, detachable
	MOC of Branch pipe / nozzle	Gun metal grade LTB-2
	HOSE COUPLING	
	Type	Instantaneous Male and Female
	Size	63 NB
	Code / standard	IS : 903
	Material of construction	Gun Metal to IS : 318 LTB-2
	Testing	As per IS : 903

Sl.No.	Description	Technical Data
	HOSE CABINET	
	Type	Fabricated out of 16 SWG. MS sheet
	Size	900 x 600 x 450
	Mounting	Wall / column mounted
	Painting	Fire red as per IS-5, Total DFT - 100µ
	FIRE HOSE	
	Type	Controlled Percolation
	Size	63 mm
	Code / standard	IS : 8423
	Length	15 m for external hydrant.
	Approval	ISI marked
	GASKET	
	Material	Nitrite Butyl Rubber (NBR)
	Thickness	3 mm
	Design	ANSI B16.21
	Facing	Full Face
	STRAINERS	
	Type	Y – Strainers
	End connector	Flanged and drilled to ANSI 150# B 16.5

Sl.No.	Description	Technical Data
	Material of construction	MS to IS : 2062
	BOLTS, NUTS	
	Service	Fire Water
	Material / IS Code	IS 1367 Cl 4.6/4

7.0 PIPING SYSTEM

The details for hydrant piping shall be laid at underground and above ground pipelines provided to understand the materials used for system and preparation of erection drawings and execution plan.

8.0 STANDARD/CODE FOR WATER PIPE LINES:

SI.No	Item	Nominal dia (DN) mm	Specification
1.	Pipe	150 and below	IS:1239 (Part I), heavy, ERW, black
		200 to 2500	ERW Pipes rolled from plates to IS: 3589 (min. tensile strength=410 Mpa).
2.	Pipe fittings		
	Screwed fittings	50 and below	IS:1239(part II),black
3.	Bends	50 and below	IS:1239(part II),black
		65 and above	IS:1239(part II),black
4.	Tees/Crosses	450 and below	Fabricated from pipes
5.	Reducers	450 and below	IS:1239(part II),black / Fabricated by taper cutting of pipes and welding
6.	Bolting	All Sizes	IS:1367
7.	Gaskets	All Sizes	Sheet rubber to IS:638, type A, 3mm thick/compressed asbestos to IS:2712, Gr C, 1.6 mm thick
8.	Flanges	All Sizes	Slip on flanges to IS: 6392 made from carbon steel plates to IS: 2002 Gr 2A, with bore to suit pipe O.D.
9.	Valves		
	Isolation, Drains etc.	50 and below	Copper alloy gate valves, screwed upto25mm and flanged 25 to 50 mm as per IS: 780 class.2

SI.No	Item	Nominal dia (DN) mm	Specification
		65 to 150	CI gate valve, flanged, as per IS: 780,class 2 / CI sluice valve flanged, as per IS:14846-2000
		200 to 400	CI gate valve, flanged as per IS 14846-2000 or equivalent.
	Throttling	100 and below	Copper alloy globe valves, screwed up to 25mm and flanged over 25 mm as per IS: 778-1984
		100 to 300	CI globe valves as per IS9338-1984 with flanged ends.
		Over 300	CI butterfly valve – Regulating type, flanged as per IS 13095 or equivalent.
	Non-return	50 and below	Copper alloy horizontal/vertical check valve (lift type), screwed, as per IS:778, class 3
		65 to 400	CI swing check valve, flanged generally as per IS:5312 -2004
	Air release cum vacuum valves	300 and below	Automatic air release cum vacuum valves, iron double air valves, gun metal/bronze internals, screwed down isolating valves, flanged end. As per is14845-2000

SI.No	Item	Nominal dia (DN) mm	Specification
10.	Filter		Strainer with CI body and brass strainers of 16 g sheet with 1.25 mm dia perforations @ 20 per sq cm. Ends screwed for DN 65 and below and flanged to IS:6392 for DN 80 and above
11.	Hose assembly	All Sizes	With textile braided reinforcement to IS: 444 or SAE-100 R-3 with screwed female threaded couplings at both ends and adaptor at one end f or sizes DN 50 and below. For hoses of DN 65 and above flanged couplings shall be provided.

9.0 LAYING OF UNDERGROUND PIPELINES:

All buried pipe work shall be laid with earth cover sufficient to avoid damage from pressure of vibration caused by surface traffic. Minimum earth covering over the pipe shall be 1200 mm from the finished ground level in areas subject to temporary loads and 1000 mm from finished ground level in areas not subject to temporary loads or shown on enclosed drawings. In case site conditions require the pipes to be laid at depths less than the above limits, permission from Purchaser's Engineer will be required.

The excavation of trenches shall be so carried out such that the digging of trenches does not go far ahead of the pipe laying operations, so as to prevent risk of falling of sides etc. All work shall be so organized that trench digging, pipe laying, testing and backfilling of trenches follow one another closely.

Replaced the pipe, making wholly good any injury or damage which may The excavated soil shall be laid, leaving 500 mm clear distance by the side of the trench. The excavated soil shall preferably be on the side of traffic parallel to the trench, so as to have extra protection and to leave the opposite side free for placing pipes and accessories and for joining them. Laying of pipes in backfilled soil shall be done after soil consolidation in layers for all the materials.

Large stones, rubble etc found during excavation shall be dumped far away to avoid damage to pipe work during refilling. The trench bottom shall be leveled to the required levels keeping in view the pipe slopes required. In steeply sloping trenches, pipe anchors shall be provided. Where loose earth is met during excavation, or where trench is very deep, sidewalls shall be shored properly with timber or other means.

Precautions shall be taken at all times to prevent damage to the coating and wrapping on the pipe and appurtenances by workmen or trespassers. During laying and at any other time while pipe is exposed, no person shall be permitted to walk on a pipe (or in, if lined) wearing boots or shoes with nails or other attachments that may injure the coating. Care must be exercised to prevent the dropping of tools, rivets and other materials on, and the dragging of heavy objects over a pipe, and other acts that would mar its coating and wrapping. Pipe handling slings and any blocking used in handling or storing pipe must be well paddled to avoid damage to pipe coating.

Ends of coated pipes in the storage yard shall be closed by an approved head or barrier, unless otherwise specified. The heads or barriers shall not be removed until a pipe is about to be laid. Each day, at the close of work and when laying is not in progress, the open ends of a line shall be

similarly protected. If it becomes necessary to backfill a trench before making connections to adjacent piping, the open ends shall be closed by suitable means.

After a pipeline has been laid on skids, it shall be thoroughly cleaned, inspected and any damage to the protective coating satisfactorily repaired while the pipe is suspended above the trench. The pipe shall then be lowered into place upon the sub grade and laid to the required line and grade. After completion and acceptance of the field test on each major section of an underground pipeline, all testing media shall be removed from the section and all interior surface cleaned. All abrasions and other damages to the coating shall then be repaired.

All underground pipelines crossing rail tracks or roads where the depth of cover is between 1,200 mm and 1,800 mm shall be protected. This protection shall be a reinforced concrete casing pipe. The annular space between casing pipe and inner pipe at the ends shall be suitably sealed.

Concrete pipe sleeves shall be extra strong reinforced concrete casing pipes in 2,500 mm lengths, wherever practicable. The size of the casing pipe shall be selected as per requirements.

Suitable anchors of concrete shall be provided at bends and other locations in a pipeline where unbalanced pressure may develop under normal or test pressure and tend to cause movement in the pipeline.

All the pipes to be lay with the slope of 1:500 towards pipe drain or trench directions.

The bidder shall take every precaution against the floating of the pipe due to water flowing into the trench or from caving, flushing or puddling. In case of such floating, the bidder shall result.

10.0 COATING AND WRAPPING;

Coating and Wrapping of underground buried steel pipe line shall be carried out as per IS 10221-1982.

The coating shall be as follows:

A) One coat of synthetic primer with characteristics as per table-3 of IS 10221-1982

B) One coat of coal tar enamal as per table-5 of IS 10221-1982, with an inner wrap of glass fibre tissue with characteristics as per table-7 of IS 10221-1982 and outer fibre glass wrap with characteristics as per table 10 of IS 10221-1982.

Surface preparation, method of coating and wrapping etc. Shall be strictly as per IS 10221-1982.

If the pipes are fabricated at site and the coating & wrapping is done at site, surface cleaning should be done by either sand or shot blasting or other approved mechanical cleaning methods.

Before sand or shot blasting any oil or grease if present on the metal surface should be removed by a suitable solvent cleaning.

11.0 WELDING OF PIPELINES:

All steel pipelines both underground and above ground shall be of welded construction and all jointing by electric arc and gas welding processes shall be as per IS: 823 and 1323 respectively or equivalent. However, the provisions of mandatory codes such as Indian Boiler Regulations, Explosives Manual, fire protection manual etc. shall be met where required.

All welding work shall be carried out by qualified welders; all filler materials, edge preparation, post-weld treatment etc shall be as per relevant standards. All welds shall be made in such a manner that complete fusion and penetration are obtained without an excessive amount of filler metal beyond the root areas. The voltage, amperage, and polarity of welding current shall be in accordance with the electrode manufacturer's recommendations. Reinforcement, if provided shall be applied in such a manner that it will have a smooth contour merging gradually with the surface of adjacent pipe and welded fitting. Backing rings shall not be used without approval of Engineer.

Pipe and attachments shall be aligned properly by accurate and permanent methods prior to welding. If tack welds are used, the tacks shall be either fused into the first layer of weld or else chipped out. All welds shall be built up by the application of multiple beads or passes; the thickness of metal deposited in each bead or pass shall not exceed 3 mm. Each bead shall be

cleaned and, if not a work hardening material, shall be lightly peened before the next bead is laid. The complete weld shall be cleaned of slag and splatter metal on all surface and the inside beads shall be ground smooth where practicable.

All welding by the shielded electric arc process shall be done using electrodes in accordance with the relevant standards. Composition of consumable electrodes or filler rods in case of non-consumable electrodes shall be same as that of the parts being welded so that there is no dilution of the alloying components at the welded joints.

Bends, branches, reducers etc may be fabricated from pipes, by cutting and welding as above, where permitted by the service conditions.

Alloy and stainless steel pipe work shall be heat treated after welding and cold working in accordance with the relevant codes to maintain their composition and grain structure and to keep their strength and corrosion resistant properties.

Welding shall be done after ensuring all the safety precaution as per standards/as envisaged by MRPL. All the welding equipments shall be tested and certified at MRPL before commencement of the work.

12.0 VENTS, DRAINS, VALVE PITS, STRUCTURAL SUPPORTS ETC:

Valves on an underground pipeline shall be located in a masonry chamber with RCC roof, manhole with cover in the roof and access ladder or open to atmosphere with access ladder, hand rail around valve chamber etc., as per the site requirements. The chamber size shall enable free movement during maintenance and/or repair work to the valves. Chambers which because of their design or construction could become, in any way, hazardous to human life shall not be permitted. The design shall incorporate sufficient escape provisions for personnel in the event of flooding or other emergency.

In case of roof covered valve chamfer shall be a minimum of two manholes must be provided where, because of its size, maintenance or replacement of valves may require more than one person at a time. Manholes shall be of suitable size and shall be located on the roof in opposite locations. A separate rung ladder shall be provided at each manhole.

Pipe sleeves shall be provided for pipelines passing through foundation, walls including valve pit walls, floors, roofs etc. They shall be of sufficient size to permit the passage of flanges or fittings assembled with the line. Sleeves in floors or roofs shall be set sufficiently above the floor or roof to prevent drainage through them.

Adequate drains at all low points and vents at high points shall be provided for proper operation and maintenance of the pipelines laid underground and also other service lines laid above ground for which hydraulic testing is required as per specification. Air release cum vacuum relief valves of adequate size shall be provided on all large diameter water lines to expel the air from the lines during filling of the line and allow entry of air into the line when the line is drained. The vacuum relief valves are a safety feature to be provided on all large diameter water lines.

All required supporting structures as shown on the drawings including operating platforms, valve stands, access ladders, hand rails etc. shall be provided as part of the overhead piping system as required for proper operation and maintenance of the piping system. All structural steel work shall conform to relevant BIS.

All the equipment's/structural's/tanks/vessels shall be double earthed to the nearest earth grid.

13.0 PAINTING:

All overhead and underground pipelines and structures shall be thoroughly cleaned by approved mechanical means and coated as per the below schedule. All over head pipelines shall be color coded as per firefighting system norms.

14.0 FIRE SYSTEM ACCESSORIES:

The fire protection system accessories for each shop or unit shall include the following in addition to the other facilities.

Sign boards to indicate fire hazard areas/equipment, the type of fire hazard and other prohibited action such as 'No Smoking' sign.

Total system display boards to be installed in the strategic places.

Schematic drawing indicating operating instruction boards to be installed.

Caution instruction boards are to be displayed in each shop for gas fire, oil fire, electrical fire etc.

Help line boards to be displayed with Department Phone no., fire brigade phone no., ambulance phone no, central control hospital phone no.

Operation and Maintenance manual for all the equipment and system shall have to be provided.

15.0 MAKE OF MATERIALS TO BE USED:

All the material shall be got approved by MRPL / EIC prior to their use

Sl. No	ITEM	VENDORS
1.	M.S.Heavy Class pipes as per IS-1239 and IS 3589	Jindal / Sail / Tata
2.	Pipe supports structural steels	Jindal / Sail / Tata
3.	Wrapping	IWL India Limited / M.K. Petro Products India Pvt. Ltd.
4.	Painting	ASAIN / BERGER / NEROLAC
5.	Double / Single fire hydrant	New Age / Fire Knock / Supremex / Minimax
6.	Isolation valve	L&T / BDK / R&D MULTIPLE / LEADER / KBL
7.	Fire hose, hose pipe coupling & proof lockable cabinet etc.	New Age / Fire Knock / Minimax

Electrical Works

1.1 Introduction

MRPL is an organization which is certified to ISO 14001 Environment Management System & ISO 50001 Energy Management System.

The following locations within / outside the MRPL complex need to be upgraded / revamped / refurbished / augmented with new construction as per per the detailing in this tender document:

- Main Gate
- Phase III Gate
- LP Gate
- Cargo Gate
- CISF Township
- New Culvert near PP Gate
- Railway Siding

1.2 Site Data

- Project Location – MRPL, Mangalore
- Nearest Railway station – Mangalore
- Average Rainfall – 3800 mm
- Ambient Temperature – 50ºC
- Soil Bearing Capacity – 15 T / M²
- Wind speed – 39 m/s
- Seismic – Zone – IV
- Electrical Power Supply – 415V, AC

1.3 Scope of Electrical Work

Design, manufacture, supply, shop testing, inspection, transportation to site, proper storage and handling at site, erection, testing and commissioning of Electrical equipment & auxiliaries briefly listed below (but not limited to) on Item rate Basis in line with this specification approved Drawings / Data sheets, site orders and statutory regulations.

Scope of Supply includes, but not necessarily limited to following.

a) LT Panel board.
b) Power & Lighting Distribution Boards, Control Stations, etc
c) Low Voltage Motors

d) Illumination System

e) Low Voltage power cable, Control and illumination cables.

f) PVC Conduit Pipes

g) Ceiling Fans, LED Tube Light, LED Ceiling Light, LED Wall Bracket, LED Flood light(Peripheral & Sports), LED streetlight, LED mirror light, LED bulk head fitting, Sockets (6/16A,16A),Air-Conditioner, Geyser, Exhaust Fans, Bell/Push, Telephone, TV Point, LED Solar street light, LED lighting Mast etc.

h) All associated civil works such as excavation & back filling

i) Obtaining all necessary approvals (if applicable) from statutory bodies for commissioning the electrical installations pertaining to the project locations.

j) Electrical service design and drawings, internal communication, networking, fire detection and protection system

k) Earthing& Lightning Protection.

All scope of work shall comply with requirements of latest statutory regulations in force but not limited to the Indian Electricity Rules & Acts, Relevant IS Specifications, Local Statutory Regulations and Specifications of this Tender. The contractor shall obtain all necessary approvals from relevant statutory authorities (if any) for executing electrical system facilities at the project locations.

1.4 **Codes and Standards:**

- IS 2675: 1983: Enclosed distribution fuse boards and cut-outs for voltages not exceeding 1000V.
- IS 732:1989 Code of practice for electrical wiring installations (third revision)
- IS 4648:1968 Guide for electrical layout in residential buildings
- IS 8061:1976 Code of practice for design, installation and maintenance of service lines upto and including 650V March 2011
- IS 8884:1978 Code of practice for the installation of electric bells and call systems August 2012
- IEC 60391 (1972) Guide for marking of insulated conductors (first revision) March 2011

- IS 11353:1985/ IEC 60445 (1973) Guide for uniform system of marking and identification of conductors and apparatus terminals July 2012
- IS 13234:1991/ IEC 60909: 1988 Guide for short circuit current calculations in three-phase ac systems (superseding IS 5728) August 2012
- IS 7752 (Part 1): 1975 Guide for improvement of power factor in consumer installation: Part 1 Low and medium supply voltages March 2011
- IS 3646 (Part 1): 1992Code of practice for interior illumination: Part 1 General requirements and recommendations for working interiors (first revision) March 2008
- IS 3646 (Part 2): 1966Code of practice for interior illumination: Part 2 Schedule of illumination and glare index March 2008
- IS 3646 (Part 3): 1968Code of practice for interior illumination: Part 3 Calculation of coefficients of utilization by the BZ method March 2008
- IS 6665:1972 Code of practice for industrial lighting May 2010
- IS 2672:1966Code of practice for library lighting May 2010
- IS 10118 (Part 1):1982 Code of practice for selection, installation and maintenance of switchgear and control gear: Part 1-4 General March 2011
- IS-6875 (Part 1 to 3) 1992: Recommendations for the colour of Local Control Station.
- IS: 1255: 2001: Code of practice for installation and maintenance of power cables.
- IS: 10810(Part 43):2006: Method of Test for cables; Part 43 Insulation resistance.
- IS: 2309:2005: Protection of buildings and allied structures against lightning.
- IS: 3043:2006: Code of practice for Earthing.
- BS-5649 Part-VI : Design of street light polesIS-226/IS-2062/IS-1367/
- S355 JO : Design materials for Street light poles
- IS-2629/IS-2633/IS-4759/BS EN ISO 1461: Galvanization for Street light poles
- SP-30(BIS):2005 : National Electrical Code.
- OISD-RP-149 : Design aspects for safety in electrical systems.
- OISD-GDN-180 : Lightning Protection.
- OISD 110: Recommended practices on static electricity.
- IS 555:1979Electric table type fans and regulators (third revision)
- IS 374:1979Electric ceiling type fans and regulators (third revision)

- IEC: 60665 (1981) IS 2312:1967 Propeller type ac ventilating fans (first revision) Draft Standard issued in wide circulation
- IS 3588:1987Electric axial flow fans (first revision)
- IS 11037:1984Electronic type fan regulators
- IS 12155:1987General and safety requirements for fans and regulators for household and similar purposes
- IS 2675:1983Enclosed Distribution Fuse Boards and Cut Outs for voltages not exceeding 1000 V A.C. or 1200 V D.C.
- IS 8828:1996 Circuit-breakers for over current protection for household and similar installations (second revision)
- IS 13032:1991 Miniature circuit breaker boards for voltage up to 1000 Volt ac
- IS 12640 (Part 1): 2008 Residual current operated circuit-breakers for household and similar uses: Part 1 circuit-breakers without integral over current protection (RCCBs) (First Revision)
- IS 12640 (Part 2): 2008 Residual current operated circuit-breakers for household and similar uses: Part 2 circuit breakers with integral over current protection (RCBOs) (First Revision)
- IS 2959:1985 Contactors for voltages not exceeding 1000 V ac or 1200 V dc (first revision) [superseded by IS 13947 (Part 4/ Section 1)]
- IS 694:1990/ IEC 602271 to 5 (1979)PVC Insulated cables for working voltages up to and including 1100 V
- IS 694: 2010 Polyvinyl chloride insulated sheathed and unsheathed cables with rigid and flexible conductor for rated voltages up to and including 450/750 V
- IEC 60502 (1983) PVC insulated (heavy duty) electric cables: Part 2 For working voltages up to and including 1100 V (Third revision)
- IS 3961 (Part 1): 1967Recommended current ratings for cables: Part 1 Paper insulated lead sheathed cables
- IS 4288:1988 PVC insulated (heavy duty) electric cables with solid aluminium conductors for voltages up to and including 1100 V (second revision) (withdrawn)
- IS 3480:1966 Flexible steel conduits for electrical wiring

- IS 2667:1988 Fittings for rigid steel conduits for electrical wiring (first revision) [Superseded by IS 14768 (Part 2): 2003]
- IS 3837:1976 Accessories for rigid steel conduits for electrical wiring (first revision)
- IS 9537 (Part 4): 1983 Conduits for electrical installations: Part 4 Pliable self- recovering conduits of insulating materials
- IS 9537 (Part 5): 2000/ IEC 60614-2-3(1990) Conduits for a electrical installations: Part 5 Pliable conduits of insulating material
- IS 3419:1989 Fittings for rigid non-metallic conduits (second revision)
- IEC 60670-1 (1989) Enclosures for accessories for household and similar fixed electrical installations
- IS 2412:1975 Link clips for electrical wiring (first revision)
- IS 371:1999 Ceiling roses (third revision)
- IEC 60669-1 (1998) Switches for domestic and similar purposes (second revision)
- IEC 62305:2010 (Design), IEC 62561:2018 (Requirement and Testing)/NBC Standard requirements. – Lightning protection for buildings

1.5 **Electrical System Data**

System Voltage Level	:	415V AC & 230V AC
Voltage variation	:	±10%
System Frequency	:	50Hz
Frequency variation	:	±3%
Neutral Earthing	:	Through Earth Pit (Solid earthing)
Bus bar System	:	3 Phase, 4 Wire Air Insulated

1.6 List of Tender Drawings

The drawings attached should be considered for tender purposes and are not construction drawings.

1.7 **Inspection and Testing**

1.7.1 Responsibility for inspection, certification, etc. of all materials, parts lies with Vendor. Vendor shall specify all the inspection and testing requirements in their quality assurance plan which shall identify the activities requiring Owner's approval, review, witnessing etc. Inspection and

testing requirements shall be in accordance with this specification and other applicable standards as listed in this specification and the data sheets.

1.7.2 All Equipment shall be inspected for compliances with:

- Requirement of Owner's specification
- Applicable codes, standards and specifications, which shall also include sub-referenced standards therein.
- Test and Inspection Plans produced by the equipment manufacturer

1.7.3 Vendor shall furnish valid Type Test Certificates of similar models along with the offer. Vendor can submit certificates that the equipment complies with all type tests as prescribed by IEC/IS Standard specifying the test requirements for that equipment.

1.7.4 Routine tests on all the equipment shall be carried out as per the relevant IEC/IS.

1.7.5 Supplier is required to furnish all relevant documents pertaining to the electrical utility equipment / LT Panel / distribution-boards / light-fixtures / motors / etc for the owner's / engineer-in-charge's scrutiny & approval before any equipment is dispatched.

1.7.6 Relevant documents which are required for dispatch clearance must include type & routine test certificates – specific to the supplied equipment, equipment data-sheets, general arrangement drawings, vendor's catalogues.

1.7.7 Access to the manufacturer's works / Vendor / Sub-Vendor, at all reasonable times, shall be made available to the Owner / Consultant / Engineer-in-charge for Inspection & Testing of electrical equipment – meant for the Project.

1.7.8 All spare parts shall be subjected to the same inspection standards and full material certification as the main order.

1.7.9 Site Acceptance Tests (SAT) are to be carried out by the contractor on completion of installation, these tests are broadly enlisted in Specification for Installation, Testing & Commissioning of Electrical Equipment. Any equipment which fails the SAT shall be liable for rejection & the contractor shall replace the faulty equipment at no additional cost to the owner – within the stipulated time.

Civil & Structural Works for Electrical System

1.7.10 All civil works pertaining to electrical systems shall be included in scope of bidder.

1.7.11 No separate payments shall be admissible for Mild Steel Structural works envisaged for the installation of electrical equipment in this project. Rates for the supply, fabrication & installation

of MS Structural Steel supports / brackets (Flats, Angles, Channels, Plates, etc) for all equipment mounting / installation are included in the respective equipment installation rates and will not be paid separately.

1.7.12 Payments for structural Mild Steel required for Cable Tray Supports – including supply, fabrication, installation & painting shall be done separately on weight basis. Before claiming payments, relevant measurement sheets shall be prepared with sectional drawings indicating dimensions & weights of cable tray supports – which shall be duly approved by the owner / engineer-in-charge.

1.8 **Vendor Documentation**

1.8.1 All information listed here is to be furnished along with the offer as a minimum.

- Clause wise comments / deviations on tender specification
- A detailed scope of supply that fully describes the package offered.
- List of all equipment supplied in package with makes & brands of Supply Items.
- List of recommended spares of each equipment for two years normal operation rates.
- Type test certificates of each equipment.
- Technical Catalogues and brochures of major Components.
- Proven Track record of supply items for the past 3 years – with respect to the manufacturer, brand-name & quality of the proposed supply material.
- Complete list of special tools & tackles.
- Any other drawing required for approval from KSPCB/statutory authority, for installation shall be included by vendor.

1.8.2 Any other drawing required for approval from KSPCB/statutory authority, for installation shall be included by vendor.

1.8.3 Owner/Consultant will review drawings submitted by Vendor & return to the Vendor one copy of drawings with comments to carry out necessary changes, if any, during the engineering /manufacturing stage.

1.8.4 Drawings submitted by Vendor shall clearly indicate schematics, Bill of Material, General Arrangement, foundation drawings, terminal diagrams etc. The schematic drawings shall clearly indicate catalogue numbers of all components in the scheme

1.8.5 Contractor shall submit two sets (Hard-Copies) of all As-Built drawings &Layouts, Single Line Diagrams, Cable Schedules, Catalogues of Light Fixtures & other electrical equipments, Guarantee / Warranty Certificates of all electrical equipments, Factory & Site Acceptance Test Certificates – filed in Hard-Bound Cardboard files – as part of the final documentation. No additional payments shall be admissible for submission of the final documents.

1.8.6 Two soft copies of the final documentation in CD-ROM shall be submitted – with all layouts & drawings in PDF as well as in AutoCAD (Native) formats.

1.8.7 Final Documentation procedure as attached with the tender shall be adhered to and the completion of the final documentation shall be one of the prerequisites before certification of the contractor's final bill.

1.9 **Spares and Special Tools**

1.9.1 Spares

Vendor shall furnish list of spares and supply all necessary spares for testing, pre-commissioning and Commissioning. Any of the spares if used during testing/commissioning must be replenished at no extra cost to the purchaser. The Vendor shall also supply all consumables during erection up to commissioning.

1.9.2 Special tools

The Vendor shall supply a set of any special tools, which are required for the installation, commissioning, operation and maintenance of the equipment being supplied. A list of special tools shall be furnished along with the offer.

1.10 **Painting**

1.10.1 Internal and external electrical equipment's enclosure and all metal parts including the canopy likely to come in contact with the surrounding air shall be protected with anti-acid paint that will resist the specified environment conditions.

1.10.2 The paint specifications (as per Indian Standards or the RAL System) &color shades shall be finalized by the owner / engineer-in-charge during detailed engineering.

1.11 **Installation and Commissioning**

Installation & commissioning shall be included in vendor scope. Vendor shall provide qualified personnel to supervise the installation and carryout site testing and commissioning of all equipment supplied under this package contract.

1.12 **Packing and Transportation**

Packing, Shipping and delivery at site, unloading etc. of equipment shall be in Vendor's scope. Packing, shipping and delivery of equipment at site and unloading requirements shall be as per agreed Terms & Conditions of MRPL.

1.13 **Statutory Approval**

1.13.1 Electrical equipment supplied & complete installation shall be acceptable to local statutory authorities and changes required, if any, shall be carried out by the vendor without any extra cost. All necessary documents / applications shall be completely filled-in by the contractor and submitted to the statutory authorities in consensus with the Owner / Engineer-In-Charge.

1.13.2 Vendor shall provide liaison services, which shall include, but not necessarily be limited to the following:

- Contractor shall have valid license (Electrical Contractor's License & Electrical Supervisory & Wireman's License) to execute Electrical Installation works as given under the scope of works.
- The vendor shall be responsible for obtaining all necessary approvals (if applicable) from relevant statutory authorities for the electrical installations at no extra cost.
- Necessary co-ordination with statutory authorities for obtaining approval shall be done by the owner.

1.14 **Guarantee**

Equipment & installation shall be guaranteed to meet the specified performance at specified conditions in terms of power, air flow, thermal performance, design conditions etc. Equipment and its components & Installation shall be guaranteed against faulty design, defective /improper materials poor workmanship or failure from normal use during the guarantee period. Vendor shall make all necessary and desirable alterations, repairs and replacement free of charge in the event of faulty performance or defects occurring in the equipment during guarantee period.

2.00 LT Panel Board & Medium Voltage Switch Board Tables of Contents

LT Panel Board

List of Abbreviations:

BIS	Bureau of Indian Standards
CT	Current Transformer
CRCA	Cold Rolled Cold Annealed
DCS	Distributed Control System
FRP	Fiber Reinforced Plastic
HV	High Voltage
LED	Light Emitting Diode
MCC	Motor Control Center
MCCB	Miniature Case Circuit Breaker
NC	Normally Closed Contact
NO	Normally Open Contact
PLC	Programmable Logic Controller
PT	Potential Transformer
PVC	Poly Vinyl Chloride
SWG	Standard Wire Gauge
VCB	Vacuum Circuit Breaker
VT	Voltage Transformer
XLPE	Cross Linked Poly Ethylene

2.02 SCOPE

This specification covers the design, manufacture, testing, packing and supply of indoor, draw-out type High Voltage Switch boards up to and including 33kV,incorporating Vacuum Circuit breakers.

2.03 CODES AND STANDARDS

The equipment shall comply with the requirements of latest revision of the following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified:

IS-5	Colors for ready mixed paints and enamels.
IS-694	PVC – insulated cables for working voltages up to and including 1100V
IS-1248	Direct acting indicating analogue electrical measuring instruments and their accessories
IS-2071	Methods of high voltage testing
IS-2544	Porcelain post-insulators for systems with nominal voltage greater than 1000 V
IS-2705	Current transformers
IS-3156	Voltage transformers

IS-5082	Material data for aluminum bus bars
IS-5578	Guide for marking of insulated conductors
IS-6005	Code of practice of phosphate of iron and steel
IS-9920	Switches and switch isolators for voltages above1000V
IS-9921	AC dis-connectors(isolators)and earthing switches for voltage above 1000 V
IS-10601	Dimensions of terminals of high voltage switch gear and control-gear
IS-11353	Guide for uniform system of marking and identification of conductors &apparatus terminals
IS-12661	HV motor starters
IS-12729	General requirements for switch/control gear for voltages exceeding 1000 V
IS-13118	General requirements for circuit breakers for voltages above1000V
IS-13703	Low voltage fuses for voltages not exceeding 1000Vac or 1500Vdc

2.03.01 In case of imported equipment, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian Standards.

2.03.02 The switch boards shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

2.03.03 In case Indian standards are not available for any equipment, standards issued by IEC/BS/ VDE/NEMA or equivalent agency shall be applicable.

2.03.04 In case of any contradiction between various referred standards / specifications /data sheet and statutory regulations, the following order of decreasing priority shall govern:

- ✓ Statutoryregulations.
- ✓ Datasheets.
- ✓ Jobspecification.
- ✓ Thisspecification.
- ✓ Codesandstandards.

General Requirements

2.04.01 The switch boards shall be suitable for installation and satisfactory operation in a pressurized sub-station or in a sub-station with restricted natural air ventilation in a tropical, humid and corrosive atmosphere. The switch boards shall be designed to operate under site conditions as specified in the data sheets. If not specifically mentioned therein, a design ambient temperature of 40°C and an altitude not exceeding 1000 meters above mean sea level shall be considered.

2.04.02 All equipment supplied under the purview of this specification is intended for continuous duty operation, as per nameplate rating under the specified ambient conditions.

2.04.03 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least for 15 years from the date of supply.

2.04.04 Vendor shall give a notice of at least one year to the end user of equipment before phasing out the product / spares to enable the end user for placement of order for spares and services.

2.04.05 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

Enclosure and Protection

a) The High Voltage Switchboard shall be metal-enclosed and shall comprise of standard pre-fabricated, cold-rolled, sheet steel units, assembled to form a rigid, freestanding, dead-front structure. As a minimum, 2 mm (14 SWG) sheet steel shall be used for all front and rear doors and covers and 1.6 mm (16 SWG) sheet steel for inter-panel partitions. Wherever required, stiffeners shall be provided to increase stiffness of large size doors and covers.

b) Vertical panels shall be assembled to form a continuous line-up of uniform height. Rear panel sections for cable / bus-duct termination shall also be of the same height as that of the front panel section.

c) The switchboards shall be totally enclosed and vermin-proof. If necessary, openings for natural ventilation shall be provided. These shall be louvered and provided with wire mesh having opening less than 1 mm. The enclosure shall have complete protection against approach to live parts or contact with internal moving parts (IPH 6) as per IS: 3427.

d) All openings, covers and doors shall be provided with suitable neoprene gaskets.

e) Each unit of the switchgear shall have necessary internal sheet metal barriers to form separate compartments for circuit breaker, bus-bars, instruments and relays, cable connections, etc. Compartments for cable connections shall allow cable termination and connection work with the switchgear energized.

f) Suitable arc propagation metallic-barrier shall mandatorily be provided in the bus bar compartment at every junction between two adjacent cubicles. In case propagation barrier cannot be provided due to constructional factors, arc traps shall be provided, for example, at the end panels. Independent pressure relief devices shall be provided for all HV compartments, i.e. bus bar, cable and breaker compartments and each compartment shall have type test certificate for withstanding internal arc fault.

g) All identical equipment and corresponding parts shall be fully interchangeable.

h) Safety barriers I shutters shall be provided to permit personnel to work safely within an empty compartment with the bus bars energized.

i) It shall be possible to extend the switchgear in either direction at a later date. Ends of bus bars shall be suitably drilled for this purpose. Panels at extreme ends shall have openings, which shall be covered with plates screwed to the panel. Details of drilled holes in bus bar and openings in the panels, provided for future extension shall be clearly shown in the vendor drawings.

j) The breaker draw-out carriage on the switchboard shall have three positions: "Service", "Test" and "Draw out" viz.:

- The "Full In" or "Service" position - In this position both power and control circuits shall be connected. This shall be the normal operating position of the circuit breaker.
- The "Test" position - The power contacts shall be disconnected in this position but the control connections shall not be disturbed, it shall be possible to close and trip the breakers in this position.
- The "Draw-Out" Position - both power and control circuits shall be disconnected in this position.

k) The circuit breaker shall be lockable in "service" and "test" positions. Automatic safety shutters shall be provided to ensure the inaccessibility of all live parts after the breaker carriage is drawn out.

l) There shall be a distinct overall door for the breaker compartment, which can be closed with the carriage in draw-out position and it shall be lockable type. In the service position, it shall not be possible to open the front breaker compartment door. The front breaker compartment door shall be openable only in conditions when the breaker is either in the "test" or in "draw out" conditions.

m) It shall not be physically possible to put the breaker in the "Service" position with the front breaker compartment door in open condition.

n) All front breaker compartment doors shall be provided with a Folding lockout hasp, allowing up to three padlocks to lock out the breaker compartment door for personnel safety. Three nos. locks with two keys each must be provided with every LOTO – Lock-Out-Tag-Out hasp.

o) All circuit breaker modules of the same rating shall be inter-changeable. Suitable interlocks shall be provided to prevent the following operations:

- "Plugging-In" or "drawing out" of a closed breaker.

- "Plugging-In" a breaker with the earthing isolator closed. "Closing" of the earthing isolator with the breaker "Plugged-In".
- Pulling Out the auxiliary circuit plug with the breaker in the "Service" position.
- Pushing in the breaker to the "Service" & "Test" position, with the auxiliary circuit plug not in position.

p) All hardware shall be corrosion-resistant. All joints and connections of the panel members shall be made by zinc-passivated or cadmium-plated, high-quality Steel plates. All nuts, bolts & washers for assembling the panel shipping sections, for HV & Control Cable termination must be necessarily of stainless-steel and must be secured against loosening.

q) Suitable removable type eyebolts shall be provided for the lifting of the panel / shipping sections. These bolts, when removed shall not leave any opening in the panels.

r) Cable Gland plates must be of removable type in multiple sections – construction must be such so as to minimize cutting / grinding of gland plates. HV Cable openings & cable terminals must be suitable for termination of HV Cables with overall outer diameters of 50 mm to 80 mm & suitably long bolts are to be provided for tightening of copper / aluminum cable lugs with washers & nuts.

s) Prefixed clamps must be made available on cable gland plates to secure HV cables in plates upon panel entry. In cases wherein it is specifically mentioned for terminating multiple cables in a single compartment, adequately long cable terminals with multiple holes for bolting of cables are to be provided. The terminal holes must be so spaced so as to accommodate cable lugs placed adjacent to each other for each phase.

Accessibility for Panel Operation

a) All relays, metering and control components shall be mounted on the panel front only.

b) Checking and removal of components shall be possible without disturbing adjacent equipment. All equipment shall be easily accessible.

c) It shall be possible to set all measuring relays and instruments in situ without de-energizing the switchboard. Mounting of relays for a particular breaker feeder panel shall be limited to that particular feeder only and must not be mounted on adjacent cubicles.

d) All mounted equipment shall have identification tags of self-sticking PVC tapes at the rear also. In addition, for all shipping sections, the serial nos. must be permanently etched / painted both on the front & rear sides for identification in a panel line-up.

e) Current Transformer secondary terminals must be easily accessible (facing outwards) for confirming tightness, cleaning & inspection. All CTs must be properly marked with legible name-plate details on the CT body.

f) The CT ratio for Feeder / Motor / Differential Protection & Metering must be marked on each of the Breaker front door nameplate along with the breaker rating, year of manufacture, P.O. Number.

g) Similarly, for Bus & Line PT cubicles, the PT details (voltage rating / turns ratio / PT Fuse details / etc.) must be marked on the front door name-plate.

h) All terminals shall be shrouded with plastic covers to prevent accidental contact.

i) For ease of opening of panel rear doors (which must be of bolted type with two handles), these doors must not be larger than 800 mm X 800 mm in size. In case the rear opening is larger, multiple doors may be provided, but each door must be sized strictly within the specified dimensions. Each rear door must be provided with an inspection window of adequate size.

