1.0 SCOPE OF WORK

A. WATER SUPPLY PIPING

Scope of work covers the following.

1) Supplying, stacking, laying and jointing ISI marked PVC pipes as per IS 4985 / Schedule 40 high pressure uPVC pipes pasting type conforming to ASTM-D-1785 and specials such as Tees, elbows, bends, flanges, reducers, end caps, saddles, plugs, coupling, including cost of all jointing materials like solvent cement, bolts, nuts, rubber washers, ferrule, pipe supports, etc. hire of tools and plants, cost and conveyance of water for testing etc. complete so as to withstand the internal design pressure. uPVC specials shall confirm to ASTM D 2466 (for SCH 40 Fittings) and ASTM D 2467 (for SCH 80 Fittings).

2) Supplying and fixing sluice valves, air valves, scour valves, etc.

3) Earth work excavation in all classes of soil, hard rock/under water etc. as the case may be including construction of RCC pipe supports, anchor blocks/thrust blocks, refilling the trenches, ramming and consolidating, conveying and disposing the excess earth, rock, etc.

4) Hydraulically pressure testing of the line to the field hydrostatic test pressure.

5) Maintaining the commissioned line for a defect liability period of 12 months.

RELEVANT APPLICABLE STANDARDS

1. IS 4985 - PVC pipes for potable water supply.
2. IS 1239 - GI pipes & fittings.
3. IS 14846 - Sluice valve.
4. IS 10124 - Fabricated PVC fittings for potable water supplies.
5. IS 12235 - Methods of tests for un plasticized PVC pipes for potable water supplies.

2.0 PIPING MATERIALS

General

The piping system shall consist of Schedule 40 high pressure uPVC pipes pasting type conforming to ASTM-D-1785 (sizes in ID) with necessary fittings and schedule 80 specials conforming to ASTM-D-2467 for cold water supply. The pipes shall be manufactured by extrusion process and fittings are manufactured by injection moulding process.

Product Specifications

The system shall be made as per ASTM (American Society for Testing of Materials) standards. The Pipes shall be made as per ASTM D 1785 and Fittings are made as per ASTM D 2466 (for SCH 40 Fittings) and ASTM D 2467 (for SCH 80 Fittings). The pipes shall be plain ended in lengths of 3 meters in SCH 40 and SCH 80 pressure classes. The fittings shall be available in SCH 80. The pipes and fittings shall be available in 1/2" to 4" size. The fittings shall be classified into three categories.

1. Solvent weld fittings
2. Threaded fittings with plastic threads and
3. Threaded fittings with metal inserts.

The metal inserts in the threaded fittings shall be made of nickel-plated brass to withstand chemical corrosion.

The system shall be highly resilient, tough and durable with high tensile strength and high impact strength. It shall be free from problems caused by scale formation, rusting, weathering and chemical action, and lasting for a life time. The PVC piping system shall be virtually immune to attack by bacteria, fungi and other microorganisms or insects.

The system shall be non-conductive and immune to galvanic and electrolytic corrosion. The PVC piping system shall be corrosion resistant to a great extent, so much that they can be buried in alkaline or acidic soils or installed in over-the-ground environments, with no paint or special coating.

The PVC piping system shall be inert to most chemicals and can resist attacks from most chemicals at moderate temperatures.

The interior walls of the pipes and fittings shall have a mirror smooth finish ensuring high flow rates and low frictional losses.

The PVC piping system shall be free from rusting, pitting or scale formation so that there is no particle deposition and the inner bore of the pipe remains undiminished throughout the life of the system.

Jointing shall be done with the special solvent which ensures 100% leak proof joints.

The system shall be UV stabilized which eliminates the adverse effect of sunlight and weather. The system can, therefore, be safely used for outdoor installations.

The PVC pipes shall be relatively more flexible and shall have adequate tensile strength and even burst strength to withstand the operating pressures encountered in most service conditions, with the acceptable range of temperature for the system. External shocks or impacts that could cause failure more rigid materials can be absorbed by the system, with little or no damage.

Pipes shall be self-extinguishing and shall not support combustion. This eliminates the need for fire resistant coating.

3.0 SPECIFICATION FOR PIPE LAYING AND CONNECTED CIVIL WORKS

3.1 All pipes and valves should be ISI marked. Detailed data sheets for all bought out items shall be got approved by Owner/Consultant before they are ordered for manufacture/supply as the case may be.

3.2 The pipes shall be laid with specials such as tees, bends, tail pieces, valves etc. strictly according to the specifications.

3.3 The valves are to be protected with manhole chambers of minimum size 1.2m x 1.2 m and with CI manhole cover with frame and necessary locking arrangements.

3.4 The trench width shall not be less than 300mm wider than the outside of the socket of pipes and the minimum depth at any section shall be such that to have...
a minimum cover of 1 m above the crest of the pipe. The bottom of the trenches should be levelled to give an even bed for the pipes. In the stretch where valves are installed, the depth of the excavation shall be suitably increased so that the top of the manhole cover shall match with the formation level of the road.

3.5 When rock is excavated the trench should be dug 100mm deeper than the required depth and filled with sand of 10cm thick before the pipes are laid.

3.6 The body of the pipe should evenly rest in the trench surface and for this purpose socket pits if necessary may be made. The maximum deflection in a pipe joint shall not exceed 3 degrees and any deviation more than this is to be traversed with specials.

3.7 For over ground portion, it shall be laid over concrete supports suitably designed to hold the pipes in position and duly clamped with necessary clamps. Wherever the supports are more than 0.5m high, they shall be constructed with RCC and provided on proper foundation. For inside, the pipe shall be laid using proper metallic supports suitably designed to hold the pipes in position and duly clamped with necessary clamps.

3.8 The back filling of the trenches shall be made in layers not exceeding 20 cm thickness duly rammed and consolidated. From the bed of the trenches up to 150mm above the crest of the pipe shall be filled with selected soft material such as sand, fine gravel, red earth, etc. Excess earth after refilling of trenches shall be conveyed and disposed off as directed by Purchaser/Consultant.

3.9 Thrust blocks, anchor blocks, etc. with RCC shall be provided at all bends, dead ends and where movements are likely to occur. When the pipes are laid at a slope more than 15°, anchor blocks shall be provided along the trenches as stipulated in the relevant IS Code.

3.10 After installation, the pipe line installed shall be hydraulically tested to the required field hydrostatic test pressure as per provision contained in the Manual on Water Supply and Treatment III Edition published by CPHEEO, Govt. of India and relevant BIS specification.

3.11 After satisfactory pressure testing the pipe line shall be flushed with potable water so as to remove any dirt or other materials. The line thereafter shall be disinfected with liquid chlorine or bleaching powder as per normal practice.

4.0 SPECIFICATION FOR PIPING - GENERAL

4.1 All pipe work shall be in conformity with the requirements of the applicable drawings and this specification. Where specific details of fabrication are not shown on the drawings or specified therein fabrication shall be in accordance with relevant I.S.

4.2 Piping shall also comply with applicable state, local or other Governmental laws and codes. In case of conflict with this specification the more rigid specification shall govern.

4.3 All work shall be performed in accordance with the best modern practice for this type of work and shall be of the highest quality workmanship.

4.4 Any deviation from this specification must have the approval of Engineer-in-charge.

4.5 PVC Piping

A. Transportation and Stacking

Because of the light weight, there may be a tendency for the PVC pipes to be thrown much more than their metal counterparts. This should be discouraged and reasonable
care should be taken in handling and storage to prevent damage to the pipes. On no account should pipes be dragged along the ground. Pipes should be given adequate support at all times. These pipes should not be stacked in large piles, specially under warm temperature conditions, as the bottom pipes may be distorted thus giving rise to difficulty in pipe alignment and jointing. For temporary storage in the field, where racks are not provided, care should be taken that the ground is level, and free from loose stones. Pipes stored thus should not exceed three layers and should be so stacked as to prevent movement. It is also recommended not to store one pipe inside another. It is advisable to follow the practices mentioned as per IS 7634 Part I.

Laying and Jointing Procedure

B. Trench Preparation

The trench bed must be free from any rock projections. The trench bottom where it is rocky and uneven a layer of sand or alluvial earth equal to 1/3 dia of pipe or 100mm whichever is less should be provided under the pipes.

The trench bottom should be carefully examined for the presence of hard objects such as flints, rock, projections or tree roots. In uniform, relatively soft fine grained soils found to be free of such objects and where the trench bottom can readily be brought to an even finish providing a uniform support for the pipes over their lengths, the pipes may normally be laid directly on the trench bottom. In other cases, the trench should be cut correspondingly deeper and the pipes laid on a prepared under-bedding, which may be drawn from the excavated material if suitable.

C. Laying and Jointing

As a rule, trenching should not be carried out too far ahead of pipe laying. The trench should be as narrow as practicable. This may be kept from 0.30m over the outside diameter of pipe and depth may be kept at 0.60 - 1.0m depending upon traffic conditions. Pipe lengths are placed end to end along the trench. The glued spigot and socket jointing technique as mentioned later is adopted. The jointed lengths are then lowered in the trench and when sufficient length has been laid, the trench is filled.

If trucks, lorries, or other heavy traffic will pass across the pipeline, concrete tiles 600 x 600mm of suitable thickness and reinforcement should be laid about 2m above the pipe to distribute the load. If the pipeline crosses a river, the pipe should be buried at least 2m below bed level to protect the pipe.

Jointing of PVC pipes can be made in following ways:

i) Solvent cement
ii) Rubber ring joint
iii) Flanged joint
iv) Threaded joint

For further details on laying & jointing of PVC pipes, reference can be made to IS 4985-1998, IS 7634 - Part 1-3.

Socket and spigot joint is usually preferred for all PVC pipes upto 150mm in dia. The socket length should at least be one and half times the outer dia for sizes upto 100mm dia and equal to the outer dia for larger sizes.

For pipe installation, solvent gluing is preferable to welding. The glued spigot socket connection has greater strength than can ever be achieved by welding. The surfaces to be glued are thoroughly scoured with dry cloth and preferably chamfered to 30°. If the pipes have become heavily contaminated by grease or oil, methylene cement is applied with a brush evenly to the outside surface of the spigot on one pipe and to the inside of
the socket on the other. The spigot is then inserted immediately in the socket upto the
shoulder and thereafter a quarter \((90^\circ)\) turn is given to evenly distribute the cement over
the treated surface. The excess cement which is pushed out of the socket must be
removed at once with a clean cloth. Jointing must be carried out in minimum possible
time, time of making complete joint not being more than one minute. Joints should not be
disturbed for at least 5 minutes. Half strength is attained in 30 minutes and full in 24
hours. Gluing should be avoided in rainy or foggy weather, as the colour of glue will turn
cloudy and milky as a result of water contamination.

D. Pre-fabricated Connections

In laying, long lengths of pipe, prefabricated double socketed connections are frequently
used to join successive pipe lengths of either the same or one size different. The socket
in this case must be formed over a steel mandrel. A short length of pipe is flared at both
ends and used as the socket connection. The mandrel used is sized such that the
internal dia of the flared socket matches the outer dia of the spigot to be connected. By
proper sizing of the two ends of a connector, it is possible to achieve reduction (or
expansion) of pipe size across the connector.

E. Standard Threaded Connections

Normally PVC pipes should not be threaded. For the connections of PVC pipes to metal
pipes, a piece of a special thick wall PVC connecting tube threaded at one end is used.
The other end is connected to the normal PVC pipe by means of a glued spigot and
socket joint. Before installation, the condition of the threads should be carefully examined
for cracks and impurities.

Glue can be used for making joints leak proof. Yarn and other materials generally used
with metal pipe and fittings should not be used. Generally, it is advisable to use PVC as
the spigot portion of the joint.

F. Pressure Testing

The method which is commonly in use is filling the pipe with water, taking care to
evacuate any entrapped air and slowly raising the system to appropriate test pressure.
The field test pressure to be imposed should be not less than the maximum of the
following:

a. 1 1/2 times the maximum sustained operating pressure
b. 1 1/2 times the maximum pipeline static pressure
c. Sum of the maximum sustained operating pressure and the maximum surge
   pressure.
d. Sum of the maximum pipeline static pressure and maximum surge pressure, subject
to a maximum equal to the work test pressure for any pipe fitting incorporated.

After the specified test time has elapsed, usually one hour, a measured quantity of water
is pumped into the line to bring it to the original test pressure, if there has been loss of
pressure during the test. The pipe shall be judged to have passed the test satisfactorily if
the quantity of water required to restore the test pressure of 30m for 24 hours does not
exceed 1.5 litres per 10mm of nominal bore for a length of 1 Km.

4.6 Valves

A. General

1. Whenever practicable and except as otherwise shown on the drawings, valve stems
shall be installed in a direction suitable for easy operation.
2. Where not otherwise specified on drawings, control valves shall be located and installed so as to provide the following clearance.

   a) Below Valves - 300 mm minimum
   b) Above valve - Sufficient to remove bonnet with wedge.