Bus Bars

a) The switchboard shall comprise of 3-phase bus bars which shall extend through all units of the switchgear line-up. The main bus bars shall have uniform cross-section throughout their length, and shall be sized to carry continuously the rated current specified in the data sheet. Preferably the bus-bars are to be of flat strip shaped with a rectangular cross section.

b) The Bus-bar shapes must be efficiently designed for heat dissipation and ideally have a high surface area to cross-sectional area ratio for high-current applications.

c) Bus bars shall be of high conductivity electrolytic copper only and supported on insulators made of non-hygroscopic, non-inflammable material with tracking index equal to or more than that defined in Indian standard.

d) Bus bars shall be housed in a separate chamber and shall be accessible for inspection. Wire guards or mesh shall be provided inside the enclosure to allow visual inspection of bus bars, to avoid accidental contact when the outer solid cover is removed.

e) Both bus bars and the supports shall be adequately sized and braced to withstand the specified short-circuit current for 1 second. Dynamic stresses shall be calculated on the basis of the specified peak short-circuit current. All bus supports shall be of non-carbonizing material, resistant to acids and alkalis.

f) Bus bars shall be insulated by using heat-shrinkable PVC sleeves or with epoxy coating of requisite thickness. The insulating wrap or coat must be of Red, Yellow and Blue colors for phase-identification throughout the length of the switchboard and in all shipping sections. The sleeves / insulating coat shall be rated to withstand the system line-to-line voltage for 1 minute. This shall be verified by a type test in which the line voltage will be applied between the sleeved / coated main bus bar and an aluminum foil wrapped closely around the insulation over a length of at least 500 mm.

g) All bus-bar joints (T-type or L-type joints) and all tap-off connections from the main horizontal bus-bars shall be provided with removable flexible FRP shrouds of correct dimensions for making a proper fit.

h) The thermal design of the bus bars shall be based on installation of the switchgear in poorly ventilated conditions. The cooling air volume shall take into account only the bus bar enclosure.

i) The hot spot temperature for bus-bars including joints at design ambient temperature shall not exceed 95°C for normal operating conditions.

j) All bus-bar joints shall be provided with high tensile strength Stainless steel bolts, nuts and washers. Stainless-steel nuts / bolts / washers shall be used for all bus bar joints and supports.

k) The current rating as defined for switchboard and components in data sheet/job specification are for design ambient temperature at site conditions and for being inside the cubicle at fully loaded condition. The vendor shall suitably de-rate the nominal rating to suit the above condition.

HV Power Connections

a) The incoming power connection shall be through XLPE HV cables or bus-duct and outgoing power connection shall be through XLPE HV cables, as indicated in the data sheet. Ample space for connection for these cables shall be provided at the rear of the switchboards. In order to avoid accidental contact in the cable compartment while carrying out inspection by opening the rear cover, a removable expanded metal barrier shall be provided in the cable compartment. Unless otherwise specified, the power cable shall enter the switchboard from the bottom. Non-magnetic cable gland plates shall be provided for feeders wherever single core cables are used.

b) The switchboard shall be supplied complete with supports for clamping outgoing and incoming cables. The head-room available between cable gland plate and terminal lugs shall not be less than 800 mm for switchgear up to 11 kV, and 1000 mm for 22 and 33 kV cables.

c) In case the standard panel depth cannot accommodate the specified no. of cables, a rear extension panel of full height shall be provided. A copper earth strip of adequate cross-section & multiple holes (with stainless steel nuts & bolts) shall be brought near to the cable terminals along the bottom most part of the rear compartment – for terminating the shielding / armour braid extending from the cable termination kit. This will be applicable for any extension panel as well.

d) Unless otherwise specified, all power cables shall enter the switchgear from the bottom.

Auxiliary Wiring and Terminals

a) Inside the cubicles, the wiring for control, signaling, protection and instrument circuits shall be done with BIS approved, PVC insulated, flame retardant type, copper conductor wire. The insulation grade shall be 660 V. The wiring shall preferably be enclosed in plastic channels or neatly bunched together. Wiring between HV breakers or cable compartments to relay and metering compartments shall be routed through flexible conduits.

b) Separate color coding shall be maintained for 110 V DC rated control cabling & 240 V / 415 V AC rated control cabling.A minimum of 10% spare terminals shall be provided on each terminal block. Conductors shall be terminated with adequately sized compression-type lugs for connection to equipment terminals and strips. Stranded conductors shall be soldered at the ends before connections are made to the terminals. Sufficient terminals shall be provided on each terminal block to ensure that only one outgoing wire is connected per terminal. Terminal strips shall preferably be separated frompower circuits by metal barriers or enclosures. All spare contacts of auxiliary relays, timers, etc shall be wired up to the terminals.

c) Each wire shall be identified at both ends by correctly sized PVC ferrules. Shorting links shall be provided for all CT terminals.

d) PVC insulated copper conductor of cross section 1.5 mm^2 may normally be used provided the control fuse rating is 10 A or less. For 16 A distributions, the control fuse circuit must be done with 2.5 mm^2 copper conductors. Each wire shall be terminated at a separate terminal. CT Circuit wiring shall be done with 2.5 mm^2 copper conductors with Red Yellow Blue color coding. Shorting links or suitable shorting arrangement for shorting CT secondary shall be provided.

e) Unless otherwise specified, all external control cables shall enter the switchgear from the bottom.

f) Supporting facilities shall be provided for clamping the control cables.

g) All inter-panel control wiring within each shipping section shall be by switchgear vendor. The inter-panel wiring shall be taken through PVC sleeves or suitable grommets. For inter-panel wiring between the shipping sections, wires in rolls of the required length, connected at one point, shall be supplied with the panel for connection at site.

Control and Indication

a) Breaker tripping, closing and spring charging devices shall be fed with DC control power supply. The rated DC voltage shall be as specified in the data sheet. The power supply for breaker opening, closing and indication devices shall be arranged as follows:

- One DC feeder shall be provided for each bus section. The bus coupler panel may be fed from either of the two supplies. Supply voltage shall be 110 V DC, unless otherwise specified.
- One separate, single-phase power supply shall be provided for each bus section for feeding space heaters, audible alarm hooters, convenience single-phase power sockets, etc. Supply voltage shall be 240 V AC, unless otherwise specified.
- Provision to receive DC and AC control supply shall preferably be provided in the bus-PT panel.

b) Breaker positions (CLOSE, OPEN, spring-charged, test position, service position) shall be indicated mechanically. Electrical indications, with colors as given below, shall also be provided:

- Breaker 'CLOSE' ------ Red Lamp
- Breaker 'OPEN' ------ Green lamp
- Breaker auto-trip ------ Amber lamp
- Trip circuit healthy ------ White lamp
- Spring charging ------ Blue lamp

c) A common DC control supply fail indication shall be provided for each bus section with a blue colored lamp preferably on the respective Bus-PT panel.

Earthing Connections

a) All cubicles shall be connected to an earth bus-bar running throughout the length of the switchboard. The minimum earth bus bar size shall be 30 x 6 mm^2 copper for aShort-circuit

withstand capacity of up to 31.5 kA, and 50 x 6 mm^2 copper for a short-circuit withstand capacity above 31.5 kA.

b) All doors and movable parts shall be connected to the earth bus with flexible copper connections. The frame work of all the panel verticals shall be connected to this earth bar Provision shall be made to connect the earthing bus-bar to the plant earthing grid at the two ends of the switchboard line-up.

c) All non-current carrying metallic parts of the equipment and components shall also be earthed. The earth bus shall be brought back to each of the cable compartments near to the cable terminals – separated by a safe distance, and earthing bolts & nuts (all nuts / bolts / washers shall be of stainless steel) shall be provided to ground the cable armor. The mating surfaces of all bolted parts shall be zinc passivated to ensure continuity between them.

d) For Bus-Duct Earthing, two runs (double earthing) of copper strips of adequate cross-section, as per the short-circuit current withstand capacity, must run along the sides of the bus-duct throughout its entire length. These earth strips are to be terminated at the switchboard end with the main switchboard earth bus-bar – adequate openings shall be made on the switchboard enclosure for taking-in the bus-duct earth strips. At the other end, the bus-duct earth strips are to be terminated with the transformer earth-grid.

2.11 **Space Heaters**: The panels shall be provided with space heaters to prevent moisture condensation and maintain cubicle temperature 5°C above the ambient. The space heaters shall be located at the bottom of the panel and shall be controlled through a MCB and a thermostat with an adjustable setting. One such thermostat shall mandatorily be located in the metering or relay chamber. In addition to the instrument / metering chamber, the CT compartment is also to be kept at a higher temperature for avoiding moisture condensation on CT surface & resultant flashovers. Hence along with the metering / instrumentation compartment, the cable terminal compartment – housing the CTs is also to be provided with separate space heaters.

2.12 **Panel supporting Base-Frames** (to be supplied & installed by the owner): The panels shall be suitable for installation on panel supporting base-frames fabricated out of mild-steel. Hence the panel verticals shall be suitable for tack welding at the bottom, directly to this base-frame.

2.13 **Nameplates**

a) A nameplate with the switchboard designation shall be fixed at the top of the central panel. Separate nameplates giving details for each feeder / breaker (such as CT ratio, Breaker rating,

P.O. Number, Date of Manufacture, etc) shall be provided on the front doors of each of the panel verticals.

b) A Danger notice plate (Skull & Bones Arrangement with voltage rating in Red Background) shall be provided at the front and rear of each panel vertical. The danger notice plate shall indicate danger notice with voltage rating both in Hindi and English. Overall dimensions of the danger notice plate shall be 150 mm - wide & 150 mm – high.

c) The nameplates for feeder compartments shall contain all details regarding the feeder type (incomer / bus-coupler / plant-feeder / Motor Feeder / Capacitor Feeder / Transformer Feeder / etc) for drives / equipment controlled by the particular module as per approved single line diagram, including the rating of the feeders.

d) Blank nameplates shall be provided for all spare and vacant modules, indicating "SPARE FEEDER" and also indicating the type & rating of the feeder.

e) Nameplate or polyester adhesive stickers shall be provided for all equipment mounted inside the switchboard. Inside the feeder compartments, the electricalcomponents, equipments, accessories like switchgear, control gear, LED Indication lamps, relays, MCBs. Control Fuses, etc shall be suitably be identified by providing permanently affixed stickers.

f) Special warning plates " ISOLATE SUPPLY BEFORE OPENING THIS COVER" shall be provided on removable covers or doors giving access to cable terminals and bus bars maintained at High Voltage.

g) Special warning labels shall also be provided inside the switchboards, wherever considered necessary. Identification tags shall be provided inside the panels matching with those indicated on the switchboard wiring diagrams.

h) Engraved nameplates shall preferably be of 3-ply (Black-White Black) lacmoid sheets or anodized aluminum. However back engraved Perspex sheet nameplates may also be acceptable. All such nameplates & danger notice plates must have rounded corners and shall be fastened by counter sunk removable screws and not by adhesives.

2.14 Painting

a) All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and coat of yellow zinc

chromate primer. The under surface hall be made free from all imperfections before undertaking the finishing coat.

b) After preparation of the under surface, the switchboard shall be spray painted with two coats of epoxy based final paint or shall be powder coated.

c) Color shade of the switchboard final paint shall be as per BS 627 (Light Aircraft Gray) unless specified otherwise.

d) The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint etc. Vendor shall supply final paint in spray-paint bottles (total of 15 spray-paint cans per switchboard) for final touch up at site.

e) All unpainted steel parts shall be of stainless steel only. If these parts are moving elements then they shall be greased.

2.15 Marshalling Cabinet & DCS Interface Signals

a) A separate vertical with control cable terminals for terminating all control cables for DCS interface must be provided for each bus-section.

b) Provisions for terminating &gland several multi-core control cables must be made at the bottom of the Marshalling cabinets.

c) Each feeder must be internally wired up to the respective bus-section's marshalling cabinet and the following signals must be made available as a minimum for relaying up to the owner's DCS:

Digital Inputs to Owner's DCS	Run Indication (Breaker On)
	Breaker Off Indication
	Breaker Trip Indication (fault indication)
Digital Output from Owner's DCS	Breaker Start Command
	Breaker Stop Command
4-20 mA Signals to Owner's DCS over 24 V - DC	From Current Transducers in Motor Feeders – for current indication
	From Voltage Transducers in Switchboard Incomers – for voltage indication.

a) Inside the Marshalling Cabinet, all terminals pertaining to a single feeder must be grouped together, with adequate gaps / partitions between each such groups.

b) Adequate naming of marshalling cabinet terminals and printed barrel ferruling for inter-panel wiring must be strictly followed easy identification.

2.16 SwitchBoard Components

2.16.1 Circuit Breakers:

a) Vacuum circuit breakers shall be used in all the High Voltage switchboards rated from 3.3 kV upwards up to 33 kV. The exact type and rating of breakers shall be as indicated in the data sheet. Breaker transport trolleys must be provided for cassette-mounted breakers for each switchboard. One trolley per Bus-Section must be mandatorily supplied.

b) Vacuum circuit breakers shall be designed to have low switching-over voltage levels and with a long switching life. The interrupter shall be leak-free.

c) Each of the breakers shall have at least 6 normally open (NO) and 6 normally closed (NC) spare auxiliary contacts for purchaser's use. If these are not available, auxiliary relays shall be used to multiply the auxiliary contacts of the breakers.

d) The breakers shall have a universal motor-operated, spring-charged mechanism. It shall also be possible to charge the springs manually. The closing spring shall get re-charged (for subsequent closing) soon after a closing shot and prior to breaker tripping. In case the limit switch fails to cut out the spring-charging motor with the springs fully charged, the motor shall be automatically de-coupled. The control circuit shall be suitable for local as well as remote control. Breakers shall be trip-free and shall have an anti-pumping device. The breaker operating duty shall be O – 0.3 Seconds – CO – 3 Minutes – CO unless otherwise agreed. (O - Open, C - Close).

2.16.2 Operating Mechanism

1) Electric power operating mechanism shall be motor wound spring charged stored energy type. However, manual-operating mechanism may be of the spring charging stored energy type or the spring assisted type. For circuit breakers with electrical power operating mechanism, provision shall also be made for manual spring charging. Closing time of circuit breakers with manual operating mechanism shall be independent of the speed of the operating handle.

2) All stored energy operating mechanism shall be equipped with following features.
   - Failure of springs, vibrations or shocks shall not cause unintended operation of breaker or prevent intended tripping operation.
   - Closing of circuit breakers shall be prevented unless the spring is fully charged.

3) All electrical power operating mechanisms shall be suitable for remote operation and shall be equipped with following features:

- Provided with universal motor operable on AC or DC control supplies.
- Provided with emergency manual charging facility. The motor shall be automatically, decoupled (mechanically) once the manual-charging handle is inserted.
- Closing operation of circuit breaker shall automatically initiate charging of the spring for the next closing operation without waiting for tripping of circuit breaker.
- Closing operation shall be completed once the closing impulse is given and the first device in the control scheme has responded even though the control switch/ Push Button is released provided no counter trip impulse is present.

e) Circuit breaker trip and closing coils in case of electrically operated breakers and trip coil in case of mechanically operated breakers and circuit breaker indication shall be suitable for satisfactory operation on a control supply system indicated in data sheets/job specification.

f) All circuit breakers shall be provided with mechanically operated emergency trip device. This device shall be available on the front of the panel. Mechanically operated 'closing' device shall be provided for all breakers. However mechanical closing shall be inhibited for all circuit breakers in service position.

g) The breakers shall be shall be provided with anti pumping& trip free provision. Each breaker shall be also provided with an operation counter.

h) Metal Oxide surge suppressors shall be provided on all outgoing vacuum circuit breakers to limit the over voltage to a maximum of 2.2 p. u. rated peak line to earth voltage.

i) Line PT shall be mounted in a separate draw-out carriage. In case of truck mounted breaker, line PT shall be provided in a separate panel.

j) The complete breaker assembly should have inter-changeability with breakers of identical ratings.

k) An integral earthing system, or a separate earthing carriage/truck, shall be provided. In case of a separate earthing carriage, the necessary trolleys for bus-side and line (cable)-side earthing shall be supplied. After withdrawing the circuit breaker, this can be inserted to facilitate earthing of cables and bus bars. Earthing truck shall be complete with the PT and voltmeter, giving audio-visual indication and solenoid inter-lock to prevent closing of bus side earthing truck on live bus-bars. Earthing truck operation with door open is acceptable.

l) The actual numbers & type of earthing trucks shall be as per attached data sheet.

m) For tripping of circuit breakers, Open – to – Trip type feature must be built in the tripping logic circuit. For all purposes, such as process trip command from Owner's DCS or a faulty DCS Interface Cable, the breakers must trip upon sensing a Open circuit.

2.16.3 Current Transformers

a) Current transformers shall conform to IS: 2705. The short-time rating shall be equal to that of the HV switchboard. They shall be mounted on the stationary part of the switchboard. The CT ratings shall be as shown in the data sheet. Protective CTs shall have an accuracy class of SP and an accuracy limit factor greater than 10. CTs for instruments shall have an accuracy class of 1.0 and an accuracy limit factor less than 5.0. One leg of the CTs shall be earthed. Separate CTs shall be provided for Differential and Restricted Earth fault protections.

b) All CTs shall be star connected. Interposing CT (ICT) shall be provided (if required) for differential protection of transformers having star-delta connection.

c) Proper access to each set of CTs especially to check the tightness of the CT secondary terminals - shall be available for repair & maintenance.

d) Each CT must have a name-plate – with legible letters – indicating the CT serial no. / CT parameters.

2.16.4 Potential / Voltage Transformers:

a) Voltage transformers shall conform to IS: 3156. The voltage transformers shall be of draw-out type and shall be provided with 4 pole miniature circuit breakers with auxiliary contacts on the secondary side.

b) The draw-out mechanism shall disconnect the VT from the bus-bars. The primary connection shall be disconnected before the VT becomes accessible. Neutral point of the star connected VTs both on the primary and secondary sides shall be earthed.

c) The VTs shall have an over-voltage factor of 1.9 for 30 seconds, and an accuracy class of 1.0 from 10% to 120% of normal voltage. The VTs selected shall be compatible with the system grounding.

d) The primary rated voltage shall be equal to the rated voltage V of the system or V / √3, if the VT is connected between phase and neutral.

e) If not otherwise specified, the secondary voltage shall be 110 V, or 110 / √3 V. The burden and class of accuracy shall be as specified in data sheets. For directional relays, either a 3 - phase 5 -

limb VT or 3 single-phase VTs with secondary windings connected in open delta shall be provided.

2.16.5 **Measuring Instruments:**

All analogue instruments shall be of square pattern, 96 x 96 mm, flush - mounted type. Measuring instruments shall be provided, as specified in the attached data sheet. All required auxiliary equipment such as shunts, transducers, CTs, VTs, etc, shall be included in the scope of the switchboard supplier. Accuracy class for all instruments shall be 1.0 as per IS: 1248.

Digital instruments shall also be acceptable, provided specific approval from the Owner is obtained (for make and model) before placement of switchboard order.

a) **Ammeters and Voltmeters:** Analogue meters shall be of moving-iron type. The range shall be as indicated on the drawings. Ammeters for motor feeders shall have a non-linear compressed scale above rated current to indicate motor starting current.

b) **KW / kWh meters**: The kW / kWh meters shall be suitable to measure unbalanced loads on a 3-ph, 3-wire system. The kW meters shall operate on a VT secondary voltage of 110 V.

c) **Frequency meters:** These shall be of direct-reading or digital type, and shall operate on a VT secondary voltage of 110 V. The standard range shall be 45-50-55 Hz.

2.16.6 **Relays:**

a) Type of relay i.e. electromechanical, static or numerical shall be as defined in the attached data sheet or job specification.

b) All electromagnetic protective relays shall be back-connected, of draw-out type, suitable for flush mounting and fitted with dust-tight covers. Alternatively, "plug-in" type relays will also be acceptable. Auxiliary relays are acceptable in fixed execution.

c) The relay cases shall have a provision for insertion of a test plug at the front for testing and calibration using an external power supply without disconnecting the permanent wiring. The insertion of the test plug shall automatically short circuit the CTs and permits extension of external power supply to the relay.

d) All protective relays shall have hand reset facility and clear operating indication, e.g. flags for mechanical type relays or light emitting diodes for static type relays. It shall be possible to reset the flag without opening the relay case.

e) All tripping relays shall be of lockout type with hand-reset contacts and shall be suitable to operate on the specified voltage. These relays shall have self-coil cut off contacts, and shall be

provided with hand-reset operation indicators. Tripping relays will be acceptable in non-draw-out cases.

f) The tripping relay shall be suitable for satisfactory operation from 50% to 110% of the specified control supply voltage.

2.16.7 **Auxiliary Equipment:**

a) **Auxiliary relays and contactors**: Auxiliary relays and contactors shall generally be used for inter-locking and multiplying contacts. Auxiliary contacts shall be capable of carrying the maximum anticipated current.

b) **Control switches**: All control switches shall be rotary type, having a cam-operated contact mechanism. Unless otherwise stated, circuit breaker control switches shall be 3-position C-N-T, spring return to Neutral (N) from both Close (C) and Trip (T) positions. They shall have pistol-grip handles with a lockable arrangement.

Ammeter selector switches shall have a make-before-break feature on its contacts. The selector switch shall generally have four positions: three for reading 3-phase currents and the fourth for the OFF position. The voltmeter selector switch shall also have four positions: three shall be used to measure three line (RY - YB - BR) voltages and the fourth shall be for the OFF position.

c) **Timers**: For re-acceleration duty, timers unless otherwise stated, shall be pneumatic type and shall have adjustable time setting of 0-60 seconds. Alternatively static timer may be considered. The time settings, where specified, shall be accurately set before dispatch of the switchboard. Timer provided for control of capacitor feeder shall have minimum setting of 0-5 minutes.

d) **IndicatingLamps**: Clustered LED type indicating light with minimum 8 mm diameter size shall be provided for indications.

e) **Current Transducers**: For every HV Motor Feeder, a current transducer of matching ratings must be provided for taking a 4-20 mA signal over 24 V DC to owner's DCS / PLC. The Current Transducers must be of three element type for a three-phase true RMS value indication and a 110 V DC auxiliary voltage.

f) **Voltage Transducers:** For each of the Incomer Feeders in the HV Switchboard line-up, voltage transducers are to be provided for taking a hard-wired voltage indication to the owner's DCS. The Voltage Transducers must give a 4-20 mA signal over 24 V DC with an input signal voltage of 110 V - AC from the secondary of potential transformers and an auxiliary voltage of 110 V

DC. The Voltage transducers are to be of 3-phase / 3-element, 3-wire type for giving true RMS value indications.

2.17 Spares & Accessories

The following accessories must be mandatorily supplied with the HV Switchboards – without any additional cost implication as part of switchboard supply:

a) Bus & Line Side Earthing Trucks;
b) Breaker Trolleys (for each bus-section) for cassette type breakers;
c) Earthing / Discharge Rods of adequate voltage grade (one each for every bus-section);
d) One Digital Multi-meter of MRPL approved make;
e) 15 nos. Spray Paint Bottles / Cans for final touch-up paint with each switchboard line-up.

The following spares must be mandatorily supplied with the HV Switchboards – without any additional cost implication as part of switchboard supply:

a) One set (3 nos. each) of Bus & Line PT Fuses;
b) One no. each of all types of numerical & auxiliary relays;
c) 20 nos. of control fuse-links of all current ratings;
d) One set (3 nos.) of Current Transformers of all current ratios;
e) One set (3 nos.) of Line PTs & Bus PTs;
f) 5 nos. each of LED indication lamps of all colors;
g) One no. each of all types of Rotary Switches & Selector Switches;
h) One no. each of all types of Digital Multifunction & Analogue Meters;

The above enlisted accessories & spares will be supplied as part of all switchboard packages without any additional cost to the owner. In cases, where additional quantities of the above enlisted switchboard components are envisaged or components other than those enlisted above are required to be supplied, the same will be specified in the respective data-sheets for which the supplier may quote prices separately.

2.18 Inspection and Testing

2.18.1 During fabrication, the switchboard shall be subject to inspection by the Owner, or by an agency authorized by the Owner, to assess the progress of work, as well as to ascertain that only quality

raw material is being used in the process. The manufacturer shall furnish all necessary information concerning the supply to the Owner's inspectors.

2.18.2 All routine tests shall be carried out as per IS:12729 at the manufacturer's works under his care and expense.

2.18.3 Type tests, if specified shall be performed. Short circuit and internal arc tests shall be performed at CPRI or equivalent independent testing lab. Impulse withstand and Heat run tests may be performed at manufacturer's works.

2.18.4 Type and shop tests shall be witnessed by an inspector of the Owner, or of an agency authorized by the Owner. Prior notice of minimum 4 weeks shall be given to the Owner/ inspector for witnessing the tests.

2.18.5 **Acceptance Tests**: The following acceptance tests shall be carried out at the manufacturer's works under his care and expense

a) A general visual check shall be carried out matching with the detailed Bill of Materials for the switchboard. This shall cover measurement of overall dimensions, location, number and type of devices, location and connection of terminals, etc.

b) Manual and electrical operation of all circuit breakers and all numerical / auxiliary relays shall be checked under the worst conditions of auxiliary supply voltage.Dry insulation test with power-frequency voltage shall be conducted for the main and auxiliary circuits.

c) Insulation resistance of the main and auxiliary circuits shall be checked before and after power frequency voltage withstand test.

d) Operation and scheme check shall be carried out for every control function as per the approved schematic diagrams by manually simulating fault conditions and operation of control switches, numerical / auxiliary relays, etc. For example, in a two incomer & one bus-coupler arrangement, all schemes & interlocks as per the switchboard data-sheets are to be simulated at the testing location and offered for witnessing.

e) For equipment bought from other sub-suppliers, certified test reports of the tests carried out at the manufacturer's works shall be submitted. Normally, all routine tests as specified in the relevant standards shall be conducted by the sub-supplier at his works.

f) Each of the switchboard feeders must be checked for functionality after testing of individual feeder protection CTs & Bus / Line PTs (insulation resistance tests, winding resistance tests, ratio tests, etc). For differential protection CTs, fault-conditions are to be created at the testing location

and the tripping of associated numerical relays is to be demonstrated. Bus Differential protection feature needs to be demonstrated at the testing location.

2.19 Packing and Dispatch

The switchboard shall be divided into several shipping sections for protection and ease of handling during transportation. All outgoing feeders shall be packed as separate shipping sections. The equipment shall be properly packed for selected mode of transportation i.e. ship / rail / trailer. The panels shall be wrapped in polyethylene sheets in multiple layers before being placed in wooden crates / cases to prevent damage to the finish. All such crates / cases shall have hard skid bottoms made of non-perishable plastic / polycarbonate base material for lifting / shifting / handling.

All interconnecting accessories such as nuts / bolts / washers / bus-bars / shrouds / gaskets / interconnecting wires & sockets including the spared shall be packed in separate wooden crates. These boxes must be with seaworthy packing with a detailed packing list placed inside the box as well as attached with other transit documents.

Packing must protect the front panel of every shipping section very effectively – including the Numerical Relays / Auxiliary relays / LED Indications / Meters / selector & T-N-C switches which must be given additional cushion packing. The crate package must bear the following essential indications:

- Fragile (glass);
- Not waterproof (umbrella);
- Position: top (this side up), bottom (arrows);
- Centre of gravity (G);
- Lifting points (chains);
- Owner's particulars;
- P.O. Nos.; etc.

The switchboards & associated equipment will be stored outdoors for long periods before installation. The packing should be suitable for outdoor storage areas with heavy rains / high ambient temperature unless otherwise agreed. It is the supplier's responsibility to ensure that all panels are delivered in undamaged condition to MRPL and any damages to the switchboards & associated components during transit must be repaired / replaced by the supplier free of cost.

2.2 SPECIFICATION FOR MEDIUM VOLTAGE SWITCHBOARD

Abbreviations:

ACB	Air circuit breaker
BIS CT	Bureau of Indian Standard
CRCA	Cold rolled cold annealed
CT	Current Transformer
MCCB	molded case circuit breaker
PCC	Power control center
LED	Light emitting diode
PMCC	Power cum motor control center
MCC	Motor control center
PT	Potential transformer
PVC	Poly vinyl chloride
SWG	Standard wire gauge
NC	Normally open contact
NO	Normally open contact

2.2.1 Scope

This specification covers the requirements of design, manufacture; testing, Packing and supply of Fixed I draw out type Medium Voltage Switchboards.

2.2.20 Codes and standards:

The equipment shall comply with the requirements of latest revision of following Standards issued by BIS unless otherwise specified.

IS : 5	Colors for ready mixed paints and enamels
IS : 772	AC Electricity Meters
IS : 1248	Direct acting electrical indicating instruments
IS: 2705	Current transformers
IS: 2824	Method for determining the comparative tracking index of solid insulating materials under moist conditions
IS: 3156	Voltage transformers
IS : 3231	Electrical relays for power systems protection.
IS: 3618	Phosphate treatment of iron and steel for protection against corrosion.
IS: 5082	Material data for aluminum bus bars.
IS: 5578	Guide for marking of insulated conductor.

IS: 6005	Code of practice of Phosphate of iron and steel.
IS: 8623	Factory built assemblies of switchgear and control gear for voltages up to and including 1000 VAC and 1200 V DC. Part -II particular requirements for bus bar trunksystems (bus ways).
IS : 11353	Guide for uniform system marking and identification of conductors and apparatus terminals.
IS: 13703	Low voltage fuses.
TS:13947	LV Switchgear and control gear

2.2.21 In case of imported equipment, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

2.2.22 The equipment shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

2.2.23 In case Indian standards are not available for any equipment, standards issued by IEC/BS I VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

2.2.24 In case of any contradiction between various referred standards I specifications I data sheet and statutory regulations the following order of priority shall govern:

- Statutory regulations
- Data sheets
- Job specifications
- This specification
- Codes and standards

2.2.30 General Requirements

2.2.31 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

2.2.32 Vendor shall ensure availability of spare parts andmaintenance support services for the offered equipment at least for 15 years from the date of supply.

2.2.33 Vendor shall give a notice of at least one year to the end user of equipment and BIL before phasing out the product/spares to enable the end user for placement of order for spares and services.

2.2.40 Site Conditions

2.2.41 The switchboards shall be suitable for installation and satisfactory operation in a pressurized substation or in substation with restricted natural air ventilation in a tropical, humid and corrosive atmosphere.

2.2.42 The switchboards shall be designed to operate under specified site conditions. If not specifically mentioned a design ambient temperature of 40°C and altitude not exceeding 1000 meters above mean sea level shall be considered.

2.2.43 All the equipment described in this specification is intended for continuous duty at the Specified ratings under the specified ambient conditions.

2.2.50 Design and Fabrication Requirements

2.2.51 Medium voltage switchboard shall be metal enclosed fully draw out, free standing, floor mounting, compartmentalized, modular type suitable for indoor installation.

2.2.52 The switchboard enclosure shall be dust and vermin proof and shall provide a degree of protection not less than IP-41.

2.2.53 The switchboard shall be assembled out of vertical panels of uniform height in single line up.

2.2.54 It shall be possible to extend the switchboards, in either direction at a later date. Ends of bus bars shall be suitably drilled for this purpose. Panels at extreme ends shall have openings, which shall be covered with plates screwed to the panel. Details of drilled holes in bus bar and openings in the panels, provided for future extension shall be clearly shown in the vendor drawings.

2.2.55 The switchboard shall be designed to ensure maximum safety during operation, inspection, connection of cables, relocation of outgoing circuits and maintenance, with the bus bar system energized and without taking any special precautions.

2.2.56 Adequate means shall be provided to prevent shorting of power and I or control terminals due to accidental dropping of maintenance tools etc. Inside the switchboard. Checking and removal of components shall be possible without disturbing adjacent equipment.

2.2.57 All identical equipment and corresponding parts shall be fully interchangeable.

2.2.58 The frame, of individual vertical panels shall be fabricated using pressed and cold rolled sheet steel.

2.2.59 The sheet steel used for panel shall be of minimum 2mrn (14SWG) CRCA except that the doors and covers may be made of 1.6mrn (16SWG) CRCA. Wherever required, stiffeners shall be provided to increase stiffness of large size doors and covers.

2.2.60 The switchboard shall be provided with integral base frame for each vertical panel. The switchboard integral base frame shall be suitable for tack welding.

2.2.61 All openings, covers and doors shall be provided with neoprene Gaskets. Removable blanking plates shall be provided to cover the openings in the event of withdrawing the feeder modules. Number of blanking plates shall be 10% of each module size with a minimum of one number.

2.2.62 All hardware shall be corrosion resistant. All joints and connections of the panel members shall be made by zinc passivated cadmium plated high quality steel bolts, nuts and washers.

2.2.63 Suitable removable type eyebolts shall be provided for the lifting of the panel/shipping section.

2.2.64 These bolts, when removed shall not leave any opening in the panels.

2.2.65 Non-magnetic cable gland plates shall be provided for termination of single core cables.

2.2.66 Switchboard shall be formed using distinct vertical panels each comprising of following compartments.

2.2.67 A metal enclosed horizontal bus bar compartment running at top unless otherwise specified.

2.2.68 Individual feeder modules in multitier mode.

2.2.69 Vertical bus bars serving all feeder modules in the vertical panel.

2.2.70 Cable termination compartment

2.2.71 Perforated sheet steel I insulating material enclosed horizontal auxiliary bus bars for control, interlock, indication and metering wiring running horizontally.

2.2.72 Metal sheets shall be provided between two adjacent vertical panels running up to Full useful height of the switchboard

2.2.73 LT PMCC shall be of single/double front execution as specified in data sheet/job specification. However Circuit breaker panels and fixed type switchboard shall be in single front execution only.

2.2.74 Motor starter and switch fuse modules shall not be accommodated at front and rear of ACB Incomer and bus coupler panel.

2.2.75 All metering and protection equipment associated with a particular circuit as specified in data sheet shall be housed in separate and independent compartment earmarked for that particular circuit and in the fixed portion of the vertical panel in case of breaker panels.

2.2.76 All auxiliary devices for control, reset, indication, measurement and protection such as push buttons, control and selector switches, indicating lamps, measuring instruments and protective relays shall be mounted on the front side of the respective compartment. The design shall be such that all power on/off or start I stop and relay reset operations shall be performed without opening the panel door.

2.2.77 Space Heaters

The switchboard panels shall be provided with space heaters to prevent moisture condensation. The space heater shall be located in the bottom part of each panel and shall be supplied from 240 VAC auxiliary buses for space heater. The space heater shall be provided with a thermostat.having adjustable setting and double pole miniature circuit breaker.

2.2.78 Auxiliary Bus bars

Auxiliary bus bars each of minimum size 18-mm² coppers shall be provided for following applications. Exact number of bus bars shall depend on various controls, metering and auxiliary power distribution requirement.

a. Panel space heater supply and motor space heater supply.
b. Control supply for breaker tripping, closing and indication circuits.
c. Control supply for breaker spring charging motors, motor starter control and indication circuit.
d. AC potential supply for energy meters, voltage operated relays etc.
e. Tee-off connectors shall be used for distributing auxiliary supply to each vertical panel. Rubber grommets shall be used for all wire entries to make the entries dust and vermin proof.
f. Provision to hook up of external DC control supply to be provided either in bus PT panel or bus coupler panel.

2.2.79 Bus Bar

i) Bus bars shall be of high conductivity electrolytic aluminum /copper supported on insulators made of non-hygroscopic, non-inflammable material with tracking index equal to or more than that defined in Indian standards.
ii) The main bus bars shall have uniform current ratings throughout their length as specified in data sheet/job specification. The current rating of the neutral shall be half that of the phase bus bars. Removable neutral links shall be provided on feeders to permit isolation of the neutral bus bar.
iii) Both horizontal and vertical bus bars, bus joints and supports shall be capable of withstanding dynamic and thermal stresses of the specified short circuit currents for 1 second. The short circuit capacity of the neutral bus bars shall be in line with IS: 13947.

iv) Only zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers shall be used for all bus bar joints and supports.

v) The hot spot temperature of bus bars including joints at design ambient temperature shall not exceed95°C for normal operating conditions.

vi) The current rating as defined for switchboard and components in data sheet/job specification are for design ambient temperature at site conditions and for being inside the cubicle at fully loaded condition. The vendor shall suitably de-rate the nominal rating to suit the above condition.

vii) All bus bars shall be insulated with heat shrunk PVC sleeves of 1100 V grade. Red, yellow and blue color shall be used for phase bus bars and black color shall be used for neutral bus bars. Removable type shrouds shall be provided for joints.

viii) Minimum clearance between live parts, between live parts/neutral to earth shall be 19mm. However clearances between terminals at components shall be as per applicable individual standards for components.

ix) Interconnections between the main bus bars and individual units shall be made by using aluminum bus bars of adequate rating. These interconnections of the vertical bus bars shall be in separate compartment and fully shrouded.

x) Vertical bus bars for circuit breaker panels shall be sized depending upon the rating and number of breakers per vertical panel. However Vertical bus bars of all other panels shall be of uniform cross section. Size of vertical bus bars shall not be less than 500 mm' Aluminum per phase or equivalent copper for panels rated above 25kA.

2.2.80 Wiring and Terminals

a. Inside the cubicles, the wiring for control, signaling, protection and instrument circuits shall be done with BIS approved, PVC insulated, flame retardant type, copper conductor wire. The insulation grade shall be 660 V. The wiring shall preferably be enclosed in plastic channels or neatly bunched together.

b. PVC insulated copper conductor of cross section 1.5 mm' may normally be used provided the control fuse rating is 10A or less. For 16A control fuse circuit 2.5 mm² copper conductors shall be used. Each wire shall be terminated at a separate terminal. C.T. Circuit wiring shall be done with2.5rnm² Copper conductor.

c. Shorting links/suitable-shorting arrangement for shorting CT secondary shall be provided.

d. Each wire shall be identified at both ends by PVC ferrules

e. Inter panels wiring within each shipping section shall be switchboard vendor's responsibility. For wiring between shipping sections, vendor shall provide terminal blocks on adjoining shipping sections and supply suitable jumper wires. Interpanel wiring shall be taken thorough PVC sleeves or rubber grommets.

f. A minimum of 10% spare terminals shall be provided on each terminal block.

g. Conductors shall be terminated with adequately sized compression-type lugs for connection to equipment terminals and strips. Stranded conductors shall be soldered at the ends before connections are made to the terminals. Sufficient terminals shall be provided on each terminal block to ensure that not more than one outgoing wire is connected per terminal.

h. Terminal strips shall preferably be separated from power circuits by metal barriers or enclosures. All spare contacts of auxiliary relays, timers, etc. shall be wired up to the terminals.

2.2.81 Earthing

a. All panels shall be connected to a tinned copper earth bus bar running throughout the length of the switchboard.

b. The minimum earth bus size shall be 30x6 mm' copper for fault level up to 31.5kA and 50x6 mm' copper for fault level above 31.5kA.

c. All doors and movable parts shall be earthed using flexible copper connections to the fixed frame of the switchboard. Provision shall be made to connect earthing bus bar to the plant-earthing grid at two ends.

d. All non-current carrying metallic parts of the mounted equipment shall be earthed. Minimum 4 nos, IO mm diameter bolts with nuts shall be provided on the earth bus for termination of fourth core of cable per vertical panel.

2.2.82 Name plate

i) A nameplate with the switchboard designation shall be fixed at the top of the central panel. Aseparate nameplate giving details for each feeder compartment of all panels shall be provided.

ii) The nameplates for feeder compartments shall be in two parts. One part shall have necessary details pertaining to the compartments number of vertical panel of the switchboards. The other parts shall be removable and shall contain all details regarding the feeder number for drives/equipment controlled by the particular module as per approved single line diagram.

iii) Blank nameplates shall be provided for all spare and vacant modules.

iv) Nameplate or polyester adhesive stickers shall be provided for each of the equipment mounted inside the switch board. Special warning plates shall be provided on removable covers or doors giving access to cable terminals and bus bars.

v) Special warning labels shall be provided inside the switchboards also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.

vi) Engraved nameplates shall preferably be of 3-ply (Black-White Black) lamicoid sheets or anodized aluminum. However back engraved Perspex sheet nameplates may also be acceptable. Nameplates shall be fastened by screws and not by adhesives.

2.2.83 Painting

a. All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and coat of yellow zinc chromate primer. The under surface shall be made free from all imperfections before undertaking the finishing coat.

b. After preparation of the under surface, the switchboard shall be spray painted with two coats of epoxy based final paint or shall be powder coated.

c. Color shade of final paint shall be 631 as per IS:5 unless otherwise specified. - .

d. The finished panels shall be dried in stoving ovens in dust free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint etc. Vendor shall supply final paint (1 liter per switchboard) in non-returnable container for final touch up at site.

e. All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust formation. Ifthese parts are moving elements then they shall be greased.

2.30 Specific requirements of air circuit breakers panels

The breaker panels shall have distinct bus bar, breaker and cable compartments.

a. The design of each compartment shall be such as to prevent movement of vermin from a particular compartment to any other compartment of the panel when the breaker is withdrawn and compartment door is closed.

b. Blanking plates shall be provided for each circuit breaker compartments, which would be used after installation, to cover the openings in the event of taking out the breaker outside the compartment.

c. In order to minimize accidental access and avoid accidents due to falling tools, all the outgoing links shall be shrouded.

d. Outgoing Air circuit breaker can be mounted in a maximum of two-tier execution while the incoming/bus coupler Air circuit breaker shall be in single tier execution only.

2.31 Cable compartment

i) Separate compartment totally enclosed from all sides shall be provided for cable termination, on the rear side. Access to cables shall be from rear side after opening cabling compartment door.

ii) The incoming/outgoing cable termination shall be staggered for each circuit and barriers of sheet steel or insulating material shall be provided between termination of two circuits such that maintenance on one circuit could be carried out while the other circuit is live. Suitable clamping arrangements shall be provided for cables and cable termination. Terminal blocks shall not be used for supporting the cables.

iii) The incoming supply for PCC/ PMCC panels shall be through top entry bus ducts or through bottom entry cables unless specified otherwise. The outgoing cables shall have bottom entry unless specified otherwise.

iv) The cable terminations shall be suitably sized for receiving specified number of cables per termination and provision shall be made for terminating each outgoing cable with a separate bolted connection. In case the total number of cables entering a particular panel cannot be accommodated in the cabling compartment of the panels an extension panel of full height shall be added to the cabling compartment for accommodating extra cables.

2.32 Circuit breaker compartment

a) The circuit breaker compartment shall be fully drawn out. Suitable guides shall be provided to facilitate easy withdrawal of the circuit breaker.

b) The current transformers for the ammeter/protection circuits shall be mounted on the fixed portion of the compartment. However, current transformers associated with built-in releases may be mounted on the breaker trolley.

c) All terminals except wiping/sliding type control terminals shall be shrouded with plastic covers to prevent accidental contact. For direct termination - clip on shrouded type terminals shall be provided.

d) There shall be three positions for the draw out trolley viz:

- "Service" position - In this position both power and control circuits shall be connected. This shall be the normal operating position of the circuit breaker.
- "Test "position - The power contacts shall be disconnected in this position but the control connections shall not be disturbed, it shall be possible ~o close and trip the breakers in this position.
- "Draw out" Position - both power and control circuits shall be disconnected in this position and breaker removed from the cubicle.

e) The circuit breaker shall be lockable in "service" and "test" positions. Safety shutters shall be provided when the breaker is in withdrawn/drawout position.

f) The earth connection must remain connected in "Test" position; Earthing of the unit shall be done with a "pin" or with scrapping earth connections.

g) The earth connection shall make before the main power I control contacts make and break after the power /control contacts are disconnected. Earthing connection through a plug and socket connection shall not be acceptable

2.33 Interlocks

Following interlocks shall be provided:

i) Compartment doors shall be interlocked against opening when breaker is in closed condition.However, it shall be possible to defeat this interlock for inspection purposes.

ii) It shall not be possible to push "in" a drawn out circuit breaker in closed condition or withdraw a circuit breaker in closed condition.

iii) It shall be possible to operate a circuit breaker only in the defined "Full in" or "service" and "test' position inside the panel. It shall not be possible to operate the breaker in intermediate positions while inserting or withdrawing circuit breaker.

iv) Any unused circuit breaker compartment shall be fully equipped and provided with compartment door, vertical busbars and control terminals/ wiring etc. Such that the same could be used for housing outgoing breakers in future without any modifications to the panel.

2.34 Specific requirements of non-air circuit breaker feeders

a. The design of drawout feeder modules shall not change for single front or double front execution.Separate vertical bus bars shall be provided for each front side modules.

b. All identical feeder modules shall be interchangeable.

c. Each vertical panel shall have a separate cable alley. The width of this cable alley shall be sufficient to accommodate all the cables and shall have free access for cable terminations and in any case shall not be less than 200rnm minimum. Cable alleys shall be provided with suitable doors.

d. Sheet steel barriers shall be provided between individual compartments and cable alley. This barrier shall be provided with opening for power and control connections and it shall be possible to safely carryout maintenance work on cable connections to any one circuit in the cable alley with the busbars and the adjacent circuits live.

e. Maintenance and connection of cables to any modules shall be possible without having to take out the modules from its position from the panel.

f. The outgoing feeder trolleys for drawout type switchboard shall be fully drawout and shall have the following features.

   i. It shall be possible to withdraw the trolley without having to unbolt or unscrew any power and control connections to the equipment mounted on the withdrawal trolley.

   ii. Both power and control connections shall be drawout type. All line and bus PTs shall be in drawout execution only. However, outgoing modules having size more than half of the useful vertical height of the panel may be in mixed combination of drawout /fixed type.

   iii. Control supply transformer modules with burden higher than 2.5KVA may be in fixed execution.

   iv. The trolley withdrawal shall be by means of crank and screw arrangement. Alternatively movement on guided rollers may also be acceptable. Plug in operation shall be independent of manual force.

   v. For drawout type feeders of size equal to or greater than half the useful vertical height of panel, positive clamping arrangement shall be provided on the top portion of the trolley in addition to clamping arrangement at the bottom, to ensure all round positive pressure on the power drawout contacts once the trolley is plugged in.

   vi. Power drawout contacts shall preferably be located towards the bottom portion of each trolley. The trolley shall be lockable in fully plugged in position and devicesshall be provided to ensure positive plugging in. In test position, power contacts shall be totally isolated and a device shall be provided for indication of test position.

g. The incomer and bus tie feeders with load break switches rated 800A and above may be in fixed execution

h. Various compartment sizes in a vertical panel shall be multiples of a basic dimension. However the minimum module size for switch fuse feeder and motor starter/contactor feeder shall not be less than that defined in data sheet/job specification. Vertical bus bars shall be pre-drilled at regular intervals for complete flexibility for changes in size of modules.

i. All switch drives other than rotary control switches, shall be lockable in both 'ON' and 'OFF' positions.

j. The switches/Molded case circuit breakers /MCB shall be interlocked with the compartment door to prevent opening of the door when the switch/ molded case circuit breaker is in 'ON' position and to prevent switching on when the door is open. A defeat mechanism for this interlock shall also be provided.

k. The maximum height of the operating handle and switches shall not exceed 1900 mm and the minimum height not below 300 mm.

l. Unused modules in the panel shall be fully equipped with hinged door, power and control terminals for starter modules and cradle for future use.

2.35 SwitchGear Modules

a) Switchboard shall be completely lined up in one straight row with the type and quantities of feeders as defined in switchboard data sheet. Generally the feeders of three main categories are identified as circuit breaker, motor starters and switch fuse.

b) Starter modules required for motor control shall be of following types and internal control wiring of all starter modules of each type shall be identical for all ratings.

   i) FVNR Full voltage non -reversing starter with minimum 18 control terminals.

   ii) FVR Full voltage reversing starter with minimum 24 control terminals.

   iii) FVNR-HD Full voltage non -reversing heavy duty starter with long starting time such as for compressors and fans etc. with minimum 18 control terminals.

c) Switch fuse /contactor feeder modules shall be of following types and internal control wiring of all modules of each type shall be identical for all ratings.

   i) SFU Switch fuses modules with no control terminals.

   ii) SFUC Switch fuse contactor modules with 18 control terminals.

d) Type of modules for fixed type switchboard shall be similar to above specified drawout modules except that the modules shall be of fixed type.

e) Minimum 2000VA control transformer shall be provided for each bus section of the PMCC/MCC switchboard having contactor control feeders and each transformer shall be sized for the entire switchboard. For switchboard having two bus sections and coupled by bus tie shall have manual changeover switch for the control transformers.

f) To facilitate site modification due to changes in motor KW ratings and to minimize spares inventory, overload relays and power fuse links shall meet the fol1owing requirements.

g) All bimetal overload relays shall be separately mounted type with connecting links rated for the maximum rating of the contactor in a starter module.

h) Bimetal overload relays of various current ranges required for motors likely to be connected to a contactor must be identical in dimension for inter-changeability. In case offered relays are with different dimension for any particular starter module, special mounting plate suitable for mounting different relays shall be provided in all the modules of that size.

i) Heavy duty starters shall be provided with saturable type current transformer operated overload relays only, which shall be suitable for motor starting time of 15-60 seconds.

j) All contactor controlled starter feeders shall meet requirements of type-2 co-ordination as per IS:13947

2.36 Switchboard Components

Circuit breakers

a) Circuit breakers shall be air break, 3 poles and drawout type. However Circuit breaker for generator incomer shall be with four poles unless specified otherwise.

b) The circuit breakers shall be provided with mechanically operated emergency tripping device. This device shall be available on the front of the panel. Mechanically operated 'closing' device shall be provided for all breakers. However mechanical closing shall be inhibited for all breakers in service position

c) The circuit breakers shall be provided with minimum 4NO+ 4NC contacts, wired and available for purchaser's use.

d) Circuit breakers Open and closed positions; Service and test locations and spring charged condition shall also be indicated mechanically in addition to electrical indications.

e) Unless otherwise specified, all circuit breakers in the switchboard shall be provided with electrical power operating mechanism. Wherever circuit breakers are provided in place of Isolators, Breaker can be manually operated type.

2.37 Operating Mechanism

a. Electric power operating mechanism shall be motor wound spring charged stored energy type.However, manual-operating mechanism may be of the spring charging stored energy type or thespring assisted type. For circuit breakers with electrical power operating mechanism, provision shall also be made for manual spring charging. Closing time of circuit breakers with manual operating mechanism shall be independent of the speed of the operating handle.

b. All stored energy operating mechanism shall be equipped with following features.Failure of springs, vibrations or shocks shall not cause unintended operation of breaker or prevent intended tripping operation. Closing of circuit breakers shall be prevented unless the spring is fully charged.

c. All electrical power operating mechanisms shall be suitable for remote operation and shall be equipped with following features.
   - Provided with universal motor operable on AC or DC control supplies.
   - Provided with emergency manual charging facility. The motor shall be automatically, decoupled (mechanically) once the manual-charging handle is inserted.
   - Closing operation of circuit breaker shall automatically initiate charging of the spring for the next closing operation without waiting for tripping of circuit breaker.
   - Closing operation shall be completed once the closing impulse is given and the first device in the control scheme has responded even though the control switch I Push Button is released provided no counter trip impulse is present.

d. Circuit breaker trip and closing coils in case of electrically operated breakers and trip coil in case of mechanically operated breakers and circuit breaker indication shall be suitable for satisfactory operation on a control supply system indicated in data sheets/job specification.

e. Circuit breakers shall be provided with anti-pumping and trip free feature.

f. Circuit breakers shall be provided with operation counters.

g. Releases are not required to be provided with breakers where relays are used. However breaker• having AC control supply voltage shall be provided with under voltage release unless specified otherwise.

2.38 Switches

i) All switches or fuse switches shall be air break type provided with quick make/break manual operating mechanism. The operating handle shall be mounted on the door of the compartment having the switch.

ii) Rating of switches for starter module shall meet the requirements of AC-23 duty as per IS: 13947 and minimum rating shall be as specified in job specification/data sheets.

2.39 Fuses

a. Fuses shall be non-deteriorating HRC cartridge link type.

b. Power fuses shall be pressure fitted type and shall preferably have ribs on the, contact blades to ensure good line contact. ..

c. It shall be possible to handle fuses during off load conditions with full voltage available on the terminals. Wherever required fuse pullers shall be provided. The fuse base shall be so located in the modules to permit insertion of fuse pullers and removal of fuse links without any problem.

2.40 Contactors

a) The contactors shall be air break type, equipped with three main contacts and minimum 1NO+ 1 NC auxiliary contacts. The main contacts of a particular contactor for motor stator module shall have AC-3 or AC4 ratings as specified in data sheet.

b) Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240 V, 1 Phase, AC supply and shall work satisfactorily between 65 to 110% of the rated value.

2.41 Thermal overload relay

i) Bimetal relays shall be provided for protecting the motor from thermal overload.

ii) Bimetal relays shall be manually reset type with the reset push button brought out on the front of the panel. The reset push button shall be capable of being operated without opening the compartment door.

iii) Bimetal relays shall be positive acting ambient temperature compensated type with adjustable setting range.

iv) Bimetal relays shall have built-in single phasing prevention feature, which operate even with 50%rated current at the time of single phasing.

2.42 Molded case circuit breakers

a) MCCBs sha11 be provided with spring assisted quick make/ break manually operated trip free mechanism. Wherever specified, MCCB shall be suitable for remote tripping operation and the tripping device shall be suitable for the specified control supply voltage.

b) MCCBs shall be provided tripping device with inverse time characteristic for over load protection and instantaneous characteristics for short circuit protection and MCCB rated above 125A shall preferably have adjustable settings.

c) ‘ON’ and 'OFF' position of the operating handle of MCCB shall be displayed and the operating handle shall be mounted on the door of the compartment housing MCCB.

d) Each MCCB shall be provided with minimum 1NO+1NC auxiliary contact and 1NO contact for tripping indication/alarm for purchaser's use.

e) MCCBs shall be provided with solenoid/ Motorized closing mechanism to make them suitable for remote closing operation if specified. The closing solenoid/motor shall be suitable for specified control supply voltage.

f) MCCB's as part of motor starter module shall be current limiting type and type tested for type-2 co-ordination as per IS: 13947.

2.43 Relays

i) Type of relay shall be numerical, static or electromagnetic type as specified in the data sheet /job specification.

ii) All electromagnetic protective relays shall be back connected, of drawout type, suitable for flush mounting, and fitted with dust-tight covers. Alternatively, “plug-in" type relays will also be acceptable. Auxiliary relays are acceptable in fixed execution.

iii) The protective relay cases shall have provision at the front for "testing and calibration "purposes. It shall be possible to test the relays without disconnecting the wiring and without withdrawing the relays. The insertion of the test plug shall automatically short circuit the CTs and permits extension of external power supply to the relay.

iv) Each protective relay shall be provided with minimum 2 nos. potential free contacts of required configuration. .

v) Each tripping relay shall be lockout type with hand reset coil cut-off contact. The tripping relay shall be suitable for satisfactory operation from 50 % to 110 % of the specified control supply voltage.

vi) Protective relays shall be preferably mounted on the front side and upper par1 of the panel and mounting of relays on the lower portion shall be avoided.

2.44 Instrument transformers (CTs/PTs)

a) Current transformers shall generally conform to IS: 2705 and any special requirement with respect to Numerical relay shall be take care by the vendor.

b) For general guidance the vendor shall note that the protective current transformers shall have an accuracy class "5 P" and an accuracy limit factor greater than "10 ". However CTs for restricted earth fault shall be of class “PS". Vendor shall co-ordinate the knee point voltage, magnetizing current for PS class CTs to avoid saturation and mismatching of CTs provided at other end by other vendor.

c) Current transformers for instruments shall have an accuracy class 1.0 and accuracy limit factor less than 5.0. However accuracy class of 3.0 is acceptable for CT's meant for remote ammeters.

d) The current transformers in breaker feeders shall be capable of withstanding the applicable peak momentary short circuit and the symmetrical short circuit current for I .0 second.

e) The voltage transformers shall be cast resin type transformers and PT shall generally conform to IS: 3156. PT shall be provided with HRC fuses on primary side and Miniature circuit breakers with auxiliary contact on the secondary side.

2.45 Measuring instruments

i) All measuring instruments shall be of 96 x 96 mm and 72 x 72 mm square pattern, flush mounting type for incomer and outgoing feeders respectively in the switchboard.

ii) All auxiliary equipment such as shunts transducers, CT's PT's etc. As required shall be included in the supply of the switchboard.

iii) All AC ammeters and voltmeters shall be of moving iron type with accuracy class of 1.5 as per IS:1248.Ammeters for motor feeders shall have a non-linear compressed scale at the end to indicate motor starting current and red mark for the full load current.The KW/KWH meters shall be suitable to measure unbalanced loads on 3 phase 4-wire system.

iv) Test terminal block shall be provided for KWH meters. The accuracy class of KW! KWH metersshall be a minimum of 2.5.

v) Digital meters shall be provided if specified in job specification/data sheets. All digital meter shall be high reliable, accurate, compact and self-powered. Digital meter data shall be saved in case of power failure. Field programming from front of the meter shall be possible and shall be RS232/485 port in case specified in the job specification/data sheet.

2.46 Control switches

a) All control switches shall be rotary type, having a cam operated contact mechanism. Switch shall have pistol grip handles for circuit breaker control and knob type handle for other applications.

b) Ammeter selector switches shall have make before break feature on its contacts. The selector switch shall generally have 4 positions for reading 3 phase currents and fourth position for off. Thevoltmeter selector switch shall also have 4 positions. Three positions shall be used to measure phaseto-phase voltage and fourth shall be OFF position.

c) **Push buttons:**

Push button colors shall be as follows:

- Stop /open/emergency -Red
- Start/close - Green
- Reset/test - Yellow/ Black /white

d) **Indications**

e) Clustered LED type indicating light with minimum 8mm diameter size shall be provided for indications.

f) Breaker positions (Close, Open, spring-charged, test position, service position) electrical indications, with colors as given below, shall also be provided:

- Breaker 'Close' Red lamp
- Breaker 'Open' - Green lamp
- Breaker auto-trip - Amber lamp
- Trip circuit healthy - White lamp
- Spring charging - Blue lamp

g) Outgoing feeder (Close, Open, trip) electrical indications, with colors as given below, shall also be provided:

- 'Close'
- 'Open'
- 'Trip'

2.47 Auxiliary relays/contactors

Auxiliary relays/contactors shall generally be used for interlocking and multiplying contacts. Auxiliary contact shall be capable of carrying the maximum anticipated current.

2.48 Timers

For re-acceleration duty, timers unless otherwise stated, shall be pneumatic type and shall have adjustable time setting of 0-60 seconds. Alternatively static timer may be considered. The time settings, where specified, shall be accurately set before dispatch of the switchboard. Timer provided for control of capacitor feeder shall have minimum setting of 0-5 minutes.

2.49 Miniature circuit breaker

MCB shall provide high mechanical and electrical life, reliable protection of circuits against overload and short circuit and shall have minimum breaking capacity of 9KA unless otherwise specified. Positive ON/OFF indication shall be provided.

Earth leakage circuit breaker shall have earth sensitivities range 30mA to 300mA unless otherwise specified.

2.50 Inspection, Testing and Acceptance

a) During fabrication, switchgear shall be subject to inspection by EIL/ Owner or by an agency authorized by the owner. Manufacturer shall furnish all necessary information concerning the supply to EIL /owners inspectors.

b) All routine and acceptance tests shall be carried out at manufacturer's work under his care and expense.

c) Type tests, if specified shall be performed. Short circuit test shall be performed at CPR! Or equivalent approved testing agency and heat run test may be performed at manufacturer's works. Heat run test shall be performed at least on one incomer and two outgoing vertical panels of the ordered switchboard.

d) Type and shop tests shall be witnessed by an inspector of BIL I Owner or of an agency authorized by the owner. Prior notice of minimum 4 weeks shall be given to the inspector for witnessing the tests.

2.51 Acceptance tests

Acceptance tests shall be as follows:

i) A general visual check shall be carried out. This shall cover measurement of overall dimension, location, number and type of devices, location and connection of terminals etc,

ii) Manual and electrical operation of Circuit Breakers. I Relays shall be checked under the worst conditions of auxiliary supply voltage.

iii) Dry insulation test with power frequency voltage shall be conducted for the main and auxiliary circuits.

iv) Insulation resistance of the main and auxiliary circuits shall be checked before and after power frequency voltage withstand test.

v) Operation check shall be carried out for every control function /interlocks as per the schematic diagrams by manually simulating fault conditions and operation of control switches/relays etc.

vi) For equipment bought from other sub-suppliers, certified test reports of tests carried out at the manufacturer's works shall be submitted. Normally all routine tests as specified in the relevant standards shall be conducted by the sub-supplier at his works.

vii) Interchange ability of similar modules shall be checked on a random basis. This may be done on one module of each size.

2.52 Packing and Dispatch

All the equipment shall be divided into several shipping sections for protection and ease of handling during transportation.The equipment shall be properly packed for selected mode of transportation i.e. by ship/rail or trailer. The panels shall be wrapped in polyethylene sheets before being placed inwooden crates /cases to prevent damage to the finish. Crates /cases shall have skid bottoms for handling. Special precaution notations such as Fragile, This side up, center of gravity, weight, Owner's particulars, Purchase number etc. shall be clearly marked on the package together with other details as per purchase order.

The equipment may be stored outdoors for long periods before installation. The packing should be suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed.

3.0 Lighting & Power Distribution Board

3.1 Scope

This specification covers the requirements of design, manufacture, testing, packing and supply of Weather proof Lighting and Power Distribution boards/accessories suitable for installation in the project locations.

3.2 Codes and Standards

Equipment shall comply with the requirements of latest revision of the following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified:

IS-5	Colors for ready mixed paints and enamels.
IS-1248(Parts-1&2)	Direct acting indicating analogue measuring instruments and their accessories.
IS-8828	Specifications for Circuit-breakers for Over-current protection for house hold and similar installations
IS-12640	Residual current operated circuit-breakers.
IS-13947(Parts-1&5)	L. V. Switchgear & Control-gear

a) Imported equipment shall conform to the international standards such as IEC/ BS/ VDE/ NEMA or equivalent.

b) The equipment shall also conform to the provisions of Indian Electricity Rules and other statutory regulations currently in force in the country.

c) In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ NEMA or equivalent agency shall be applicable.

d) In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations, the following order of decreasing priority shall govern:

- Statutory regulations
- Datasheets
- Job specification
- This specification
- Codes and standards

3.3 General Requirements

Offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

3.4 Site Conditions

Equipment shall be suitable for installation and satisfactory operation to provide related space / conduits / channels / cables / wire for services like Lighting, Switches, Fans, and Distribution Boards that shall be located on various floors in separate buildings, street lighting, parade ground lighting etc. that shall be designed to operate under site conditions as specified in data sheet. If not specifically mentioned therein, a design ambient temperature of 45°C and an altitude not exceeding 1000 m above mean sea level shall be considered.

3.5 Power Supply

Lighting and power distribution boards shall be suitable for 415V, 50Hz, three phase and neutral (FP) incoming supply.

For projects falling under jurisdiction of DGMS, the following additional requirements shall apply:

a) The phase-to-phase voltage shall not exceed 125 volts (where electric lighting is used in underground mines)/ 250 volts (where electric lighting is used in open cast mine or surface of a mine), with the neutral or the mid-point of the lighting system connected with earth.

b) The panels shall have three phases, 4-wire system.

c) In power distribution board, incomer feeder shall be controlled by FP MCB + DP RCB.

d) In lighting distribution board, incomer feeder shall be controlled by FP MCB + RCB with contactor and timer.

e) Outgoing circuits shall be controlled by Single pole MCB.

3.6 Certification

Equipment shall have test certificates issued by recognised independent test house (CIMFR/ CPRV ERTL/ BASEEFA/ LCIE/ UL/ FM or equivalent). All indigenous equipment shall conform to Indian standards and shall be certified by Indian testing agencies. All equipment (indigenous & imported) shall also have valid statutory approvals as applicable for the specified location. All indigenous equipment shall have valid BIS license and marking as required by statutory authorities.

3.7 Technical Requirements

3.7.1 Construction

Enclosures of lighting and power distribution board shall be made of sheet steel enclosure with copper bus bars suitable for single phase or three phase MCBs. These enclosures shall be sized to facilitate easy maintenance and heat dissipation.

3.7.2 Distribution board shall be suitable for use in indoor/outdoor locations and shall have IP-52 degree of protection for indoor and IP55 protection for outdoor.

3.7.3 Hinged doors shall be provided and shall be complete with All DB's front door should be self lockable. The MCBDB shall have sheet steel hinged lockable door top to prevent access to MCBs from outside. DB shall have suitable neutral and earth terminal block to facilitate easy termination of wires. All wires inside the DBs shall be terminated using copper end terminations

3.7.4 The Distribution boards (Power / Lighting / Motor & Lighting Control / Push-Button Station/Junction Box) shall be factory-wired and assembled at the enclosure Original Equipment Manufacturers (OEM) works. All relevant Factory Testing as specified in this document shall be carried out on the Distribution Boards by the manufacturer / assembler & the test reports are to be submitted for review & approval during panel delivery.

3.7.5 The final outer colour of the enclosures shall be as decided by the owner / engineer-in-charge – during detailed engineering & before manufacturing.

3.7.6 A warning inscription "Isolate power supply upstream before opening" shall be provided on each enclosure with skull bone danger sign. The warning inscription shall be on a sticker on the front of each distribution board.

3.7.7 All accessories like nuts, bolts, washers etc. shall be made of stainless steel SS-304. All terminals shall be readily accessible from front of distribution board. All the non-current carrying metallic parts of the panel shall be inherently bonded together. Each lighting and power panel shall be provided with two earthing studs with copper lugs on the exterior of the panel enclosure suitable for termination of 8SWG GI earthing conductor.

3.7.8 Each outgoing feeder shall be provided with distinct terminals for phase, neutral and earth. The terminal block enclosures shall be adequately sized to properly terminate the cables by taking into account the required bending radii of cable cores and shall have the following minimum gland to terminal distances:

i) For Conductor Size Up to 2.5 mm² (Gland to terminal distance 40mm)
ii) Above2.5 ~ 10 mm² (Gland to terminal distance 60mm)
iii) Above 10~ 35 mm² (Gland to terminal distance 100mm)
iv) Above 35 ~ 95 mm² (Gland to terminal distance 150mm)

3.7.9 Panels shall be provided with suitably sized cable entries at the bottom/top sides, for incoming and outgoing cables. Panels shall be complete with PVC cable glands of various sizes as specified in the Bill of Quantities – both for incoming & outgoing cables.

3.7.10 Panels shall have external fixing lugs for mounting on wall or column. The holes provided on these lugs shall be of oblong type.

3.8 Component Specification

3.8.1 Bus-bars in lighting and power distribution boards shall be made of high conductivity copper, and shall be supported by non-hygroscopic insulators. Bus-bars shall be colour coded for identification of phases and neutral.

3.8.2 Indoor Lighting & Power Distribution Board (DB) incomer shall have4-pole 10kA, 32A MCB with 30mA RCBO.

3.8.3 Outdoor Lighting Distribution Board (LDB) incomer shall have 4-pole 32A MCB with RCBO.

3.8.4 The Outgoing feeders shall be as per the Bill of Quantities.

3.8.5 All MCBs and RCBOs shall be with 10kA (M9 category) interrupting capacity.

3.8.6 The operating knobs (ON/ OFF/ Reset) shall be provided with a suitable rack and pinion arrangement for operating them smoothly from outside.

3.9 Terminals &Wiring

3.9.1 Panels shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. Unless otherwise specified, terminals for termination of incoming and outgoing external cables shall be suitable for termination. Terminals shall be suitable for termination of solid conductors up to $6mm^2$and stranded conductors above $6mm^2$. Wherever lugs are required for cable termination, tinned copper type lugs shall be provided.

3.9.2 All internal wiring in lighting and power panels shall employ adequately sized, 1100 V grade, PVC insulated copper conductor wires, colour coded for phase, neutral and earth, with conductor sizes as per SLDs:

3.10 Inspection, Testing and Acceptance

3.10.1 During fabrication, equipment shall be subjected to inspection by Owner / Engineer-in-Charge, if specified/ agreed in Inspection Test Plan. Manufacturer shall furnish all necessary information concerning supply to Owner. All routine/acceptance tests shall be carried out at manufacturer's works under his care & expense.

3.10.2 Type test certificates from, BIS license and original drawings referred in type test certificates shall be shown to the Owner/Engineer In charge during site inspection. The certificates and BIS license must be valid at the time of despatch.

3.10.3 On completion of an electrical installation (or an extension to an installation), a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form in addition to the test certificate required by the local Electric Supply Authorities.

3.10.4 Test certificates of bought out components shall be shown to the owner/Engineer In charge during site inspection / acceptance.

3.10.5 All equipment's shall be subjected to various acceptance tests as per standards but not limited to the following:

- General visual inspection
- Dimensional inspection

- Verification of mechanical and electrical operations
- Dielectric tests
- Routine pressure test as per IS-2148
- Any other routine and acceptance test as per applicable standards.
- Type tests shall be carried out if specified in data-sheet/job specification.

3.11 Packing and Dispatch

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for the selected mode of transportation, i.e. by ship/ rail or trailer, and shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. The crates/ cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., shall be clearly marked on the packages together with other details as per purchase order. The equipment may be stored in a covered shed for long periods before installation. The packing should be suitable for such storage.

4 Plugs & Sockets

4.1 Scope

This specification covers the requirements of design, manufacture, testing, packing and supply of plugs, sockets and accessories suitable for installation in the project locations.

4.2 Codes and Standards

4.2.1 The equipment shall comply with the requirements of latest revision of the following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified:

IS-5	Colors for ready mixed paints and enamels.
IS 3854	Switches for Domestic.
IS 1293	Plug and Socket outlets
IS-1248(Parts-1&2)	Direct acting indicating analogue measuring instruments and their accessories.
IS 1293:2005/ IEC 60884-1 (2002)	Plugs and socket outlets of rated voltage up to and including 250 volts and rated current up to and including 16 amperes - Specification (third revision)

4.2.2 Imported equipment shall conform to the international standards such as IEC/ BS/ VDE/ NEMA or equivalent.

4.2.3 Equipments shall also conform to the provisions of Indian Electricity Rules and other statutory regulations currently in force in the country.

4.2.4 In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ NEMA or equivalent agency shall be applicable.

4.2.5 In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations, the following order of decreasing priority shall govern:

- Statutory regulations
- Datasheets
- Job specification
- This specification
- Codes and standards

4.3 General Requirements

The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

4.4 Site Conditions

Equipment shall be suitable for installation and satisfactory operation in tropical, humid and corrosive atmosphere in the project locations. If not specifically mentioned therein, a design ambient temperature of 40°C and an altitude not exceeding 1000 m above mean sea level shall be considered.

4.5 Certification

Equipment shall have test certificates issued by recognised independent test house (CIMFR/CPRV ERTL/BASEEFA/LCIE/UL/FM or equivalent). All indigenous equipment shall conform to Indian standards and shall be certified by Indian testing agencies. All equipment (indigenous & imported) shall also have valid statutory approvals as applicable for the specified location. All indigenous weather proof equipment shall have valid BIS license and marking as required by statutory authorities.

4.6 Technical Requirements

4.6.1 Construction

4.6.1.1 Enclosures of plugs and sockets shall be made of cast light metal alloy/die cast free aluminum.The magnesium content in the alloy shall be as per IS-13346. Temperature of external surfaces shall be limited to 200°C, unless otherwise specified. Enclosures shall be sized to facilitate easy maintenance and heat dissipation.

4.6.1.2 Equipment shall be suitable for use in indoor locations and shall have IP-52 degree of protection and for outdoor locations shall have IP-55 degree of protection. Sockets shall be rated as 240V – 6/16A, 5 pin single phase sockets and 16A/10A, 3 pin single phase sockets.

4.6.1.3 Enclosures shall be provided with gaskets made of non-inflammable and self-extinguishing material.

4.6.1.4 Enclosures shall be treated and prepared for painting with two coats of epoxy paint with final colour shade (both internal and external) as aproved by Engineer in charge.

4.6.1.5 Accessories like nuts, bolts, washers etc. shall be made of stainless steel SS-304.

4.6.1.6 All the non-current carrying metallic parts of the panel/Metal switch box/ Metal socket box (Gang box) shall be inherently bonded together. The SPN sockets shall be provided with two earthing studs, with lugs

on the exterior of the enclosure, suitable for termination of 4mm² flexible copper earthingcables. Internal earth terminals shall be provided in each enclosure for all single phase plugs and sockets for connecting the earth core of the cables.

4.6.1.7 Terminal block enclosures shall be adequately sized to properly terminate the cables by taking in to account the require bending ratio of the cable cores and shall have the following minimum gland to terminal distances:

Conductor Size	**Up to 2.5 mm^2**	**Above2.5 mm^2& Up to 10 mm^2**	**Above 10mm^2 &Up to 35mm^2**	**Above35mm^2& Up to 95mm^2**
Gland to terminal distance	40 mm	60 mm	100 mm	150 mm

4.6.1.8 The sockets shall be provided with 2nos. suitably sized cable entries at the bottom for specified cable sizes and complete with 2no's.Of cable gland. Each socket shall be supplied with 1no.weatherproof nickel plated brass sealing plug, for plugging the unused cable entries.

4.6.1.9 The sockets shall have external fixing lugs for mounting on wall or column. The holes provided on these lugs shall be of oblong type.

4.6.1.10 Name plate indicating Tag No shall be provided one a socket. Name plates shall also be provided for each incoming and outgoing feeder. Separate name plate shall also be provided to indicate the details of testing agency (CIMFR or equivalent), test certificate no. With date, statutory approval no. with date and agency (PESO/CCE/DGFASLI/DGMS), BIS license number and date, applicable as group etc. Name plates shall be engraved on 3plyblack white black lami cold sheets using square cutters. Black engraved per specification sheet name plate shall also be acceptable. Name plates shall be fixed by screws and shall not be pasted. In case the standard details given above are embossed on the enclosures, same need not be repeated on name plate.

4.6.2 Socket Outlets & Plugs

4.6.2.1 Sockets shall be provided with a switch and a mechanical interlock so as to break the electrical circuit before the plug is completely withdrawn and make the circuit after the plug is fully inserted.

4.6.2.2 In order to prevent accidental removal of plug from socket, the engagement and disengagement shall be by two separate and distinct movement and position

4.6.2.3 Single Phase 240V, 16/20A plug & socket shall be provided with 3 pins (P + N + E).

4.6.2.4 Sockets shall be provided with either a spring loaded hinged cover, or with a cap connected through metallic chain, to close the same when not in service.

4.6.2.5 Scraping earth connection shall be provided between the plug and socket. Earth pin of plug shall first engage with earth pin of switch socket.