3. A minimum of 50 mm clearance shall be kept between the surface of insulation and the adjacent surface either insulated or uninsulated. Exceptions shall have the approval of the Engineer-in-charge.

B. Cleaning of Valves

Valves will be cleaned before installation. All possible precautions shall be taken to prevent contamination and valves shall be inspected immediately prior to installation. If a valve is found to be contaminated in anyway, it shall be cleaned as follows.

1. Remove all foreign particles by wiping with a clean lintless cloth.

2. Wipe interior of valve with a clean lintless cloth moistened with clean trichloroethylene

If contamination is excessive:

Suspend the valve in a degreasing tank with hand wheel uppermost. Direct a stream of liquid trichloroethylene into the rim of the valve, through both ends and against all inside surfaces. Flush thoroughly to remove all foreign matter.

4.7 GENERAL NOTES ON ERECTION / INSTALLATION OF PIPING

1. All piping shall be laid as shown on the approved for construction drawings and in accordance with this specification.

2. Arrangement drawings shall show general location and will indicate special dimensions, location of valves, fittings, etc.

3. Special attention shall be given to the handling and erection of piping to prevent damage and ensure the continued cleanliness of such piping.

4. All assembled piping shall be installed in place without spiring or forcing.

5. Slopes of piping specified on drawings shall be maintained. Where no slope is required or where a required slope approaches the horizontal, piping shall be checked for sag with a level not less than 1 meter long equipped with a graduated bubble vial. All low points where liquid may be entrapped shall be removed.

6. After piping is erected in a position, it shall be cleaned, tested for tightness and dried out where required as described in this specification.

7. Necessary piping supports and expansion loops shall be provided.

8. All piping and fittings shall be cleaned thoroughly inside and outside, to remove loose scales and foreign materials by wire brushing before erection/laying.

4.8 FABRICATED STRUCTURAL ITEMS FOR PIPE SUPPORTS

The work covered consists of supply, fabrication, transportation to site and erection of structural steel work like pipe bridge, pipe supports and other structural steel work required for supporting the pipes, and other utilities in accordance with the specifications,
layout drawings, and support drawings. The contractor shall also provide supports as and where required as per the detailed drawing and as per the instruction/specification given from time to time by the Purchaser/Consultant. The rate shall include the cost of all materials, welding charges, bolts and nuts, all consumables, labour, transportation, etc. all inclusive.

Civil works like RCC column footing for supports, grouting of bolts, etc. shall be the responsibility of the contractor.

The fabrication work generally included and not necessarily limited to in the contractors scope is as follows:

a) Pipe supports
b) Inter connecting structural beams/bridges
c) Vertical structural supports from floor
d) Anchoring

4.9 PAINTING

All structural supports, columns, etc. to be cleaned of loose substance and foreign material, dirt, rust, scale, oil, grease, welding flux etc. so that the prime coat adheres to the original metal surface. The work shall be carried out generally in accordance with 18:1477 (Part I & II).
B. SANITARY PIPING

Scope of Work

1.0 Scope of work shall cover the following:

Supplying, laying, jointing and testing uPVC pipe, with specials such as tees, bend, door bend, coupling, Y with door, unions, rubber ring, etc. cutting, earth work excavation, back filling, making good the walls, testing the line, etc.

Supplying and fixing gully traps with gully chamber, ventilation cowl, floor trap, etc.

Commissioning the Sanitary Piping System

Maintaining the commissioned line for a defect liability period of 12 months.

2.0 PIPING MATERIALS

UPVC Piping and fittings

The pipe shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean and free from grooving and other defects. The end shall be cleanly cut and square with the axis of the pipe. The pipe shall be designated by external diameter and shall conform to IS: 4985-1981. The pipe shall be of class III - 6kg/sqm pressure rating.

Fittings

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to Indian Standard.

Laying and Jointing

The pipes shall be laid and fixed using GI Saddle clamps to suitable GI slotted rails fixed on walls using anchor fastener legs / grouting legs. Provision shall be made for the effect of thermal movement by not gripping or disturbing the pipe at supports between the anchors for suspended pipes. The supports shall allow the repeated movements to take place without abrasion.

Jointing for UPVC pipes shall be made by means of solvent cement for horizontal and vertical line. The type of joint shall be used as per site conditions / direction of the Engineer-in-Charge. Where UPVC pipes are to be used for rain water pipes, the pipe shall be finished with GI adopter for insertion in the RCC slab for a water proof joint complete as directed by Engineer-in-Charge.

Supports

UPVC pipes require supports at close intervals. Recommended support spacing for unplasticised PVC pipes is 1400mm maximum for pipes 50mm dia and above. Pipes shall be aligned properly before fixing them on the slotted rails with saddle clamps. Even if the slotted rails are fixed using a plumb line, pipe shall also be checked for its alignment before clamping. Piping shall be properly supported on, or suspended from clamps, hangers as specified and as required. The tenderer shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency. Pipe supports shall be primer coated with rust preventive paint.
### 3.0 Specification for laying and jointing sanitary pipes

#### Jointing

1. Make sure the spigot end and inside of socket is clean and the sealing ring is placed evenly in the socket.

2. During cutting of pipes, make sure that they are cut square. Chamfer the end cut to an angle of 150 with a medium file.

3. A correct depth of entry of the spigot into the socket is required to allow thermal movement. To achieve this, push spigot fully into the socket (remove sealing ring at this time) and make a mark on the spigot. Withdraw the spigot by 10mm and mark the spigot with a bold line. This bold mark indicates the correct depth of entry to allow the necessary expansion gap.

4. Apply rubber lubricant evenly on the chamfered spigot and the sealing ring. Then insert the spigot into socket and pull out the pipe to allow 10mm expansion gap.

**Precautions**

1. Only uPVC Pipes should be used.

2. Avoid over tightening of door caps.

3. Avoid misalignment of vertical Pipe stacks and incorrect spacing of Pipe clips.

4. Cutting of pipes should be straight, as diagonal cutting leads to leakages.

5. All entry to main stacks should be protected with water seal trap, wherever there is mixing of Soil & Waste lines.

6. Keep a gap of 10mm between all Pipes and Fittings to accommodate thermal expansion and contraction of pipes for longer life of the system.

7. Horizontal lines within bathrooms should be cement encased and tested before compacting of sunken floor to avoid any accidental damages.

### 4.0 Installation in walls/concrete

The wall/concrete slots should allow for a stress-free installation.

### 5.0 Testing Non-pressure Installation above ground

The uPVC drainage system can be put to use immediately after installation, as no waiting time required for joints to be set and dried. The water level shall then be raised to a height of not less than three meters above the highest point of the section being tested or as the Inspection Officer may direct. Every joint shall be carefully examined for leaks.

### 6.00 Applicable codes

1. IS: 13592  Code of practise for uPVC SWR pipe.

2. IS: 5329  Code of practise for sanitary pipe work above ground for building.

3. IS: 1726  Code of practise for cast iron manhole covers and frames.

4. IS: 2326  Automatic flushing cisterns for urinals.
5. IS:2470    Code of practice for design and construction of septic tanks.
6. IS:2556    Vitreous sanitary appliances
7. IS. 774    Flushing Cisterns for water closets and urinals (valveless siphonic type).
8. IS.775    Cast iron brackets and supports for wash basins and sinks.
9. IS.781    Sand-cast brass screw-down bib taps and stop taps for water services.
10. IS.1068   Electroplated coatings of nickel and chromium on iron and steel.
11. IS.1626   Asbestos cement building pipes, gutters and fiaings (spigot and socket types)
12. IS.1703   Sail valves (horizontal plunger type) including floats (spigot and socket types)
14. IS.2963   Non-ferrous waste fittings for wash basins and sinks.
15. IS.3311   Waste plug and its accessories for sinks and wash basins.
16. IS.5434   Non-ferrous alloy bottle traps for marine use.
17. IS:14735  uPVC SWR pipe fittings
18. IS:5382   Rubber rings

7.0 Providing & Laying uPVC line for Sanitary application.

The strength of the pipe shall be to withstand 6kg/cm² pressure rating. It shall be of approved make. It shall be provided with all necessary specials. It shall be jointed with manufacturer's specifications.

8.0 Testing

Testing shall be done in accordance with IS: 1172 and IS: 5329 except as may be modified herein under.

Entire drainage system shall be tested for water tightness and smoke tightness during and after completion of the installation. No portion of the system shall remain untested. Tenderer must have adequate number of expandable rubber bellow plugs, manometers, smoke testing machines, pipes and fittings for tests.

All materials obtained and used on site must have manufacturer's hydraulic test certificate for each batch of materials used on the site.

Soil and waste pipes shall be tested in sections after installation, by filling up the stack with water. All opening and connections shall be suitably plugged as approved by the Project Manager. The total head in the stack shall be 4.5 m at the highest point of the section under test. The period of test shall be minimum for 30 minutes or as directed by the Project Manager. If any leakage is visible, the defective part of the work shall be cut out and made good.
On completion of the work the entire installation shall be tested by smoke testing machine. The test shall be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging the outlets with bellow plugs. The tenderer shall give a smoke test to the soil and waste pipe at his own expense and replace defective sections as per Engineer-in-Charge’s instruction.

After the installation is fully complete, it should be tested by flushing the toilets, running at least 20% of all taps simultaneously and ensuring that the entire system is self draining, has no leakages, blockages etc. and rectify and replace defective sections where required.

A test register shall be maintained and all entries shall be signed and dated by the Tenderer and the Project Manager or his representative.

All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

9.0 TRAPS

9.1 Floor Traps

Floor traps where specified shall be siphon type multi trap of PVC having a minimum 50 mm deep seal. The trap and waste pipes when buried below ground shall be set and encased in cement concrete blocks firmly supported on firm ground or when installed on a sunken RCC structural slab. The blocks shall be in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size).

Tenderer shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30 x 30 cms of the required depth.

10.0 Floor Trap Grating

Floor and urinal traps shall be provided with 100 - 150 mm square or round stainless steel gratings with frame and rim of approved design and shape or as specified in the bill of quantities approved by the Engineer-in-Charge.

11.0 Cleaning out Plugs

Cleanout on Drainage Pipes

Cleanout plugs shall be provided on head of each drain and in between at locations indicated on plans or directed by Owner's site representative. Cleanout plugs shall be of size matching the full bore of the pipe but not exceeding 150 mm dia. Clean out plugs on drains of greater diameters shall be 150 mm dia, shall be fixed with a suitable reducing adapter.

Cleanouts provided at ceiling level pipe shall be fixed to a GI flanged tail piece. The clean out door shall be specially fabricated from light weight galvanized sheets and angles with hinged type doors with fly nuts, gasket etc. as per drawing.
12.0 PIPE PROTECTION

Soil and waste pipes under floor in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate e of 12 mm size) 10 cm bed and around. When pipes are running well above the structural slabs, the encased pipes shall be supported with suitable cement concrete pillars of required height and size at intervals directed by the Project Manager.

13.0 CUTTING AND MAKING GOOD

Pipes shall be fixed and tested as building proceeds. The tenderer shall provide all necessary holes, cutouts and chases in structural members as building work proceeds. Wherever holes are cut or left originally they shall be made good with cement concrete 1:2:4 (1 cement; 2 coarse sand; 4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement : 2 coarse sand) cured and the surface restored to original condition.

14.0 GULLY TRAP

Gully trap shall be Stone Ware as specified in the Bill of quantities. These shall be sound and free from visible defects such as fire cracks, or hair cracks. Each gully trap shall have one CI grating of square size corresponding to the dimension of inlet of gully trap. It will also have a water tight CI cover with frame inside dimension 300x300 mm the cover weight not less than 4.5kg and the frame not less than 2.7Kg. The grating cover and frame shall be of good casting and shall have truly square machined seating faces.

Fixing of Gully Trap

The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the Engineer-in-Charge. The gully traps shall be fixed on cement concrete foundation 65cm square and not less than 10cm thick. The mix for the concrete will be 1:4:8. The jointing of gully outlet to the branch drain shall be done similar to the jointing of PVC pipe described earlier. After fixing and testing gully and branch drain, a brick work of specified class in cement mortar 1:5 shall be built with brick masonry work round the gully trap from the top of the bed concrete upto ground level. The space between the chamber and trap shall be filled in with cement concrete 1:3:6. The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside the cement mortar 1:3 finished with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded of so as to slope towards the grating.

CI cover with frame 300 x 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 and rendered smooth. The finished top cover shall be so as to prevent the surface water from entering the gully trap.