4.6.2.6 The plug assembly shall be mechanically rugged, light and shall not unduly stress the socket or its own pins when fitted on to the socket. The diameter of the earth pin of the plug and socket shall be at least 1.1 times the diameter of the phase pins.

4.6.2.7 The light plug (6/10A) point and power (16/20A) point wiring shall be measured on linear basis, from the respective tapping point of live cable, namely, switch box, another socket outlet point, or the sub-distribution board as the case may be, up to the socket outlet.

4.6.2.8 The metal/PVC box with cover, switch/MCB, socket outlet and other accessories shall be measured and paid as a separate item.

4.6.2.9 Single phase indoor socket outlets shall be of modular type for the rating of 6/10 A 5 pin, 16/20 Amp 6 pin or 16/6 Amp 5 pin.

4.6.2.10 Single phase outdoor industrial sockets shall have polycarbonate weather proof enclosure with 230V, 20A DP MCB & 3 pin socket & pin.

4.6.2.11 Three phase outdoor industrial sockets shall have polycarbonate weather proof enclosure with 415V, 32A, TP MCB & 5 pin socket & pin.

4.6.2.12 Sockets for Telephone shall be Modular type RJ-11 telephone socket with jack & shutter of 1-module size including fixing the telephone socket on the modular base-plate and termination of telephone paired wires

4.6.2.13 Sockets for DTH TV shall be of modular type Coaxial Cable Outlet / TV Socket in 1-module size including fixing the Cable / TV outlet on the modular base-plate and termination of cable

4.6.2.14 Third pin shall be connected to earth through protective (loop earthing) conductor.

4.6.2.15 Conductors connecting electrical appliances with socket outlets shall be of flexible type with an earthing conductor for connection to the earth terminal of plug and the metallic body of the electrical appliance.

4.6.2.16 Sockets for power outlets of rating above 1KW shall be of industrial type with associated plug top and controlling MCB. Where specified, shutter type (interlocking type) of sockets shall be used. Every socket outlet shall be controlled by a switch or MCB, as specified. The control switch/MCB shall be connected on 'live' side of the line.

4.6.2.17 6/10A and 16/20A socket outlets shall be installed at residential building unless otherwise specified.

4.7 Modular GI Gang Box (Back Box)

Supply & installation of 1 to 8 modules shall be Hot-Dipped GI metal gang box suitable for mounting modular switch plates. The box should be firmly flush mounted after due groove cutting in brick/stone/C.C wall & refilling of gaps with cement plaster.

4.8 Modular PVC Gang Box (Back Box)

Supply & installation of 1 to 8 modules shall be PVC type gang box suitable for mounting modular switch plates. The box should be firmly flush mounted after due groove cutting in brick/stone/C.C wall & refilling of gaps with cement plaster.

4.9 Aesthetic Switch Cover Plate with Back Plate and Switches

Supply & installation of 10A/20A rated One/Two way modular switch with Neon indicator, (for lighting circuits) including fixing the switch on the modular base-plate and termination of wires with aesthetic Cover Plate of sizes between two to eight modules

4.10 Inspection, Testing and Acceptance

4.10.1 During fabrication, the equipment shall be subjected to inspection by the Owner /Engineer-in-Charge, if specified/ agreed in Inspection Test Plan. Manufacturer shall furnish all necessary information concerning the supply to Owner's inspector. All routine/acceptance tests shall be carried out at manufacturer's works under his care & expense.

4.10.2 Type test certificates from CIMFR or equivalent test house, applicable PESO/ CCE/ DGFASLI/ DGMS approval certificates, BIS license and original drawings referred in type test certificates shall be shown to the Owner/Engineer In charge during inspection. The certificates and BIS license must be valid at the time of despatch.

4.10.3 Test certificates of bought out components shall be shown to the Owner/Engineer In charge during inspection.

4.10.4 All equipment's shall be subjected to various acceptance tests as per standards but not limited to the following:

- General visual inspection / Dimensional inspection.
- Verification of mechanical and electrical operations.
- Dielectric tests / Routine pressure test per IS-2148
- Any other routine and acceptance test as per applicable standards.
- Type tests shall be carried out if specified in data sheet/ job specification.

4.11 Packing and Dispatch

All equipment shall be divided into several sections for protection and ease of handling during transportation. This equipment shall be properly packed for the selected mode of transportation, i.e. by ship/ rail or trailer, and shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. The crates/ cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., shall be clearly marked on the packages together with other details as per purchase order. The equipment may be stored in a covered shed for long periods before installation. The packing should be suitable for such storage.

5.0 Low Voltage Induction Motors

5.1 Scope

This specification covers the design, manufacture, testing, packing and supply of three phaseLow Voltage induction motors rated up to 1000V.

5.2 Codes and Standards

5.2.1 The equipment shall comply with the requirements of latest revision of the following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified:

IS-5	Colors for ready mixed paints and enamels.
IS-325	Three phase induction motors
IS-1076	Preferred numbers
IS-1231	Dimensions of three phase foot mounted induction motors
IS-1271	Thermal evaluation and classification of electrical insulation
IS-2223	Dimensions of flange-mounted AC Induction motors
IS-2253	Designation for type &construction and mounting arrangement of rotating electrical machines
IS-2254	Dimensions of vertical shaft motors for pumps
IS-2968	Dimensions of slide rails for electrical motors
IS-4029	Guide for testing of three phase induction motors
IS-4691	Degree of protection provided by enclosure for rotating electrical machinery
IS-4722	Rotating electrical machines
IS-4728	Terminal marking and direction of rotation for rotating electrical machinery
IS-4889	Method of determination of efficiency of rotating electrical machines
IS-6362	Designation of methods of cooling of rotating electrical machines
IS-6381	Construction and testing of electrical apparatus with type of protection
IS-7816	Guide for testing insulation resistance of rotating machines
IS-8223	Dimensions and output series for rotating electrical machines
IS-8289	Electrical equipment with type of protection
IS-8789	Values of performance characteristics for three phase induction motors
IS-9283	Motors for submersible pump-sets
IS-9628	Three phase induction motors with type of protection
IS-12065	Permissible limits of noise level for rotating Electrical Machines

IS-12075	Mechanical vibration of Rotating Electrical Machines with shaft heights of 56 mm and higher measurement, evaluation and limits of vibration severity
IS-12802	Temperature rise measurement of Rotating Electrical Machines
IS-12824	Type of duty and classes of rating assigned to rotating electrical machines
IS-13529	Guide on effects of unbalanced voltages on the performance of three phase induction motors
IS-13555	Guide for selection and application of three phase induction motors for different types of driven equipments
IS-14568	Dimension and output series for rotating electrical machines, frame numbers 355 to1000 and flange numbers1180 to 2360

5.2.2 In case of imported motors, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian Standards.

5.2.3 The motors shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

5.2.4 In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ NEMA or equivalent agency shall be applicable.

5.2.5 In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations, the following order of decreasing priority shall govern:

- Statutory regulations
- Data sheets
- Job specification
- This specification
- Codes and standards

5.3 General Requirements

5.3.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

5.3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment at least for 15 years from the date of supply.

5.3.3 Vendor shall give a notice of at least one year to the end user of equipment before phasing out the product/spares to enable the end user for placement of order for spares and services.

5.4 Operating Conditions

5.4.1 Ambient Conditions: Motors shall be suitable for operating satisfactorily in humid and corrosive atmospheres found in Township. Service conditions shall be as specified in the motor data sheet. If not specifically mentioned therein, a design ambient temperature of 40°C and an altitude not exceeding 1000 meters above mean sea level shall be taken into consideration.

5.4.2 Frequency and Voltage variations: Unless otherwise agreed, motors shall be designed for continuous operation at rated output under the following conditions:

a) The terminal voltage differing from its rated value by not more than ±6% or
b) The frequency differing from its rated value by not more than ± 3%
c) Any combination of (a) and (b)

5.4.3 Starting:

i) Motors shall be designed for direct on line starting.
ii) Motors shall be designed for re-acceleration under full load after a momentary loss of voltage with the residual voltage being 100% and is in phase opposition to the applied voltage.
iii) Minimum locked rotor thermal withstand time at rated voltage shall be 10 seconds under cold conditions and 8 seconds under hot conditions. The starting time of the motor shall be less than the hot thermal withstand time to permit application of conventional bimetal relays or thermal release against locked rotor and overload conditions.
iv) Unless otherwise specified, all motors shall be suitable for starting under specified load conditions with 75 % of the rated voltage at the motor terminals.

5.5 Performance

5.5.1 Motors shall be rated for intermittent periodic duty (S3), unless otherwise specified.

5.5.2 Unless otherwise specified, the starting current (as % rated current) shall not exceed 600% subject to tolerance.

5.5.3 Starting torque and minimum torque of the motor shall be compatible with the speed torque curve of the driven equipment under specified starting and operating conditions.

5.5.4 In case where characteristics of driven equipment are not available while selecting the motor, minimum starting torque shall be 110% of rated value for motors up to 75 kW and shall be 90% of rated value for motors above 75 kW.

5.5.5 The pull out torque at the rated voltage shall be not less than 175 percent of the rated load torque with no negative tolerance. Unless otherwise agreed, the pull out torque shall not exceed 300 percent of the rated load torque.

5.5.6 In case of motors driving equipment with pulsating loads (e.g. reciprocating compressors) the minimum value of pull out torque at 75% of the rated voltage shall be more than the peak value of pulsating torque and the current pulsation shall be limited to 40%.

5.5.7 Efficiency and power-factor figures for motors having synchronous speeds of 750 RPM and below shall be as agreed between the purchaser and the manufacturer. All LT motors efficiency type shall be of minimum IE2.

5.6 Construction Details

All windings shall be of CopperMotors weighing more than 25 kg. Shall be provided with eyebolts, lugs or other means to facilitate safe lifting

5.6.1 Windings:

5.6.1.1 Motor windings shall be provided Class-F insulation and temperature rise shall be limited to class-B.

5.6.1.2 The winding shall be tropicalized. The windings shall preferably be vacuum impregnated. Alternately the windings shall be suitably varnished, baked and treated with epoxy gel for operating satisfactorily in humid and corrosive atmospheres.

5.6.1.3 Windings shall be adequately braced to prevent any relative movement during operation. In this respect, particular care shall be taken for the stator windings for direct-on-line starting squirrel cage motors. Insulation shall be provided between coils of different phases that lie together. Core

laminations must be capable of withstanding burnout for rewind at 400°C without damage or loosening.

5.6.1.4 In case of motors driving equipment with pulsating loads, special care shall be taken for the joints of rotor bars and end rings to avoid premature failures due to induced fatigue stresses.

5.6.1.5 The ends of the windings shall be brought out into a terminal box. These shall be terminated by means of terminals mounted on an insulating base made of non-hygroscopic and non-flammable material.

5.6.1.6 All motors shall be with six terminals and suitable links to connect them in star or in delta except for motors rated up to and including 2.2 kW which may be accepted with three terminals.

5.6.1.7 All terminals shall be thoroughly insulated from the frame with material resistant to tracking.

5.6.2 Terminal Boxes and Cable Entries

5.6.2.1 Unless otherwise agreed, the terminal box shall be located on the right hand side as viewed from the driving (coupling) end. However, as a special case, terminal box located on top may also be accepted. The terminal box design shall allow rotation in steps of 90° to facilitate cable entry from any direction.

5.6.2.2 The terminal box shall be of robust construction and large enough to facilitate easy connection of the cables. The terminal box shall be with necessary clearances, creepage distances between live parts and between live parts to earth considering air insulation and without any compound filling. Terminal box cover shall be provided with handles to facilitate easy removal. However, for terminal box covers weighing less than 5 kg, terminal box covers without handles can be accepted.

5.6.2.3 An adequately sized earth terminal shall be provided in the motor terminal box for termination of the fourth core of specified cables.

5.6.2.4 The terminal box shall be provided entries for suitable cable glands corresponding to the size of the specified cable. Crimp type tinned Cu lugs and nickel-plated brass (or aluminium if specifically required), double compression type cable glands shall be supplied along with the motors for the specified cable sizes for power and space heater cables.

5.6.2.5 Cable sizes for motors having synchronous speeds 750 RPM and below shall be as agreed between the purchaser and manufacturer.

5.6.2.6 Cables used are of 660/1100 V grade copper/Aluminium conductor, PVC insulated, PVC extruded inner sheath, armoured with overall PVC sheath. However for cables up to & including

16 mm^2 cross-section, cables used may be with copper or aluminium conductor as indicated in the motor data sheet.

5.6.2.7 The terminal box shall be capable of withstanding internal short circuit conditions without danger to personnel or plant from the emission of hot gases or flame or due to excessive distortion or damage to the terminal enclosure.

5.6.2.8 Appropriate phase markings as per IS shall be provided inside the terminal box. The marking shall be non-removable and indelible.

5.6.3 Motor Casing & Type of Enclosure

5.6.3.1 Motors for use in safe areas shall be industrial type meeting the specified ambient conditions, starting and operating requirements.

5.6.3.2 The minimum degree of motor enclosures including terminal boxes and bearing housing shall be IP-55 as per IS.

5.6.3.3 Motors for outdoor use shall be suitable for installation and satisfactory operation without any protective shelter or canopy. Motor casing shall be provided with a suitable drain for removal of condensed moisture except in case of flameproof motors. However, all motors shall be supplied with sturdy FRP canopies – adequately covering the top & sides with a certain overhang portion.

5.6.3.4 Vertical motors with downward shaft shall be provided with suitable canopies covering the motor fully. Vertical motors with upward shaft e.g. on fin-fan coolers, shall be adequately protected, (such as cowls/canopies) against ingress of water into the enclosure or the bearing housing even when standing still for long periods of time. Motors designed to handle external thrust from the driven equipment shall be supplied with a thrust bearing at the non-driving end.

5.6.3.5 All internal and external metallic parts, which may come into contact with cooling air, shall be of corrosion resistant material or appropriately treated to resist the corrosive agents, which may be present in the atmosphere. Screws and bolts shall be of rust proof material or protected against corrosion. Unless otherwise agreed, motors shall have standard frame sizes for various output ratings as stipulated in IS.

5.6.4 Bearings & Lubrication

5.6.4.1 Motors shall have greased lubricated ball or roller bearings. In all cases, the bearings shall be chosen to provide a minimum L-10 rating life of 5 years (40,000 hours) at rated operating conditions (The L-10 rating life is the number of hours at constant speed that 90% of a group of identical bearings will complete or exceed before the first evidence of failure).

5.6.4.2 Unless otherwise specified, the bearings shall be adequate to absorb axial thrust produced by the motor itself or due to shaft expansion.

5.6.4.3 Vertical motors shall be provided with thrust bearings suitable for the load imposed by the driven equipment.

5.6.4.4 In cases such as pumps for hot liquids where the driven equipment operates at high temperatures, bearings shall be cooled by a shaft-mounted fan. This shall ensure efficient ventilation of the bearing and disperse the heat transmitted from the driven equipment by conduction or convection.

5.6.4.5 Pre-lubricated sealed bearings may be considered provided a full guarantee is given for 4 or 5 years of trouble-free service without the necessity of re-lubrication.

5.6.5 Cooling Systems

All motors shall be self-ventilated, fan cooled. Fans shall be corrosion resistant or appropriately protected. They shall be suitable for motor rotation in either direction without affecting the performance of the motor. If this is not possible for large outputs, it shall be possible to reverse the fan without affecting the balancing of the motor. For motors operating in hazardous area, the fans shall be of an anti-static non-sparking material.

5.6.6 Rotor

The rotor shall be of squirrel cage type, dynamically balanced to provide a low vibration level and long service life for the bearings. The accepted values of peak to peak vibration amplitudes for a motor at rated voltage and speed on a machined surface bedplate with the motor levelled and with a half-key or coupling fitted shall not exceed those given in IS.

5.6.7 Shaft Extension

Motors shall be provided with a single shaft extension with key-way and full key. Motor shaft shall be sized to withstand 10 times the rated design torque.

5.6.8 Lifting hooks

All motors weighing more than 30 kg shall be provided with lifting hooks of adequate capacity.

5.6.9 Earth Terminals

Two earth terminals located preferably on diametrically opposite sides shall be provided for each motor. Necessary nuts and spring washers shall be provided with each stud for earth connection. An additional earth terminal shall be provided inside the terminal box as stated in the size of each earth stud shall be as given below in Table

Motor Rating	Stud size
Up to and including 7.5 kW	6 mm

5.7 **Name Plates**

A stainless steel name plate manufactured from series 300 stainless steel and having information as per IS shall be provided on each motor.

5.7.1 In addition to the motor rating plate, a separate number plate for motor tag number shall be fixed in a readily visible position. This number shall be as per the motor data sheets. Additional information as stipulated in applicable standards shall be included in the nameplate for motors meant for use in hazardous atmospheres.

5.8 Noise Levels

The permissible noise level shall not exceed the stipulations laid down in IS, unless otherwise specified in the motor data sheet

5.9 Motor Vibrations

Motor vibrations shall be with-in the limits of IS, unless otherwise specified for the driven equipment.

5.10 Speeds

Motor speed shall be to meet load/pump requirement

The first actual critical speed of stiff rotors shall not be lower than 125 % of the synchronous speed. For flexible rotors this shall be between 60 % and 80 % of the synchronous speed; the second actual critical speed shall be above 125 % of the synchronous speed.

Motor speed shall be to meet load/pump requirement as per BIS tolerance.

5.11 Painting

Internal and external Internal and external parts of the casing and all metal parts including the canopy likely to come in contact with the surrounding air shall be protected with anti-acid paint that will resist the specified environment conditions. All external surfaces of the motor and its canopy shall be given two coats of epoxy-based paint. Paint shade shall be 692 (Smoke Gray) as per Indian Standard IS-5 or as approved by the Engineer in charge.

5.12 Inspectionand Testing

5.12.1 During manufacturing of motors, the motors shall be subject to inspection by the Owner/Engineer In charge. The manufacturer shall provide all necessary information concerning the supply to the Owner's Inspector.

5.12.2 Type tests, if specified, all the routine tests and other acceptance tests shall be witnessed by the Owner's Inspector. The manufacturer shall give prior notice of minimum 4 weeks to the Inspector for witnessing the tests. Witness of acceptance test shall be applicable for motors rated above 11 kW. In case of motors rated up to 11 kW, routine test records shall be provided as part of final documentation.

5.12.3 All tests shall be carried out at manufacturer's shop under his care and expense.

5.12.4 Tests certificates duly signed by the Owner's Inspector shall be a part of final documentation.

5.12.5 The manufacturer shall submit all internal test records of the tests carried out by him on the bought-out items, motor sub-assembly and complete motor assembly to the Inspector before offering the motors for final inspection and testing.

5.12.6 The manufacturer shall periodically carry out the following type tests as per applicable Indian Standards for all the frame sizes and ratings of motors:

- Full load test and measurement of voltage, current, power & slip;
- Measurement of starting torque, starting current, full load torque and pull out torque;
- Measurement of efficiency and p.f. at 100%, 75% and 50% load.
- Temperature rise test;
- Momentary Overload test;
- Measurement of noise level;
- Measurement of vibration;
- Over speed test

5.12.7 The above tests must be witnessed and approved by reputed inspection agencies. The manufacturer shall maintain test records and submit to the Owner’s Inspector at the time of final inspection & testing. In no case, the test records shall be more than 5 year old. In special cases where type tests are asked to be carried out, Owner's Inspector shall witness these.

5.12.8 The manufacturer shall carry out routine tests as per applicable Indian Standards on all the motors. Routine tests not limited to the following shall form part of acceptance testing:

General visual checks, name plate details, mounting, terminal box location and cable gland sizes;

- Measurement of shaft centre height dimensions;
- Measurement of clearances in the terminal box;
- Verification of direction of rotation;

- Measurement of winding resistance;
- Insulation resistance test (before & after high voltage test);
- No load test and measurement of voltage, speed, current & power input;
- Locked rotor test at reduced voltage and measurement of voltage, current & power input;
- Reduced Voltage Starting & Running;

5.12.9 The manufacturer shall submit the following certificates for verification by the Owner's Inspector:

5.12.10 Test certificate for degree of protection of enclosure;

5.12.11 Though the motors shall be accepted on the basis of the satisfactory result of the testing at the shop, it shall not absolve the Vendor from liability regarding the proper functioning of the motors coupled to the driven equipment at site.

5.13 Certification

5.13.1 All indigenous motors shall conform to Indian Standards and shall be certified by Indian testing agencies. All motors (indigenous & imported) shall also have valid statutory approvals as applicable for the specified location.

5.14 Packing and Despatch

5.14.1 All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by ship/rail or trailer. The equipment shall be wrapped in polythene sheets before being placed in crates/cases to prevent damage to the finish. Crates/cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight', 'Owner's particulars', 'PO Nos.' etc. shall be clearly marked on the package together with other details as per purchaser order.

5.14.2 The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage in areas with heavy rains/high ambient temperature, unless otherwise agreed.

6.0 <u>Low Voltage Cables, Wires and Accessories</u>

6.1 Scope

This specification along with data sheets covers requirements for design, manufacture, testing at works and supply of Low Voltage cables, wires, telephone cable, and TV cable, cable jointing & terminating accessories.

6.2 Codes and Standards

The cables and cables jointing & terminating accessories shall comply with the requirements of latest edition of revision of the following standards:

IS 1753	:	Aluminum conductors for insulated cables
IS 8130	:	Conductors for insulated electric cables and flexible cords
IS 5831	:	PVC insulation and sheath of electric cables
IS 3975	:	Mild steel wires, strips and tapes for armoring cables
IS 3961	:	Recommended current ratings for cables
IS 5831	:	Fire Resistance property of cable
IS 1554(Part-I)	:	Electrical and mechanical characteristics of FRLS Cable
IS 10418	:	Design and dimension of Cable drum
IEC 60332-1	:	Ignition Resistance and flame tests on FRLS Cable
IEC 60332-3	:	Ignition Resistance/Flame propagation tests on bunch of FRLS Cable
IEC 60183	:	Guide for selection of HV Cables
IEC 60885	:	Test methods for Electrical cables
IEC 60811	:	Common Test methods for insulating and sheathing materials for electric cable
IS 10810	:	Methods of test of cables
NEPA70 (NEC)	:	Underwriters Laboratories Inc. USA, Standard 62
ASTM-D-2843	:	Standard test method for density of smoke from burning or decomposition of plastics

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

b) In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations, following order of decreasing priority shall govern:

- Statutory regulations
- Data sheets
- Job specification
- This specification
- Codes and standards

6.3 General Construction

a) The cables shall be suitable for laying in trays, trenches, ducts and conduits for underground buried installation with uncontrolled backfill and possibility of flooding by water and chemicals.

b) Outer sheath of all cables shall be black in colour and the minimum value of oxygen index shall be 29 at 27±2°C. In addition suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack.

c) All Electrical wires /Incoming cable to LT Panel covered in this specification shall be FRLS unless specified otherwise in the data sheet.

d) Sequential marking of the length of the cable in metres shall be provided on the outer sheath at every one metre. The embossing /engraving shall be legible and indelible.

e) The overall diameter of the cables shall be strictly as per the values declared by the manufacturer in the technical information subject to a maximum tolerance of ±2mm up to overall diameter of 60mm and ±3mm for beyond 60mm.

f) PVC/Rubber end caps shall be supplied free of cost for each drum with a minimum of eight per thousand metre length. In addition, ends of the cables shall be properly sealed with caps to avoid ingress of water during transportation and storage.

g) The cables meant to be used in mining area under the Jurisdiction of DGMS shall comply with the requirements as specified in the Job specification/Datasheet.

6.4 Low Voltage Cables

a) All power/control cables for use on low voltage systems shall be of 1100 V grade with aluminum/copper conductor, XLPE/PVC insulated, inner-sheathed, armored/un-armored and overall PVC sheathed unless specified otherwise in datasheet.

b) Conductors shall be solid and copper for conductor of nominal area up to and including 6 mm^2 and stranded and aluminum above 6 mm^2. Conductors of nominal area less than 16 mm^2 shall be circular only. Conductors of nominal area16mm^2 and above may be circular or shaped as per IS-8130. Cables with reduced neutral conductor shall have sizes as per Table -1 of IS-1554(Part-I).

c) The core insulation shall be with XLPE compound applied over the conductor by extrusion and shall conform to the requirements of type 'A' compound as per IS: 5831/IS: 7098 for control/power cable respectively. The thickness of insulation and the tolerance on thickness of insulation shall be as per Table-2of IS-1554 (Part-1). Control cables having 6-cores and above shall be identified with prominent and indelible Arabic number also the outer surface of the

insulation. Color of the numbers shall contrast with the color of insulation with a spacing of maximum 50mm between two consecutive numbers. Color-coding for cables up to 5 cores shall be as per Indian Standards.

d) The inner sheath shall be applied over the laid-up cores by extrusion and shall be of PVC conforming as per IS: 5831. The minimum thickness of inner sheath shall be as per IS-1554 (Part-1). Single core cables shall have no inner sheath.

e) Unless otherwise specified, all cables shall be provided with armor. For multi-core cables, the armor shall be by single round galvanized steel wires where the calculated diameter below armoring does not exceed 13mm and by galvanized steel strips where this dimension is greater than 13mm. Requirement and methods of tests for armor material and uniformity of galvanization shall be as per IS-3975 and IS-10810 (Part-41). The dimensions of armor shall be as per method (b) of IS-1554 (Part-1).

f) The outer sheath for the cables shall be applied by extrusion and shall be of PVC compound conforming as per IS-5831.The minimum and average thickness of outer sheath for un-armored cables and minimum thickness of outer sheath for armored cables shallbeasperIS:1554(Part-1).

6.5 Wiring Cables

Copper conductor cable only will be used for submain/ circuit/ point wiring.

Minimum size of wiring:

- Light Wiring :2.5mm²
- Power Wiring : 4mm²
- Power circuit rated: More than 1 KW, Size as per calculation.
- Insulation: Copper conductor cable shall be PVC-HR insulated conforming to BIS Specification.
- Multi stranded: Cables are permitted to be used.

6.6 Flexible Cable

- Conductor of flexible cables shall be of copper. The cross sectional area of conductor for flexible cable shall be as per design.
- Only 3 core flexible cables shall be used for connecting single-phase appliances.
- Unless the flexible cables are mechanically protected by armour, or tough rubber, or PVC sheath, these shall not be used in workshops and other places where they are liable to mechanical damage.

- Flexible cable connection to bell push from ceiling rose shall be taken through steel conduit/metallic casing and capping.

6.7 Wiring Accessories

- Control Switches for Point
- Control switches (single pole switch) carrying not more than 16A shall be modular type. The switch shall be 'On' when the knob is down.
- Piano type control switches shall be provided (unless specifically asked for by the user department / Architect.)
- It is recommended to provide single pole MCB in proper enclosure as power outlet for AC units, geysers etc.

6.8 Telephone Cabling System (Conductors and Cables)

a) Conductors: Jacketed, multi-stranded twisted pair and twisted multi pair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.

b) Insulation: Thermoplastic, not less than 0.8 mm thick.

c) Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil. Minimum Shielding Coverage on Conductors: 60 percent.

6.9 System requirements

a. Components: Plug-in, modular, heavy-duty, industrial- or commercial-grade units.

b. Equipment: Silicon-based, solid-state, integrated circuit devices.

c. Power Supply Characteristics: Devices shall be within specified parameters for ac supply voltages within the range of 105 to 130 V.

d. Protect signal cables and connected components against transient-voltage surges by suppressors and absorbers designed specifically for that purpose. Provide ac-powered equipment with integral surge suppressors complying with UL 1449.

e. RF and Video Impedance Matching: Signal-handling components, including connecting cable, shall have end-to-end impedance-matched signal paths. Match and balance devices used at connections where it is impossible to avoid impedance mismatch or mismatch of balanced circuits to unbalanced circuits.

6.10 Cable Accessories

a. The termination and straight through jointing kits for use on the systems shall be suitable for the type of cables offered as per this specification and shall meet requirements of IS-13573.

b. The accessories shall be supplied in kit form. Each component of the kit shall carry the manufacturer's mark of origin.

c. The kit shall include all stress grading, insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction sheet shall also be included in each kit.

d. The contents of the accessories kit including all consumable shall be suitable for storage without deterioration at a temperature of 45°C, with shelf life extending to 5years from the date of supply to MRPL.

e. Terminating Kits: The terminating kits shall be suitable for termination of the cables to indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer / motor. For outdoor terminations, weather shields / sealing ends and any other accessories required shall also form part of the kit. The terminating kits shall be from one of the makes / types mentioned in the data sheet.

f. Jointing Kits: The straight through jointing kits shall be suitable for installation on overhead trays, concrete lined trenches, and ducts and for underground burial with uncontrolled backfill and possibility of flooding by water and chemicals. These shall have protection against any mechanical damage and suitably designed to be protected against rodent and termite attack. The inner sheath similar to that provided for cables shall be provided as part of straight through joint. The jointing kits shall be from one of the makes / types mentioned in the data sheet.

6.11 Inspection and Testing

The cables shall be tested at the manufacturer's works. The vendor shall submit all relevant test certificates for scrutiny & approval by the owner / engineer-in-charge before dispatch clearance is issued by the owner.

6.12 Cables

After completion of manufacture of cables and prior to dispatch, the cables shall be subjected to type, routine, acceptance and special tests as detailed below. Owner reserves the right to witness

all tests with sufficient advance notice from vendor. The test reports for all cables shall be got approved from the Engineer-in-charge before dispatch of the cables.

a) All routine tests, acceptance tests, type tests and additional type tests for improved fire performance shall be carried out as listed in IS-1554 (Part-I) and IS-7098 (Part-2) on PVC and XLPE insulated cables respectively.

b) The test requirements for PVC insulation and sheath of cables shall be as per latest revision of IS-5831.

c) Test for Resistance to Ultra Violet Radiation: This test shall be carried out as per DIN 53387 or ASTM-G-154 on outer sheath. The retention value of tensile strength and ultimate elongation after the test shall be minimum 60% of tensile strength and ultimate elongation before the test. Test certificates with respect to this test (not older than one year) from recognized testing laboratory to be furnished for review by MRPL before dispatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognized test laboratory or in house testing laboratory, before dispatch clearance of cables. Sampling for this test is to be done randomly once for each order, provided outer sheath remains same.

d) Acceptance tests as per IS-1554 (Part-I) and IS-7098 (Part-2) and the following special tests to be performed on the cables as per sampling plan. These tests are required to be witnessed by the owner before dispatch of cables:

- Accelerated water absorption test for insulation as per NEMA-WC-70. (For PVC insulated cables) and as per NEMA-WC-53 (for XLPE / EPR insulated cables). Test certificates with respect to this test (not older than one year) from recognized testing laboratory to be furnished for review by MRPL before dispatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognized test laboratory or in house testing laboratory, before dispatch clearance of cables. Sampling for this test is to be done randomly once for each order, provided type of insulation remains same.
- Dielectric Retention Test: The dielectric strength of the cable insulation tested in accordance with NEMA-WC-70 at 75 ± 1°C shall not be less than 50 % of the original dielectric strength. (For PVC insulated cables). Test certificates with respect to this test (not older than one year) from recognized testing laboratory to be

furnished for review by MRPL before dispatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognized test laboratory or in house testing laboratory, before dispatch clearance of cables. Sampling for this test is to be done randomly and once for each order.

- Oxygen Index Test: The test shall be carried out as per IS-10810 (Part 58). Sampling to be done for every offered lot/size as per sampling plan.
- Flammability Test: The test shall be carried out on finished cable as per IS-10810 (parts 61 & 62). Sampling for these tests is to be done randomly once for each order, provided outer sheath remains same. The acceptance criteria for tests conducted shall be as under:
- Part-61 - The cable meets the requirement if there is no visible damage on the test specimen within 300 mm from its upper end.
- Part-62 - The maximum extent of the charred portion measured on the test -sample should not have reached a height exceeding 25 Meters above the bottom edge of the burner at the front of the ladder.
- Test for rodent and termite repulsion property shall be done by analyzing the property by chemical method. Sampling to be done for every offered lot / size as per sampling plan

e) The test for circuit integrity for fire survival cables shall be carried outasperIEC-60331(Part-21).

f) The routine and other acceptance tests shall be witnessed by the Inspector. The manufacturer shall give prior notice of minimum 4 weeks.

6.13 Cable Accessories

Type tests should have been carried out to prove the general qualities and design of a given type of termination / jointing system as per IS-13573. The type test certificates from independent testing laboratory shall be submitted before despatch.

6.14 Packing and Dispatch

Cables shall be despatched in non-returnable steel drums only of suitable barrel diameter, securely battened, with the take-off end fully protected against mechanical damage. Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.

On the flange of the drum, necessary information such as project title, manufacturer's name, type size, voltage grade of cable, length of cable in metres, drum no., cable code, BIS certification mark, gross weight etc. shall be printed. An arrow shall be printed on the drum with suitable instructions to show the direction of rotation of the drum.

7.0 LED Light Fixtures, Street Light & Junction Boxes

7.1 Scope

This specification covers the requirements of design, manufacture, testing, packing and supply of LED type lighting fixtures, street light& junction boxes suitable for installation in the project locations.

7.2 Codes and Standards

7.2.1 The equipment shall comply with the requirements of latest revision of the following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified:

IS-5	Colors for ready mixed paints and enamels.
IS 3646 : Part 1	Code of practice for interior illumination: Part 1 General requirements and recommendations for welding interiors
IS 3646 : Part 2	Code of Practice for Interior Illumination - Part 2 : Schedule of Illumination and Glare Index
IS 3646 : Part 3	Code of practice for interior illumination: Part 3 Calculation of coefficients of utilization by the BZ method
BS5266 Pt1	Emergency lighting. Code of practice for the emergency lighting of premises other than cinemas and certain other specified premises used for entertainment (No longer current but cited in Building Regulations)
IS-16103 (Parts 1 & 2)	LED Modules for General Lighting – Safety & Performance Requirements.
IS-16104	DC or AC supplied Electronic Control Gear for LED Modules – Performance Requirements.
IS-16105	Methods of Measurement of Lumen Maintenance of Solid State Light (LED) Sources.
IS-16106	Methods of Electric & Photoelectric Measurements of Solid State Lighting (LED) Products.
IS-16107 (Part-2 / Section-1)	Luminaries Performance Part-2 (Particular Requirements) – Section-1 for LED Luminaries.

7.2.2 Imported equipment shall conform to the international standards such as IEC/ BS/ VDE/ NEMA or equivalent.

7.2.3 The equipment shall also conform to the provisions of Indian Electricity Rules and other statutory regulations currently in force in the country.

7.2.4 In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ NEMA or equivalent agency shall be applicable.

7.2.5 In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations, the following order of decreasing priority shall govern:

- Statutory regulations.
- Data sheets
- Job specification
- This specification
- Codes and standards

7.3 General Requirements

The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

7.4 Site Conditions

The equipment shall be suitable for installation and satisfactory operation in classified Non-hazardous locations in tropical, humid and corrosive atmosphere as prevalent in refineries, petrochemical and fertilizer plants. If not specifically mentioned therein, a design ambient temperature of 40°C and an altitude not exceeding 1000 m above mean sea level shall be considered.

7.5 Power Supply

All AC LED lighting fixtures including the auxiliaries such as LED Drivers / Voltage Adapters / junction boxes shall be suitable for operation within a range of 150 Volts - 270 Volts AC, Single Phase plus Neutral, at a frequency of 50Hz ± 3% power supply.

7.6 Certification

The equipment shall have test certificates issued by recognised independent test house (CIMFR/ CPRV ERTL/ Baseefa / LCIE/ UL/ FM or equivalent). All indigenous equipment shall conform to Indian standards and shall be certified by Indian testing agencies. All equipment (indigenous & imported) shall also have valid statutory approvals as applicable for the

specified location. All indigenous flameproof equipment shall have valid BIS license and marking as required by statutory authorities.

7.7 Technical Requirements

Construction

a) The enclosures of the lighting fixtures and junction boxes shall be made of cast light metal alloy/Die cast free aluminium. The magnesium content in the alloy shall be as per IS-13346. The temperature of external surfaces shall be limited to 200°C, unless otherwise specified. The enclosures shall be sized to facilitate easy maintenance and heat dissipation - especially for LED Light Fixtures.

b) The equipment shall be suitable for use in indoor/outdoor locations and shall have IP-52 degree of protection for indoor and IP55 protection for outdoor.

c) The enclosures shall be provided with gaskets made of non-inflammable and self-extinguishing material.

d) The enclosures shall be treated and prepared for painting with two coats of epoxy paint with final colour shade (both internal and external) as approved by Engineer In charge:

e) A warning inscription "Isolate power supply elsewhere before opening" shall be provided on each enclosure. The warning inscription shall be embossed on the enclosure or a separate warning plate with above inscription shall be fixed to the enclosure with screws. The warning plate shall be of nickel plated brass or stainless steel.

f) All accessories like nuts, bolts, washers etc. shall be made of stainless steel SS-304.

g) All equipments on single phase supply shall be provided with an independent earth terminal with lug inside the enclosure for terminating the third (earth) core of the cable and shall have facility for looping.

h) A nameplate indicating TAG NO. Shall be provided on each socket. Nameplates shall also be provided for each incoming and outgoing feeder. Separate nameplate shall also be provided to indicate the details of testing agency (CIMFR or equivalent), test certificate no. with date, statutory approval no. with date and agency (PESO/ CCE/ DGFASLI/ DGMS), BIS license number and date, applicable gas group etc. The nameplates shall be engraved on 3 ply black white black lamicold sheets using square cutters. Black engraved perspex sheet nameplate shall also be acceptable. Nameplates shall be fixed by screws and shall not be pasted. In case the

standard details given above are embossed on the enclosures, the same need not be repeated on the name plate.

7.8 Lighting Fixtures

a) Glass used for lighting fixture shall be clear and suitable for use under conditions involving exceptional risk of mechanical damage.

b) LED Street Light Fixtures shall be of the weather-proof type with minimum IP-55 Ingress protection. The LED Street Lights shall have a minimum rating of 70 Watts with Warm White Colour (within 2500 to 3000 Kelvin Temperature Scale). Lumen output from each LED Street Light Fixture must not be less than 13,500 Lumens. Each such street light fixture must be of integral type having COB type LEDs with built-in driver / control module for the LED Lamps / Panel.

c) LED lamp shall have the single colour output. The lamp shall have Low power consumption, High reliability and long life.LED should have minimum of 50,000 burning hours.LED lamps shall be of standard makes such as CREE, OSRAM, NICHIA, and LUMILITE. LED lamps shall have LM80 certification.

d) Luminous efficacy shall be more than 100 lumen / Watt. THD shall be less than 10%. Power factor shall be more than 0.95 and driver efficiency more than 85%. High efficiency constant current driver shall be provided. Junction Temperature shall be kept as low as possible so as to increase performance and life time of LED and ensure that the luminaries are as heat efficient as possible. LED Light fittings shall be suitable for operation at an ambient temperature of 50°C. Heat sink temperature rise above ambient shall be limited as per relevant available IS/IEC.

e) LED Tube Light Fixtures (T5 / T8 type SMD LEDs - 4 feet length) shall be of indoor type with minimum IP-52 Ingress protection. The LED Tube-Lights shall have a minimum rating of 32 Watts with Warm White Colour (within 2500 to 3000 Kelvin Temperature Scale) and the Lumen output of each LED Tube Light Fixture must not be less than 2,500 Lumens. Each such LED Tube Light must be of integral type with built-in driver / control module for the LED Lamps / Panel and must be inclusive of the Baton with adequate terminals for looping two such fixtures.

f) LED Ceiling / Wall Light Fixtures shall be of indoor type with minimum IP-52 Ingress protection. The LED Ceiling Lights shall have a minimum rating of 20 Watts with Warm White Colour (within 4000 to 6000 Kelvin Temperature Scale) and the Lumen output of each LED

Ceiling Light Fixture must not be less than 1000 Lumens. Each such LED Ceiling Light must be of integral type with built-in driver / control module for the LED Lamps.

g) LED wall bracketLight Fixtures shall be of indoor type with minimum IP-52 Ingress protection. The LED wall bracket Lights shall have a minimum rating of 9 Watts with Warm White Colour (within 4000 to 5000 Kelvin Temperature Scale) and the Lumen output of each LED Ceiling Light Fixture must not be less than 1100 Lumens. Each such LED wall bracket Light must be of integral type with built-in driver / control module for the LED Lamps.

h) LED flood light Fixtures shall be of weatherproof type with minimum IP-55 Ingress protection. It shall have a minimum rating of 150 Watts with Warm White Colour (within 2500 to 3000 Kelvin Temperature Scale) and the Lumen output of each Light Fixture must not be less than 2,500 Lumens. Each such LED Light must be of integral type with built-in driver / control module for the LED Lamps / Panel and must be inclusive of the Baton with adequate terminals for looping two such fixtures.

i) LED Mirror Light fitting shall have a minimum rating of 10 Watts and shall be considered for bath room & living room shall be with Beam Angle of 120°, Transparent / Diffused Optical Cover, Aluminium Housing Material, Power Requirement @ 230Vac, IP52Protection Rating, Lumens level at 1000 ~ 1500 Lux, 50°C Operating Temperature inclusive of External Driver.

j) Bulk head LED light fitting shall be weather proof type fittings for use in corridors, stair case landings; low level ceiling shall be suitable for direct fixing to accommodate lamps. These fittings shall be provided with housing of cast aluminium alloy with stove enamelled finish, prismatic heat resistance glass cover hinged on to the housing & fixed by screws, neoprene gaskets to make assembly of fitting as weather proof. For mechanical protection to glass cover, a protective cover guard of 3mm galvanized wire with stove enamelled finish paint shall be provided.

k) The fixing parts of the enclosure, which are to be opened for replacement & cleaning of LED Lamps, shall be so fastened that they can be unfastened only with special tools.

l) The lighting fixtures shall have integral control box consisting of any LED Driver, Voltage Adapter, etc. These auxiliaries shall be housed within the LED Light Fixtures themselves. All light fixtures shall be provided with 2 nos. threaded entries and 2 nos. double compression nickel plated brass cable glands – for incoming & outgoing looping cables. The cable glands

shall be suitable for the specified cable size – ideally 3Cx4/2.5mm² Armoured PVC Insulated Cables.

m) The LED lighting fixtures shall be supplied with adjustable mounting arrangement both in horizontal and vertical planes for ease in focusing / tilting of the LED Light Fixtures. All LED Flood-light fixtures must be of integral type with all accessories such as LED Drivers, PCB Modules, Voltage Adapters, etc – housed within the flood-light fixture.

n) A minimum of 20% spares must be supplied with the LED type well-glass Fixtures these spares may include modular / removable type LED panels / LED MPCBs / LED Drivers / Voltage Adaptors / etc without additional cost to the owner. All light-fixtures and associated components must be guaranteed for five (5) years of hassle free operation.

o) Light type as per **MRPL approved light fixture schedule** shall be as indicated below.

- LED Bulk head fixtures - 1x9 Watts
- LED Tube light fixtures - 1x20 Watt Batten type LED fixture
- LED 1x20W Ceiling/wall mounted Light fixtures
- LED 1x30W flood Light fixtures
- LED 1x70W Street Light fixtures

p) **Flood Light Masts (FLM's)**

- LED Flood-Light fixtures rated for 350Watts each.

7.9 Junction Boxes

Junction boxes shall be PVC / Metal construction. All junction boxes for looping of single phase lighting circuits using cables up to 6mm^2 shall be of minimum 150 mm internal diameter in size giving adequate space for bending of cable cores & termination. Each junction box shall be complete with 4 nos. of cable entries of ideally 3Cx4/2.5mm² sized armored PVC insulated cables. Along with every junction box, 2 nos. of double compression flameproof nickel plated brass cable glands and 2 nos. of nickel plated brass plug of correct dimensions are to be supplied to suit the specified cable size.

7.10 Terminals & Wiring

7.10.1 All equipment's shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. Unless otherwise specified, the terminals for external cable termination shall be suitable for conductor sizes up to 4mm² solid copper conductors. In case lugs are required for cable termination, tinned copper type lugs shall be provided.

All internal wiring shall employ 2.5mm^{2}with 1100V grade, PVC insulated copper conductor FRLS wires, and colour coded for phase (Red), neutral (Black) and earth (Green).

7.11 Street Light Pole:

a) 8 Meter Hot Dip GI Poles (Octagonal) shall be designed to withstand the maximum wind speed of 169km/hr. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI 1982.

b) The pole shaft shall have octagonal cross section (thickness of the section shall be 3mm or more) 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.

c) All octagonal pole shafts shall be provided with the rigid flange plate with provision for fixing 4 foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside. The drawing of pole shaft is attached.

d) The 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 also be suitable arrangement for the purpose of earthing.

e) Welding shall be carried out confirming to MRPL approved procedures. Welders shall be also being qualified for welding octagonal shafts.

f) There shall be in-built facility to mount single pole MCB (2A) and Bakelite sheet with stud type copper terminal connectors suitable for termination of 3Cx4mm² and 3Cx2.5mm² cable for fitting.

g) Each pole must have internal 4 pole terminal sets mounted on brackets / DIN Rails for looping in & looping out of power cable sizes between 4mm² to 10mm².

h) Within each lighting pole, light fixtures, flexible cable (3C x 2.5mm² Cu.) of adequate length for connection to MCB & Earthing stud.

i) Light pole shall be adequately strengthened at the location of the door to compensate for the loss in section. Light Pole shall be octagonal in construction & there shall not be any circumferential weld joints.

j) Light poles shall be hot dip galvanized internally and externally as per IS standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping after welding is totally complete.

k) Light Poles shall be bolted on a pre-cast foundation with a set of four foundation bolts for greater rigidity.

l) Electrical wiring details inside street light pole opening shall be as per MRPL standard indicated in drawing. Door opening for electrical wiring shall be reinforced & weather proof.

m) All wiring terminals & MCB must be DIN rail mounted, suitably crimped with pin type Copper lugs. All terminals must be of cage clamp type for cable sizes between 4mm² to 16mm².

n) Civil foundation details for street light pole shall be as per MRPL standard indicated in the drawing.

o) All civil works (such as excavation, casting & installing of pole-foundation, levelling & disposal of surplus earth) pertaining to the street-lighting pole installation shall be inclusive in the rates for the street-light poles itself. No separate rates for RCC pole foundation shall be admissible. Foundation will involve supplying and laying of design mix (RMC),Reinforced cement concrete of M-30 grade using 20mm downgraded coarse aggregate in sub-structure for street light poles including supply & fixing of M-24x750 Foundation Bolts J Type 4 No's and 63 dia. PVC Cable entry sleeve for street Light cable.

7.12 Inspection, Testing and Acceptance

a) During fabrication, the equipment shall be subjected to inspection by Owner/Engineer-in-Charge, if specified/ agreed in Inspection Test Plan. Manufacturer shall furnish all necessary information concerning the supply to Owner for scrutiny & approval. All routine/acceptance tests shall be carried out at manufacturer's works under his care & expense.

b) Type test certificates from CIMFR or equivalent test house, applicable PESO/ CCE/ DGFASLI/ DGMS approval certificates, BIS license and original drawings referred in type test

certificates shall be shown to the owner/Engineer In charge during inspection. The certificates and BIS license must be valid at the time of despatch.

c) Test certificates of bought out components shall be shown to the owner/Engineer In charge during inspection.

d) All equipments shall be subjected to various acceptance tests as per standards but not limited to the following:

- General visual inspection
- Dimensional inspection
- Verification of mechanical and electrical operations
- Dielectric tests
- RoutinepressuretestperIS-2148
- Any other routine and acceptance test as per applicable standards.
- Type tests shall be carried out if specified in data sheet / job specification.

7.13 Packing and Dispatch

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for the selected mode of transportation, i.e. by ship/ rail or trailer, and shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. The crates/ cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., shall be clearly marked on the packages together with other details as per purchase order. The equipment may be stored in a covered shed for long periods before installation. The packing should be suitable for such storage.

8.0 Cable Tray, Earthing & Lightning Protection

8.1 Scope

This specification covers the requirements of design, manufacture, testing, packing and supply of Cable tray, Earthing & Lightning and accessories suitable for installation in the project locations.

8.2 Codes and Standards

a) The equipment shall comply with requirements of latest revision of following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified:

IS5	Colors for ready mixed paints and enamels
IS 3043	Code of practice for earthing
IS 2309	Code of practice for the protection of buildings.
IS1079/IS2629/IS2633	Cable Tray
ANSI / NFPA	American National Standards Institute / National Fire Prevention Association
ASTM	American Society for Testing & Material
NEMA	National Electrical Manufacturer's Association

b) Imported equipment shall conform to the international standards such as IEC/ BS/ VDE/ NEMA or equivalent.

c) The equipment shall also conform to the provisions of Indian Electricity Rules and other statutory regulations currently in force in the country.

d) In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ NEMA or equivalent agency shall be applicable.

e) In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations, the following order of decreasing priority shall govern:

- Statutory regulations.
- Data sheets.
- Job specification.
- This specification.
- Codes and standards.

8.3 General Requirements

The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

8.4 Site Conditions

The equipment shall be suitable for installation and satisfactory operation in tropical, humid and corrosive atmosphere as prevalent in the project locations. The lighting and power panels shall be designed to operate under site conditions as specified in the data sheet. If not specifically

mentioned therein, a design ambient temperature of 40°C and an altitude not exceeding 1000 m above mean sea level shall be considered.

8.5 Certification

The equipment shall have test certificates issued by recognised independent test houses. All indigenous equipment shall conform to Indian standards and shall be certified by Indian testing agencies. All equipment (indigenous & imported) shall also have valid statutory approvals as applicable for the specified location.

8.6 Earthing System

a) The entire earthing system for the project shall confirm to IS: 3043.

b) Earth Pits shall be with GI Pipe Electrode as per MRPL approved drawing attached with this specification. The earthing strips shall be connected to individual earth-pits by bolting only (with Bolts, nuts, washers) & not by welding. Charcoal used for the earth-pits shall not be less than 12 mm size – with minimum 300kgs of charcoal per earth-pit. The Salt shall be granular – with minimum 300kgs of salt per earth-pit.

c) A GI funnel with wire mesh shall be provided at the top of the GI pipe electrode - welded to the pipe. The brick chamber for the earth pit shall be constructed only after complete settling of the earth in the pit. Any sinking of the pit brick-chamber shall be rectified by the contractor without any price implication – so as to provide a flushed earth pit with the finished ground level. The earth pits shall be covered with RCC Slab covers of adequate size & thickness with handles.

d) Method of Earthing Installation:

I. The pit for an earth electrode will be dug with its centre normally at minimum 2.5 meters away from the edge of any building / masonry work.

II. The GI pipe will be erected vertically at the centre of the pit, with top of the pipe minimum 200 mm below ground level.

III. Alternate layers of charcoal and salt each 150 mm, will be put into the pit beginning from the bottom of pit, around the pipe to cover the same up to minimum 3.0 meters length

from bottom. Alternately charcoal and salt shall be thoroughly mixed at site and poured into earth pit.

IV. The space above the salt / charcoal layers will be filled with loose sandy soil, up to a level of 550 mm from ground level.

V. A cement concrete chamber of inner dimension 350 x 350 mm will be erected around the top of the earth pipe so that top surface of the chamber is flushed with the outside finished ground level.

VI. A GI earthing strip (25 x 3) mm, of required length size will be tightly connected to the electrode GI plate by means of GI bolt, nuts and washers. End of this GI strip will be welded to the earthing ring GI wires /strip.

e) Resistance of Earth-Pits: The earth resistance of each electrode (earth station) will be measured by a calibrated earth testing apparatus and recorded. In case the earth resistance is more than the required value, additional earth pits, as required shall be made and inter-connected by the contractor. The value of earth resistance (earth grid with earth pits) shall be less than 1ohms.

f) Earthing Ring Main: The earthing ring shall be made by GI strips of specified size. The ring shall be buried 600mm below ground level and 500mm away from outer side wall.

g) Earthing for Distribution Boards: The Distribution board shall be provided with two separate earth terminals. An earth bus-bar of appropriate cross section shall be provided inside the Distribution board and connected to the earth terminals provided on either side of the board. Adequate number of holes / terminals shall be provided on earth bus with suitable provision for terminating the earth flexible cable / wire. Flexible 8SWG GI wire used for earthing of the Distribution boards and street light fixtures, by connecting the two earth terminals separately to the earthing main in the shop / earth pit.

8.7 Lightning Protection

a) The lightning protection system with SS body working in early steamer emission technology mounded at height of 3M and protection radius shall not be less than 32 m and shall also be complying with NFC-17-102 code. It shall be hot dipped galvanised 25 x 3 GI strips as approved. The whole building which is needed lightning protection shall be covered under protection zone and no part of structure/ building be left free from protection zone.

b) **Conductors on parapet:** The conductors shall be coursed along ridges, parapets, edges of the flat roof, over flat roof where necessary in such a way as to join each air terminal to the rest. The conductors shall be fixed securely.

c) **Vertical down conductors:** These conductors, direct from earth termination, shall be connected to parapet conductors or air terminals and shall be coursed through shortest possible routes without abrupt turns or kinks. While passing through cornices, these shall pass through GI pipe (Class ‘B’) having adequate bore.

d) **Protection against damage and corrosion:** No upturns are permitted and any bend necessary shall have a permissible radius. The end of GI pipe protections on wall shall be properly sealed with bitumen compound to prevent corrosion.

e) **Metallic objects near conductors:** The conductors shall be so laid as to maintain a separation distance exceeding 2 metres between:

- Any electric conductors running in parallel,
- Metallic objects, viz., iron girders, water tanks, and iron stair case, water / gas pipes inside or by the side of the building.

f) All the external metallic objects viz., water tanks, gutters, rain water down pipes, water mains etc., shall be bonded to the nearest conductor by means of a short tail. Joints and bonds: All joints between conductors shall be made after cleaning and tinning the ends of conductors to be joined, binding them together for about 100mm (4") with No. 25X3 GI Flat and then welding them together. All welded joints must be finished with anti-corrosive aluminium / zinc based paints.

g) Bonding shall be as short as possible. All joints and bonds are to be mechanically and electrically sound. Down conductors shall be directly connected to dedicate lightning earth pits which in turn shall be connected to overall earthing grid by suitable conductor in two different routes.

h) **Installation Tests**: After completion of works the ohmic resistance of Lightning Protection installation shall be measured from the highest point and this shall be a fraction of one Ohm. Suitable test link shall be provided at 1m from FGL in the down conductor which to be connected with earth station. The resistance to earth of individual earth stations shall be tested by earth testing megger and must not exceed 10Ω.This earth station pit shall be constructed as per IS:3043.The above tests shall be made in the presence of the representative of the engineer – in charge / architects and the results recorded.

8.8 Cable Trays

a) The cable trays supplied for the township shall be galvanised steel ladder type / ventilated & solid bottom cable trays. All cable tray accessories such as bends, tees, crosses, reducers and splicers shall be factory fabricated – requiring minimal site adjustments & modifications. All hardware such as clamps, nuts, bolts & washers required for the cable-tray assembly shall be of anti-corrosive stainless steel material.

b) All cable trays shall be supplied in standard length of 3000 mm and shall have a minimum thickness of 4 mm. The tolerance on width & length shall be ±4mm. The Cable Tray sizes for the project shall be of the following sizes:

For lighting / power cables

- 300 mm (Width) x 50 mm (Collar Height) size main tray size
- 100 mm (Width) x 50 mm (Collar Height) size main tray size

c) Ladder type cable trays shall be made from 2mm thick sheet formed in `C' section of 50mm height and inward flanges of 15mm as side runners and 30mm wide x 10mm high rungs (`C' shaped) from a 1.5mm thick sheet. Perforations as mentioned above shall be provided in the width of the rungs. Pitch of the rungs shall not exceed 250 mm centre to centre. Rungs shall be tack welded to the side members.

d) Each cable tray section shall be completely supplied with necessary connector plates and hardware. All hardware (Nuts, Bolts, Washers, etc) shall be of SS 316 for the tray coupler plates. The hardware shall conform to NEMA FGI – 1984 and shall be able to withstand the loading as specified below. The bends, tees, reducers, crosses & droppers shall have required bending radii not less than 300 mm.

e) The side rails / collars and all accessories shall have the holes on each end for fixing connector plates. The connectors between two sections of cable trays or a Section of cable tray with associated accessories shall be done by bolting only.

f) For the cable tray system, in addition to self load, following guidelines for design shall be considered :

- Support Span of: 2500 mm
- Cable Load for 300 mm wide trays: 50 kg / Line Meter;
- Cable Load for 100 mm wide trays: 30 kg / Line Meter;
- In addition to this, the cable trays shall be suitable for 75kg concentrated load at the centre span with a safety factor of 2.

8.9 Inspection, Testing and Acceptance

a) During fabrication, the equipment shall be subjected to inspection by Owner / Engineer-in-Charge, if specified/ agreed in Inspection Test Plan. Manufacturer shall furnish all necessary information concerning the supply to Owner for scrutiny & approval. All routine/acceptance tests shall be carried out at manufacturer's works under his care & expense.

b) Type test certificates from CIMFR or equivalent test house, applicable PESO/ CCE/ DGFASLI/ DGMS approval certificates, BIS license and original drawings referred in type

test certificates shall be submitted to the Owner/Engineer In charge for approval before dispatch clearance. The certificates and BIS license must be valid at the time of despatch.

c) Cable trays shall be tested as per NEMA-FG1-1984. Following tests shall be carried out on each type of tray system.

- Destruction Load Test
- Deflection Test: The permissible deflections under test shall not exceed L/200mm or 10mm whichever being less (For Cantilever loading at mid point).
- Fibre glass reinforced material shall be tested for surface burning characteristic as per ASTM-E84/IS-6746 and for flammability as per ASTM-D635/IS-6746. The flame-spread index shall be as small as possible and in no case shall exceed 15.

d) Test certificates of bought out components shall be submitted to the Owner/Engineer In charge before dispatch clearance.

e) All equipment's shall be subjected to various acceptance tests as per standards but not limited to the following:

- General visual inspection
- Dimensional inspection
- Verification of mechanical and electrical operations
- Di-electric tests
- Routine pressure test as per IS-2148
- Any other routine and acceptance test as per applicable standards.
- Type tests shall be carried out if specified in data sheet /job specification.

8.10 Packing and Dispatch

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for the selected mode of transportation, i.e. by ship/ rail or trailer, and shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. The crates/ cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., shall be clearly marked on the packages together with other details as per purchase order. The equipment may be stored in a covered shed for long periods before installation. The packing should be suitable for such storage.

9.0 Technical Requirement for Electrical Utility Equipments

9.1 Scope

This specification covers the requirements of design, manufacture, testing, packing and supply of Electrical utility equipment's like Switch Box, Ceiling Rose, Lamp Holders, Fittings, Ceiling Fans, Exhaust Fans, Air Conditioner, Conduits, etc.

9.2 Codes and Standards

a) The equipment shall comply with the requirements of latest revision of the following standards issued by BIS (Bureau of Indian Standards), unless otherwise specified:

IS-16103 (Parts 1 & 2)	LED Modules for General Lighting – Safety & Performance Requirements.
IS-16104	DC or AC supplied Electronic Control Gear for LED Modules – Performance Requirements.
IS-16105	Methods of Measurement of Lumen Maintenance of Solid State Light (LED) Sources.
IS 374:1979	Electric ceiling type fans and regulators (third revision)
IS 11037:1984	Electronic type fan regulators
IS 2675:1983	Enclosed Distribution Fuse Boards and Cut Outs for voltages not exceeding 1000 V A.C. or 1200 V D.C.
IS 8828:1996	Circuit-breakers for over current protection for household and similar installations (second revision)
IS 12640 (Part 1): 2008	Residual current operated circuit-breakers for household and similar uses : Part 1 circuit-breakers without integral over current protection (RCCBs) (First Revision)
IS 4289 (Part 1): 1984/ IEC 60245-5	Flexible cables for lifts and other flexible connections: Part 1 Elastomer insulated cables (first revision)
IS 8544 (Part 1): 1977	Motor starters for voltages not exceeding 1000 V: Part Direction line ac starters [superseded by IS 13947: 1993]

IS 1258:2005/ IEC 61184 (1997)	Bayonet lamp holders (fourth revision)
IS 3323:1980/ IEC 60400 (1972)	Bi-pin lamp holders for tubular fluorescent lamps(first revision)
IS 302 (Part 1): 2008/ IEC 60335-1 (2006)	Safety of household and similar electrical appliances: Part 1 General requirements (sixth revision)
IS 2268:1994	Electric call bells and buzzers for indoor use (second revision)

b) Imported equipment shall conform to the international standards such as IEC/ BS/ VDE/ NEMA or equivalent.

c) The equipment shall also conform to the provisions of Indian Electricity Rules and other statutory regulations currently in force in the country.

d) In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ NEMA or equivalent agency shall be applicable.

e) In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations, the following order of decreasing priority shall govern:

- Statutory regulations
- Data sheets
- Job specification
- Codes and standards

9.3 General Requirements

The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

9.4 Site Conditions

The equipment shall be suitable for installation and satisfactory operation in the project locations.. If not specifically mentioned therein, a design ambient temperature of 40°C and an altitude not exceeding 1000 m above mean sea level shall be considered.

9.5 Power Supply

All AC LED lighting fixtures including the auxiliaries such as LED Drivers / Voltage Adapters / junction boxes shall be suitable for operation within a range of 150 Volts - 270 Volts AC, Single Phase plus Neutral, at a frequency of 50Hz ± 3% power supply.

9.6 Certification

The equipment shall have test certificates issued by recognised independent test house (CIMFR/ CPRV ERTL/ Baseefa/ LCIE/ UL/ FM or equivalent). All indigenous equipment shall conform to Indian standards and shall be certified by Indian testing agencies. All equipment (indigenous & imported) shall also have valid statutory approvals as applicable for the specified location. All indigenous flameproof equipment shall have valid BIS license and marking as required by statutory authorities.

9.7 Technical Requirements of Electrical Utility Equipment

Construction

a) Switch Box

Switch box shall be hot dip galvanized, factory fabricated, suitable in size for surface/ recess mounting and suitable in size for accommodating required number of switches and accessories (where required to be used for applications other than modular switches/ sockets).

Switch box also can be of non-metallic material. The technical sanctioning Authority will approve specified makes of reputed quality and specifications.

Switch Box Covers (for application other than modular type) Phenol laminated sheets of approved shade shall be used for switch box covers. These shall be of 3mm thick synthetic phenol resin bonded laminated sheet as base material and conforming to grade P- I of IS 2036 : 1974.

b) Ceiling Rose

A ceiling rose shall not be used on a circuit; voltage of which normally exceeds 240V.Only one flexible cord shall be connected to a ceiling rose. Specially designed ceiling roses shall be used for multiple pendants. A ceiling rose shall not embody fuse terminal as integral part of it.

c) Lamp Holders

Lamp holders may be batten, angle, and pendant or bracket holder type as required. The holder shall be made of brass and shall be rigid enough to maintain shape on application of a nominal external pressure. There should be sufficient threading for fixing the base to the lamp holder part so that they do not open out during attention to the lamp or shade.

Lamp holders for use on brackets and the like shall have not less than 1.3 cm nipple and all those for use with flexible pendant shall be provided with cord grips.

All lamp holders shall be provided with shade carriers.

Where centre contact Edison Screw lamp holders are used, the outer or screw contact shall be connected to the 'middle wire', or the neutral conductor of the circuit.

d) Indoor Type Fittings

Where conductors are required to be drawn through tube or channel leading to the fitting, the tube or channel must be free from sharp angles or projecting edge, and of such size as will enable them to be wired with the conductors used for the final circuit without removing the braiding or sheathing. As far as possible all such tubes or channels should be of sufficient size to permit looping back.

Wires used within prewired fittings shall be flexible with PVC insulation and 14/0.193 mm (minimum) copper conductors. The leads shall be terminated on built-in-terminal block, ceiling rose or connector, as required.

Fittings using discharge lamps shall be complete with power factor correction capacitors, either integrally or externally. An earth terminal with suitable marking shall be provided for each fitting for discharge lamps.

Fittings shall be installed such that the lamp is at a height of 2.4m above floor level, unless otherwise directed by the Engineer-in-charge.

Fittings made of CRCA shall be phosphatised and powder/epoxy painted.

For humid area like toilets, kitchen, for prolonging the life of such fittings, corrosion free materials like engineering plastic, aluminium, stainless steel etc. should be used.

e) Outdoor Fittings

Outdoor fittings shall have suitable IP protection. It is preferable that street light fittings are of cast aluminium body of IP55, for reducing recurring maintenance cost and improved performance.

Other fittings, which are not available with tested IP 55 protection, can be properly fabricated with weather proof features, proper gasketing etc. As far as possible corrosion free material like cast aluminium, stainless steel, engineering plastics may be used for fabrication of such fittings, to prolong life of such fittings. There should not be any exposed wiring in such outdoor fittings.

f) Conduit Wiring System

All accessories like switches, socket outlets, call bell pushes and regulators shall be fixed in flush pattern inside the switch/regulator boxes. Accessories like ceiling roses, brackets, batten holders etc. shall be fixed on outlet boxes. The fan regulators may also be fixed on outlet boxes, if so directed by the Engineer-in-charge.

Aluminium alloy or cadmium plated iron screws shall be used to fix the accessories to their bases.

Switch box/Regulator box shall normally be mounted with their bottom 1.25 m from floor level, unless otherwise directed by the Engineer-in-charge.

g) Fixing to Walls and Ceiling

Wooden plugs for fixing to wall/ceiling will not be allowed. Fixing will be done with the help of PVC sleeves/Rowel plugs/ dash fasteners as required.

Drilling of holes shall be done by drilling machines only. No manual drilling of hole will be allowed.

h) Fans, Regulators and Clamps

Ceiling fans of 1200 mm sweep (having BEE 5-Star Rating) including supply of all fixing accessories including their suspension shall confirm to relevant Indian Standards. The capacity of a ceiling fan to meet the requirement of a room with the longer dimension D meters should be about 55 D M^3/min.

Modular type **100 Watts** rated Step Regulators for Ceiling Fans of 2-module size including fixing the regulator on the modular base-plate and termination of wires

Height of fan blades above the floor should be (3H + W)/4, where H is the height of the room, and W is the height of the work plane. Minimum distance between fan blades and the ceiling should be about 0.3 meters.

When actual ventilated zone does not cover the entire room area, then optimum size of ceiling fan should be chosen based on the actual usable area of the room, rather than the total floor area of the room.

Energy Efficient fans with BEE 3-5 star rating or complying with IS 374:1979 shall be used. The minimum service value of fans shall be 3.5 M^3/Min/W and air delivery 200 M^3/Min. All ceiling fans covered under this standard shall comply with minimum air Delivery of 210 M^3/Min.

Step Type Electronic regulators should be used instead of resistance type regulators for controlling speed of fans.

Enclosure of Fan Regulator shall be either ventilated or totally enclosed type.

Electronic Regulator handle shall be either of insulating material adequately insulated electrically or thermally. Handle or knob shall be designed that it does not become loose while in use. Run / Off Positions of Regulator shall be distinctly or clearly marked to indicate exact position. Mechanism of regulator shall be designed to ensure positive contact at each running position. In case of inductance type regulator it is essential that circuit should be operated between contacts in order to avoid short circuits. Fan shall be capable of start-up from rest when 85% of rated voltage is applied.

All ceiling fans shall be wired to ceiling roses or to special connector boxes, and suspended from hooks or shackles, with insulators between hooks and suspension rods. There shall be no joint in suspension rod.

For wooden or steel joists and beams, the suspension shall consist of GI flat of size not less than 40mm x 6mm, secured on the sides of the joists or beams by means of two coach screws of size not less than 5cm for each flat. Where there is space above the beam, a through-bolt of size not less than 1.5cm Ø, shall be placed above the beam from which the flats are suspended. In the latter case, the flats shall be secured from movements by means of another bolt and nut at the bottom of the beam. A hook consisting of MS rod of size not less than 1.5 cm Ø shall be inserted between the MS flat through oval holes on their sides. Alternatively, the flats may be bent inwards to hold tightly between them by means of a bolt and nut, a hook of 'S' form.

In the case of 'I' beams, flats shall be shaped suitably to catch the flanges and shall be held together by means of a long bolt and nut.

For concrete roofs, a 12mm dia. MS rod in the shape of 'U' with their vertical legs bent horizontally at the top at least 19cm on both side, and bound to the top reinforcement of the roof shall be use. Canopies on top of suspension rod shall effectively hide the suspension.

The leading in wire shall be of nominal cross sectional area not less than 1.5mm² and shall be protected from abrasion.

Unless otherwise specified, all ceiling fans shall be hung 2.75 m above the floor. In case of measurement of extra down rod for ceiling fan including wiring, the same shall be measured in units of 10 cm. Any length less than 5 cm shall be ignored.

i) Air Conditioner

Split type indoor air conditioner shall be of 1.5 Ton capacity with cooling capacity of 5.25KW, Single phase power supply, Air Flow Rate of 6mmwc, Indoor Noise level @ <45db, Outdoor Noise Level @ <55db, Function Modes like Auto/Cool/Dry/Fan with sleep & power saving mode, Automated vertical swing for horizontal louver, Anti-freeze thermostat, Rotary Compressor, powder coated quality paint finish, Activated carbon cartridge, dust proof and anti-bacteria filter, Remote handset, LCD display with night glow, Stabilizer having ISI quality certification and power rating that matches with the power rating of the A/C unit. Energy Efficient air-conditioner with BEE 3-5 star rating shall be used.

Equipment shall be supplied along with4 meters copper piping with super iron insulation for suction line, 4 meters copper piping with super iron insulation for Discharge line, 1 meter PVC piping for drain, Indoor - Outdoor unit connecting power cable and required cable from power socket to stabilizer and from stabilizer to AC Unit5 Base plate for hanging indoor unit

j) Exhaust Fans

Exhaust fans shall conform to relevant Indian Standards.

For fixing an exhaust fan, a circular opening shall be provided in the wall to suit the size of the frame, which shall be fixed by means of rag bolts embedded in the wall. The hole shall be neatly plastered to the original finish of the wall. The exhaust fan shall be connected to the exhaust fan point, which shall be wired as near to the opening as possible, by means of a flexible cord, care being taken to see that the blades rotate in the proper direction. Exhaust fans for installation in corrosive atmosphere, shall be painted with special PVC paint or chlorinated rubber paint.

These three blades exhaust fan shall made of made of metal, thereby making it completely rust-proof, Ideal for Mounting on Glass Windows with lightweight and the glass can take the weight of the fan.

300 mm sweep Exhaust Fans for Kitchen, Toilets & Bathrooms with an outer mesh for bird protection & louver's for rain protection. Installation will include breaking of Wall / Cutting of Window Frame & restoration of wall with cement plaster / water-proofing / fixing of window frames

450 mm dia sweep 1-Phase, wall mounting type, industrial / heavy duty exhaust fan with an outer mesh for bird protection & louvers for rain protection including supply of all necessary supports, mounting frame, fixing bolts, fixing of cable glands, lugs

The exhaust fan shall be made of fine quality metal that have advantage of this material shall be completely rust-free. Apart from this, cleaning exhaust fan shall be extremely easy. Exhaust fan Air delivers shall be 1160 M^3/Minute at the speed of 1300 RPM.

This exhaust fan power consumption shall be of 48W powers, making it energy efficient with Sturdy metal body and powerful motor.

k) Residual Current Operated Circuit Breaker (RCCB)

In general, every circuit is provided with a means of over current protection. If the earth fault loop impedance is low enough to cause these devices to operate within the specified times, such devices can be relied upon to give the requisite automatic disconnection of supply. Where the earth fault loop impedance is too large, efforts are required to make it low enough. Guidelines are available in IS 3043: 1987. When protection against indirect contact is decided to be provided by RCCB, IS 732: 1989 prescribes that the product of its rated residual current (rated tripping current sensitivity) of 30mA.

Where RCCBs are required to be used for affording shock protection; there are several broad parameters that are required to be carefully chosen. These are described in the following clauses.

RCCB should be so chosen as to have lowest suitable tripping current. Lower the tripping current, the greater is the degree of protection afforded. Nevertheless, it would introduce the possibility of nuisance tripping and may also become unnecessarily expensive. The minimum operating current will, therefore, have to be above any standing leakage that may be unavoidable in the installation.

Provision of RCCB shall be specified in individual cases keeping in view the type, use, importance, system of earthing and nature of electrical installations to be protected by the RCCBs, requirements of the local electric supply company, etc. The sensitivity shall be 30mA, 100mA, as specified.

Decision regarding providing of RCD (RCCB) shall be taken in individual cases keeping in view the type, use, importance, system of earthing and nature of electrical installations to be protected by the RCD, requirements of the local Electric Supply Companies etc.

l) Earth leakage relay with CBCT

Earth leakage current gives rise to generation of heat & result in progressive failure of insulation, which will lead earth fault sparking flash over, deterioration of earthing& finally result in catastrophic fire. It will be therefore essential to detect earth leakage current well before any they cross threshold limits and isolate circuit in the event of major earth leakages. Conventional over current & short circuit protection devices are not designed to detect earth leakage currents.

Earth Leakage Relays with Core Balance Current Transformer (CBCT) are used to detect leakage current in Power System. ELR transmits a signal to activate trip coil of MCCB / ACB / OCB / Contactor in the event of earth leakage resulting in automatic isolation of power system. In case of Earth Leakage due to insulation failure of direct line to ground fault, vector sums of currents is not zero, it therefore generate resultant magnetic flux in CBCT & this signal will be fed to electronic circuit of ELR.

Feature of CBCT with ELR shall be consistent reliability including accuracy, Fixed / Variable current sensitivity selection, LED visual indication in case of fault, Test / Reset provision for testing healthiness of relay. ELR with Type class “A” true RMS measurement that provide user benefit shall be in compliance with IEC 60947-2.

Input auxiliary voltage: 110/230/440Vac, 48~220Vdc, Current Sensitivity Range: 30~300mA, Fixed – 30mA, Tripping Time– 0.15~3 Seconds, CBCT Type: Tape Wound or Resin Cast, Relay Contact: one pair of potential free contact with 6 Amp rating, Mounting Type: Flush / DIN.

m) Switch & Socket

These shall be of single pole / double pole type, shock proof, in compliance with relevant IS standards. Switches shall be surface mounting & continuous rating shall be of 6A / 16A, 240Vac, Socket with plugs shall be 2 pin & earth design of best quality suitable for single phase 240Vac supply. Earth pin shall be effectively connected to nearest conduit of earth connections in

distribution board with not less than 2.5mm². Socket outlet shall be complete unit with ratings of 16Amps to suit individual requirements. Socket outlet shall be in tumbler type design or Piano type, flush mounting on plate.

9.8 Packing and Dispatch

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for the selected mode of transportation, i.e. by ship/ rail or trailer, and shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. The crates/ cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., shall be clearly marked on the packages together with other details as per purchase order. The equipment may be stored in a covered shed for long periods before installation. The packing should be suitable for such storage.

10.0 Specification for Lighting& Equipment Installation

10.1 Scope

This specification defines the requirements for the installation, field inspection, testing and commissioning of LT Panel, Distribution board, lighting & other electrical equipments, forming part of electrical power distribution and utilization system, including Telephone and Communication system.

10.2 Codes& Standards

a) The work shall be carried out with quality workmanship and in conformity with this specification, MRPL Installation Standards, layout drawings and to the following specifications/ codes of practice of Bureau of Indian Standards and OISD standards.