Measurements

Gully traps shall be measured by the number and rate which shall include all excavation, foundation, concrete, brick masonry, cement plaster inside and outside, CI gratings and sealed cover and frame

15.0 CONSTRUCTION OF MANHOLE

Where manholes are to be constructed, the excavation filling back and ramming, disposal of surplus earth, preparation of bottom and sides etc. shall be carried out as described earlier under trench excavation. Manhole shall be sized and depths as called for in the drawings and Bill of Quantities.

The manhole shall be built on a base concrete 1:3:6 of 150mm thickness for manholes up to 1500mm depth and 250mm thickness for manholes from 1500 to 2500mm depth.
and 300mm thickness manholes of depth greater than 2500mm. Reinforcement as shown shall be provided in base slabs.

The walls shall be of brick work of thickness as shown in drawings built in cement mortar 1:5. The joints of brick work shall be raked and plastered internally in cement mortar 1:3 (at least 12 mm thick) and finish with a coat of neat cement, external plaster shall be rough plaster in 1:3, PCC benching & semi circular channels of the same diameter' as the pipes shall be provided and finished with neat cement coating.

Above the horizontal diameter, the sides of channel shall be extended vertically to the same level, as the crown of the outgoing pipe and the top edge shall be suitably rounded off. The branch channels shall also be similarly constructed with respect to the benching but at their junction with the main channel an appropriate fall suitably rounded off in the direction of flow in the main channel shall be given. All manholes / sumps shall be provided with CI foot rest. These rungs / foot rests shall be set at 30cms interval in two vertical runs at 380mm apart horizontally. The top rung shall be 450mm below the manhole cover. Unless otherwise mentioned, manholes shall be constructed to the requirements of Indian Standard IS: 4111 (Part I). All manholes shall be constructed so as to be water tight under test. All angles shall be rounded to a 75mm radius with cement plaster 20mm thick. The benching at the side shall be carried out in such a manner so as to provide no lodgement for any splashing in case of accidental flooding. Manhole cover with frame shall be of cast iron of an approved make. The covers and frame shall generally be double seal as specified in the bill of quantities.

15.1 Measurements

Manhole shall be measured in numbers as indicated in the Bill of Quantities. The depth of manhole shall be measured from invert of channel to the top of manhole cover.

Manhole with depth greater than specified under the main item shall be paid for under extra depth and shall include all items as given for manholes. Depth will be measured to the nearest cm. Depth of the manholes shall be measured from top of the manhole cover to bottom of channel. The following are inclusive in the cost of manhole viz:

i. Bed concrete.
ii. Brick work
iii. Plastering (Inside and outside)
iv. RCC top slab, CI cover, benching and channelling including drop connections
v. Supply and fixing foot rest.
vi. Keeping holes and embedding pipes for all the connection
vii. Excavation, refilling, necessary dewatering and disposing of surplus soil to a place as directed by Project Manager.
viii. Curing
ix. Cost of angle frame and embedding in concrete bed.
x. Testing
xi. Dewatering

15.2 Drop Connection

Drop connection shall be provided between branch sewer and main sewer in the main sewer itself in steep ground when the difference in invert level of two exceeds 60 cm of the required sizes. Drop connections from gully traps to main sewer in general shall be made inside the manhole and shall have PVC special type door bend on to top and heel rest bend at bottom connecting by a PVC pipe. The pipe shall be supported by holding clamps at 100 cms intervals with atleast one clamp for each drop connection. All joints shall properly sealed.

Drop connections from branch sewer to main sewer shall be made outside the manhole wall with PVC pipe, connection, vertical pipe and bend at the bottoms. The top of the tee...
shall be finished upto the surface level and provided with a CI hinges type frame and cover 30cmx30cm.

Drop connection made from vertical stacks directly into manholes shall not be considered as drop connections.

15.3 Making Connections

Tenderer shall connect the new sewer line to the existing manhole by cutting the walls, benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Tenderer shall remove all sewage and water if encountered in making the connection without additional cost.

15.4 Cast iron Manhole cover and Frame

The cast iron manhole cover and frame shall conform to IS: 1726 and the grade and types have been specified in the Bill of Quantities. The cover and frames shall be cleanly cast and they shall be free from air and sand holes and from cold shuts. They shall be neatly dressed and carefully trimmed. All castings shall be free from voids whether due to shrinkage, gas inclusion or other causes. Covers shall have a raised chequered design on the top surface to provide an adequate non-slip grip.

The sizes of covers specified shall be taken as the clear internal dimensions of the frame.

The covers and frames shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63° C and shall not brittle as to chip off at a temperature of 0° C.

15.5 TESTING

All parts of the sewer and drain shall be carefully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subject to a test pressure of 1.5 meter head of water. The test pressure will however, not exceed 6 meters head at any point. The pipes shall be plugged preferably with standard design plugs or with rubber plugs on both sides, the upper end shall, however be connected to a pipe for filling with water and getting the required head poured at one time.

16.0 Rainwater Pipes

All open terraces shall be drained by rain water down takes.

Rainwater down takes are separate and independent of the soil and waste system and will discharge into the underground storm water drainage system of the complex

Rainwater in open courtyards shall be collected in catch basins and connected to the Storm Water drains.

Any dry weather flow from waste appliances, e.g. AHU's pump rooms, waste water sumps shall connected to sewers after traps and not in the storm water drainage systems.

17.0 Balcony / Planter drainage

Wherever required, all balconies, terraces, planters and other frontal landscape areas will be drained by vertical down takes or other type of drainage system shown on the drawings and directed by the Project Manager.
1.0 SCOPE

The scope of this section consists of but is not necessarily limited to supply and installation / installation, testing and commissioning of the following items as per the schedule of quantities and specifications.

a. Sanitary appliances and fixtures for toilets
b. Water supply fittings
c. Accessories e.g. towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails, coat hooks etc.

Whether specifically mentioned or not the Tenderer shall provide for all appliances and fixtures all fixing devices, nuts, bolts, screws, hangers as required.

2.0 GENERAL REQUIREMENT

Sanitary appliances and fixtures for toilets, water supply fittings, bathroom accessories like towel rods, toilet paper holders, soap dish, liquid soap dispenser, towel rails, coat hooks, etc as listed in the relevant items in the Bill of Quantities shall be supplied by the Tenderer. The rates shall be inclusive of accessories required for installation.

All appliances, fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Bill of Quantities, specifications, drawings, etc. Accessories shall include proper fixing arrangements, brackets, nuts, bolts, washers, screws and required connection pieces.

The sanitary fixtures and fittings shall be installed at the correct assigned position as shown on the drawings and as directed by the Engineer-in-Charge and shall fully meet with the aesthetic and symmetrical requirements as demanded by the Architect /Interior Designer.

All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Engineer-in-Charge’s requirements. Wherever necessary, the fittings shall be centered to dimensions and pattern as called for.

Fixing screws shall be half round head chromium plated (CP) brass screws, with CP brass washers unless otherwise specified.

Fixtures shall be installed by skilled workman with appropriate tools according to the best trade practice.

All appliances, fittings and fixtures shall be fixed in a neat workmanlike manner true to level and to heights shown on the drawings and in accordance with the manufacturer’s recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulation or terrace shall be made good by the Tenderer at his own cost. Fixtures shall be mounted rigid, plumb and true to alignment.

All materials shall be rust proofed. Materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

Wall flanges shall be provided on all walls, floors, columns etc, wherever supply and disposal pipes pierce through them. These wall caps shall be of chromium plated brass fittings and the receiving pipes and shall be large enough to cover the punctures properly.
Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following:

i. Tenderer shall, during the entire period of installation and afterwards protect the appliances by providing suitable cover or any other protection so as to absolutely prevent any damage to the appliances until handing over. (The original protective wrapping shall be left in position for as long as possible).

ii. The appliances shall be placed in correct position or marked out in order that pipe work can be fixed or partially fixed first.

iii. The appliance shall be fixed in a manner such that it will facilitate subsequent removal if necessary.

iv. The appliance shall be securely fixed. Manufacturer’s brackets and fixing methods shall be used wherever possible. Compatible rust-proofed fixings shall be used. Fixing shall be done in a manner, that minimize noise transmission.

v. Appliances shall not be bedded (e.g. WC pans, pedestal units) in thick strong mortar that could crack the unit (e.g. ceramic unit).

vi. Pipe connections shall be made with demountable unions. Pipe work shall not be fixed in a manner that it supports or partially supports appliance.

vii. Appliances shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer and additional anchors or supports where necessary.

Sizes of sanitary fixtures given in the Specifications or in the Bill of Quantities are for identification with reference to the catalogues of make considered. Dimensions of similar models of other makes may vary within ± 10% and the same shall be provided and no claim for extra payment shall be entertained nor shall any payment be deducted on this account.

The tenderer shall fix all plumbing fittings such as water faucets, shower fittings mixing valves etc. in accordance with manufacturer’s instructions and connect to piping system. The tenderer shall supply all fixing materials such as screws, rawl plugs, unions, collars, compression fittings etc., as required.

Joints / gaps between all sanitary appliances / fixtures and the floor / walls shall be caulked with an approved mildew resistant sealant, having antifungal properties, of colour and shade to match that of the appliances / fixture and the floor / wall to the extent possible.

3.0 Sanitary Fittings

3.1 Water Closet

Water Closet shall be wash down or siphonic wash down type floor or wall mounted set, as shown in the drawings, designed for low volume flushing from 5-7 litres of water, flushed by means of a PVC flushing cistern. Flush pipe / bend shall be connected to the WC by means of a suitable rubber adaptor.

Each WC set shall be provided with approved quality of seat, rubber buffers and chromium plated hinges. Seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the WC.

Each WC shall be provided with 110 mm dia (OD) PVC pan connector connecting the ceramic outlet of WC to PVC pipe.
Squatting Type Water Closet - Orissa Pattern

Squatting type water closed (WC) pan shall be of Orissa pattern of size as specified in Bill of Quantities. Each WC pan shall be provided with a 100 mm dia porcelain P or S trap with or without vent horn as directed by Engineer-in-Charge.

WC shall be flushed by means of PVC flushing cistern.

3.2 Urinals

Urinals shall be half stall with glazed vitreous china of size as called for in the Bill of Quantities.

Half stall urinals shall be provided with 15 mm dia CP spreader, 32 mm dia CP dome shaped waste and with waste pipe and shall be fixed to wall by CI brackets, CI wall clips and CP brass screws as recommended by manufacturer complete or as directed by the Engineer-in-Charge.

Flush pipes shall be PVC pipes concealed in wall chase but with chromium plated bends at Inlet and outlet.

Urinal Partitions

Urinal partitions shall be vitreous china of size specified in Bill of Quantities

Porcelain partitions shall be fixed at proper heights with CP brass bolts, anchor fasteners and MS clips as recommended by the manufacturer and as directed by the Engineer-in-Charge.

3.3 Cisterns / Flush Valve

Flushing cistern (exposed or concealed) shall be provided for WC in specified toilets. Tenderer shall install cistern in accordance to the manufacturer’s specification to the satisfaction of the Engineer-in-Charge.

3.4 Wash Basin

Wash basins shall be vitreous china of size, shape and type specified in the Bill of Quantities.

Each basin shall be provided with painted MS angle or CI brackets and clips and the basin securely fixed to wall / counter slab. Placing of basins over the brackets without secure fixing shall not be accepted. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Engineer-in-Charge. The cost of fixing the basin shall be inclusive of supply and installation of brackets as described above.

Each basin shall be provided with 32mm dia CP waste with overflow, pop-up waste or rubber plug and CP brass chain as specified in the Bill of Quantities.

3.5 Towel Rail

Towel rail shall be chromium plated brass or of stainless steel or powder coated brass or size, shape and type specified in the Bill of Quantities.

Towel rail shall be fixed with screws / capping having finish similar to towel rail in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by the Engineer-in-Charge.
4.0 MOCKUP AND TRIAL ASSEMBLY

The installation of the sanitary fixtures and fittings shall be as per the shop drawings approved by the Engineer-in-Charge.

The tenderer shall have to assemble at least one set of each type of sanitary fixtures and fittings in order to determine precisely the required supply and disposal connections. Relevant instructions from manufacturers shall follow as applicable. This trial assembly shall be developed to determine the location of puncture holes, holding devices etc, which will be required for final installation of all sanitary fixtures and fittings. The above assembly shall be subjected to final approval by the Engineer-in-Charge.

The fixtures in the trial assembly can be used for final installation without any additional payment for fixing or dismantling of the fixtures.

5.0 SUPPORTING AND FIXING DEVICES

The tenderer shall provide all the necessary supporting and fixing devices to install the sanitary fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not represent an unsightly appearance in the final assembly. Where the location demands, the Engineer-in-Charge may instruct the tenderer to provide chromium plated or other similarly finished fixing devices. In such circumstances the tenderer shall arrange to supply the fixing devices and shall be installed complete with appropriate vibration isolating pads, washers and gaskets.