I. SP – 30 (BIS): National Electrical Code.
II. IS: 7816: Guide for testing Insulation resistance of rotating machines.
III. IS: 10118 (Part-3): Code of practice for selection, installation and maintenance of switchgear and control gear.
IV. OISD 137: Inspection of Electrical Equipment.
V. OISD 147: Inspection and safe practices during electrical installations

b) In addition to the above it shall be ensured that the installation conforms to the requirements of the following as applicable:

I. Indian Electricity Act and Rules.
II. Regulations lay down by CEA/Electrical Inspectorate.
III. Regulations lay down by CCOE/DGMS (as applicable).
IV. The petroleum rules (Ministry of Industry Government of India).
V. Any other regulations laid down by central/state/local authorities and Insurance agencies.

10.3 LT Panels / Distribution Boards

a) LT Panel, Lighting and Power panels shall be made of sheet steel enclosures with minimum of IP-52 Ingress Protection. Indoor type distribution boards shall be suitable for surface mounting on walls / structures as specified. Lighting / power / control panels located outdoor shall also have IP-55 weather protection and shall have integral canopy for additional weather protection.

b) In addition, a circuit diagram indicating incomer details and outgoing details viz. Circuit number, circuit rating and load connected and details of the load shall be pasted inside the panel. Also a

laminated copy of the diagram shall be provided inside the panel in a suitably designed pocket. Two external earthing studs for connection to the plant earthing grid shall be provided on the panel. Further the panel shall be provided with an earth bus bar with terminal studs for connection to the third core of each outgoing circuit. Each circuit phase and neutral shall be given ferrule numbers. Complete wiring inside the panel, shall be neatly bunched with PVC tape and button. Sufficient terminals shall be provided in the terminal block so as to ensure that no more than one wire (core) is connected to a terminal. The distribution board shall have knock out holes or removable gland plate for the entry of incoming and outgoing conduits or cables. The panels shall be complete with requisite number of PVC cable glands as specified.

c) The LT Panel shall also be in a sheet steel enclosure with 4 pole MCCB incomer & MCCB outgoings as specified. All MCCB's shall have over current and short circuit protection.

d) Wherever the size (cross-section) of incoming cable to LT Panel/Distribution Boards is more than 35mm², a suitable cable adapter box shall be provided and attached to the panel. The incoming cable leads shall be connected to terminal block (bolted type terminals) of required size. This terminal block shall be connected to 4 pole incomer unit through separate XLPE insulated Aluminum conductor wires/bus-bars. Sufficient space shall be provided (minimum 300mm) between gland plate and the bottom of terminal block for easy termination.

e) Pre-Commissioning Check List: The panels shall be checked for correct vertical position using spirit levels. The distribution boards shall then be fixed on to walls / structures with heavy duty anchor-bolts / welding of supports & brackets respectively. Before commissioning any switchboard, following points shall be checked and ensured for safe energizing of the switchboard:

   I. That the installation of equipment to be commissioned is complete in all respects with its auxiliaries and all other mounting including earthing. All distribution board openings have been sealed off. All cover and door gaskets are intact to make the enclosure vermin proof.

   II. That all the metering instruments have been checked and found in working order.

   III. Electrical simulation tests shall be carried out for all the protective, alarm and annunciation features and external interfaces to ascertain proper functioning.

   IV. Safety insulation mats of approved make and of required voltage grade shall be provided in the sub-station.

   V. Indicating lamps are healthy and are in correct position.

VI. That IR Value has been recorded for bus bars, circuit breaker, incoming and outgoing cables, control wiring and potential transformers.

VII. Where required joint resistance of bus bars have been recorded and found to be satisfactory. All the surroundings and panels have been cleaned and temporary earth leads have been removed.

f) Following tests shall be ensured before panel / distribution boards commissioning:

I. For all CTs: Insulation resistance test / Ratio test through primary injection / Polarity test / Knee point voltage for class-PS CTs.

II. Following tests shall been ensured for all meters: Calibration of meters / Functional verification and settings.

III. Following tests shall been ensured for all relays: Secondary injection test / Relay settings / Timing check with timers / any other test recommend by the supplier.

IV. Following tests shall been ensure for all bus bars: Tightness of all nuts / bolts using Torque wrench / IR value / Contact resistance using 100 A DC Kit.

10.4 Lighting Fixtures& Lighting Installation

a) The types, makes and catalogue numbers of various types of lighting fixtures shall be as per the details given in the Bill of Quantities. All light fixtures shall be of integral type only and complete with LED lamps / LED Panels. The fixtures shall be of high power factor type i.e. at least 0.9 or more.

b) All light fixtures supplied & installed for this project shall be of LED type with LED panels sourced from reputed manufacturers such as Osram, Samsung, Everlite, Epistar, Philips, Cree, etc. All LED light-fixtures with driver units, LED Panels & other accessories shall be guaranteed for a minimum of 2 years continuous operation. In case the LED luminaries develop faults within the warranty period, the supplier / contractor shall be liable to replace the faulty component / entire LED luminaries free of cost.

c) The lighting fixtures shall be fed from the distribution board (DB). All outdoor lighting shall be group controlled manually or through synchronous timer. Lighting cabling / wiring between the LDB and lighting fixtures shall be done with overall PVC insulated 3 - core (phase, neutral and earth) stranded copper conductor un-armored cable inside the building. Lighting cabling / wiring outside the shed shall also be done with 3-core (phase, neutral and earth) stranded copper conductor unarmored cables. All joints of conductors

in Switch boards/Junction Boxes Fittings shall be made only by means of approved mechanical connectors (nylon/PVC connectors). Bare twisted joints shall not be permitted anywhere in the wiring system.

d) The lighting layouts furnished by owner will indicate approximate locations of lighting fixtures. The electrical contractor shall determine, with approval of Engineer-in-Charge, 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 much uniform illumination as practicable, and to avoid objectionable shadows. Cable Trays & Wire Conduits shall be laid out by the contractor to suit field conditions and as per directions of the Engineer-in-Charge.

e) Light fixtures installed on walkways, platforms and other outdoor areas, shall be located nearer to landing of stairs or ladders, gauges, flow meters, panel boards and other equipment to provide proper illumination for easy operation.

f) All outdoor cable terminations to outdoor junction boxes, panels, socket outlets etc. shall be through bottom or from side. Top entries for cables shall be avoided to avoid water entry. All cable glands for outdoor terminations shall be double compression type and the gland shall be covered with PVC or rubber boot shroud. All unused cable entries shall be plugged with suitable blanking plugs.

g) The minimum height of any lighting fixture shall be preferably not less than 3 meters above the floor level. Mounting height of equipment shall be as under:

h) Top of Switch Box, Top of Lighting / Power Distribution Boards, Convenience & Welding receptacles shall be installed at 1200mm above the Finished Floor Levels.

i) Lighting fixtures on wall shall be installed at a minimum of 3000mm from the finished floor level; the actual height shall depend upon the purpose & wattage of the wall-mounted light fixture.

j) Fixtures shall be firmly supported from the structures. Support clamps etc. may be bolted or welded to the existing steel work or metal inserts. In case of concrete structures, where metal inserts are not available, fixtures shall be suspended from concrete surfaces with the help of anchor fasteners. In such cases special care shall be taken to see that anchoring is firm. In places where ceiling fans are provided, lighting fixtures shall be suspended below the level of fan to avoid shadow effect.

k) Lighting Circuit cables inside building shall be laid on PVC Conduit. Cables used for internal wiring of the lighting fittings shall be with appropriate type and size, number with conductor of size not less than 1.5mm² single core. The insulation of the cables shall withstand the maximumtemperature throughout the life of the fitting. It will be subject to normal use without deterioration which could affect the safety of the fitting.

l) Cables within the lighting fittings shall be neatly bundled by nylon self locking cable ties. Wiring shall be properly routed and secured away from control gear etc. wherever possible.

m) All cable terminations within the light fittings shall be suitably shrouded.

n) All light fittings shall be supported with appropriate fixing accessories such as clips, supporting brackets, suspension sets, nuts, washers, screws etc. for their proper installation on different types of ceiling panels. Suspension sets shall be of adjustable type suitable to carry the weight of the lighting fittings unless otherwise stated or indicated on drawings. The suspension sets shall be generally of 900 mm length. Exact lengths required shall be provided to suit the site requirement.

o) Cabling / Wiring for all Convenience Receptacles / outlet sockets shall be done with overall PVC insulated 3-core (phase, neutral and earth) stranded copper conductor un-armored cable. The terminals of switch sockets shall be suitable to receive the size of cable specified.

p) All lighting fixtures shall be provided with terminal block with required terminals suitable for connection of wire up to 4 mm2 stranded copper conductors with pin type lugs.

q) The cable shall be straightened after unwinding it from the drum. All cables are clamped / laid in straight run without any sag and kink.

r) Wiring for exhaust fans shall be terminated in receptacles as specified in layout drawing and the connection from receptacle to the exhaust fan shall be by means of a flexible cord equivalent in size to the main run of wires. Switch for exhaust fan shall be located in a separate switch board along with other switches.

s) Exhaust fans shall be of the desired sweep & CFM as mentioned in the Bill of Quantities. unless otherwise specified with double ball bearing and regulator. Exhaust fans shall be with anticorrosive blades suitable for use in acidic fumes.

10.5 Switches / Sockets& Outlet Boxes

Switches, manufactured in accordance with IS: 13947. Switches in areas where concealed wiring has been adopted, shall be flush mounting piano type unless otherwise specified. For surface conduit wiring, piano type switches with surface mounted boxes (heavy duty PVC) shall be provided. Industrial Type switches (Weather-protected) shall be used for out-door areas. Modular switches along with required boxes shall be provided for indoor application in case shown in the layout.

a) Switches for external use shall be of weatherproof construction with IP55 rating unless otherwise specified.

b) Lighting switches shall be suitable for indoor or outdoor service according to location housed in standardized purpose manufactured galvanized steel boxes completed with conduit knockouts made up into single or multi-gang units employing a grid switch system of fully interchangeable components at standardized fixing centers of matching switches of different types and ratings but of identical dimensions, push buttons, neon indicator lamps, blanking units, grids, steel boxes and plates all capable of integration into standard composite assemblies in any combination as required.

c) Bell push switches shall be flush/surface mounted having single-pole AC switch of 6 amps rating and marked with bell symbol.

d) Switch box shall be made of Mild steel, factory fabricated, suitable in size for wall/ recess mounting and suitable in size for accommodating the required number of switches and accessories (where required to be used for applications other then modular switches/ sockets).

e) Switch box also can be of non-metallic material. The technical sanctioning Authority will approve specified makes of reputed quality and specifications.

f) The outlet boxes used as point outlets shall be prefabricated & constructed out of heavy duty PVC material – suitable for surface installation. These shall be complete with terminal block suitable for connection of wires up to 4mm². Front cover plate shall be homogeneous with the modular type Switch / sockets & mechanically tough. The color shall suit the shade of the walls or shall be white if the shade of the walls is not finalized. The Cover plates shall be fixed by Stainless steel screws. Outlet boxes shall be provided

with adequate number of knock outs on all the sides for ease of wiring either with conduits or with cables.

g) Three pin type 15A receptacles / sockets manufactured in accordance with IS: 1293. The receptacles and the controlling ON / OFF switch shall be mounted in the same enclosure box but these shall be in separate units to facilitate replacement by parts. Flush mounting type receptacles shall be used in areas where concealed wiring has been adopted and surface type shall be used in other areas.

h) For exhaust fans, socket and switch enclosures shall be separate. Modular type receptacles along with required boxes shall be provided for indoor application in case shown in the layouts.

10.6 Conduits and Accessories

a) Conduits for Electrical installations shall conform to IS: 9537. All conduits used for the Hazardous Waste Storage Shed shall be of heavy duty PVC type of desired color and the minimum thickness of PVC conduit shall be 1.6 mm. These PVC conduits shall be used in concealed as well as surface cabling / wiring.

b) All Conduit accessories used during installation shall be of stainless steel only – including saddle / clamp bars / screws / nuts-bolts / etc.

c) Required number of pull boxes shall be used at intervals to facilitate easy drawing of wires. Separate conduit shall be run for lighting and power circuits. Further, conduits for Telephone & data shall be separate. Conduit layout shall be decided at site as per site conditions. Drop conduits for switch boards shall be decided by contractor as per wall locations shown in Architectural drawings. All exposed run of conduits on surface, shall be vertical or horizontal.

10.7 Street Lighting Poles

a) Lighting poles shall be Hot-dipped GI Octagonal type of 8 meters height with single arm and fabricated as per MRPL specifications / drawings enclosed with this document. The minimum coating thickness of zinc shall be 86 microns & relevant test certificates from the manufacturer shall be submitted to confirm the same. The pole shall have a cut-out with a flappable hinged door for housing MCB / Terminal Block / Earthing Links.

b) The poles shall be free from scaling / flaking and in cases where unevenness is observed on the surface of the poles – the same shall be liable for rejection.

c) Street lighting poles to be located on road side shall be installed at a minimum distance of 300 mm from the edge of the walkway of the road. Size of wires from the pole terminals up to fixture shall be with 2core x 4 mm² copper conductor PVC insulated flexible cable.

d) Each pole shall be earthed at two points by connecting to the plant earth grid as shown by the engineer-in-charge.

e) The foundations for the street lighting poles shall be casted separately for which the foundation bolts & template (supplied by the pole manufacturer) shall be available at site before starting the civil works. The foundations shall be as per the attached drawings.

f) All civil works such as excavation (& disposal of surplus earth), casting, shifting & positioning of the foundations – shall be in the scope of the electrical works contractor & no separate claim shall be admissible for payment towards street light pole civil works.

g) The poles shall be numbered as per the drawings/ directions of Engineer-In-charge.

10.8 Push Button/Control Stations

The push buttons / control stations shall be installed near to the motors to be controlled. Individual channel supports shall be installed as per MRPL standard. All outdoor push buttons / control stations shall preferably have integral canopies for additional weather protection.

10.9 LT MOTORS

a) Unless otherwise specifically mentioned, all motors shall be rated for Intermediate duty cycle.

b) All the motors generally would be erected by the mechanical contractor.

c) The electrical contractor shall measure the insulation resistance (IR) of motor windings. Insulation resistance of the motors shall be measured between the winding of the machine and its frame by means of a 500 / 1000V Megger in case of 230 V motors. A minimum value of 1 mega-ohm for 415 V motors shall be considered as a safe value.

d) Blowing hot air from external source

e) Putting the motor in oven

f) Placing heaters or lamps around and inside after making suitable guarding and covering arrangements so as to conserve the heat

g) After IR value improvement, the motor shall be started on no-load after decoupling, and shall be allowed to run for a minimum period of 4 hours, or for a time as instructed by Engineer-in-charge. Attention shall be given to the proper running of the bearings, vibration or unusual noises if any. Voltage, starting current, no load current, stator winding and bearing temperature shall be recorded after every 1 hour during this test. Direction of rotation shall be checked and recorded. Normally the motors run in clockwise direction as viewed from the driving end with reference to the phase sequence R, Y, B.

h) After switching off the motor, the insulation resistance of the motor shall be recorded under hot and cold conditions.

i) If the no load test run is found satisfactory, the motor shall be allowed to run for 8 hours and all readings shall be recorded.

10.10 List of Construction Equipment

The contractor shall have all necessary construction equipment, tools and tackles and testing instruments to carry out the erection works and to commission the system as specified. These shall include, but not be limited to the following, and these shall be brought to site by contractor before the start of work.

10.10.1 Test Instruments

- Insulation Resistance (IR) Tester 1000 V – digital type Megger.
- Phase sequence indicator.
- Earth Resistance tester.
- Secondary and primary injection testing kit.
- Multi-meter – digital type.
- Portable Ammeters, Watt-meters, Power Factor meters.
- Portable Voltmeters.
- Clip on meters of different ranges.
- Tacho-meter.
- Kelvins double bridge for measurement of very low resistance.
- Lux Meter to measure illumination levels.
- Timers
- 100 A DC milli-volt drop (Contact resistance) kit

- Vibration measuring Instrument
- Thermo meters

10.10.2 Construction Equipment:

- Portable grinder.
- Portable welding machine.
- Portable gas cutting / welding set.
- Pipe threading machine.
- Pipe bending machine (hydraulic).
- Portable drill machine suitable to take up drilling for different sizes as per requirement.
- Dewatering pump-sets (diesel driven).
- Power Hacksaws
- Conduit dye-set.
- Hydraulic crimping machine with round/hexagonal dye-set.
- Hand crimping Tool.
- Portable electric blowers, vacuum cleaners.
- Miscellaneous items such as slings, pulleys, tarpaulins, wooden sleepers, ladders, etc. as required.
- Safety belts, safety goggles and gloves.
- Separate tool-kit for each Electrician.
- Hydraulic/Hand-held grease-gun

10.10.3 Testing& Commissioning

a) Lighting installation shall be tested and commissioned by installation contractor as per MRPL specifications. Pre-commissioning checks and tests shall include but not be limited to the following:

b) The insulation resistance of each circuit without the lamps (load) being in place shall be measured and it should not be less than 1 Mega ohms. (Between phases, phase to neutral, phase & neutral to Earth).

c) 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.

d) The earth continuity for all socket outlets shall be checked. A fixed relative position of the phase and neutral connections inside the socket shall be established for all sockets.

e) After inserting all the lamps and switching on all the circuits, minimum and maximum illumination level shall be measured in the area and recorded.

f) It shall be ensured that switch provided for ON/OFF control of point (light / fan / socket) is only on LIVE side.

g) Operation of ELCBs shall be checked.

h) Contractor shall duly fill in all the above test results and submit the test reports to Engineer-in-Charge in triplicate.

i) All layout drawings shall be marked by contractor for 'AS BUILT' status and two sets of hard copies plus 1 set of softcopies in CD-ROM shall be submitted to MRPL for review & records.

11.0 Specifications for Earthing Installations

Material Specification

a) All materials and hardware to be supplied by the contractor shall be new, unused and of best quality and shall conform to the specifications given here under and to latest specifications of Bureau of Indian Standards. Contractor shall bring material samples to site and get it approved by Engineer-in-charge before installation.

b) The main earth grid conductor shall be hot dip GI flat unless otherwise specified. Sizes for main conductors shall be as indicated on the earthing layout drawing. Amount of galvanizing shall be 610 gm per square meter. Earth electrodes and Earth plate shall be as per MRPL Installation Standards.

11.1 Earthing Network

a) This consists of main earth conductor (grid conductor) forming a closed ring network with required number of earth electrodes connected to it to provide a common earth for electrical devices and metallic structures. From each earth electrode two distinct connections shall be made to the main earth conductor. The earth plates shall be used for taking multiple earth connections to two or more equipment.

b) Earth conductor laid underground shall be at a depth of 600mm below finished grade level. The earth conductor shall be laid along cable trays/cable trench as indicated on the earthing layout drawing. Where lined cable trenches are available, the earth conductor shall be laid in

the trenches and shall be firmly cleated to the sidewall of concrete trenches using GI clamps at interval of 400 mm to 500 mm and near to the termination end. The earthing conductor shall run along one of the cable trays along a cable route. The earthing conductor shall be suitably cleated and electrically bonded to all the other cable trays on the same cable route at a regular interval of 25 to 30 meter. The earthing for equipment shall be tapped from the main earth conductor and not from cable tray support structure.

c) Joints and tapping's in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and shall be suitably protected by giving two coats of bitumen and covering with Hessian tape. Earth strip laid above ground shall be welded across straight through joints and joints shall be suitably protected by giving two coats of bitumen to avoid oxidation and insulation film formation of the strip surface. When two earth strips are to be joined by means of welding, lap welding with an overlapping of strip equivalent to double the width of the strip and all four sides shall be continuously welded. All joints at tapping above ground shall be by means of connector / lugs. A minimum of two bolts of adequate size shall be used for this purpose. Earthing strip joints at earth plate and equipment shall be through GI bolts, nut etc.

11.2 Installation of Earth Electrode

a) Earth Electrode shall be installed as shown on installation standard and layout drawings. The location shown on the layout drawings are indicative.

b) The exact location of earth electrodes in the field shall be determined by contractor in consultation with the Engineer-in-charge, depending on the soil strata and resistivity. Earth electrodes shall be located avoiding interferences with road, building foundation, column, pipelines etc. The civil area drawings shall be referred for this. The distance between two electrodes shall not be less than twice the depth of electrode.

c) Electrodes shall preferably be located in a moist soil which has a fine texture, grain size and distribution. Wherever practicable the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes and soil packed by watering and ramming as tight as possible.

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

e) All earth electrodes shall be tested for earth resistance by means of standard earth test meter.

f) The tests shall take place in dry months, preferably after a protracted dry spell.

g) The disconnect facility shall be provided for the individual earth electrode to check its earth resistance periodically.

h) Location of earth electrodes shall be marked by permanent markers for easy identification. All earth Electrodes shall be serial numbered and also marked on 'As Built' drawing for future reference.

i) Individual earth electrodes shall be provided for each lightning arrestor and flood light mast.

j) Earthing system provided for concrete paved area by other agency where applicable; shall be connected to the plant earthing system below ground by minimum two earth connections

11.3 Earthing Connection

a) The earth system connections shall generally cover the following: Equipment earthing for personnel safety, System neutral earthing and Static and lightning protection

b) The following shall be earthed.

- LT Panel board, Distribution board.
- Motors, street light pole, control stations, etc.
- Steel structures / columns, rail loading platforms, etc. Cable trays and racks, lighting mast and poles

c) Conductor size for branch connection to various equipment shall be as per MRPL Installation

d) Standards unless otherwise stated on earthing layout drawings.

e) Equipment/street light pole etc. located remote from main earth network may be earthed by means of individual earth electrode and earth conductor unless otherwise stated in job specifications.

f) Lightning protection shall be provided for the equipment, structures and buildings as shown on layout drawing. Self-conducting structures shall not require separate aerial rod and down conductors. These shall however be connected to the earthing system at two or more points as shown on layout drawing. An independent earthing network shall be provided for lightning protection and this shall be bonded at least at two points with the main earthing network below ground. Lightning down conductor shall be brought to earth electrode in shortest straight path as feasible to minimize surge impedance.

g) The main earthing network shall be used for earthing of equipment to protect against static electricity.

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

i) All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground wherever provided. Equipment foundation bolts shall not be used for earthing connection.

j) Earth connections shall be made through compression type cable lugs/by welded lugs.

k) All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections and all connections adequately locked against loosening.

l) GI pipe **earth-pits**, excavation, back filling, 65 mm diameter Hot-Dipped Galvanized GI pipe of 3 meter length and funnel. The pit should be filled with equal proportion of salt, charcoal all-round the pipe to complete depth with brick-chamber and MS Chequered Plate cover as per attached drawings / specifications.

m) Main earthing conductors of 50mm x 6mm Hot-Dipped Galvanized GI strip including welding & supply of necessary accessories for burying in earth at 450mm depth/ clamping on walls as per MRPL specifications.

n) Sub earthing conductors of 25mm x 6mm Hot-Dipped Galvanized GI strip including welding & supply of necessary accessories for burying in earth at 450mm depth/ clamping on walls as per MRPL specifications.

o) Connection of individual equipment to the grounding loop at the nearest earth plate with 1.1 kV Grade PVC Insulated (Green Colored) 1 Core x 10mm² stranded Copper Conductor un armored-flexible cable including supply of Copper Cable with Copper Lugs, other necessary hardware for connection.

11.4 Testing and Commissioning

a) Field inspection, testing and commissioning of electrical installation shall be done as per MRPL standard specifications. Earthing systems / connections shall be tested as follows:

b) Resistance of individual earth electrodes shall be measured after disconnecting it from the grid by using standard earth test megger.

c) Earthing resistance of the grid shall be measured after connecting all the earth electrodes to the grid. The resistance value of an earth grid to the general mass of earth shall be as follows:

d) For the electrical system and equipment a value that ensures the operation of the protection device in the electrical circuit but not in excess of 5Ω.

e) For lightning protection, ear thing resistance shall be very low, but in no case it shall be more than 10Ω.

f) The resistance to earth shall be measured typically at the following points:

- At each earth provided for structure lightning protections.
- At one point on earthing system used to earth electrical equipment enclosures.
- At one point on earthing system used to earth wiring system, enclosures, such as metal conduits and cable sheaths or armor.

g) All earthing layout drawings be marked by contractor for 'AS BUILT' status and two sets of hard copies plus 1 set of soft copy in CDs, shall be submitted to the owner for reference & records.

12.0 Specifications for Cable Laying

12.1 General

a) Cable installation shall include power, control, lighting, telephone and communication cables. These shall be laid in cable trays / Cable trench / Conduits or buried in ground as detail indicated in the Cable tray/conduit drawings. Cable routing given on the cable layout drawings shall be checked in the field so as to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc. Any change in routing shall be done to suit the field conditions wherever deemed necessary, after obtaining approval of Engineer-in-charge.

b) Telephone, fire alarm and plant communication cables shall be directly buried in road berm area, (unless otherwise specified in cable layout drawings). These cables shall cross power cables preferably at right angles. Street lighting cables shall be laid on the other side of road berm area.

c) All cables shall be identified close to their termination point by cable tag numbers as per cable schedule. Cable tag numbers shall be punched on Aluminum / Lead straps (2mm thick, 20mm wide and of enough length) securely fastened to cable and wrapped around it.

d) Each underground cable shall be provided with cable tags of lead Aluminum securely fastened every 20 m of its underground length with at least one tag at each end before the cable enters/leaves the ground. In unpaved areas, cable trenches shall be identified by means of cable markers as per installation drawing. These cable markers shall be placed at location of changes in the direction of cables and at intervals of not more than 30 m and also at cable straight through joint locations.

e) Where cables pass through foundation walls, the necessary openings shall be provided in advance for the same by another agency. However, should it become necessary to cut holes in existing structures for example floor slab etc., the electrical contractor shall determine their location and obtain approval of the Engineer-in-charge before carrying out the same.

f) Cables for road crossings shall be taken through ERC (Electrical Road Crossing) as shown in the cable layout drawings.

g) 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.

12.2 Cables Laid Directly in Ground

a) Cables shall be laid underground in excavated cable trenches where specified in cable layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables. Cables shall be properly spaced as per installation standards. Maximum number of cable layers in trench shall be preferably limited to 6 layers.

b) Minimum depth of directly cable trench shall be 800mm, for medium voltage cables. The depth and the width of the trench shall vary depending upon the number of layers of cables as per MRPL installation standards. The depth and the width of the trench shall vary depending upon the number of layers of cables as per MRPL installation Standards

c) Cables shall be laid in buried trenches at depth as shown in the cable layout drawings. It is to be ensured by the contractor that the bottom of buried trenches shall be cleared of all rocks, stones and sharp objects before cables are placed. The trench bottom shall be filled with a layer of sand or stone dust. This sand /stone dust shall be leveled and cables laid over it. These cables shall be covered with 150mm of sand on top of the largest diameter cable and sand shall be lightly compacted. A flat protective covering of 75mm thick second class red bricks or concrete tiles as per specification shall then be laid and the remainder of the trench shall then be back -filled with soil, rammed and leveled.

12.3 Above Ground Cables

a) Cables installed above grade shall be run in cable trays/conduits, clamped on walls, ceiling or structures and shall be run parallel or at right angles to beams, walls or columns. Cables laid in conduit shall be embedded in the building RC construction. All embedded conduits shall be Medium Mechanical stress (MMS) PVC type. Where conduit laid in exposed it must be GI type. Cable routing shall be planned to be away from heat sources such as hot piping, gas, water, oil drainage piping, air-conditioning duct etc. Each cable tray shall contain only one layer of cables as far as possible for power cables. However control cables may be laid in double layer in the cable trays. All cables running above the suspended false ceiling, columns, or on surface shall be supported by proper clamps, on cable tray or cable ladder system. No free hanging of cable is allowed.

b) Individual cable or small group of cables (up to 3 cables) which run along structures, walls etc. shall be clamped by means of 16SWG GI saddles on 25x 6 mm saddle bars. Alternatively small group of cables can be taken through 60 / 100 / 150 mm slotted channel tray or channel ISMC-75 / 100. Cables shall be supported so as to prevent 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. to prevent the sagging of cables.

c) Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable trays shall be suitably clamped by means of GI saddles / clamps, whereas cables in horizontal run of cable trays shall be tied by means of nylon cords. Distance between supporting angles shall not exceed 600 mm.

d) All cable trays (other than galvanized trays) and supporting steel structures shall be painted before laying of cables. The under surfaces shall be properly degreased, degusted, de-scaled and cleaned. The painting shall be done with one coat of red oxide zinc chromate primer. Final painting shall be done with two coats of approved bituminous aluminum paint unless otherwise specified.

e) Where cables rise from trench to motor, lighting panel, control station, junction box etc., they shall be taken in GI pipe for mechanical protection up to a minimum of 300 mm above grade for outdoor area. Cable ends shall be carefully pulled through conduit to prevent damage to cable.

f) All GI Pipes shall be laid as per layout drawings and site conditions. Before fabrication of various profiles of pipes by hydraulically operated bending machine (which is to be arranged by the contractor) all the burrs from the pipes shall be removed. GI Pipes having bends shall be buried in soil I concrete in such a way that the bend shall be totally concealed. For G.I. pipes buried in soil, bitumen coating shall be applied on the buried lengths, Installation of G.I. pipes shall be undertaken well before paving is completed and necessary co ordination with paving agency shall be the responsibility of Electrical Contractor.

Following guide shall be used for sizing of GI pipes:

I. 1 cable in a pipe -53% of pipe cross-sectional area occupied by cables.
II. 2 cables in a pipe - 31% of pipe cross-sectional area occupied by cables.
III. 3 cables in a pipe - 43% of pipe cross-sectional area occupied by cables.
IV. 4 and above cables in a pipe - 40% of pipe cross-sectional area occupied by cables.

g) After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/bitumen/suitable sealing compound. Alternatively rubber bushes shall be employed for the purpose of sealing.

h) Fire proofing of end of power cables at least 1 meter at each end as per OISD norms for the refinery and Petroleum industry, shall be carried out as per the recommendation of the paint

supplier .Rates for the fire proofing of cables shall be included in the cable laying / installation and no separate payment shall be made for the fire-proof painting.

12.4 Terminations

a) All cables up to 1.1kV grade shall be terminated at the equipment by means of compression type cable glands suitable for the cable size. They shall have a screwed nipple with electrical threads and check nut. The cables shall be identified close to their termination points at both the ends of cable(cable numbers shall be punched on aluminum straps (2 mm thick) and securely fastened to the cable, wrapped around it) and also along the route at recommended intervals, by cable tag numbers

b) All cable entries for outdoor termination shall be preferably through bottom. Outdoor cable termination through top of equipment shall not be permitted.

c) In case of control cables, all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules suitable for core size. Wire numbers shall be as per schematic/ wiring/inter-connection diagram. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends, for future use.

d) The cable shall be terminated at electrical equipment/switchboards through glands of proper size. The individual cores shall then be dressed and taken along the cables ways or shall be fixed to the panels with polyethylene straps. The cable gland shall be done as per manufacturer's instructions. Cable armor shall not be exposed after termination is complete.

e) Crimping of lugs to cable leads shall be done by hand crimping / hydraulically operated tool as per requirement. Insulation of the leads shall be removed before crimping. Conductor surface shall be cleaned and shall not be left open. Suitable conducting jelly shall be applied on the conductor lead. Lugs shall enclose all strands of cable core. Cutting of strands shall not be allowed.

f) All power and control cables glands installed outdoor shall be provided with suitable sized shrouds and rates for the same shall be included in the scope of the termination of the cable glands. No separate payment is envisaged for the same.

12.5 Electrical Road Crossing (ERC)

a) Scope covers RCC pipe culverts & Electrical Road Crossings (ERC), / Instrumentation Road Crossings (IRC) with RCC / PVC pipes.

b) Codes & Standards for Road crossing shall be as indicated below.

I. IS: 458 – Pre-Cast Concrete Pipes (with & without reinforcements)
II. IS: 783 – Code of Practice for laying of RCC pipes.
III. IS: 4985 – Unplasticised PVC pipes & portable water suppliers.
IV. Note: Latest edition of all Codes & Standards shall be followed.

c) **Materials**

I. All pipes must be new & perfectly sound free from cracks, cylindrically straight & of standard nominal diameter and length with even texture. PVC pipes shall be class – I as per IS-4985. For pipe culverts, class of RCC pipe shall be NP3/NP4 or as mentioned in drawing.
II. Contractor shall submit manufacturer's test certificates for Acceptance of RCC / PVC pipes.
III. Spun yam for pipe joints shall be of best quality. It shall be free from dust.

d) **Transportation & Stacking**

I. Transportation of materials to work sites & stacking shall be done in a manner to cause minimum inconvenience to traffic & other construction work.
II. Pipe shall be protected during handling against impact, shocks & free fall to avoid cracks & damage.
III. Contractor shall be fully responsible for safety and security of materials transported and stocked in field.

e) **Lowering & Laying of PVC Pipes**

I. Lowering & laying of PVC pipes shall be done as per IS: 4985. Jointing of pipes shall be done by one end after heating and using solvent cement.
II. Payment shall be made on running meter basis of PVC pipes which included supplying, transporting, lowering, laying, jointing, concreting around PVC pipes etc. al complete.

12.6 Testing and Commissioning

a) Field testing and commissioning of electrical installation shall be carried out as per MRPL specification.
b) Before energizing, the insulation resistance of every circuit shall be measured from phase to phase, phase to neutral and from phase/neutral to earth.

c) Where splices or terminations are required in circuits rated above 650 volts, insulation resistance of each length of cable shall be measured before splicing and terminating. After completion of splices and /or terminations measurements shall be repeated.

d) Insulation resistance of directly buried cables shall be measured before cable trenches are backfilled. Measurements shall be repeated after back filling. For cables up to 1.1kV grade 1000V Megger and for H.V. Cables 2.5kV/5kV Megger shall be used.

e) D.C. High Voltage test shall be conducted on cables given below after installation.

   I. All 1100 volts grade power cables in which straight through joints have been made.

   II. All cables above 1100V grade.

f) The DC High Voltage test shall be performed as detailed below in the presence of the Engineer-in-charge or his authorized representative only.

g) Cables shall be installed in final position with the entire straight through joints complete. During the high voltage test, all other electrical equipment related to the cable installation, such as switches, instrument transformers, bus-bars, etc., must be earthed and adequate clearance shall be maintained from the other equipment and framework to prevent flash over.

h) In each test, the metallic sheath / screen / armor shall be connected to earth.

i) All checks and tests shall be made as per MRPL standard test Perform a available with site engineer.

j) All test readings shall be recorded and submitted to MRPL for review & records.

k) Cable schedule, cable layout drawings, Inter connection drawings shall be marked by contractor for 'AS BUILT STATUS' and two sets of copies along with CD shall be submitted to the Owner for reference & records.

13.0 Specifications for Lighting Mast

13.1 Codes and Standards

All standards, specifications, and codes of practice referred to herein shall be the latest edition including all applicable official amendments and revisions as on date of bid opening. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards & codes.

List of Codes and Standard

IS: 5 Color for ready mixed paints & enamels

IS: 226 Structural steel (standard quality)

IS: 280	Mild steel wires for electrical wiring installation
IS: 694	PVC insulated cables up to 1100 V
IS: 732	Code of practice for electric wiring installation up to 650V
IS: 800	Code of practice for general construction in steel
IS: 875	Wind loads
IS: 1161	ERW Pipes
IS: 1239	Mild Steel tubes
IS: 1255	Code of practice for installation and maintenance of electric cables
IS: 1544	1.1 KV grade PVC Cables
IS: 1569	Capacitors for discharge lamps circuits
IS: 1777	Industrial luminaries with metal reflectors
IS: 1913	General and safety requirements for luminaries
IS: 1944	Code of practice for lighting
IS: 1947	Flood lights
IS: 2062	Steel grades
IS: 2147	Degree of protection provided by enclosures for LT switch gear
IS: 2149	Luminaries for street lighting
IS: 2208	HRC cartridge fuse links up to 650V
IS: 2551	Danger notice plates
IS: 2629	recommended practice for hot-dip galvanizing of steel
IS: 2633	Methods of testing uniformity of zinc coating
IS: 2959	Contactors for voltage not exceeding 1000 V AC
IS: 3043	Code of practice for earthing
IS: 3202	Climate proofing of electrical equipment
IS: 3961	recommended current ratings for PVC insulated cables
IS: 4012	Dust proof electrical lighting fittings

IS: 5831 PVC insulation and sheath of electric cables

IS: 6616 Ballasts for high-pressure mercury vapour lamps

IS: 6665 Code of practice for industrial lighting

IS: 6875 Specification of control switches for voltage not exceeding 1000 V AC

IS: 7098 1.1 KV grade XLPE Cables

IS: 8130 Conductors for insulated electric cables

IS: 8623 Factory built assemblies of switchgear up to 1000 V AC

IS: 8828 MCBs for AC circuits not exceeding 1000 V AC

IS: 9224 Low voltage fuses

IS: 9974 High pressure sodium vapor lamps

IS: 10322 Luminaries

IS: 10810 Methods of tests for cables

TR-7 of ILE High mast & mid-hinged pole shafts

National Electrical Code

Indian Electricity Rules

Indian Electricity Act

13.2 Raising / Lowering High Mast

High masts shall be used for various locations as per drawings. Mast dimensions given below are guidelines only.

13.2.1 Structure:

The High mast shall be of continuously tapered, polygonal cross section, at least 20 sided, presenting a good and pleasing appearance and shall be based on proven In-Tension design conforming to the standards referred to above, to give an assured performance, and reliable service. The structure shall be suitable for wind loadings as per IS 875 part3 1987.

13.3 Construction:

The mast shall be manufactured using special steel plates, conforming to BS-EN10-025 and shall be delivered in multiple sections of effective length 10 meters. Thus a 25 m mast shall be delivered in three sections and 16 M / 20 masts in 2 sections to site. Each section shall be fabricated out of single plate duly folded and welded. There shall be only one longitudinal seam weld per section. Sections with more than one weld,

Circumferential or longitudinal, shall not be accepted. At site the sections shall be joined together

by slip-stressed-fit method. No site welding or bolted joint shall be done on the mast. The minimum overlap distance shall be 1.5 times the diameter at penetration. The minimum top diameter shall be 150 mm. Bottom diameters and plate thickness shall be as per the structural requirements. Detailed design calculation of the mast shall be submitted for verification. The mast shall be provided with fully penetrated flange, which shall be free from any lamination or incursion. The welded connection of the base flange shall be fully developed to the strength of the entire section. The base flange shall be provided with supplementary gussets between the bolt-holes to ensure elimination of helical stress concentration. For the environmental protection of the mast, the entire fabricated mast shall be hot dip galvanized, internally and externally, having a uniform average thickness of 85 microns for plates with more than 5 mm thickness and 70 microns for 5 mm or less. Galvanizing shall be done in single dipping method for better adhesion and life.

Galvanizing to be witnessed by TPI

13.3.1 Door Opening:

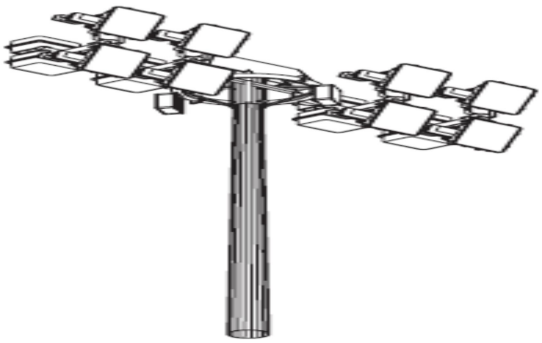
An adequate door opening shall be provided at the base of the mast and the opening shall be such that it permits clear access to equipment like winches, cables, plug and socket, etc. and also facilitate easy removal of the winch. The door opening shall be complete with a close fitting, vandal resistant, weatherproof door, provided with a heavy-duty double internal lock with special paddle key. The door opening shall be carefully designed and reinforced with welded steel section, so that the mast section at the base shall be unaffected and undue buckling of the cut portion is prevented. Size of door opening shall not be more than 1200 x 250 mm to avoid buckling of the mast section under heavy wind conditions.

13.3.2 Dynamic Loading for the Mast:

The mast structure shall be suitable to sustain an assumed maximum reaction arising from a wind speed as per IS 875 (three second gust), and shall be measured at a height of 10 meters above ground level. The design life of the mast shall be at least 25 years. The force co-efficient taken for design of the polygonal structure is to be established from the wind tunnel test data. The manufacturer should have conducted wind tunnel at reputed laboratory or institute on sample model of high mast for deriving force coefficients (as per TR-7) and relevant test reports to be submitted in tender.

13.3.3 Lantern Carriage

Fabrication: A fabricated Lantern Carriage shall be provided for fixing and holding the flood light fittings and control gearboxes. The Lantern Carriage shall be of special design and shall be of steel tube construction, the tubes acting as conduits for wires, with holes fully protected by grommets. The Lantern Carriage shall be so designed and fabricated to hold the required number of flood light fittings and the control gearboxes, and also have a perfect self-balance. The Lantern Carriage shall be fabricated in two halves and shall be provided with protective PVC arrangement, so joined by bolted flanges with stainless steel bolts and nylon type stainless steel nuts to enable easy installation or removal from the erected mast. The inner lining of the carriage shall ensure that no damage is caused to the surface of the mast during the raising and lowering operation of the carriage. The entire Lantern Carriage shall be hot dip galvanized after fabrication. The High mast shall each have a lantern carriage with a total of eight (8) nos. asymmetrically arranged 350 Watts LED Flood-Lights as shown in the figure below:



13.4 Junction Box:

Weather proof junction box, made of Cast Aluminum shall be provided on the Carriage Assembly as required, from which the inter-connections to the designed number of the flood light luminaries and associated control gears fixed on the carriage shall be made.

13.4.1 Raising and lowering mechanism:

For the installation and maintenance of the luminaries and lamps, it will be necessary to lower and raise the Lantern Carriage Assembly. To enable this, a suitable Winch Arrangement shall be provided, with the winch fixed at the base of the mast and the specially designed head frame assembly at the top.

13.5 Winch:

The winch shall be of completely self-sustaining type, without the need for brake shoe, springs or clutches. Each driving spindle of the winch shall be positively locked when not in use, gravity activated PAWLS. Individual drum also should be operated for fine adjustment of lantern carriage. The capacity, operating speed, safe working load, recommended lubrication and serial number of the winch shall be clearly marked on each winch. The gear ratio of the winch shall be 53: 1. However, the minimum-working load shall be not less than 750 kg. The winch shall be self-lubricating type by means of an oil bath and the oil shall be readily available grades of reputed producers. The winch drums shall be grooved to ensure perfect seat for stable and tidy rope lay, with no chances of rope slippage. The rope termination in the winch shall be such that distortion or twisting is eliminated and at least 5 to 6 turns of rope remains on the drum even when the lantern carriage is fully lowered and rested on the rest pads. It should be possible to operate the winch manually by a suitable handle or by an integral power tool. It shall be possible to remove the double drum after dismantling, through the door opening provided at the base of the mast. A test certificate shall be furnished by the Contractor from the original equipment manufacturer, for each winch in support of the maximum load operated by the winch. The winch shall be type tested through reputed institutions like IIT as consultants and the type test report shall be submitted along with offer. A test certificate is to be submitted along with supplies.

13.5.1 Head Frame:

The head frame, which is to be designed, as a capping unit of the mast, shall be of welded steel construction, galvanized both internally and externally after assembly. The top pulley shall be of appropriate diameter, large enough to accommodate the stainless steel wire ropes and the multi-core electric cable. The pulley block shall be made of non-corrodible material, and shall be of die cast Aluminum Alloy (LM-6). Pulley made of synthetic materials such as Plastic or PVC is not acceptable. Self-lubricating bearings and stainless steel shaft shall be provided to facilitate smooth and maintenance free operation for a long period. The pulley assembly shall be fully protected by a canopy galvanized internally and externally. Close fitting guides and sleeves shall be provided to ensure that the ropes and cables do not dislodged from their respective positions in the grooves. The head frame shall be provided with guides and stops with PVC buffer for docking the lantern carriage.

13.5.2 Stainless Steel Wire Ropes:

The suspension system shall essentially be without any intermediate joint and shall consist of

only non-corrodible stainless steel of AISI 316 grade. The stainless steel wire ropes shall be of 7/19 construction, the central core being of the same material. The overall diameter of the rope shall not be less than 6 mm. The breaking load of each rope shall not be less than 2350 kg. Giving a factor of safety of over 5 for the system at full load as per the TR-7 referred to in the beginning of this specification. The end constructions of ropes to the winch drum shall be fitted with telluric. The thimbles shall be secured on ropes by compression splices. Two continuous lengths of stainless steel wire ropes shall be used in the system and no intermediate joints are acceptable in view of the required safety. No intermediate joints/terminations, either bolted or else, shall be provided on the wire ropes between winch and lantern carriage.

13.6 Electrical System, Cable and Cable Connections:

Bottom electrical accessories of the mast shall be flame proof. A suitable flameproof plug socket unit shall be provided at the bottom compartment. This unit shall have facilities for terminating incoming cable (up to 4 core 16 mm² Al Armored). Outgoing of this unit shall be trailing cable for the mast through a plug. The electrical connections from the bottom to the top shall be made by special trailing cable. The cable shall be EPR insulated and PCP sheathed to get flexibility and endurance. Size of the cable shall be minimum 5 cores 2.5 mm² copper. The cable shall be of reputed make. At the top there shall be weatherproof junction box to terminate the trailing cable. Connections from the top junction box to the individual luminaries shall be made by using 3 core 1.5 mm² flexible PVC cables of reputed make. Also, suitable provision shall be made at the base compartment of the mast to facilitate the operation of internally mounted, electrically operated flame proof power tool for raising and lowering of the lantern carriage assembly.

13.6.1 Power Tool for the Winch:

A suitable, high-powered, electrically driven, internally mounted power tool, with manual over ride shall be supplied for the raising and lowering of the lantern carriage for maintenance purposes. The speed of the power tool shall be to suit the system. The power tool shall be single speed, provided with a motor of the required rating. The power tool shall be supplied complete with suitable control. The capacity and speed of the electric motor used in the power tool shall be suitable for the lifting of the design load installed on the lantern carriage. The power tool mounting shall be so designed that it will be not only self-supporting but also aligns the power tool perfectly with respect to the winch spindle during the operations. Also, a handle for the

manual operation of the winches in case of problems with the electrically operated tool shall be provided and shall incorporate a torque-limiting device. The power tool operation shall always be through a separate torque-limiting device to protect the wire ropes from over stretching. It shall be mechanical with suitable load adjusting device. The torque limiter shall trip the load when it exceeds the adjusted limits. There shall be suitable provision for warning the operator once the load is tripped off. The torque limiter is a requirement as per the relevant standards in view of the overall safety of the system. Each mast shall have its own power tool motor.

13.7 Lightning Finial:

One number heavy duty hot dip galvanized lighting finial shall be provided for each mast. The lightning finial shall be minimum 2 M in length and shall be provided at the centre of the head frame. It shall be bolted solidly to the head frame to get a direct conducting path to the earth through the mast. The lightning finial shall not be provided on the lantern carriage under any circumstances in view of safety of the system

13.7.1 Aviation Obstruction Lights:

Suitable Aviation Obstruction Lights of reliable design and reputed manufacturer shall be provided on top of each mast.

13.8 Earthing Terminals:

2 Nos. earth terminal using 12mm diameter stainless steel bolts shall be provided at a convenient location on the base of the Mast, for lightning and electrical earthing of the mast.

Each Flood light mast shall be provided with 2 nos. earth electrode in test pits with GI earth strip connections

13.9 Feeder Pillar:

The Feeder Pillars / Control panel for the Flood Light Masts (FLM) shall each have a separate Timer-Contactor arrangement with controls for the winch-motor assembly. The FLM feeder pillars shall be with polycarbonate enclosures, with IP-65 protection, having loop in loop out feature. The FLM feeder pillar control wiring diagram shall be as provided by MRPL

13.9.1 R, Y, B to be fed from separate (dedicated) cables, so that if one phase goes out the luminaries connected with other phases should continue illumination.

13.9.2 **Flood Light Masts (FLM's)** & other facilities provided at the parking area, gate area and junctions**.**

- A total of 5 nos of 25 meter high FLMs (at Main Gate area) and 4 nos of 25 meter FLMs

(at Phase III Gate area) have to be installed with each FLM having eight (8) nos. LED Flood-Light fixtures rated for 350Watts each.

- FLMs shall each have a lantern carriage with a total of eight (8) nos. asymmetrically arranged **350 Watts LED Flood-Lights** as per reference drawing.
- LED Flood Lights shall have a minimum luminous efficacy of 100 lumen / Watt & only Bajaj make of FLMs shall considered mandatorily.
- FLMs, shall be all comprehensive – including all civil works for excavation / PCC / RCC / back filling for foundation and shall include the 350 Watts flood light fixtures as well (8 no's LED Flood-Lights per FLM).
- Feeder Pillars / Control panel for Flood Light Masts shall each have a separate Timer-Contactor arrangement with controls for winch-motor assembly. FLM feeder pillars shall be with polycarbonate enclosures, with IP-65 protection, having loop in loop out feature. FLM feeder pillar control wiring diagram shall be provided by MRPL for inclusion in the tender.
- Each FLM shall be provided with 2 nos. earth electrode in test pits with GI earth strip connections. Earthing works shall not be inclusive in FLM item but shall be considered separately.

14.0 SOR BASED ELECTRICAL ITEMS – SPECIFICATIONS

Part I	POWER CONTROL CENTRES & DISTRIBUTION BOARDS
Notes :	The rates for all these items under the above heading should include all necessary items and equipments as required.
a)	Assembling loose components of the various equipment as per OEM's specifications and as per advise of Consultant .
b)	Bonding onto masonry/concrete work including cutting/drilling holes through walls/floors and grouting with cement mortar 1:2:4.
c)	Providing All fixing accessories such as nuts, screws, bolts, Anchor Fastners etc. as required.
d)	Effecting adequate and proper connections to the main Earthing Stations .
e)	Touching up all damaged paint over equipment with two coats of Red Oxide Primer and two finishing coats of approved synthetic enamel paint.

f)	All items listed in the BOQ shall be of approved make only as per tender. Any unspecified item shall be as per approval of consultant.
g)	All necessary Lifting, Shifting & Instalaltion charges to be included in instalaltion rates. No extra amount shall be paid for the same.
	Design as per technical specifications and obtaining approval of drawings prior to manufacturing, manufacture, insure, pack with PVC sheets, transport to site, unload, store, erect in proper position, testing and commissioning of following Panel ccustomercles. The panels shall be front operated, dead back having Bottom Bus bars & Top Cable entry, & fabricated using 14 gauge, CRCA sheet steel for main frame, door and partitions, dust and vermin proof lockable doors and carrying the control wiring using approved make FRLS colour coded Wires of minimum 2.5 sq.mm and using approved make push on terminals. The panel shall be floor mounting type, all complete with interconnections by using electrolytic grade tinned copper Bus Bars of 99.95% purity, colour coded heat shrinkable PVC sleeves. The Panel shall be painted with Powder Coated granular finished painting with 7 tank painting process with shade as per approval from inside and outside all complete as per drawings, technical specifications and final approval of Bank/Consultant. Note : Discrimination study to submitted for all panels along with offer.
1.0	**Main LT Panel (Main gate)**
1.1	**Incomer Section :**
	1 Nos. of 800 Amps., Four Pole, Microprocessor Based Molded Case Circuit Breaker with microprocessor based built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=35kAfor1sec & RS-485 port ready to hook up with BMS. 1 Nos of RS 485 Module for BMS Connectivity showing all Electrical Parameters with necessary Hardware to be provided for Panel.
1.2	**Metering Section for Incomer**
	1 No., CT Operated load manager of approved make. The Load manager should have Ammeter, Voltmeter, kWH, kVAR, Power Factor & Frequency meter & built in RS-485 port ready to hook up with BMS (Power Quality Meter)
1.3	**Indication Section For Each Incoming Section :**
	3 Nos., Phase Indicating lamps, Led type of approved make.

	2 Nos., One Red and One Green Led type lamps for indicating MCCB is in `ON' or `OFF' position.
	1 No., Trip Circuit Healthy White lamp with Push Button
	1 No., Amber lamp for Auto Trip indicating of MCCB
1.4	**Current Transformers For Incoming Section =**
	3 Nos. of 800/5 Amps Cast Resin type Current Transformers, having 15 VA burden and Class-1 accuracy for metering purpose.
	3 Nos. of 800/5 Amps Cast Resin type Current Transformers, having 15 VA burden and Class- 5P20 accuracy for protection purpose.
1.5	**Bus bars :-**
	800 Amps uniformly rated, continuous duty, 415 V AC, 3 Phase and Neutral electrolytic grade 99.95% Purity Tinned Copper Bus-bars having SC withstand capacity of 50 kA for 1 sec, with colour coded heat shrink sleeves supported on SMC type grip supports. The Horizontal / Vertical sections of the busbars should all be uniformly rated for 800 Amps.
1.6	**Out goings :-**
	2Nos., of 250 Amps., Four Pole, Microprocessor Based Molded Case Circuit Breaker with built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=25 kA for 1sec & built in RS-485 port ready to hook up with BMS.(Including all indications and metering as per SLD)
	2 Nos., of 160Amps., Four Pole, Microprocessor Based Molded Case Circuit Breaker with built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=25 kA for 1sec & built in RS-485 port ready to hook up with BMS.(Including all indications and metering as per SLD)
	2Nos., of 125Amps., Four Pole, Microprocessor Based Molded Case Circuit Breaker with built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=25 kA for 1sec & built in RS-485 port ready to hook up with BMS.(Including all indications and metering as per SLD)

	8 Nos., of 63Amps., Four Pole, Thermal magnetic Based Molded Case Circuit Breaker with built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=25 kA for 1sec & built in RS-485 port ready to hook up with BMS.(Including all indications and metering as per SLD)
	4 Nos., of 40Amps., Four Pole, Thermal magnetic Based Molded Case Circuit Breaker with built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=25 kA for 1sec & built in RS-485 port ready to hook up with BMS.(Including all indications and metering as per SLD)
	The above board shall be enclosed in design with powder coated paint all complete and as per final direction and final approval of the Consultant
2.0	**Main LT Panel (PHASE III gate)**
1.1	**Incomer Section :**
	1 Nos. of 400 Amps., Four Pole, Microprocessor Based Molded Case Circuit Breaker with microprocessor based built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=35kAfor1sec & RS-485 port ready to hook up with BMS. 1 Nos of RS 485 Module for BMS Connectivity showing all Electrical Parameters with necessary Hardware to be provided for Panel.
1.2	**Metering Section for Incomer**
	1 No., CT Operated load manager of approved make. The Load manager should have Ammeter, Voltmeter, kWH, kVAR, Power Factor & Frequency meter & built in RS-485 port ready to hook up with BMS (Power Quality Meter)
1.3	**Indication Section For Each Incoming Section :**
	3 Nos., Phase Indicating lamps, Led type of approved make.
	2 Nos., One Red and One Green Led type lamps for indicating MCCB is in `ON' or `OFF' position.
	1 No., Trip Circuit Healthy White lamp with Push Button
	1 No., Amber lamp for Auto Trip indicating of MCCB

1.4	**Current Transformers For Incoming Section =**
	3 Nos. of 400/5 Amps Cast Resin type Current Transformers, having 15 VA burden and Class-1 accuracy for metering purpose.
	3 Nos. of 400/5 Amps Cast Resin type Current Transformers, having 15 VA burden and Class- 5P20 accuracy for protection purpose.
1.5	**Bus bars :-**
	400 Amps uniformly rated, continuous duty, 415 V AC, 3 Phase and Neutral electrolytic grade 99.95% Purity Tinned Copper Bus-bars having SC withstand capacity of 50 kA for 1 sec, with colour coded heat shrink sleeves supported on SMC type grip supports. The Horizontal / Vertical sections of the busbars should all be uniformly rated for 800 Amps.
1.6	**Out goings :-**
	2 Nos., of 250 Amps., Four Pole, Microprocessor Based Molded Case Circuit Breaker with built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=25 kA for 1sec & built in RS-485 port ready to hook up with BMS.(Including all indications and metering as per SLD)
	2 Nos., of 160Amps., Four Pole, Microprocessor Based Molded Case Circuit Breaker with built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=25 kA for 1sec & built in RS-485 port ready to hook up with BMS.(Including all indications and metering as per SLD)
	2Nos., of 125Amps., Four Pole, Microprocessor Based Molded Case Circuit Breaker with built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=25 kA for 1sec & built in RS-485 port ready to hook up with BMS.(Including all indications and metering as per SLD)
	6 Nos., of 63Amps., Four Pole, Thermal magnetic Based Molded Case Circuit Breaker with built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=25 kA for 1sec & built in RS-485 port ready to hook up with BMS.(Including all indications and metering as per SLD)

	2 Nos., of 40Amps., Four Pole, Thermal magnetic Based Molded Case Circuit Breaker with built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=25 kA for 1sec & built in RS-485 port ready to hook up with BMS.(Including all indications and metering as per SLD)
	The above board shall be enclosed in design with powder coated paint all complete and as per final direction and final approval of the Consultant
3.0	**140 kVAR Capacitor PANEL :- (Main gate)**
3.1	**Incomer Section :-**
	1 Nos. of 250 Amps., Four Pole, Microprocessor Based Molded Case Circuit Breaker with microprocessor based built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=35kAfor1sec & RS-485 port ready to hook up with BMS. 1 Nos of RS 485 Module for BMS Connectivity showing all Electrical Parameters with necessary Hardware to be provided for Panel.
3.2	**Metering Section :-**
	1 No. 12 Step 3 Phase Sensing CT Operated approved make APFC Relay.
	1 No. CT Operated load manager of approved make. The Load manager should have Ammeter, Voltmeter, kWH, kVAR, Power Factor & Frequency meter & built in RS-485 port ready to hook up with BMS.
3.3	**Indication Section For Incoming Section :-**
	3 Nos., Phase Indicating lamps, Led type of approved make.
	2 Nos., One Red and One Green Led type lamps for indicating MCCB is in `ON' or `OFF' position.
	1 No., Trip Circuit Healthy White lamp with Push Button
	1 No., Amber lamp for Auto Trip indicating of MCCB
3.4	**Current Transformers For Incoming Section :**
	3 Nos. of 250/5 Amps Cast Resin type Current Transformers, having 15 VA burden and Class-1 accuracy for metering purpose.
3.5	**Bus bars :-**

	250 Amps uniformly rated, continuous duty, 415 V AC, 3 Phase and Neutral electrolytic grade 99.95% Purity Tinned Copper Bus-bars having SC withstand capacity of **36 kA** for 1 sec, with colour coded heat shrink sleeves supported on SMC type grip supports. The Horizontal / Vertical sections of the busbars should all be uniformly rated for 650 Amps.
3.6	**Out goings :-**
	04 Set of **63** Amps Thermal Magnetic Three Pole MCCB with Nos 60 Amps Semi Conductor Type 120 KA Din Type Fuses with Thyristors and 7% Detuned reactors alongwith and Nos 25 KVAR Dry Type Capacitors of approved make .
	04Set of **32** Amps Thermal Magnetic Three Pole MCCB with 4Nos 30 Amps Semi Conductor Type 120 KA Din Type Fuses with Thyristors and 7% Detuned reactors alongwith and 4 Nos 10 KVAR Dry Type Capacitors of approved make .
	8 - set of terminal blocks and control fuses and Connecting cables from Terminal Block to Capacitors using suitable electrolytic grade copper bus-bars/ XLPE insulated Copper Cables as required.
	The above board shall be enclosed in design with powder coated paint all complete and as per final directions and final approval of the Consultant.
5.0	**100 kVAR Capacitor PANEL :- (Phase III gate)**
5.1	**Incomer Section :-**
	1 Nos. of 250 Amps., Four Pole, Microprocessor Based Molded Case Circuit Breaker with microprocessor based built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=35kAfor1sec & RS-485 port ready to hook up with BMS. 1 Nos of RS 485 Module for BMS Connectivity showing all Electrical Parameters with necessary Hardware to be provided for Panel.
5.2	**Metering Section :-**
	1 No. 12 Step 3 Phase Sensing CT Operated approved make APFC Relay.
	1 No. CT Operated load manager of approved make. The Load manager should have Ammeter, Voltmeter, kWH, kVAR, Power Factor & Frequency meter & built in RS-485 port ready to hook up with BMS.
5.3	**Indication Section For Incoming Section :-**
	3 Nos., Phase Indicating lamps, Led type of approved make.

	2 Nos., One Red and One Green Led type lamps for indicating MCCB is in `ON' or `OFF' position.
	1 No., Trip Circuit Healthy White lamp with Push Button
	1 No., Amber lamp for Auto Trip indicating of MCCB
5.4	**Current Transformers For Incoming Section :**
	3 Nos. of 250/5 Amps Cast Resin type Current Transformers, having 15 VA burden and Class-1 accuracy for metering purpose.
5.5	**Bus bars :-**
	250 Amps uniformly rated, continuous duty, 415 V AC, 3 Phase and Neutral electrolytic grade 99.95% Purity Tinned Copper Bus-bars having SC withstand capacity of **36 kA** for 1 sec, with colour coded heat shrink sleeves supported on SMC type grip supports. The Horizontal / Vertical sections of the busbars should all be uniformly rated for 650 Amps.
5.6	**Out goings :-**
	04 Set of **63** Amps Thermal Magnetic Three Pole MCCB with 5 Nos 60 Amps Semi Conductor Type 120 KA Din Type Fuses with Thyristors and 7% Detuned reactors alongwith and 3 Nos 25 KVAR Dry Type Capacitors of approved make .
	02Set of **32** Amps Thermal Magnetic Three Pole MCCB with 4Nos 30 Amps Semi Conductor Type 120 KA Din Type Fuses with Thyristors and 7% Detuned reactors alongwith and 3 Nos 10 KVAR Dry Type Capacitors of approved make .
	01Set of **32** Amps Thermal Magnetic Three Pole MCCB with 4Nos 30 Amps Semi Conductor Type 120 KA Din Type Fuses with Thyristors and 7% Detuned reactors alongwith and1 Nos 5 KVAR Dry Type Capacitors of approved make .
	7 - set of terminal blocks and control fuses and Connecting cables from Terminal Block to Capacitors using suitable electrolytic grade copper bus-bars/ XLPE insulated Copper Cables as required.
	The above board shall be enclosed in design with powder coated paint all complete and as per final directions and final approval of the Consultant.
7.0	**UPS OUT PUT PANEL**
7.1	**Incomer Section :**

	1 No. of 125 Amps., Four Pole, Moulded Case Circuit Breaker with Thermal Magnetic based built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=25 kA for1sec 1 Nos of RS 485 Module for BMS Connectivity showing all Electrical Parameters with necessary Hardware to be provided for Panel.(Including all indications and metering as per SLD)
7.2	**Metering Section :**
	1 No., CT Operated Direct Reading 96 mm Square Digital Ammter of approved make. The Ammeter shall have built in RS-485 Port ready to hook up with BMS. The Bidder has to also provide 1 No 96 mm Square Direct Reading Voltmter .
7.3	**Indication Section For Incoming Section :**
	3 Nos., Phase Indicating lamps, Led type of approved make.
	2 Nos., One Red and One Green Led type lamps for indicating MCCB is in `ON' or `OFF' position.
	1 No., Trip Circuit Healthy White lamp with Push Button
	1 No., Amber lamp for Auto Trip indicating of MCCB
7.4	**Current Transformers For Incoming Section :**
	3 Nos. of 125/5 Amps Cast Resin type Current Transformers, having 15 VA burden and Class-1 accuracy for metering purpose.
7.5	**Bus bars :-**
	125 Amps uniformly rated, continuous duty, 415 V AC, 3 Phase and Neutral electrolytic grade 99.95% Purity Tinned Copper Bus-bars having SC withstand capacity of 36 kA for 1 sec, with colour coded heat shrink sleeves supported on SMC type grip supports. The Horizontal / Vertical sections of the busbars should all be uniformly rated for 160 Amps.
7.6	**Out goings :-**
	9 Nos., of 63 Amps., Four Pole , Miniture Case Circuit Breaker of C Curve and of 10 Ka fault rating including all indications and metering as per SLD)
	6 Nos., of 40 Amps., Four Pole , Miniture Case Circuit Breaker of C Curve and of 10 Ka fault rating including all indications and metering as per SLD)
	The above board shall be enclosed in design with powder coated paint all complete

	and as per final directions and final approval of the Consultant.
8.0	**LIFT Panel**
8.1	**Incomer Section :**
	1 No. of 160Amps., Four Pole, Moulded Case Circuit Breaker with Thermal Magnetic based built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=25 kA for1sec 1 Nos of RS 485 Module for BMS Connectivity showing all Electrical Parameters with necessary Hardware to be provided for Panel.(Including all indications and metering as per SLD)
8.2	**Metering Section :**
	1 No., CT Operated Direct Reading 96 mm Square Digital Ammter of approved make. The Ammeter shall have built in RS-485 Port ready to hook up with BMS. The Bidder has to also provide 1 No 96 mm Square Direct Reading Voltmter .
8.3	**Indication Section For Incoming Section :**
	3 Nos., Phase Indicating lamps, Led type of approved make.
	2 Nos., One Red and One Green Led type lamps for indicating MCCB is in `ON' or `OFF' position.
	1 No., Trip Circuit Healthy White lamp with Push Button
	1 No., Amber lamp for Auto Trip indicating of MCCB
8.4	**Current Transformers For Incoming Section :**
	3 Nos. of 160/5 Amps Cast Resin type Current Transformers, having 15 VA burden and Class-1 accuracy for metering purpose.
8.5	**Bus bars :-**
	160 Amps uniformly rated, continuous duty, 415 V AC, 3 Phase and Neutral electrolytic grade 99.95% Purity Tinned Copper Bus-bars having SC withstand capacity of 36 kA for 1 sec, with colour coded heat shrink sleeves supported on SMC type grip supports. The Horizontal / Vertical sections of the busbars should all be uniformly rated for 250 Amps.
8.6	**Out goings :-**

	4 Nos., of 63 Amps., Four Pole, Thermal Magnetic Type Molded Case Circuit Breaker with built in over-current, short circuit and earth fault releases. The Breaker shall be suitable for 415 Volts 50 Hz., AC supply and with 230 Volts AC Shunt Trip Coil. Icu=Ics=Icw=16 kA for 1sec & built in RS-485 port ready to hook up with BMS.(Including 60/5 Amps 15 VA 3 Nos CT;s indication Lamps as shown in SLD and Ammeter & KWH metering Digital type with BMS Connectivity as per SLD)
	4 Nos., of 20 Amps., Double Pole , Miniture Case Circuit Breaker of C Curve and of 10 Ka fault rating including all indications and metering as per SLD)
	The above board shall be enclosed in design with powder coated paint all complete and as per final directions and final approval of the Consultant.
9.0	Providing and fixing on angle iron frame work 63 Amps Four Pole MCB of approved make. The rate shall also include supply and Installation of CRCA 14 SWG Fabricated Box to house the Four Pole MCCB and painting of these Box and frames using two coats of anti rust red oxide primer and three coats of approved colour Powder Coated paint all complete as required and as per final direction & approval of Consultants.
10.0	**HIGH MAST LIGHTING (12 WAY VTPN)**
	Providing and fixing on angle iron frame work Raw power distribution boards MCB type of approved make only and comprising of the following. The DB shall be IP-43 with acrylic door, VTPN type. The rate shall also include supply and Installation of frame fabricated using minimum 25 x 6 mm M.S. Angles and minimum 25 x 6 mm GI flats and painting of these frames using seven tank painting process and powder coated paint all complete as required and as per final direction and approval of Consultants/Bank.
●	Incomer :-
	1 Nos., of 160 Amps., Four Pole Thermo Magnetic based Moulded Case Circuit Breaker with built in over current, short circuit releases. The MCCB shall be suitable for 415 Volts 50 Hz., AC supply and having Minimum fault level of 25 KA for 1 Sec and ICS = 100% of ICU & 1 No 110 Amps Three Phase AC-23 duty Contactor with 0-24 hrs Timer with ON/OFF indication and Digital Ammeter & Voltmter Three Phase with Selector Switch and 3 Nos Phase indicating Lamps LED type.
●	Out goings :-

	4 Nos., of 40 Amps., Four Pole , Miniture Case Circuit Breaker of C Curve and of 10 Ka fault rating
	4 Nos., of 32 Amps., Four Pole , Miniture Case Circuit Breaker of C Curve and of 10 Ka fault rating
	The above board shall be enclosed in design with powder coated paint all complete and as per final direction and final approval of the Consultant/Bank.
11.0	**LIGHTING POWER DB (8 WAY TPN) STREET LIGHT**
	Providing and fixing on angle iron frame work Lighting distribution boards MCB type of approved make only and comprising of the following. The DB shall be IP-43 with acrylic door, VTPN type. The rate shall also include supply and Installation of frame fabricated using minimum 25 x 6 mm M.S. Angles and minimum 25 x 6 mm GI flats and painting of these frames using seven tank painting process and powder coated paint all complete as required and as per final direction and approval of Consultants/Bank.
●	Incomer :-
	1 Nos., of 125 Amps., Four Pole Thermo Magnetic based Moulded Case Circuit Breaker with built in over current, short circuit releases. The MCCB shall be suitable for 415 Volts 50 Hz., AC supply and having Minimum fault level of 25 KA for 1 Sec and ICS = 100% of ICU & 1 No 110 Amps Three Phase AC-23 duty Contactor with 0-24 hrs Timer with ON/OFF indication and Digital Ammeter & Voltmter Three Phase with Selector Switch and 3 Nos Phase indicating Lamps LED type.
●	Out goings :-
	16 Amps./way, 8 ways/Phase, TPN, MCB DB comprising of 24 Nos., 1 6 Amps., Single pole C curve MCB's having Short circuit breaking capacity of 10 kA.
	The above board shall be enclosed in design with powder coated paint all complete and as per final direction and final approval of the Consultant/Bank.
12.0	**UPS POWER DB (8WAY TPN)**

	Providing and fixing on angle iron frame work UPS distribution boards MCB type of approved make only and comprising of the following. The DB shall be IP-43 with acrylic door, VTPN type. The rate shall also include supply and Installation of frame fabricated using minimum 25 x 6 mm M.S. Angles and minimum 25 x 6 mm GI flats and painting of these frames using seven tank painting process and powder coated paint all complete as required and as per final direction and approval of Consultants/Bank.
●	Incomer :-
	1 No., 40 Amps., 4 Pole, 10 kA Breaking Capacity "C" Curve MCB with 3 Nos 32 Amps Two Pole Miniature Circuit Breaker.
●	Out goings :-
	16 Amps./way, 8 ways/Phase, TPN, MCB DB comprising of 24 Nos., 16 Amps., Single pole C curve MCB's having Short circuit breaking capacity of 10 kA.
	The above board shall be enclosed in design with powder coated paint all complete and as per final direction and final approval of the Consultant/Bank.
13.0	**UPS POWER DB (6WAY TPN)**
	Providing and fixing on angle iron frame work UPS distribution boards MCB type of approved make only and comprising of the following. The DB shall be IP-43 with acrylic door, VTPN type. The rate shall also include supply and Installation of frame fabricated using minimum 25 x 6 mm M.S. Angles and minimum 25 x 6 mm GI flats and painting of these frames using seven tank painting process and powder coated paint all complete as required and as per final direction and approval of Consultants/Bank.
●	Incomer :-
	1 No., 40 Amps., 4 Pole, 10 kA Breaking Capacity "C" Curve MCB with 3 Nos 32 Amps Two Pole Miniature Circuit Breaker.
●	Out goings :-
	16 Amps./way, 6ways/Phase, TPN, MCB DB comprising of 18Nos., 16 Amps., Single pole C curve MCB's having Short circuit breaking capacity of 10 kA.
	The above board shall be enclosed in design with powder coated paint all complete and as per final direction and final approval of the Consultant/Bank.
14.0	**LIGHTING POWER DB (12WAY TPN)**

	Providing and fixing on angle iron frame work Lighting distribution boards MCB type of approved make only and comprising of the following. The DB shall be IP-43 with acrylic door, VTPN type. The rate shall also include supply and Installation of frame fabricated using minimum 25 x 6 mm M.S. Angles and minimum 25 x 6 mm GI flats and painting of these frames using seven tank painting process and powder coated paint all complete as required and as per final direction and approval of Consultants/Bank.
●	Incomer :-
	1 No., 40 Amps., 4 Pole, 10 kA Breaking Capacity "C" Curve MCB with 3 Nos 32 Amps Two Pole 100 mA sensitivity,RCBO+AFD
●	Out goings :-
	6 Amps./way, 12 ways/Phase, TPN, MCB DB comprising of 36Nos., 6 Amps., Single pole C curve MCB's having Short circuit breaking capacity of 10 kA.
	The above board shall be enclosed in design with powder coated paint all complete and as per final direction and final approval of the Consultant/Bank.
15.0	**LIGHTING POWER DB (6 WAY TPN)**
	Providing and fixing on angle iron frame work Lighting distribution boards MCB type of approved make only and comprising of the following. The DB shall be IP-43 with acrylic door, VTPN type. The rate shall also include supply and Installation of frame fabricated using minimum 25 x 6 mm M.S. Angles and minimum 25 x 6 mm GI flats and painting of these frames using seven tank painting process and powder coated paint all complete as required and as per final direction and approval of Consultants/Bank.
●	Incomer :-
	1 No., 40 Amps., 4 Pole, 10 kA Breaking Capacity "C" Curve MCB with 3 Nos 32 Amps Two Pole 100 mA sensitivityRCBO+AFD
●	Out goings :-
	6 Amps./way, 6 ways/Phase, TPN, MCB DB comprising of 18Nos., 6 Amps., Single pole C curve MCB's having Short circuit breaking capacity of 10 kA.
	The above board shall be enclosed in design with powder coated paint all complete and as per final direction and final approval of the Consultant/Bank.
16.0	**POWER DB (8WAY TPN)**

	Providing and fixing on angle iron frame work Raw power distribution boards MCB type of approved make only and comprising of the following. The DB shall be IP-43 with acrylic door, VTPN type. The rate shall also include supply and Installation of frame fabricated using minimum 25 x 6 mm M.S. Angles and minimum 25 x 6 mm GI flats and painting of these frames using seven tank painting process and powder coated paint all complete as required and as per final direction and approval of Consultants/Bank.
●	Incomer :-
	1 No., 63Amps., 4 Pole, 10 kA Breaking Capacity "C" Curve MCB with 3 Nos 32 Amps Two Pole 100 mA sensitivity,RCBO+AFD
●	Out goings :-
	16 Amps./way, 8ways/Phase, TPN, MCB DB comprising of 24Nos., 16 Amps., Single pole C curve MCB's having Short circuit breaking capacity of 10 kA.
	The above board shall be enclosed in design with powder coated paint all complete and as per final direction and final approval of the Consultant/Bank.
17.0	**POWER DB (6WAY TPN)**
	Providing and fixing on angle iron frame work Raw power distribution boards MCB type of approved make only and comprising of the following. The DB shall be IP-43 with acrylic door, VTPN type. The rate shall also include supply and Installation of frame fabricated using minimum 25 x 6 mm M.S. Angles and minimum 25 x 6 mm GI flats and painting of these frames using seven tank painting process and powder coated paint all complete as required and as per final direction and approval of Consultants/Bank.
●	Incomer :-
	1 No., 63Amps., 4 Pole, 10 kA Breaking Capacity "C" Curve MCB with 3 Nos 32 Amps Two Pole 100 mA sensitivity,RCBO+AFD
●	Out goings :-
	16 Amps./way, 6ways/Phase, TPN, MCB DB comprising of 18Nos., 16 Amps., Single pole C curve MCB's having Short circuit breaking capacity of 10 kA.
	The above board shall be enclosed in design with powder coated paint all complete and as per final direction and final approval of the Consultant/Bank.