6.0 FINAL INSTALLATION

The tenderer shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between building and the piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal / replacement of sanitary fixtures without disturbing the built in piping system. All unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid, plumb and to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes before making the joints. It shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

7.0 PROTECTION AGAINST DAMAGE

The tenderer shall take every precaution to protect all sanitary fixtures against damage, misuse, cracking, staining, breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation. At the time of handing over, the tenderer shall clean and polish all the fixtures and fittings. Any fixtures and fittings found damaged, cracked, chipped stained or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

8.0 MEASUREMENT

8.1. Rate for fixing only of sanitary fixtures accessories, CP fittings shall etc. include all items, and operations stated in the respective specifications and bill of quantities and nothing extra is payable.
8.2 Rates for all items under specifications para above shall be inclusive of cutting holes and chases and making good the same, CP screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning and making good to the satisfaction of the Engineer-in-Charge.

9.0 TESTING

All appliances, fixtures and fittings shall be tested before and after instillation Water seals or all appliances shall be tested. The tenderer shall block the ends of waste and ventilation pipes and shall conduct an air test.
COMMISSIONING AND GUARANTEE

1.0 SCOPE OF WORK

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Tenderer shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Tenderer shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Engineer-in-Charge or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Tenderer shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The tenderer shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rotameters. Tenderer shall also supply all required pressure gauge, temperature gauge & rotameter for system commissioning and balancing. The balancing shall be to the satisfaction of Engineer-in-Charge.

Three copies of all test results shall be submitted to the Engineer-in-Charge in A4 size sheet paper within two weeks after completion of the tests.

2.0 PRECOMMISSIONING

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Tenderer shall proceed as follows:

a. The water storage tanks and pipes shall first be filled with water and thoroughly flush out. The storage tanks shall then be filled with water again and disinfecting chemical containing chlorine added gradually while tanks are being filled to ensure thorough mixing. Sufficient chemical shall be used to give water a dose of 50 parts of chlorine to one million part of water.

   If ordinary bleaching powder is used, the proportions will be 150 gm of powder to 1000 liters of water. The powder shall be mixed with water in the storage tank. If a proprietary brand of chemical is used, the proportions shall be specified by the manufacturer. When the storage tank is full, the supply shall be stopped and all the taps on the distributing pipes are opened successively working progressively away from the storage tank. Each tank shall be closed when the water discharged begins to smell of chlorine. The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommended proportions. The storage tank and pipe shall then remain charged at least for three hours. Finally the tank and pipes shall be thoroughly flushed out before any water is used for domestic purpose.

   The pipe work shall be thoroughly flushed before supply is restored.

b. After the pipe work has been tested and approved, but before it is coupled, it shall be sterilized with a solution of chloride of lime.
c. Prior to start-up and hydraulic testing, the tenderer shall clean the entire installation including all water tanks, equipments and pipe work and the like after the installation and keep them in new condition. All plumbing system shall be flushed and drained at least once through to good to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris. Cleaning and flushing shall be carried out in sections as the installation becomes completed.

d. All strainers shall be inspected and cleaned out or replaced.

e. When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning sign shall be provided at all outlets during pre-treatment. The pre-treatment chemical shall:

- Remove oil, grease and foreign residue from the pipe work and fittings.
- Pre-condition the pipe surfaces to resist reaction with water or air.
- Establish an initial protective film;
- After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.
- Details and procedures of the pre-treatment shall be submitted to the architect / consultant for approval.

f. Check all clamps, supports and hangers provided for the pipes.

g. Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves are functioning properly. There after conduct & hydro test of the system as above.

h. Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

3.0 FINAL ACCEPTANCE TESTS

Following commissioning and inspection of the entire installation and prior to issue of the Completion Certificate, the Tenderer shall carry out final acceptance tests in accordance with a programme to be agreed with the Engineer-in-Charge.

Should the results of the acceptance tests show that plant, systems and / or equipment fail to perform to the efficiencies or other performance figures as given in this specification, the Tenderer shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Tenderer prior to the issue of Completion Certificate to the acceptance of the Authorities.

4.0 HANDING OVER OF DOCUMENT

All testing and commissioning shall be done by the Tenderer to the entire satisfaction of the Engineer-in-Charge and all testing and commissioning documents shall be handed over to the Engineer-in-Charge.

The Tenderer shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Engineer-in-Charge.
### 5.0 PIPE COLOUR CODE

<table>
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<tr>
<th>Sl. No</th>
<th>Pipe Lines</th>
<th>Ground / Base Colour</th>
<th>First Colour Band</th>
<th>Second Colour Band</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cooling Water</td>
<td>Sea Green</td>
<td>French Blue</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Boiler Feed</td>
<td>Sea Green</td>
<td>Gulf Red</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Condensate</td>
<td>Sea Green</td>
<td>Light Brown</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Drinking Water (All cold water line after filter)</td>
<td>Sea Green</td>
<td>French Blue</td>
<td>Single Red</td>
</tr>
<tr>
<td>5</td>
<td>Treated water (Soft water)</td>
<td>Sea Green</td>
<td>Light Orange</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Domestic Hot water</td>
<td>Sea Green</td>
<td>Light Grey</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Drainage</td>
<td>Black</td>
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<td></td>
</tr>
</tbody>
</table>
TECHNICAL CONDITIONS (SEWAGE TREATMENT PLANT)

I. SCOPE OF WORK

The general character and the scope of work to be carried out under this contract is illustrated in Drawings, Specifications and Schedule of Quantities. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the Owner’s site representative. The contractor shall furnish all labour, materials and equipment (except those to be supplied by the owner) as listed under Schedule of Quantities and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of the complete Sewage Treatment Plant as described in the Specifications and as shown on the drawings. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract. The Sewage Treatment Plant shall comprise of following:

a. Screen Chambers

b. Oil Separator and grit chamber

c. Sewage & Sullage collection tanks

d. Anaerobic High Rate reactor

e. Primary and secondary settling tanks

f. Flocculation tank

g. Aeration Tanks

h. Sludge holding tank

i. Filter feed sump

j. Pressure sand filter and activated carbon filter

k. Bio gas plant

l. Air Blowers, pumps & equipments

m. Piping (Heavy duty PVC), valves etc

n. Electro Mechanical Equipments

o. Electrical works including panel boards, cabling to various motors, level controllers for automatic running of the plant, etc.

p. Other Miscellaneous Items.

q. Approval from Statutory / Local Authorities

r. Cutting holes, chases & like through all types of walls /floors and finishing for all services crossings, including sealing, cover plates, making good structure and finishes to an approved standard.
s. Balancing, testing & commissioning of the entire STP.

t. Test reports (During commissioning and for 3 months (every 15 days) after commissioning),
   list of recommended spares, as-installed drawings, operation & maintenance manual for the
   entire STP contract.

u. Training of Owner’s staff.

v. O&M as mentioned in the Schedule of quantities.

2. ASSOCIATED CIVIL WORKS

   The civil works for construction of various units associated with Sewage Treatment Plant are
   included along with the BOQ for civil works. These shall be executed in accordance with
   approved shop drawings of the Sewage Treatment Plant.

3. PROJECT EXECUTION AND MANAGEMENT

   The Contractor shall ensure that senior planning and erection personnel from his organisation are
   assigned exclusively for this project. They shall have minimum 5 years experience in this type of
   installation.

   The Contractor shall arrange to have mechanised & modern facilities of transporting material to
   place of installation for speedy execution of work.

4. PERFORMANCE GUARANTEE

   The contractor shall carry out the work in accordance with the Drawings, Specifications,
   Schedule of Quantities and other documents forming part of the Contract.

   The contractor shall be fully responsible for the performance of the selected equipment (installed
   by him) at the specified parameters and for the efficiency of the installation to deliver the
   required end result.

   The contractor shall guarantee that the Sewage Treatment Plant as installed shall maintain the
   design conditions as described and relevant clauses in the specifications. Further, the contractor
   shall give a guarantee for the quality of waste water to meet the standards required for each of the
   application for re-use.

5. BYE-LAWS AND REGULATIONS

   The installation shall be in conformity with the Bye-laws, Regulations and Standards of the local
   authorities concerned, in so far as these become applicable to the installation. But if these
   Specifications and Drawings call for a higher standard of materials and / or workmanship than
   those required by any of the above regulations and standards, then these Specifications and
   Drawings shall take precedence over the said regulations and standards. However, if the
   Drawings and specifications require something which violates the Bye-laws and Regulations,
   then the Bye-laws and Regulations shall govern the requirement of this installation.

6. FEES AND PERMITS

   The contractor shall obtain all permits/ licenses and pay for any and all fees required for the
   inspection, commissioning & approval of their installation. After commissioning of the STP,
contractor shall obtain consent to operate under water act. Any other permit / approval / test required shall be deemed to be included in contract rates.

7. **DRAWINGS**

The Sewage Treatment Plant Drawings, which may be issued with tenders, are diagrammatic only and indicate arrangement of various systems and the extent of work covered in the contract. These Drawings indicate the points of supply and of termination of services and broadly suggest the routes to be followed. Under no circumstances shall dimensions be scaled from these Drawings. The architectural/interiors drawings and details shall be examined for exact location of drainage piping etc.

The contractor shall follow the tender drawings in preparation of his shop drawings, and for subsequent installation work. He shall check the drawings of other trades to verify spaces in which his work will be installed.

Maximum headroom shall be maintained at all points. Where headroom appears inadequate, the contractor shall notify the Architect/Consultant/Owner’s site representative before proceeding with the installation. In case installation is carried out without notifying, the work shall be rejected and contractor shall rectify the same at his own cost.

The contractor shall examine all architectural, landscape, structural, plumbing, electrical and other services drawings and check the as-built works before starting the work at site. He will report to the Owner’s site representative for any discrepancy and obtain clarification. Any changes found essential to coordinate installation of his work with other services and trades, shall be made with prior approval of the Architect/Consultant/Owner’s site representative without additional cost to the Owner. The data given in the Drawings and Specifications is as exact as could be procured, but its accuracy is not guaranteed.

8. **TECHNICAL DATA**

Each tenderer shall submit along with his tender, the technical data for all items in the indicated format. Failure to furnish complete technical data with tenders may result in summary rejection of the tender.

9. **SHOP DRAWINGS**

9.1 All the shop drawings shall be prepared on computer through AutoCAD System based on Architectural Drawings and site measurements. Within three weeks of the award of the contract, contractor shall furnish, for the approval of the Architect/Consultant, two sets of detailed shop drawings of all equipment and materials including layouts for Plant room, Pump room, Typical drawings showing exact location of supports, flanges, bends, tee connections, reducers, detailed piping drawings showing exact location and type of supports, valves, fittings etc, electrical panels inside/outside views, power and control wiring schematics, cable trays, supports and terminations. These shop drawings shall contain all information required to complete the Project as per specifications and as required by the Architect/Consultant/Owner’s site representative.

These Drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all items of equipment, also the details of all related items of work by other contractors. Each shop drawing shall contain tabulation of all measurable items of equipment/materials/works and progressive cumulative totals from other related drawings to arrive at a variation-in-quantity statement at the completion of all shop drawings. Minimum 8 sets of drawings shall be submitted after final approval along with floppy / CD.
Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer strictly from the manufacturers as listed in list of approved makes and quoted by the tenderer in technical data.

When the Architect/Consultant makes any amendments in the above drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated along with check prints, for approval. The contractor shall submit further Eight sets of shop drawings to the Owner’s site representative for the exclusive use by the Owner’s site representative and all other agencies. No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved shop drawing for the particular material / equipment / installation.

9.2 Shop drawings shall be submitted for approval two weeks in advance of planned delivery and installation of any material to allow Architect/Consultant ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved programme.

9.3 Manufacturers drawings, catalogues, pamphlets and other documents submitted for approval shall be in four sets. Each item in each set shall be properly labelled, indicating the specific services for which material or equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data of general nature shall not be accepted.

9.4 Samples of all materials like valves, pipes, control wires etc shall be submitted to the Owner’s site representative prior to procurement. These will be submitted in one set for approval and retention by Owner’s site representative and shall be kept in their site office for reference and verification till the completion of the Project. Wherever directed a mock up or sample installation shall be carried out for approval before proceeding for further installation.

9.5 Approval of shop drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings supercede the contract requirements, nor does it in any way relieve the contractor of the responsibility or requirement to furnish material and perform work as required by the contract.

9.6 Where the contractor proposes to use an item of equipment, other than that specified or detailed on the drawings, which requires any redesign of the structure, partitions, foundation, piping, wiring or any other part of the mechanical, electrical or architectural layouts, all such re-design, and all new drawings and detailing required therefore, shall be prepared by the contractor at his own expense. These drawings / Specifications shall be approved by the Architect / Consultant / Owner’s site representative. Any delay on such account shall be at the cost of and consequence of the Contractor.

9.7 Where the work has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. The contractor shall prepare composite working drawings and sections at a suitable scale, not less than 1:50. The drawings shall clearly indicate how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to the Owner.

9.8 Within one week of approval of all the relevant shop drawings, the contractor shall submit four copies of a comprehensive variation in quantity statement, and itemized price list of recommended (by manufacturers) imported and local spare parts and tools, covering all equipment and materials in this contract. The Project Manager shall make recommendation to
Owner for acceptance of anticipated variation in contract amounts and also advise Owner to initiate action for procurement of spare parts and tools at the completion of project.

10. **QUIET OPERATION AND VIBRATION ISOLATION**

The installation shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Owner’s site representative.

11. **MATERIALS AND EQUIPMENT**

All materials and equipment shall conform to the relevant Indian Standards and shall be of the approved make and design. Makes shall be strictly in conformity with list of approved manufacturers.

12. **MANUFACTURERS INSTRUCTIONS**

Where manufacturer has furnished specific instructions, relating to the material and equipment used in this project, covering points not specifically mentioned in these documents, such instructions shall be followed in all cases.

13. **COMPLETION CERTIFICATE**

On completion of the Electrical installation for STP works, a certificate shall be furnished by the contractor, countersigned by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local authority.

If required, the contractor shall be responsible for getting the entire electrical installation for Sewage Treatment Plant duly approved by the local authorities concerned, and shall bear expenses if any, in connection with the same.

14. **BALANCING, TESTING AND COMMISSIONING**

Balancing of all water systems and all tests as called for the Specifications shall be carried out by the contractor through a specialist group, in accordance with the Specifications and Manual on Sewage & Sewage Treatment – Published by CPHEEO Guide lines and Standards. Performance test shall consist of three days of 10 hour each operation of system for each season.

The installation shall be tested again after removal of defects and shall be commissioned only after approval by the Owner’s site representative. All tests shall be carried out in the presence of the representatives of the Architect/Consultant and Owner’s site representative.

15. **COMPLETION DRAWINGS**

Contractor shall periodically submit completion drawings as and when work in all respects is completed in a particular area. These drawings shall be submitted in the form of two sets of CD’s and four portfolios (300 x 450 mm) each containing complete set of drawings on approved scale indicating the work as - installed. These drawings shall clearly indicate complete plant room layouts, piping layouts, location of wiring and sequencing of automatic controls, location of all concealed piping, valves, controls, wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The contractor shall frame under glass, in the plant room, one set of these consolidated control and P & I diagrams.
16. OPERATING INSTRUCTION & MAINTENANCE MANUAL

Upon completion and commissioning of part Sewage Treatment Plant the contractor shall submit a draft copy of comprehensive operating instructions, maintenance schedule and log sheets for all systems and equipment included in this contract. This shall be supplementary to manufacturer’s operating and maintenance manuals. Upon approval of the draft, the contractor shall submit four (4) complete bound sets of printed operating instructions and maintenance manuals. These manuals shall also include basis of design, detailed technical data for each piece of equipment as installed, spare parts manual and recommended spares for 4 year period of maintenance of each equipment.

17. ON SITE TRAINING

Upon completion of all work and all tests, the Contractor shall furnish necessary operators, labour and helpers for operating the entire installation for a period of twelve weeks, to enable the Owner’s staff to get acquainted with the operation of the system. During this period, the contractor shall train the Owner’s personnel in the operation, adjustment and maintenance of all equipment installed.

18. MAINTENANCE DURING DEFECTS LIABILITY PERIOD

18.1 Complaints

The Contractor shall receive calls for any and all problems experienced in the operation of the system under this contract, attend to these within 10 hours of receiving the complaints and shall take steps to immediately correct any deficiencies that may exist.

18.2 Repairs

All equipment that requires repairs shall be immediately serviced and repaired. Since the period of Mechanical Maintenance runs concurrently with the defects liability period, all replacement of parts and labour shall be borne by the contractor.

19. UPTIME GUARANTEE

The contractor shall guarantee for the installed system an uptime of 98%. In case of shortfall in any month during the defects liability period, the Defects Liability period shall get extended by a month for every month having shortfall. In case of shortfall beyond the defects liability period, the contract for Operation and Maintenance shall get extended by a month for every month having the shortfall and no reimbursement shall be made for the extended period.

The Contractor shall provide log in the form of diskettes and bound printed comprehensive log book containing tables for daily record of all pressures, daily services rendered for the system alarms, maintenance and record of unusual observations etc. Contractor shall also submit preventive maintenance schedule.

Each tenderer shall submit along with the tender, the proposed general arrangement drawing of the plant, for the Owner’s site representative’s / Consultant’s review. This shall include the type of service planned to be offered during Defects Liability Period and beyond.

The tenderer shall include a list of other projects where such an Operation Assistance has been provided.
20. **OPERATION AND MAINTENANCE**

   Contractor shall carry out the operation / maintenance of the STP installation for the defects liability period. Further, he may also be required to carry out operation and all inclusive maintenance of the entire system for a period of three years beyond the defects liability period.

20.1 **Operation contract (STP)**
   i. 24 hours a day, year round.
   ii. All stand-by equipment to be operated as per mutually agreed programme.
   iii. Proper entry and upkeep of relevant log books.
   v. Proper housekeeping of all areas under the contract.
   vi. Prepare daily consumption report and summary of operation.

20.2 **Terms of payment for O&M (after expiry of Defect liability Period)**
   i. Monthly at the end of each month on pro-rata basis.

20.3 **All Inclusive Maintenance Contract**
   a. **Routine Preventive Maintenance Schedule to be submitted**
      i. Schedule to cover manufacturer’s recommendation and/or common engineering practice
      ii. Monthly status report.
   b. **Uptime during maintenance contract**
      i. 98% uptime of all systems under contract.
      ii. Up time shall be assessed every month and in case of shortfall during any month the contract shall be extended by a month.
      iii. There shall be no reimbursement for the extended period.
      iv. Break-downs shall be attended to within ten hours of reporting.
      v. Spare compressor/motor assembly to be made available within seven calendar days in case of total breakdown/burnout.
   c. **Manpower**
      i. Adequate number of persons to the satisfaction of the Owner’s site representative shall be provided including relievers.
      ii. Statutory requirements of EPF, ESIC and other applicable labour legislations to be complied with; and monthly certification to that effect to be submitted.
iii. Duty allocation and Roaster control shall be contractor’s responsibility.

iv. No over time shall be payable by owner for any reason whatsoever.

d. **Shutdowns**

i. Routine shutdowns shall be permitted only with prior approval of the OWNER.

ii. Tenderer shall be at liberty to carry out routine maintenance as and when required but with prior permission of the OWNER.

21. **PARTIAL ORDERING**

Owner through the Architect / Consultant / Site representative reserves the right to partially order equipment and material from any and / or all alternates and / or to order high side and / or low side equipment and materials or parts thereof from one or more tenderers.
TECHNICAL SPECIFICATIONS

I. BASIS OF DESIGN

1. THE CAPACITY/ RATING OF PUMPS AND EQUIPMENT ETC. SHALL HOLD GOOD FOR THE CAPACITY AS DEFINED IN THE SCHEDULE OF QUANTITIES AND SHALL BE GOOD FOR MEETING THE TREATED PARAMETERS REQUIREMENT AS FOLLOWS:

C. ENVIRONMENT (PROTECTION) ACT, 1986.
D. ENVIRONMENT (PROTECTION) RULES, 1986.
H. MANUAL ON SEWAGE & SEWAGE TREATMENT - CPHEEO
J. ALL STANDARDS AS LAID DOWN BY CENTRAL AND STATE POLLUTION CONTROL BOARDS AND ANY OTHER RELEVANT STATUTORY AUTHORITY.
K. 100% RECYLE OF WASTE WATER AND REMOVAL OF SLUDGE IN CAKE FORM, NO WATER TO BE DISCHARGED OUTSIDE THE PREMISES.

The treated water shall be recycled 100% & there shall be ZERO DISCHARGE. The by product of treatment shall be thickened & dried biological sludge.
II. SEWAGE TREATMENT PLANT

1 GENERAL

The sewage treatment plant (STP) system outlined in this section specifies the system design, manufacture, supply and installation of a sewage treatment system as per the norms of Kerala State Pollution Control Board.

The civil works for construction of various units associated with Sewage Treatment Plant are included along with the BOQ for civil works. These shall be executed in accordance with approved shop drawings of the Sewage Treatment Plant.

The Contractor may propose alternatives to this type of system, but these must be to a standard acceptable to Water and Sanitation Authority Requirement, Kerala State Pollution Control Board Norms, the local Environmental and Pollution Control Authorities and subject to the approval of the Project Manager.

The work shall be carried out in a manner consistent with good practice in the local market. The Contractor shall take into account all site conditions in designing the system and selecting the equipment.

The Contractor shall be responsible for engaging a STP specialist to perform the system design and obtain approval from relevant Authorities. A qualified and experienced Engineer shall be engaged for the system design, preparation of system proposal submission, obtaining approval and site supervision.

The Contractor shall perform the system design based on the criteria / data and component technical requirements specified in this section / drawings and the local Authorities’ regulation / requirement.

The Contractor shall furnish system which comprises products of manufacturers who have designed and made these associated products for a period of at least five years.

The Contractor shall submit complete catalogue information, design calculation and samples complete with full technical data and shop drawings for the entire system, test certificates, etc. for acceptance prior to commencement of installation.

The Contractor shall submit analytical test reports of effluent water samples after the commissioning or after the system is put into operation or as required by the Project Manager:

a First 3 months – 15 days

The report shall contain analysis of all data related to those requirements laid down by the local Authorities.

As a minimum the following items shall be measured and analysed as indicated under clause 2.1 following.
2 DESIGN CRITERIA

2.1 It shall be the Contractor’s responsibility to ensure the quality of the treated effluent to comply with the local Authorities requirement for the various applications and the following characteristics, whichever is stringent.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Parameters</th>
<th>Horticulture</th>
<th>Cooling tower makeup</th>
<th>Flushing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ph</td>
<td>7.0 – 8.5</td>
<td>6.5 – 8.5</td>
<td>6.5 – 8.5</td>
</tr>
<tr>
<td>2.</td>
<td>TSS</td>
<td>&lt;= 10 mg/lt</td>
<td>&lt;= 10 mg/lt</td>
<td>&lt;= 10 mg/lt</td>
</tr>
<tr>
<td>3.</td>
<td>BOD (5 days at 20 deg.C)</td>
<td>&lt;= 10 mg/lt</td>
<td>&lt;= 10 mg/lt</td>
<td>&lt;= 10 mg/lt</td>
</tr>
<tr>
<td>4.</td>
<td>COD</td>
<td>&lt;= 100 mg/lt</td>
<td>&lt;= 100 mg/lt</td>
<td>&lt;= 100 mg/lt</td>
</tr>
<tr>
<td>5.</td>
<td>Hardness</td>
<td></td>
<td>&lt; 50 ppm</td>
<td>&lt; 100 ppm</td>
</tr>
<tr>
<td>6.</td>
<td>TDS</td>
<td>&lt;= 1000</td>
<td>&lt;= 1000</td>
<td>&lt;= 1000</td>
</tr>
<tr>
<td>7.</td>
<td>Fat, Oil and Grease</td>
<td>&lt;= 1 mg/lt</td>
<td>&lt;= 1 mg/lt</td>
<td>&lt;= 1 mg/lt</td>
</tr>
</tbody>
</table>

The effluent from the Sewage Treatment Plant shall be suitably treated and the effluent water recovered shall be used for Flushing, Irrigation and cooling tower make-up.

2.2 Description of Process

The treatment process shall comprise the following stages:

- **Physical treatment:** coarse bar-screening
- **Equalization tank:** flow equalisation
- **Flow measurement:** flow meter
- **Anaerobic treatment for sewage:** High rate anaerobic reactor
- **Biological treatment for sewage:** Extended Aeration (diffused aeration system)
- **Flocculation and precipitation** Chemical dosing system
- **Final sedimentation for sewage:** final settling tank with Hoper Bottom
- **Chlorination treatment:** chlorination system with compound loop control
- **Water reclamation:** tertiary filtration and chlorination
  (For recycling)
- **Sludge disposal:** Bio Gas Plant

2.3 Performance Criteria of the Plant

Raw sewage will be conveyed into the Sewage Treatment Plant. The STP Contractors scope shall be to receive sewage from this point for further treatment.