18.0	Supply, receive, store at site, erect in position 150 mm x 150 mm x 3 mm thick Aluminum made Danger Sign Notice Boards as per specifications described in tender and as per final direction and approval of Consultant/Bank.
18.1	11 kV Enameled 'Danger' board.
18.2	415 V Enameled 'Danger' board.
18.0	Supply, receive, store at site, erect in position Shock Treatment charts duly framed and covered with non glare acrylic sheet in local language and in English, easily readable from a distance of 2 metres, as per specifications described in tender, all complete as required and as per final direction and approval of Consultants/Bank
19.0	Supply, receive, store at site, erect in position CO2 type fire Extinguishers of 6 KG all complete as required and as per final direction and approval of Consultant/Bank.
20.0	Supply, receive, store at site, erect in position CO2 type fire Extinguishers of 2 KG all complete as required and as per final direction and approval of Consultant/Bank.
21.0	Supply, receive, store at site, erect in position Dry Chemical Powder type fire Extinguishers of 6 KG all complete as required and as per final direction and approval of Consultant/Bank.
22.0	Supply, receive, store at site, erect in position First Aid Medical Box as required and as per final direction and approval of Consultant/Bank.
PartII	**CABLES & CABLE TRAYS**
	Notes:-The rates for all item of work shall include :-
a)	Effecting proper and adequate connections at terminations.
b)	Ensuring that provision is left in building components and trenches as the work proceeds for incorporation of cable supports at a later date.
c)	Providing all fixing accessories such as clamping devices, nuts and bolts, screws where laid in trenches.
d)	Providing proper supports for cable terminal boxes as called for.
e)	Providing heavy duty copper lugs, insulation tape etc. at joints and terminations as called for.

f)	All fixing accessories such as GI saddles, screws, rawal plugs, suitable size Anchor Fasteners etc.
g)	Jointing by crimping type lugs.
h)	Cutting chases, holes and making good the same wherever required.
i)	Providing GI angle iron supports in the wherever required and fabricated using 50 x 50 x 6 mm GI Angle iron frame work along with 25 x 6 mm GI flats along with anti rust painting and final coats of painting.
j)	Testing of the Cables in the Manufactures works and at the Third Party Testing Lab is the Sole responsibility of the Contractor. The Amount require to carry out such tests shall be born by the Contractor without any extra cost to the owner. The Test at the works shall be witness by the Consultants/Bank.
k)	All items listed in the BOQ shall be of approved make only as per tender. Any unspecified item shall be as per approval of consultant.
l)	Vendor to verify actual quantity as per site conditions before procurement.
Part III	**EARTHING & LIGHTING PROTECTION**
1.0	All earth pits installtion & testing shall be as per IS 3043 with latest amendments.
2.0	Earthing stations should contain relevant grade of charcoal/coke and salt packed around the earth plate/ earth pipe as called for in the item.
3.0	Earthing shall be done at indicated location by the Consultants. The minimum distance between the two earth station shall be 3 meters and that from the building is 2500 mm.
4.0	An earth ring with relevant earth test terminal boxes shall to be provided at regular intervals.
5.0	Adequate number of earth strips with proper sized holes shall be provided for extending earthing/looping earth connections at various floors shall be provided and executed as per the requirement.
6.0	The Contractor has to provide heavy duty Cover of size 450 x 450 x 8 mm thick to the Earthing Chamber. The cover is to be sand blasted and then Powder coated using Matt Jet Black Colour. The Cover is to be fabricated using 8 mm thick Chequered Plate.
Part IV	**LIGHTING FIXTURES & FANS**
	The rates for lighting fixtures and fans shall include all accessories and supply of all

Notes:	materials that may be required to make the fixture complete in all respects.
1.0	All the fixtures shall be suitable for single phase, 50 cycles, 240 Volts, AC supply system.
2.0	All light fixtures shall be provided with HF ballast having THD<10% as described in the schedule.
3.0	All fixtures shall be factory wired with flexible FRLS copper conductor wires.
4.0	All fixtures shall be supplied with fluorescent lamps/incandescent bulbs/LED's or any other special type bulbs as called for in the item.
5.0	All the fixtures shall be quoted of approved make only.
Part V	**POINT WIRING & CONDUITING WORK**
Notes :-	These notes shall apply to all the relevant wiring items described in the schedule of items given below :-
a	All points wiring, circuit wiring, sub mains wiring shall be done using rigid FR PVC / GI CONDUITS as required , conduits of minimum 2 mm thickness and shall comply with IS 2509 of 1973 or amendments there of and FIA approval.
b	All switch boards under the point wiring shall be the standard boxes available and the same shall be suitable for concealed work. The boxes should be of Electro Zinc Plated as per the Manufactures standard practice and should be suitable to accommodate number of control switches fan regulators, sockets, etc. as indicated in drawings.
c	The entire wiring shall have continuous 2.5 sq.mm. approved make FR Copper conductor earth wire for earth continuity having Green colour in 660/1100 volts grade.
d	The point wiring shall comply to IS 732.
e	The entire work has to be carried out under the direct supervision of PMC/Consultant.
f	All materials under this schedule shall deemed to be included by the Contractor in his scope.
g	The entire work to be carried out as per the specifications laid down in the tenders, approved drawings, and as per final directions of PMC/Consultant/Architects.
h	The point wiring shall include wiring of light/fan outlet of any length from distribution board via switch or to the point and including providing circuit wiring, in minimum 25 mm dia PVC Conduit of 2 mm and using minimum 2.5 sq.mm FR Copper Conductor wires having Uniley bunching Class 5 Construction and having 99.99% Purity Copper and of approved make for Circuit and Point wiring and of 1100 Volts Grade and 2.5 sq.mm Yellow/Green Colour Copper wire for Earthing in 1100 Volts grade. All the FR wires

	should be of approved make.
i	The entire work of the point wiring may be split into two parts i.e. partially to be laid on MS angle brackets ceiling supported or through existing floorings. It is understood that the bidder have included all the costs towards chasing the floors, removing the debris and redoing the flooring using cement mortar. All such costs shall be deemed to have been included.

15.0 Traffic Signal System

A traffic signal system is to be setup at the Chota Gate junction near Main Gate and the Pet Coke junction near Phase III gate. The traffic signal system should be complete in all respects including poles, LED signals, controller, cabling, junction boxes etc. The number of LED signals per pole shall be at least 4 (red, green, amber and left arrow), however, the exact design shall be as per approval of MRPL / EIC and consultant.

SPECIFICATION FOR MICROPROCESSOR BASED ROAD TRAFFIC SIGNAL CONTROLLER	
HARDWARE: -	
Design	Modular & Scalable
CPU	32 Bit or better
Memory	NVRAM (Built in)
System Clock	Built in RTC with 10 years battery backup.
Supply Interruption	Continuous Operation with Upto 50 ms Mains Break
Supply Failure	Restarts without operator intervention. No Loss of data upto 10 years
Protection	Auto Shut down on power fluctuation beyond limits and Auto Start up on restoration
Output switching	Through solidstate devices with zero cross over detection.
Input/Output isolation	Output switching isolated from control circuit by optical isolation.
Police Control Panel	'Output OFF', Auto/Manual Step & 'Flash'
PROGRAMMING FACILITY	PC Compatible or 'Built in Keyboard with LCD display'
Firmware update	Through USB/RS232
Status monitoring and data logging	Through USB/RS232
OPERATING PARAMETERS	

SPECIFICATION FOR MICROPROCESSOR BASED ROAD TRAFFIC SIGNAL CONTROLLER	
Max. Number of signal groups	Field assignable with 48 active and 16 passive lines.
Max. Number of stages	16 Stages
Max. Number of signal plans	25 cycle plan (plus one plan for manual operation)
Max. Number of Day plans	08 + 04 (Holiday plans)
Max. Number of plan transitions per day	48 cycle transitions
SIGNAL SEQUENCES	a. Vehicular Groups
	Red - Green - Amber
	(Green can be Flash, Steady or Steady & Flash)
	b. Pedestrian Group (Not required)
OPERATING MODES	1. Isolated
	2. Coordinated

Parameter	**Description**				
PROGRAMMABLE PARAMETERS	The parameters can be programmed with global applicability or specifically for the particular set.				
	Sr. No.	Parameter	Min.	Max.	Type
	1a.	Minimum Green	01 Sec	99 Sec	Global
	1b.	Minimum Green Per Group	Global Min. Green	99 Sec	Specific
	2a.	Fixed Green	00 Sec	99 Sec	Global
	2b.	Fixed Green Per Group	Global Fixed Green	99 Sec	Specific
	3a.	Amber Time	01 Sec	10 Sec	Global
	3b.	Amber Time Per Group	Global Amber Time	10 Sec	Specific
	4	Pedestrian Flash Time	Global Amber Time	10 Sec	Specific
	5	All Red Time	01 Sec	10 Sec	Global

Parameter	Description				
	6	Start Up All Red Time	Global All Red Time	10 Sec	Global
	7	Start Up Flash Time	10 Sec	15 Sec	Global
	8	Cycle Time	30 Sec	255 Sec	Global
	9	Cycle Time Per Plan	Global Cycle Time	255 Sec	Specific
	10	Cycle Monitoring Time(Check)	Global Cycle Time	255 Sec	Global
SELF DIAGNOSTIC FEATURES	- Hardware/Software Watchdog				
	-Through Watch Dog Timer				
	-System Failure Detection				
	-Software Compliance Monitor				
	-Protected Access to Critical Timings				
	-Program Data Checks				
SPECIAL FEATURES	a. Conflict Monitoring				
	Inter Group				
	-Hardware through conflict matrix				
	-Software through module				
	Intra Group				
	-Software Subsystem				
	b. FLASH Facility through hardware and software.				
ELECTRICAL FEATURES					
Lamp Switching	Solid State with Zero Cross Over Detection				
Max. Load Per Solid State Output	4 A				
Max. Controller Load State Output	4 KVA				
Max. Controller Load	4 KVA				
OPERATING ENVIRONMENT					
Operating Voltage	180 to 260 VAC & 50 ± 1 Hz				
Power Consumption	300 Watts for Control Circuits				
Temperature	0ºC to 55ºC				
Humidity	95% Relative Humidity at 40ºC Non Condensing.				
Construction	IP-65 standard incorporating following features also-Weather Proof, Vandal Proof, Dust & Splash Proof, Steel Cabinet-Passivated and Painted, cable entry points				

Parameter	Description
	available , separate access to police panel controls

SPECIFICATION FOR DUAL COLOUR DIGITAL ELECTRONIC REVERSE TIMER (If required)	
CPU	Micro controller based.
Input Signal	Lamp drive input (Red, Amber, and Green) derived from main signal group of a Fixed Time Traffic Controller
Input sensing time	2 to 3 Cycles
Output Display	Dual Colored (Red & Green)
Sensing sequence	Activated only at the start of Green signal stage. Recording of signal stage timing in first cycle, confirmation of timing in second/verification in the third cycle & display of balance timing in fourth cycle.
Output Display	i.) VEHICULAR:
	Balance time in seconds, for individual signal stage (Red, Amber, and Green). Flashing "000" during initial 2 to 3 cycles or Plan change or All Red or Start Up Flash mode.
	ii.) PEDESTRIAN:
	Balance time in seconds, for Pedestrian Green stage. Blank display during Pedestrian Red stage.
Display type	2 ½ digit, 8” x 6” digit size LED display, comprising of high efficiency red & green LEDs.
Input Voltage	230VAC ± 10%, 50Hz, single phase
Input Power	30 VA (min) to 100 VA (max).
Size (W x H x D)	360 x 370 x 220mm with 130mm hood on Top
Weight	As per standard
Storage Temp	0°C to 75°C
Operating Temp	0°C to 55°C
Humidity	95% at 40°C (Non Condensing)

SPECIFICATION FOR LED PANELS	

SPECIFICATION FOR LED PANELS	
LED Panel Light	300 mm dia in Plastic Die molding Signal Head with In-Built Blinker unit, Flashing rate: 40-50 per Min. Shape:-Round Ball Type, Colour-Amber,- Working Voltage:- 12 V DC, LED Lamp IP-with Endence/ Lab Report.
VEHICULAR (RED) LED ASPECT	
Led Viewing Angle	23°
Led Forward Current	20mA
Total Number of LED's	190 Nos. (Minimum)
Intensity of LED Aspect	260Cd (Minimum)
Total Power Consumption	Maximum 10W
VEHICULAR (AMBER) LED ASPECT	
Led Viewing Angle	23°
Led Forward Current	20mA
Total Number of LED's	190 Nos. (Minimum)
Intensity of LED Aspect	380Cd (Minimum)
Total Power Consumption	Maximum 10W
VEHICULAR (GREEN ARROW) LED ASPECT	
Led Viewing Angle	23°
Led Forward Current	10mA
Total Number of LED's	66 Nos. (Minimum)
Intensity of LED Aspect	100 Cd (Minimum)
Total Power Consumption	Maximum 4W
PEDESTRIAN (RED) LED SIGNAL ASPECT	
Led Forward Current	20 mA
Total Number of LED's	48 Nos (Minimum)
Total Power Consumption	Maximum 4W
Intensity of LED Aspect	65 Cd (Minimum)
PEDESTRIAN (GREEN) LED SIGNAL ASPECT	
Led Forward Current	10 mA
Total Number of LED's	48 Nos. (Minimum)
Total Power Consumption	Maximum 4W
Intensity of LED Aspect	45 Cd (Minimum)

SPECIFICATION FOR LED PANELS	
GENERAL	
Input Voltage	170V AC - 260 V AC/12 VDC
Protection	Fire Retardant, Glass Epoxy, FR4 Printed Circuit Board with protective cover and plain Polycarbonate Lens
Surge Protection	Built in regulated Power supply with surge suppressor & over current/ over voltage protection
PIV Protection	Reverse/Over voltage Protection for LED Chains Operating Temperature: O Degree Celsius to 55 Degree Celsius
Wave Length	640 ± 5nm (Red), 595 ± 4nm (Amber), 505 ± 4nm (Green)
Power Factor	> 0.9
Operating Temperature	0° to 55° C
Humidity	95%
Diameter	300 mm diameter

SPECIFICATION FOR POWER SUPPLY	
Type	3 core 2.5 sq. mm, Copper, Armoured, under ground cable
Conductor material	Bare Copper
Insulating material	PVC type - A
Insulation thickness	0.80 mm
No. of cores/pairs/triads	as per requirement
Inner sheath :-	
i. Material	PVC type st – 1
ii. Thickness	0.50 mm
iii. Colour	Black
Armour wire	1.40 mm
Outer sheath :-	
i. Material	PVC type st – 1
ii. Thickness	1.80 mm
iii. Colour	Black
Maximum outer diameter	16.40 mm + /- 1.00 mm
Tolerance	+/- 05 % of the ordered Length
Test & applicable standards	IS:8130, IS:5831, IS:3975 & IS:1554 part1

Sp. Information/ highlights	Cable Resistance at 20 Deg Centigrade : <12.1 ohm/km
Other details	Insulation Res: >100 mega ohm/km (cable should be flame retardant)

SPECIFICATION FOR ARMOURED CONTROL CABLES	
Type	1.5 sq. mm Multi core (4, 7, & 14), Copper, Armoured, under ground cable
Conductor material	Bare Copper
Insulating material	PVC type - A
Insulation thickness	0.80 mm
No. of cores/pairs/ triads	as per requirement
Inner sheath: -	
i. Material	PVC type st – 1
ii. Thickness	0.50 mm
iii. Colour	Black
Armour wire	1.40 mm
Outer sheath :-	
i Material	PVC type st – 1
ii Thickness	1.80 mm
iii Colour	Black
Maximum outer diameter	16.40 mm + /- 1.00 mm
Tolerance	+/- 05 % of the ordered Length
Test & applicable standards	IS:8130,IS:5831,IS:3975 & IS:1554 part-1
Sp. Information/ highlights	C.R. at 20 deg. C:<12.1 ohm/km
Other details	Insulation res:>100 mega ohm/km (cable should be flame retardant)

SPECIFICATION FOR ARMOURED CONTROL CABLES	
Type	0.5 sq. mm Multi core (4, 7, & 14), Copper, Armoured, under ground cable
Conductor material	Annealed Copper
Insulating material	PVC type - A
Insulation thickness	0.60 mm
No. of cores/pairs/ triads	as per requirement
Outer sheath :-	

i Material	PVC type st – 1
ii Thickness	1.2 mm
iii Colour	Black
Voltage Rating	1100 Volts
Current Rating	4 Amps
High Voltage Test	3 KVA for 5 Minutes
Test & applicable standards	IS:694 – 1990
Conductor Resistance	39 Ω/Km at 20 ºC (Max)

SPECIFICATION FOR CABLE LAYING ON PAVEMENT AND ON SOFT SURFACE	
Trenching of earth 3 feet depth for laying of cable under pavement and soft surface, laying of sand & bricks for cable protection, laying of cable and refilling and leveling the trenches with the excavated materials.	
SPECIFICATION FOR SUPPLY AND LAYING OF PIPES BELOW ROAD CARRIAGEWAY	
Road cutting and laying of suitable dia NP2 class HDPE/GI pipes 3 feet deep in trenches from road surface, for drawing of cable, and refilling the same with the excavated materials.	

SPECIFICATION FOR STANDARD POLE	
DIMENSION	Length - 4000 MM
	Diameter - 115 MM
	Wall thickness - 4.5 MM
MATERIAL	Mild Steel (M.S) Tubular Pipe (B-Class) as per IS-1239 (Part-1)-193
BASE PLATE	Size 200 MM x 200 MM x 12 MM thick welded to the bottom of the signal pole.

PAINT	Pole painted with two coats of primer.

16.0 Approved Vendor List

Sr. No	Electrical Item Description	Vendor / Makes / Brands
1	RCCB / MCB / RCBO / MCCB/MPCB	Legrand, Hager, ABB, Schneider, Siemens
2	ACB	L&T, ABB, Schneider, Siemens
3	Modular Switches & Sockets (6 A / 16 A) / Telephone Outlets (RJ-11) with Cover Plates & PVC Surface Boxes	Legrand, Crabtree, Anchor (Roma),
4	Low Voltage Induction Motors	Crompton Greaves, ABB, Bharat Bijlee, Marathon, Kirloskar Electric
5	Polycarbonate enclosed IP-65 Single / Three Phase Socket Units for Convenience & Welding Receptacles with 3 / 5-pin Plug-Tops	Hensel, Hager, Legrand, Schneider-Electric, ABB
6	PVC Insulated - Stranded Copper Conductor Flexible Cables / Wires	Polycab, Finolex, KEI Industries Ltd., RR Cables, Delton, Uniflex
7	PVC Insulated Telephone Wires with Tinned Copper Conductors	Polycab, Finolex, KEI Industries Ltd., RR Cables, Delton
8	PVC / XLPE Insulated - Armoured LT Power & Control Cables	Polycab, KEI, Universal Cables, Cords Cable Industries Limited, RPG Cables
9	PVC / XLPE Insulated - Armoured Fire Alarm &Signal Cables	Delton, Cable Corporation of India, Poly cab, CMI Limited, Thermo Cables, Elkay Tele links
10	Polycarbonate Enclosures for Lighting / Power Distribution Boards - Wall-Mounted Type	Legrand, Hager, Hensel, Rittal, Schneider
11	FRLS PVC Electrical Conduits / Pipes & Accessories for Wiring / Cabling	Sudhakar Polymers Ltd, VIP Pipes, Atul Poly plastPvt. Ltd., Cap Plastics & Tubes Pvt. Ltd., Finolex Industries, Sharon Extrusions
12	Indoor / Outdoor LED Light Fixtures	Philips, Bajaj, GE Lighting, Dia light, Fortune Arrt

13	Ceiling / Exhaust Fans - Single Phase	Bajaj, Crompton Greaves, Havells,
15	LED manufacturers for Light Fixtures	Samsung LED, Osram Op to Semiconductors, Philips Lumiled, Ever light, Cree, Sharp, Epi star
16	Flood light Mast (FLM)	Bajaj
17	Single / Three Phase Socket Units for Convenience & Welding Receptacles with 3 / 5-pin Plug-Tops	Sudhir Switchgears, FCG-Flameproof, FCG-Power Industries, FCG-Hi Tech Pvt. Ltd., Flexpro Electricals, Baliga
18	Control Stations & Junction Boxes	Sudhir Switchgears, FCG-Flameproof, FCG-Power Industries, FCG-Hi Tech Pvt. Ltd., Flexpro Electricals, Baliga
19	Perforated / Ladder Cable Trays	General Composites, Sintex, Sumip Composites, Kemrock, Ercon Composites
20	Out-door Electrical Equipment / Control Stations	Lotus Fibre, Sumip Composites, Sintex, General Composites, Ercon Composites
21	PVC Conduits & accessories for Wire Pulling	Finolex, Sintex, Sanco Industries Ltd., AtulPolyplastPvt. Ltd., Venkatesh Indigenous Pipes (VIP) Pvt. Ltd., Sudhakar Polymers Ltd.
22	Cable Glands - Weather-proof / Flame-proof	Cosmos, Comet Brass Products, Axis Electricals, Phoenix Contacts, Control well, Hex Brass Copper & Alloy (I) Ltd., HMI
23	Cable Lugs & Ferrules- Crimping Type	Dowells, Axis Electricals, Comet, Phoenix Contacts, Hex Brass Copper & Alloy (I) Ltd., HMI
24	PVC Shrouds for cable glands	Hex Cable Accessories, HMI, Cosmos, Control well
25	Electrically Operated / Motorized Rolling Shutters	Avians, Jai Bhavani Engineering, Sri Sai Ganesh Structurals, Gandhi Automations Pvt. Ltd., Concord BuildmatPvt. Ltd., C4G Automation Pvt. Ltd., Izonic Automation & Solutions Pvt. Ltd., Aegis Infrasolutions India Pvt. Ltd.
26	Rolling Shutter Motor & Associated Controls / Automation	Somfy India Pvt. Ltd., Elero Motors & Controls Pvt. Ltd., Toshi Automation Systems Pvt. Ltd, TESC Ltd., Centurion Systems Pty. Ltd., Automat ismiBeninca, Prime door Automations Pvt. Ltd.

27	Limit Switches for Motorized Rolling Shutter	Omron, Allen Bradley, Honeywell, Cutler Hammer / BCH / Eaton
28	Fire Alarm System & Components	Honeywell Automation, Siemens Building Technologies, Edwards - United Technologies Corporation, Fire-Lite Alarms, Cooper Safety Fire Systems, Tyco, Kidde (UTC), CN Systems (Terra Fire)
29	Telephone Hand-Set	Sudhir Switchgears, FCG-Flameproof, FCG-Power Industries, FCG-Hi Tech Pvt. Ltd., Flexpro Electricals, Baliga
30	Instrument Transformers – Current Transformers / CBCT	L&T, Kappa, Pragati, Kalpa, Precise Electricals, PROK Devices
31	Multifunction Digital Meters / Analogue Meters	Rishabh, Automatic Electric, MECO Instruments, Schneider Electric, Nippen Electrical Instruments, Conzerv (PMI), HPL Electric & Power Ltd., PROK Devices Pvt. Ltd.
32	Protective & Auxiliary Relays (Front Panel ELR & Motor Protection)	L&T / L&T - GIC, Schneider-Electric, Siemens, ABB, EasunReyrolle, GE - Alstom
33	LED Indication Lamps	L&T, Siemens, EssenDeinki, Omron, JVS Electronics, Schneider-Electric
34	Time Switches / Timer	L&T GIC, Legrand, Hager, Havells Crabtree, Schneider-Electric
35	Power & Auxiliary Contactors	L&T, Siemens, ABB, Hager, Schneider, Legrand
36	Cable Terminals & Connectors	Elmex, Phoenix Contacts, Wago, Molex
37	Push Buttons	Siemens, Schneider Electric, TeknikEuchner Electronics, L&T
38	Insulating Rubber Mats (to be glued to the surface)	Sintex , Jyoti, Tycoon, Tata Rubber (insulation-mat), Premier Polyfilm (electro-mat), RMG Polyvinyl (safe-volt)
39	Hot-Dipped GI Octagonal Street Lighting Poles / Earth Strips / Pipe Electrodes / Pipes	Authorized dealers of SAIL / Vizag Steel / JSW Steel / TATA Steel, Vatco Elec Power, Amtech Power Engineering, Aeron Earthing, Spark Electrodes, ABCO Steel, Jindal Pipes Ltd., GI Pipes India, Oswal
40	HVAC (VRV)	Daikin, Voltas, Bluestar, Mitsubishi

Notes:

1) The contractor may procure material from any of the above enlisted Owner's approved vendors. However the current validity, availability, stability & solvency of the product being supplied shall be verified by the contractor before order placement.
2) For components / electrical items not covered in the above list, the vendor shall submit past track record for the proposed material / equipment manufacturer, submit samples & catalogues for scrutiny and obtain written approval from the Owner / Engineer–In–Charge before order placement.
3) The contractor may offer material / equipment of makes other than those specified in the above table during order execution. The contractor's offer for alternate makes shall then be evaluated by the Owner / Engineer–In–Charge with respect to satisfactory track record, test certificates & price implications (if any). All such evaluation documents shall be submitted by the contractor for the Owner's scrutiny& approval before order placement.
4) The final choice of make to be used in Project will rest with the Owner / Engineer-In-Charge & their decision shall be final & binding on the contractor for this project.

17.0 Project Site Safety Procedure

Measures related to Safety of Electrical Installation during Project Execution at MRPL Site

1. Electrical Power is the main stay of any construction activity. At the same time it requires utmost care in its utilization to avoid accidents due to electrical shock, fire incidents or electric short circuits, exposure of electrical installation to adverse environmental conditions increase the risk of such accidents. Hence it is necessary to take extra precautions for such installations to ensure safety of personnel & equipment. This standard addresses the safety measures required to be adopted for the electrical installations by all contractors during construction phase.
2. All electrical connections/work for electrical installations shall be carried out as per provisions for the latest revision of the following codes & standards in addition to the requirements of the statutory and IE Rules.
3. OISD-STD-173: Fire Prevention & Protection System for Electrical Installations
4. SP-30 (BIS): National Electric Code
5. The installation shall have approval from concerned statutory authorities.
6. All electrical connections shall be done by an Electrician with valid license & to the satisfaction of Electrical –in-charge.
7. One competent licensed electrician shall be made available by contractor at the site round the clock to attend to normal / emergency jobs.All switch boards / welding machines shall be kept in well ventilated & covered shed. The shed shall be elevated to water logging. No flammable materials shall be used for constructing the shed. Also flammable materials shall not be stored in & around electrical equipment/switch board. Adequate clearances & operational space shall be provided around the equipment.
8. Fire Extinguishers & insulating MATS shall be provided in all power distribution centers.
9. Temporary electrical equipment hall not be employed in hazardous areas without obtaining safety permit.
10. Proper housekeeping shall be done around the electrical installations.All temporary installations shall be tested before energizing to ensure proper earthing, bonding, suitability of protection system, accuracy of feeders. Cables etc.
11. All welders shall use hand gloves irrespective of Holder Voltage.
12. Multilingual (English, Hindi & local language) caution boards, shock treatment charts &instruction plate containing location of isolation point for incoming supply, name & telephone

no. of contact person in emergency shall be provided in sub stations &near all distribution boards / Local Panels.

13. Operation of earth leakage device shall be checked regularly by temporarily connecting series lamp (2 bulbs of equal rating connected in series) between phase & earth.
14. Following design features shall be ensured for all electrical installations during construction phase.
15. Each installation shall have a main switch with a protective device installed in an enclosure adjacent to the metering point. Operating height of the main switch shall not exceed 1.5 meter. Main switch shall be connected to the point of supply by means of armored cable.
16. Out coming feeders shall be double or triple pole switches with fuses / MCB's. Loads in a phase circuit shall be balanced as far as possible. & load on neutral should not exceed 20% of load in the phase.
17. Installation shall be adequately protected against overload, short circuit & earth leakage by the use of suitable protective devices. Fuses wherever used shall be HRC Type. Use of renewable fuses shall be strictly prohibited. Earth leakage device shall have an operating current not exceeding 30mA.
18. All connections to the hand tools/welding receptacles shall be taken through proper switches, socket & plugs.
19. All single phase sockets shall be minimum 3 pin type only. All unused sockets shall be provided with socket caps.
20. Only 3 core (P+N+E) overall sheathed flexible cables with minimum conductor size of 1.5mm²copper shall be used for all hand tools.
21. Only metallic distribution boxes with double earthing shall be used at site. No wooden boxes shall be used.
22. All power cables shall be terminated with compression type cable glands. Lugs shall be used for multi strand wires / cables.
23. Cables shall be free from any insulation damage.
24. Cables shall be laid in underground at a minimum depth of 750 mm. For LV & Controls & 900 mm for HV cables covered with sand, brick & soil for ensuring mechanical protection. Cables shall not be laid in water logged area as far as practicable. Cable route markers shall be provided at every 25 Meters of buried trench route. When laid above ground, cables shall be properly

cleated or supported on rigid poles of at least 2 Meter height. Minimum head clearance of 6 Meters shall be provided at road crossing.

25. Underground cables shall not be allowed to cross the roads without pipe sleeve.
26. All cable joints shall be done with proper jointing kit. No taped / temporary joints shall be used.
27. An independent earthing facility should preferably establish within the temporary installation premises. All appliances & equipments shall be adequately earthed. In case armored cables are used, the armor shall be bonded to the earthing system.
28. All cables & wire rope used for earth connections shall be terminated through tinned copper lugs.
29. In case of local earthing, earth electrodes shall be buried near the supply point & earth continuity wire shall be connected to local earth plate for further distribution to various appliances. All insulated wires for earth connection shall have insulation of green color.
30. Separate core shall be provided for neutral earth/structures shall not be used as a neutral in any case.
31. On/Off position of all switches shall be clearly designated / painted for easy isolation in case of emergency.
32. All insulation shall be inspected by Engineer-in-Charge at least once in a month.

18.0 Procedure for Final Documentation

16.1 General Information

The following is a guideline for compilation and submission of the Final Documents to MRPL by any agency / contractor executing a specific job against any Work Order or a Purchase Order issued by MRPL or by any agency on behalf of MRPL.

Final Document as per these guidelines shall be prepared in addition to the documents issued during project execution, which is normally released in piecemeal basis while the job is in progress.

This is a general guideline for all projects of MRPL; however any addition or deletion of the clauses based on the specific project requirements shall be approved by the consultant or the Engineer-in- charge of MRPL. An approved deviation note shall be furnished for this purpose.

16.2 Components of the Final Documents

Basic Design & Extended Basic Design Packages: Basic and extended design packages shall be compiled and the revision control shall be maintained by the respective Consultant or the agency executing the project. Upon completion of project, all updated sets of design packages in their latest revisions shall be handed over to MRPL.

Master Documents & Drawing Index: These shall be treated as a key document for reviewing completeness of documentation at any point of time. It shall show details of documents / drawing applicable for any equipment / system / service. Master Drawing/Document Index shall have following columns:

Serial No	Drawing / Document Title	Drawing/Document No. (Revision)	No. of Sheets	Document Folder No	Remarks

Revision	Date	Prepared by	Checked by	Approved by Consultant	Approved by MRPL

A detailed list of PO / Contract is to be furnished to MRPL Engineering Documentation Centre for assessing the deliverables and for to ensuring that no critical equipment / document is left out from the final documentation.

16.3 Sections of the final vendor / engineering document folder

Section A: Contents - This section shall have the following table:

Sr. No	Drawing No	Drawing Title	Rev.	No. of Sheets	Remarks

This content or Master Index is to be certified by the Consultant / Engineer-in-charge of MRPL for its completeness in all respects.

Section B: Technical Documents / Drawings

The table below enlists the documents which shall be included in the final documentation:

Sr. No	Documents
1	Detailed Technical Purchase Order with PR / Engineering Specifications / Design Basis / Design Calculation
2	Equipment list
3	As-Built Specification sheet / data sheet

4	General arrangement drawing
5	Cross Sectional drawing
6	Assembly drawing, Fabrication Drawing
7	Layout Drawing
8	Foundation Information Document for Foundation Design
9	Line schedule
10	Piping general arrangement Drawing
11	Piping general arrangements drawing for support.
12	Line wise bill of materials and summary
13	Drawings / catalogues, for special items like Fire Alarm System, Motorized Rolling Shutters
14	Wiring Drawings / Cable Layouts / Earthing Layouts for Electrical Systems
15	Confirmation Items for Motors
16	Lubricants List
17	Details / Drawings / Catalogues of Bought - out Components,
18	Pipe Support drawings / Standards
19	Process and mechanical Design / Strength calculations
20	Piping material specification
21	Equipment specification
22	Any other items

Section C: Manual / Procedures this section must consist of the following documents as a minimum:

Sr. No	Documents
1	Fabrication Procedure/Sequence
2	Inspection and Test Procedures
3	Protection and Preservation Procedures
4	Procedures for Erection and Commissioning
5	Installation Manual
6	Operation Manual
7	Maintenance Manual

Section D: Field Inspection and Test Records – The following points need to be considered before preparing & submitting the test reports:

A detailed index to the content shall be available at the beginning of each file. Each inspection reports shall be indexed with the report number with page numbering.

All Documents / Reports shall be approved in its totality by stamping & signing the Master - Indexes as mentioned in the earlier section.

All field / factory test reports shall be in original. Any deviations to these requirements shall be acceptable only after prior approval from the Engineer – In - charge.

Section E: Spare Parts and Tool List

Section F : As - Built Drawings - In this section, as - built drawings for all site fabricated items, engineering drawings like piping, civil, electrical cabling, lighting & earthing Layouts, plot plan, line schedules, pipe supports index / register, piping isometrics, etc shall be compiled. All as built drawings shall be approved by authorized signatory of (with signature & seal).

Section G: Digital Copy – The following points are to be considered before final submission:

Two sets of digital copy shall be submitted in branded CD-ROM with labels as mentioned in this section.

All drawings shall be on the latest version of AutoCAD.

Manuals and others documents shall be on MS Word / Excel or on PDF format.

Test reports and the documents which are not prepared in Word or Excel shall be submitted on scanned images readable and printable in common window based imaging software like TIF or PDF format.

16.4 File Format of Documentation Folder

Filing: Ideally, separate folders has to be prepared for each equipment / system / service, however if documentation for a particular equipment / system / service is voluminous, then multiple files may be prepared in identical folders by suffixing file numbers such as 1 of 5, 2 of 5, etc.

Drawing Filing: Each single drawing shall be put in separate transparent drawing pouch and must not be punched.

File size: All documents and drawings shall be compiled in A4 sized files (28 cm x 31 cm), with 2 stainless steel-rings. Width of the file can be, 6.0 cm or 7.5 cm or 9.0 cm. based on the volume of documents.

Document size: The documents / drawings submitted in file shall be in its original size (A0 / A1 / A2 / A3 / A4) and to be folded in A4 size to accommodate in the A4 size drawing pouches.

Stamping / labeling: Following information / format shall be provided in all the documents and files submitted:

Title block for each document / drawing,

Each document and drawing shall have a stamp as follows:

FINAL AS - BUILT

File Label: Each file shall display following information on its spine. The dimension of the File Label & the content shall be as specified below:

6cm or 7.5cm or 9cm

FINALDOCUMENTATION

Project

Folder No.

Volume No.

P.O. No.

Description

Vendor's Logo

MRPL Logo

Mangalore Refinery

&Petrochemicals Limited

31 cm

16.5 SUBMISSION OF FINAL DOCUMENTS - The following points are to be mandatorily followed with respect to the final documentation for the hazardous waste storage project:

Final Documentation completion & submission for the Hazardous Waste Storage Shed project shall be one of the prerequisites for project completion. The final bill payment to the contractor shall be made only after submission & certification of Final Documentation completion.

All final documents duly compiled by the above specified procedure along with any deviation notes shall be handed over to MRPL Engineering Documentation Centre through the consultant / Engineer-in-charge of the project.

Piecemeal final document submission shall be avoided. If any document / drawing is required to be submitted at a later date, the part submission shall clearly appear in the content with a note "TO BE SUBMITTED LATER" - duly approved by the Consultant / Engineer-in – charge.

The total number of final documents submitted for the Hazardous Waste Storage Shed Project shall be as tabulated below:

Sr. No	Document Group	No. of Copies	Digital File
1	Basic/ Extended Design Packages	2	2
2	Vendor/Engineering Documentation/ Drawings(As – Built Final)	2	2
3	Final Field Inspection Reports (Drawings & Documents)	2	2

A Final Documentation Completion Certificate shall be issued from the Consultant / Engineer – In -Charge of the project, as per following format – which shall be attached in all document folders:

CERTIFICATE FOR COMPLETION OFFINALDOCUMENTATION

Name of Supplier / Contractor:

Owner / Customer:

Name of Project:

Purchase Order No. (Date):

Purchase Requisition / Tender No. (Date):

Name of the Work / Equipment:

Supplier's / Sub-Contractor's Work Order No. (Date):

Certified that the Engineering / Manufacturing Documents & Test Certificates submitted by the supplier / contractor are complete in all respects in accordance with the tender requirements.

Signature: …… Signature: ……

Date: …… Date: ……

Name & Seal: ……. Name & Seal: ……

Supplier / Contractor **Consultant / Owner**

TENDER DRAWINGS

CIVIL DRAWINGS: AS ATTACHED

ELECTRICAL DRAWINGS: AS ATTACHED