The treatment plant shall be designed to treat the following basic characteristic expected in the raw sewage.
<table>
<thead>
<tr>
<th>Description</th>
<th>Average Parameter for Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated daily flow</td>
<td>200 m³ / day</td>
</tr>
<tr>
<td>Discharge period</td>
<td>20 hrs / day</td>
</tr>
<tr>
<td>Average flow</td>
<td>10 m³ / hr</td>
</tr>
<tr>
<td>Peak flow</td>
<td>30 m³ / hr</td>
</tr>
<tr>
<td>Minimum Influent BOD₅ concentration</td>
<td>250 - 400 Mg/L</td>
</tr>
<tr>
<td>Minimum Influent chemical oxygen demand</td>
<td>600 - 800 Mg/L</td>
</tr>
<tr>
<td>Minimum Influent suspended solids</td>
<td>200 - 450 Mg/L</td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>50 Mg / L</td>
</tr>
</tbody>
</table>

However, as a specialist in the field, contractor may envisage the raw sewage characteristic for a Residential Complex with Club House and a shop building. Contractor to submit his confirmation on the treatment parameter considered as an Annexure. The plant shall be capable of treating effluent to the following standards as laid down by the Kerala State Pollution Control Board with amendments from time to time.

### Treated Effluent from STP

<table>
<thead>
<tr>
<th>Description</th>
<th>Average Parameter for Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended solid</td>
<td>≤ 10 ppm</td>
</tr>
<tr>
<td>BOD₅ concentration system</td>
<td>≤ 3 ppm to the external Drainage system</td>
</tr>
<tr>
<td>COD concentration</td>
<td>&lt; 25 ppm</td>
</tr>
<tr>
<td>Residual chlorine concentration</td>
<td>≥ 1 mg / ℓ</td>
</tr>
<tr>
<td>pH</td>
<td>6.0 – 8.5</td>
</tr>
<tr>
<td>Fat, Oil and Grease</td>
<td>&lt;1 mg / ℓ</td>
</tr>
</tbody>
</table>

Treated effluent shall be connected to a tertiary filtration / treatment and shall be treated for use for irrigation and cooling tower make-up purpose. The Contractor shall carefully consider the operation loading for the Sewage Treatment Plant.

### 2.4 Process Description

The Contractor shall design the Sewage Treatment Plant to receive continuous sewage inflow within the plant area allocated on the site plan. The ease of maintenance and operation is of utmost importance in the design of Sewage Treatment Plant.

The Contractor can propose suitable sewage treatment methods like combined anaerobic aerobic sewage treatment system (differential flow-floating sludge system, etc). The design of the Sewage Treatment Plant shall be such that it can be installed within the allocated space and shall be subject to the approval of the Project manager / Consulting Engineers.
2.4.1 Inlet Screen Chamber

Raw sewage shall flow into the inlet screen chamber by gravity. Large solids particles shall be intercepted by a fine S.S Bar Screen (removal type). An additional screen shall be supplied which will used as a spare.

Sullage shall flow into the inlet screen chamber and oil separator by gravity.

2.4.2 Sewage & Sullage Collection tanks

Sewage and sullage shall be collected in separate collection tanks designed to accommodate peak flow. Separate sets of two submersible pumps as per schedule shall be provided with Automatic level control with a provision for manual override.

2.4.3 High rate Anaerobic reactor

Sewage shall be retained in the High rate Anaerobic reactor for a minimum of 24 hours and subjected to decomposition by anaerobic bacteria. Four sets of two submersible pumps as per schedule shall be provided with Automatic level control with a provision for manual override.

2.4.4 Primary Settling Tank

Sullage is pumped to settling tank where the suspended solids are removed. The clear effluent shall flow into the aeration tank.

The settled sludge shall be pumped to the bio gas plant.

Any scum formed on the surface of the clarifier tanks shall be returned to the aeration tank by automatic siphoning / pumping.

2.4.5 Aeration Tank

Sewage shall be retained in the Aeration tank for a minimum of 4 hours and subjected to biochemical oxidation by fine bubbles aeration. Aeration tanks shall be provided with cylindrical shaped specially designed floating bio media (Anox Kaldnes or equivalent) to facilitate higher oxygen transfer efficiency and reduction in size of the aeration tank.

2.4.6 Chemical Treatment and Settling Tank

Sewage and sullage after aeration is transferred to settling tank after passing through flocculation tank where the suspended solids are removed. The clear effluent shall flow into the filter feed sump.

The settled sludge shall be pumped to the bio gas plant.

Any scum formed on the surface of the clarifier tanks shall be returned to the aeration tank by automatic siphoning / pumping.

2.4.7 Chlorination Tank

Sodium-hypo-chlorite solution shall be metered in to the effluent by an electric dosing pump paced according to the sewage inflow. The effluent shall be retained in the baffle walled chlorine tank for a minimum 30 minutes for effective disinfection prior to discharge.
2.4.8 **Bio Gas Plant**

Excessive sludge shall be pumped to the bio gas plant for disposal.

3 **EQUIPMENT**

The following give the minimum requirements of the different components of the system. The figures indicated are for contractor’s references. It shall be the Contractor’s responsibility to select equipment for the plant proposed by them so that the capacities and performance of the Sewage Treatment Plant meet with the criteria set out in this specification.

All equipment and components of the system shall be of top quality construction and shall be corrosion resistant.

3.1 **Coarse Screening Equipment**

Bar screen shall be of 304 stainless steel construction. Drip basket (removable type) shall be provided for holding and drainage of the screenings.

3.2 **Air Blowers**

Air blowers shall be provided in duplicate (i.e. one working and one standby). Blowers shall be of centrifugal with pressure vessel type complete with motor, base-plate, inlet filter, intake silencer and off-load starting system outlet silencer, anti-vibration damper, flexible coupling, filter restriction indicator, non-return valve, pressure relief valve, V-belt system or direct drive coupling. The casing rotor shall be of cast iron construction. Bearings and gears shall be grease lubricated. Motor speed shall be 1500 rpm.

3.3 **Air Diffusers**

Air diffusers shall be made to provide a uniform distribution of fine bubble air release performance in the system. The air diffuser shall be either made of elastomeric rubber membrane or composed of crystalline fused aluminium oxide with a suitable ceramic bonding material.

Membrane endurance shall be more than 180,000 expansion/contraction cycles.

Diffuser shall be of self-cleaning, dome-shaped type. Oxygen transfer efficiency shall not be less than 20% at 3.5m submergence in clear water. Alternatives may be offered for consideration.

Diffuser hold down assemblies shall consist of a retainer bolt, a matching washer and gasket. Sealing gasket shall be composed of solid neoprene rubber and shall be conform to ASTM D-2000 and shall be suitable for withstanding the effects of wastewater high temperature up to 120°C.

The Contractor shall submit calculation to justify the diffuser selection and air requirement during the detailed design.

3.4 **Sewage Pumps**

Working and standby sewage pumps shall be provided separately for sewage and sullage.

Each shall be of submersible type the installation shall facilitate case of removal. Pump casing and impeller shall be of SS material. The pumps shall be capable of handling solids upto 23 mm nominal diameter. Shaft shall be of stainless steel material. The BOQ identifies quote rate for alternate MOC. Contractor shall ensure submission of quote for same.
3.5 **Sludge Transfer and Disposal Pumps**

Two numbers of submersible sludge transfer and disposal pumps (one working and one standby) shall be provided.

Each shall be of centrifugal non-clog self-priming open impeller type. The installation shall facilitate easy removal. The material construction shall be the same as the sewage pumps.

3.6 **Settling Tank**

Settling tanks shall include baffles to prevent short circuiting.

3.7 **Tertiary Treatment**

This tertiary treatment shall be provided for the effluent used for irrigation and cooling tower make-up water tank/flushing system.

The tertiary treatment plant shall comprise of the pressure sand filters and activated carbon filters. This shall be sized to accommodate 100% of the effluent discharge flow rate and shall achieve the performance as outlined and described in Design Criteria.

Details of the equipment layout proposal shall be submitted for review by the Project Manager with tender documents.

3.8 **Chlorination System**

A chlorine contact tank with a capacity of not less than 30 min average flow detention shall be furnished. Construction shall be similar to the other tanks and panels comprising the treatment plant, and shall include flow diversion baffles and outlet of the chlorine contact chamber for measuring the waste flow.

A chlorine feed system shall be furnished as a complete package assembly for installation in the plant room. Assembly shall include base plate, electronic positive displacement type chemical feed pump, fibreglass solution tank, suction and discharge tubing and fittings.

Each chlorine solution dosing pump shall perform to achieve a residue not more than 1 mg/l in the treated effluent. Solution feed pump shall have a maximum capacity of 1 l/hr chemical pump will operate on 50 Hz supply. Fibreglass solution tank shall be of not less than 100 litre capacity and include suction line fitted with strainer.

Control shall be by means of compound loop (i.e. flow proportional and residual measuring).

The feed pump shall be of variable speed positive displacement, solenoid-riven diaphragm metering type. The construction material shall be suitable for corrosive nature and as follows:

3.9 **Electrical Control**

The operation of the treatment process shall be fully automatic.

A completely assembled and prewired control panel with mimic diagram consisting of weatherproof cabinet shall be furnished. The control panel shall contain all metering and status indicators, motor starters, program timbers, on-off-auto change-over switches and duty selectors for equipment.
Proper control sequence shall be designed according to system requirement and manufacturer’s standards.

3.10 Other Equipment

Any other necessary accessories, such as buffer, riser, scum removal devices, partition, control panel, collection devices, etc. for all the tanks and pumps (where necessary) shall be provided in order to provide a fully working systems.

3.11 Piping Materials

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS epoxy Air piping</td>
<td>and pumped effluent riser</td>
</tr>
<tr>
<td>PVC piping</td>
<td>Pumped effluent (submerged) &amp; tank overflow pipe line.</td>
</tr>
<tr>
<td>PVC (Heavy Duty)</td>
<td>Interconnecting pipe line after delivery header of pump / filter.</td>
</tr>
</tbody>
</table>

3.12 Valves

The Contractor shall supply and install all isolating valves and control valves as indicated on the drawings and as required for the proper and efficient operation and maintenance of the entire systems.

All valves supplied shall be suitable for the working pressure and test pressure of the system as specified elsewhere in this specification.

Regulating valves shall be of similar materials as that specified for cast iron gate valves.

All regulating valves shall be lock shield type.

All valves shall be full line size.

Each valve shall have a purpose made reference number plate for label engraved or stamped indicating the manufacturer’s catalogue number, pressure and temperature ratings. Valves shall be arranged so that clockwise rotation of the spindle will close the valve.

All valves shall be packed with an approved packing and threads shall be coated with oil and graphite. Gland packing should be replaced when found deteriorated on site.

Where possible locate all valves at convenient positions of operation from the floor with valve stems upright.

Valves that are flanged shall have flanges to the table specified for the pipe work.

Plastic or metal plates (rust less) shall be provided to indicate the open / close status as well as the use of each valve in the pump and tank rooms.
4 PIPE SUPPORTS

4.1 General Support

Tender drawings indicate schematically the size and location of pipes. The Contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-sections, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.

Piping shall be properly supported on, or suspended from hi-tech supports, on stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, hi-tech supports, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. Risers shall be supported at each floor with Galvanised steel clamps. To permit free movement of common piping support shall be from a common hanger bar fabricated from Galvanised steel sections.

Piping shall be supported from the building structure, which shall support the sum of the load of a water-filled pipe and a minimum of 120 kg applied at the point of hanging.

All piping brackets shall be constructed as shown on the standard detail drawings.

Vertical pipe work shall be supported at intervals of at least one per floor level.

Horizontal pipe work shall also be supported by hi-tech supports as mentioned below:

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>Distance between Supports</th>
<th>Diameters of Rod</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm</td>
<td>1.8 m</td>
<td>10</td>
</tr>
<tr>
<td>32 mm</td>
<td>2.4 m</td>
<td>10</td>
</tr>
<tr>
<td>40 mm</td>
<td>2.7 m</td>
<td>10</td>
</tr>
<tr>
<td>50 mm</td>
<td>2.7 mm</td>
<td>10</td>
</tr>
<tr>
<td>65-80 mm</td>
<td>3.0 m</td>
<td>12</td>
</tr>
<tr>
<td>100 mm</td>
<td>3.0 m</td>
<td>16</td>
</tr>
<tr>
<td>150-200 mm</td>
<td>3.6 m</td>
<td>18</td>
</tr>
</tbody>
</table>

The end of the steel rods shall be threaded and not welded to threaded bolt.

HANGERS SHALL BE SUPPORTED BY MEANS OF APPROVED FASTENERS. WOOD PLUGS SHALL NOT BE USED UNLESS ALLOWED BY THE STRUCTURAL ENGINEER. POWER FIXINGS MAY BE USED FOR PIPEWORK OF DIAMETER LESS THAN 50 MM. EXPANSION FASTENERS MAY BE USED FOR VERTICAL PIPEWORK UNDER 100 MM DIAMETER.

All pipe work shall be carried out in a proper workman like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized in consultation with other agencies working at site, so that the works can be carried out in one stretch.

Requirement of Cut-outs in the structural slab or wall for installing the various pipes shall be clearly identified in the detailed shop drawing to be prepared by the STP contractor.
Pipe sleeves, larger diameter than pipes, shall be provided wherever pipes pass through walls and slab and annular space filled with fibreglass and finished with retainer rings.

The contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipe supports are adequate or as specified / approved by Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reduces shall be used for the piping to drain freely. In other locations, concentric reduces may be used.

Automatic air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15mm pipe size and shall be associated with an equal size gate valves.

Discharge from the air valves shall be piped through a pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

Pressure gauges shall be provided as shown on the approved drawings. Care shall be taken to protect pressure gauges during pressure testing.

5 INSTALLATION

The machinery shall be accurately installed to correct dimensions, alignments, levels, etc., all as indicated on the final drawings. The machinery shall be mounted on flat steel packing pieces of thickness suitable to take up variations in level of the concrete foundations. Suitable packing pieces shall be located adjacent to each holding down bolt and shall be properly bedded by grinding the concrete surface to a smooth, level finish. The machinery shall be aligned and levelled and the nuts of the holding down bolts tightened with a spanner of normal length. The base plates shall be packed with grout after the machinery has been run and checked by the Project Manager for stability and vibration.

Installation shall include the provision and fixing of all necessary holding down bolts, washers, nuts etc.

The length of all bolts shall be such that when fitted with a nut and tightened the threaded portion of the bolts shall protrude from the top face of the nut by a distance not exceeding half the bolt diameter. Exposed bolt heads and nuts shall be hexagonal.

All equipment and materials of the same type shall be products of the same manufacturer. Locally made equipment will not be accepted unless otherwise specified.

All similar items of plant and their component part shall be completely interchangeable. Spare parts shall be manufactured from materials similar to the originals and shall fit all similar items of plant. Where machining may be needed before fitting renewable parts, the machining fits with their tolerance shall be shown on the drawings accompanying the instruction manuals.

All motors and/or revolving parts shall be truly balanced both statically and dynamically so that when running at normal speeds and any load up to the maximum there shall be no significant vibration due to lack of balance. All parts which can be worn or damaged by dust shall be totally enclosed in dust-proof housings.
6 MAINTENANCE FACILITIES

The loading and fixing method of lifting facility shall be submitted to the Project Manager / Engineer for approval and checking within 4 weeks on award of Contract or receipt of letter of intent.

7 TESTING

The performance of the system shall be demonstrated by taking hourly samples of the raw sewage and final effluent over a twelve hour period. The sample shall be taken at periods approximately the flow rates specified by the plant. The sample shall be combined and a 5-day BOD shall be run, the results of which must verify the capacity of the treatment plant prior to acceptance.

8 TRAINING

Training facilities courses shall be provided to ensure that the employer’s staff associated with the project may acquire full knowledge and appreciation of all aspects of the design, day-to-day operation, breakdown and routine maintenance, and fault diagnosis of all plant, equipment and systems.

Training to the employer’s staff shall be held as appropriate at the Contractor’s or manufacturer’s premises and on site. A detailed syllabus for each of the training courses specified or proposed and the timing of the courses shall be submitted for approval. The Contractor shall recommend the desirable qualifications and experience of the trainees to optimally benefit from the courses.

The Contractor shall be deemed to have included in his tender price the cost of providing training facilities as specified.

In addition to the above, the Contractor shall submit to the Project Manager a list describing such other spares and special tools, their number, price and where appropriate the anticipated frequency of replacement considering 3 years operation as soon as is practicable.
III. ELECTRICAL INSTALLATION

1.0 SWITCH GEARS AND PANEL BOARDS

1. Scope
   The following specification covers the general requirements for Design, Fabrication and Testing and Commissioning of medium Voltage switch boards.

2. Regulations
   The Switchboards to be supplied shall fully comply with the requirements laid down in the following rules and regulations as amended up-to-date.
   Indian Factories Act, Standards of Local Statutory bodies, Indian Electricity Rules, including special requirements of Electrical Inspectorate and the detailed specification mentioned below.

3. Standards
   Requirements laid down in the IS: 13947 (LV Switchgear and control gear) and other relevant Indian Standard shall be strictly adhered to.

4. Service and supply conditions
   The switch boards shall be designed to operate satisfactorily under service and supply conditions specified.

5. Construction
   The type of design and construction shall be single front / double front, floor mounting, wall mounting, fixed type or draw out type as specified. Protection provided to the enclosures shall conform to IS: 8623. The design of the switchboards shall be compact. However, it shall have ample space for the termination and support of cables and any maintenance work required on the switchboards. The design shall be such as to allow for extension at both the ends, if specified. The enclosure shall be in CRCA sheet used not less than 1.6 mm thickness. All doors shall be hinged at one side with knobs for opening and closing and shall be bolted on the other three sides for single front switchboards. All hinges shall be of concealed design for elegant appearance. Adequate lifting facilities shall be provided on each section. Lifting eyes may be of removable / foldable design. The switch board shall be totally enclosed, dust, weather and vermin proof gasket of durable material shall be provided for doors and other openings. All hardware shall be corrosion resistant. All joints and connections shall be made out of galvanized zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers secured against loosening.

6. Drawout construction
   Wherever Fully Draw out type construction of switch board is specified it must be possible to drawout the incoming and outgoing feeders using special tools, without disconnecting any cables or busbar connections. The drawout modules should have distinct Service, Test and Isolated positions. In SERVICE position both power and control contacts shall be connected and it shall be possible to open and close the switch I breaker. In TEST position both power contacts shall be isolated and control contacts shall be connected so that it should be possible to test the control circuitry whereas power is isolated. In ISOLATED position both power and control contacts shall be isolated The drawout contacts should have adequate current carrying capacity and cross sectional area and shall also withstand the specified fault conditions of the switchboard without deterioration.
7. **Busbars**

The arrangement of bus bars shall be as per IS: 375. Bus bars shall be of uniform cross section and of high conductivity wrought Aluminium, Aluminium alloy or hard drawn copper as specified and shall be suitably sized for the service conditions. The horizontal and vertical bus bars shall be designed to withstand the same fault level specified. The Bus bars size shall be so selected that the maximum current density shall not exceed 0.8 Amp/sq.mm for Aluminium and 1.2 Amp/sq.mm for Copper busbars. The Bus bars shall be insulated using color coded heat shrinkable PVC Sleeves of Red colour for R-Phase, Yellow colour for Y-Phase, Blue color for B-Phase and Black color for Neutral. The Bus bar supports and insulations used in the switchboards shall be made of SMC, DMC or FRP having sufficient mechanical strength, insulation resistance and dielectric strength. Hylam or any such hygroscopic materials are not acceptable. The vertical or dropper (sub-mains) busbars shall have a current carrying capacity of the largest incomer feeder. The busbars and busbar supports shall withstand the maximum dynamic, thermal and magnetic stresses and strains arising due to the maximum short circuit current (kA) corresponding to the fault level (mVA) indicated, without any deformation, deterioration or damage. While designing the busbars, due consideration shall be given for proximity effects, altitude factor, spacing between the insulators, strength of insulators, ambient temperature, strength of fasteners, yield strength of busbars, factors of safety etc. The contractor should furnish the detailed busbar calculation for the selection and arrangements of busbars insulators etc. if specially asked for by the Owner/Consultant at any stage of the construction. The connections of Aluminium bus links with Copper switch and starter terminals shall be specifically treated to avoid bimetallic corrosion. Wherever necessary suitable bimetallic connectors shall be provided.

8. **Feeder Arrangement**

There should be a barrier provided on all sides for feeders. The design of the switchboards should be such as to attain full compartmentalization for all feeders. Compartment sizes shall be integral multiples of one or two basic module sizes. Indicating lamps, meters and push buttons shall be mounted flush with the front hinged cover. The control components, except those coming on doors, shall be mounted on a common base plate, fixed with the frame of the vertical section. The incoming feeder shall be arranged preferably in the middle of each group of feeders, in such as way that loads are distributed equally on either side. The feeder arrangements shall be such that the operating height of the switch boards lies within 1850mm, but above 300mm from the floor level. The operating handles of switches and the positions of mounting of indicating meters shall be within the above specified levels. Each feeder shall be provided with name plates to represent feeder designation as per single line diagram. The labels shall be of white acrylic unbreakable sheets with 20mm size letters engraved in black color.

9. **Cable Compartments**

Cable compartments/ cable alleys shall be provided for easy termination of all incoming and outgoing cables. Adequate supports and facilities for clamping shall be provided for cables, wherever necessary. A horizontal wire-way, extending the entire length, shall be provided at the top/bottom for inter panel wiring. Removable gland plates, having a minimum thickness of 2mm shall be provided at cable entry side of the switchboards. Necessary holes shall be drilled on the gland plate in the manufacture’s work shop itself. Metallic knockouts /plugs of PVC or Rubber shall be provided for the gland holes. Cable glands shall be supplied loose along with the switch.
boards for fixing them at site.

10. Cable termination

All termination blocks shall be 650 V grade and have adequate current carrying capacity and shall conform to IS: 4237. Terminals should be compact, having high dielectric strength so as to prevent flash-over, and have thermal strength to prevent deterioration. All terminal shall be mounted on rails, with provision for addition of terminals. Identification numbering/lettering shall be provided for each terminal. Facilities shall be available for temporary or permanent short circuiting of terminals for earthing and testing.

11. Wiring

The switch board shall be completely pre-wired and ready for external connection at site. All control wiring shall be carried out through wire ways and these shall not cross the busbar chamber. All control wiring shall be easily accessible for maintenance. Power wiring shall be carried out with PVC insulated standard copper conductor of 650 Volt grade having adequate current carrying capacity. Ferrules shall be given to all wires and necessary color codes shall be adopted for power and control wiring for easy identification. Control wiring shall be single / multi core, PVC insulated flexible stranded copper conductor of 2.5 sq.mm cross section for current and relay circuits, and 1.5 sq.mm for potential circuits. Each control wire shall be identified at both ends with wire designation by means of unbreakable ferrules, in accordance with IS: 375. Control wiring wherever terminated shall be in single layer formation. Not more than two wires shall be in single layer formation. Double layer wiring shall never be adopted. Not more than two wires shall be connected to the terminal. Wherever ON/OFF controls, ON/OFF indications, interlocks etc. are proposed in remote control panel, terminals for the necessary wiring shall be brought from the individual outlets and be terminated at a common place near the bottom of each section for external connections. Gland plates with knockouts suitable for the multi core cables of sizes specified, shall be fixed adjacent to these group of terminals.

12. Insulation

All live parts of the switchboards shall be suitably shrouded using insulating materials for the safety of the operating personnel. Shrouding of live parts shall be done using FRP sheets only. All insulating materials shall be non-hygroscopic mould proof and treated with suitable varnishes. Hylam or such hygroscopic materials are not acceptable. Minimum clearance between phases or between connections of same phase separable electrically from each other or between phases and ground shall be as per IS 4237 for parts of switchgear as well as bus bars. The insulation resistance and the dielectric strength of the Switchboards must be verified and confirmed to safe limits before transportation from the workshop. The insulation resistance if found low will have to be improved by increasing the clearances, using insulating materials and electrical equipments of sufficiently high insulation resistance etc. No additional costs will be permissible on account of this clause.

13. Painting

All metal sheets shall undergo 7 tank metal treatment, thorough

- De-rusting.
- Rinsing.
- Degreasing.
Rinsing.
Phosphating.
Rinsing and
Passivation.

All metal surfaces shall be thoroughly cleaned and degreased to remove all scales, rust, grease and dirt. Fabricated structures shall be pickled and treated to remove any trace of acid. The enclosure shall be painted with minimum two coats of zinc chromate primer and two coats of paint of approved make. The undersurface shall be made free from all imperfections before undertaking the final coat.

After preparation of the under surface, the panel shall be spray painted with final two coats of approved enamel paint. Contractor shall obtain details of approved paint from the Engineer-In-Charge before final painting. The finished panels shall be dried in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, run-off paint etc. All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust, corrosion etc. Inside surface shall be painted with anti-corrosive paint if humidity is more than 30%. "Danger Notice" signs conforming to IS:2551 shall be provided conspicuously on all sides of the switchboards.

14. Name Plates

Name plates for all incoming and outgoing feeders shall be provided on doors for each compartment. Name plates shall be fixed by screws only and not by adhesives. Special danger plates shall be provided as per requirement. Inside the panels, stickers should be provided for all components giving identification no. as per detailed wiring diagram.

15. Air Circuit Breakers (ACB)

Air Circuit Breakers shall be manufactured as conforming to the relevant IS specifications. Air Circuit Breakers used as incomers shall be drawout type. Fixed Air circuit Breakers shall be used only for outgoing feeders for rating lower than 800A. Drawout type Air Circuit Breakers shall be fitted with an automatic closing type insulating shutter assembly for shrouding live parts while the Air Circuit Breakers is drawn out in position to protect the operating personal from contact with live parts.

Drawout type Air circuit Breakers shall have Service, Test and Isolated positions. Air Circuit Breakers shall have built in CT Operated Bimetallic overload release and direct operating magnetic Short Circuit Release. Magnetic Short circuit release for Air Circuit breakers shall be interchangeable if so required to have time delayed tripping for grading with other Circuit breakers downstream or upstream. It must be possible to provide any of the following additional standard accessories for Air Circuit Breakers if specified as per the schedule of quantities. Under Voltage Release, Earth Fault Release, Shunt trip Closing release, Auxiliary Contact Block having N/O or N/C contacts. Operations of the Air Circuit breaker shall be using stored-energy operating mechanism by spring charging. The operating mechanism shall be rechargeable when the Air Circuit Breaker is the ON position so that it is possible to execute one OFF and one ON operation without the need to recharge in between. Electrically operated Breakers should have motor operated spring charged stored energy operating mechanism and shall also be provided with a
closing release. Mechanically operated Visual indications for the ON, OFF and TRIP positions shall be provided to prevent inadvertent opening of the Air Circuit breaker compartment while the breaker is in ON position.

16. Moulded Case Circuit Breakers (MCCB)
Moulded Case Circuit Breakers shall be manufactured as conforming to IS specifications. Moulded Case Circuit Breakers shall have built in Bimetallic Overload release and magnetic short Circuit Release. It must be possible to provide any of the following additional standard accessories for Moulded Case Circuit Breakers if specified as per the schedule of quantities. Under Voltage Release, Earth Fault Release, Shunt trip, Auxiliary Contact Block having N/O or N/C contacts. Visual indications for the ON, OFF and TRIP positions shall be provided for all Moulded Case Circuit Breakers. Moulded Case Circuit Breakers shall be provided with door interlock to prevent inadvertent opening of the breaker compartment while the breaker is in ON position. Operating handle shall be provided for all Moulded Case Circuit Breakers. The On and OFF function of the contacts of the Moulded Case Circuit Breaker shall be independent of the speed of operation of the handle.

17. Load break Switches & Switch Dis-connector Fuse Unit /Fuse Switch units
The Switches and Fuse units (FSUs) shall be Air break, heavy duty, double break motor duty (AC23) and industrial type, conforming to IS 4047, IS 5987 for Switch selection. The Switches and FSUs shall have quick-make, quick-break, fault make, load-break mechanism operated by an external insulated handle, complete with ON-OFF position indicator, dial plates etc. The ON and OFF functions of the contacts of the FSUs and Switches shall be independent of the speed of operation of the handle. The continuous ampere rating of switches shall not be less than continuous maximum rating of the switch inside the starter of that of the back-up fuses. Bolted type removable copper links of adequate size shall be provided for neutral in all incomer feeders and outgoing feeders with TPN switch fuse units or TPN Breaker units. Four Pole switchgears need not have removable copper links. Tinned copper switch links of adequate current carrying capacity of not less than that of the switch rating should be provided for all switches wherever required even if not specifically mentioned. The cubicle door be interlocked (Door interlock) with the switch mechanism so that the door cannot be opened unless the switch is in OFF position. It must be possible to padlock the incomer feeder switch mechanism in the OFF position. In the event of an independent control circuit supply to the coils of the contactors, the main switch shall be provided with necessary inherent auxiliary contacts or isolation arrangement to disconnect this control supply as well, when the switch is turned to OFF position. Castle key type mechanism of mechanical interlock shall be provided between incomer switches to prevent paralleling, if so specified. Designation plates shall be provided for all switches.

18. Fuses
All fuses shall be HRC link type and shall conform to IS: 2208. Selection of fuses for motor feeders shall be as per IS 900. All power and control fuses shall be provided with distinct type operation indicators to show whether they have operated or not. For all fuses provided in the fuse holders, necessary viewing aperture shall be provided on the fuse holder for locating the blow-out fuses. Fuse holders and fuse bases shall be made of unbreakable noninflammable and non-hygrosopic material, preferably of phenolic mouldings. Set of fuse pullers required for inserting and removing HRC fuses shall be supplied for each switchboard free of cost.
19. **Protective Relays**

Relays shall conform to IS: 3842. Relays shall be flush mounted draw out type, and of a type and manufacture approved by the Owner/Consultant. All relays shall have reset type flag indicators and initiating contacts. Flag indicators shall be visible from front side of the panel. Protective relays shall be selected as suitable for the CTs secondary current rating, fault level at the installation, type of application etc. Test terminals blocks shall be provided for all relays if specifically indicated in the data sheet or schedule of quantities. All IDMT relays shall be rated to operate at a maximum time of 1.3sec with the time multiplier set at 1 with 10 times the rated setting current flowing through the CT secondary.

20. **Current transformers**

Current Transformers shall conform to IS: 2705 and IS: 4201. Current Transformers shall fully withstand the effects of maximum possible short circuit current at their primary for a minimum time of 1 second. The requirements of CT’s for Ammeters, Energy meters, watt meters, Power factor meters and protective relays shall be in correlation to each other. Current Transformers shall be provided with polarity marking adjacent to terminals both for primary and secondary and these shall be legible. CTs shall be of 660 V grade with Class 'B' insulation having a minimum of 1 Ampere rating at the secondary side. Burden of these CTs shall be a minimum of 5VA rating at the secondary side. The approximate length of Cables and Burden of remote ammeters shall be obtained form Owner/Consultant before finalizing the CT capacity. If the same CT is used for local and remote Ammeters, necessary shorting links shall be supplied. Separate CTs shall be used for metering purpose and shall have adequate capacity to cater to 130% of full load current. Metering CTs shall have instrument Security factor less than 5 and shall have an accuracy Class of 1 or as specified by the Electrical Inspectorate. Current transformers for protection purposes shall have sufficient accuracy, burden and accuracy limit factor for necessary relay co-ordination /discrimination for clearing faults. Accuracy limit factor for protection shall not be less than 10 and accuracy class shall be 5P.

21. **Control voltage transformers**

Control voltage transformer shall be provided on each bus section or each module as specified, wherever control voltage specified is different from the main voltage. Plus or minus 5% voltage tapping shall be available for control Transformers. It shall be supplied complete with isolators and protective fuses for primary and secondary sides. One of the secondary terminals shall be earthed. The transformer shall preferably be air insulated and air cooled. Where control transformers are provided in each bus-section, they shall have adequate capacity to feed all contactors coils (including those of spare panels) of a particular bus section and anyone of the adjacent bus sections also. I.e. in the event of failure of the control transformer of one bus section, control transformer feeding anyone of its adjacent bus sections shall have the capacity to feed this section also, in addition to its own section. Where control transformers are provided in each module, they shall have the capacity to feed the contactor coil and instruments in that module. It shall be possible to inter-connect the control transformers are provided bus section wise. Terminals shall be available side by side for temporary interconnection whenever one control voltage transformer fails. Where control transformers are provided bus section wise, the compartment housing the control transformer shall preferably be located towards the bottom of the switchboard, to facilitate maintenance and replacement.
22. **Indicating instruments**

Ammeters, Voltmeters. Frequency meters, Energy/ KW /PF meters etc. wherever specified in data sheet shall be supplied and mounted flush, 96x96 size, with the hinged cover of the panel. All meters shall be of reputed make and shall conform to relevant standards (IS: 2419, 722). Ammeters shall be of Direct/CT reading type Analogue AC of 90 deg deflection scale. Voltmeter shall be of AC Analogue of 90 deg deflection scale. A moving iron voltmeter having a range of 0-500 Volts AC shall be provided, along with a suitable selector switch, to read all line-to-line voltage on the incoming side of feeders. The selector switches shall have 3 way and OFF positions. Necessary facia plates to denote switch positions shall be provided. Necessary control fuses shall be provided in the voltmeter circuit. Voltmeter shall be of industrial Grade ‘B’ accuracy as per IS: 1248, and shall have suppressed scale for the lower values in the range. Ammeter having suitable range shall be provided, along with ammeter selector switch to read line currents for the incomer feeders. The selector switches shall have 3 way and off position. Necessary facia plates to denote switch positions shall be provided. These ammeter shall have uniform scale up to about full load current and suppressed end scale at least for 150% full load. Ammeter if provided for motor feeders shall have suppressed overload range (cramped end scale) to read the starting current of 600 -800% and 200-400% of normal full load current of motors for DOL starting or star-delta starting respectively. A red mark shall be provided on the ammeter dial corresponding to the full load current of the motor. Cushion stoppers and zero correction screws shall be provided for all meters. All ammeters shall be operated through current transformers and not directly connected. Calibration of the ammeters shall tally with the ratio of the current transformers. Ammeters shall be of Class -1 accuracy as per IS: 1248 and as specified by the Electrical Inspectorate. Energy meter, kilowatt meter and power factor meter if provided as per data sheet shall be operated through current transformer only. The rating shall correspond to full load requirements. The multiplication factor of Energy meters shall be furnished and exhibited by the side of the meter. All meters shall be square type, as per the size indicated.

23. **Push buttons and switches**

Colour of push buttons shall be Red color for Off / Open Trip, green for On/Close, and Black color for Reset. All stop push buttons shall have 2N/C contacts and for Start push buttons, it shall have 2 N/O contacts in the case of contactor circuits. Wherever breakers are specified push buttons shall have 2 N/O contacts. All push buttons shall be provided with NO/NC contacts wherever starting is envisaged from more than one locations.

24. **Indication lamps**

All indicating lamps shall conform to IS: 1901. All lamps shall be rated for a maximum 10 watts and shall have series resistors.

25. **Space heaters**

Space heaters /anti condensation heaters shall be provided. Necessary ON/OFF isolators and HRC protection fuses (or MCB’s) shall be provided for each space heater. For double front switchboards, space heaters if specified shall be provided on both the fronts.

26. **Control/Selector switches**

All control switches shall conform to IS 6875 Part 1 & II. Ammeter selection switches shall be so designed as to prevent open circuiting of the CT secondary Terminals while the different positions
are being selected. Minimum rating of the Voltmeter and ammeter selection switch shall be 10Amps. All selector switches shall be rotary cam operated type. The rating, type and contact arrangement of the rotary switches shall be as per requirement. They shall also have proper designation plates. The operating handle of these switches shall be knob type and of black colour. All facia plates of selector switches shall be of black anodized Aluminium with white lettering.

27. Earthing
Earthing arrangement shall be in accordance with IS: 3034. A continuous earthing strip of tinned copper conductor as specified shall be provided for the entire length of the switchboard. A minimum of 2 terminals shall be provided on the strip for external connection to the main earth grid. The body of all switches, and breakers shall be earthed in duplicate using copper earthing conductor of the same cross sectional area as that of the main copper earth strip specified. The doors of switchboards shall be earthed using PVC insulated flexible cable with copper conductor.

28. Special tools
Necessary tools and tackles required for carrying out routine inspection, maintenance etc. shall be supplied along with the switchboards.

29. Foundation bolts & base frame
All the necessary foundation bolts, nuts and base channels shall be supplied along with the switchboards and shall be part of the supply.

30. Testing and commissioning
The switchboards shall be despatched only after successfully completing the routine tests as per requirements in the Indian Standards specifications. The following tests in particular shall be conducted satisfactorily by the contractor at his own cost, in the presence of Owner/Consultant. The results of these tests shall be got approved by the Consultant.

1. Dielectric test on main circuit. Power frequency high voltage withstand test of CBs at 28kV AC for 1 min. in trip and close conditions.
2. Dielectric test on auxiliary and contact circuits at 2 kV AC for 1min.
3. Design, visual, wiring and functional checks.
4. Mechanical operating tests:
   5 Opening & 5 closing operation at 110% of control voltage.
   5 Opening & 5 closing operation at rated voltage.
   5 Opening operations at 70% control voltage.
   5 Opening operation at 85% of control voltage.

5. IR measurement of breaker
   CB open end
   R to Y
   Y to B
   B to R
   RYB to E
Busbar
R to Y
Y to B
B to R
RYB to E

Breaker close with CT
R to Y
Y to B
B to R
RYB to E

EB CT metering
RYB to E

31. Performa for Testing of Panel Boards
   a) Circuit breaker or Supplier module designation/bus no.
   b) Insulation resistance tests (contacts open, breaker racked in position).
      a) Between each phase of bus: Mega ohm
      b) Between each phase and earth: Mega ohm
      c) DC and AC control & auxiliary circuits: Mega ohm
      d) Between each phase of CT/PT and CT & PT circuit if any: Mega ohm
   c) CT checks:
      i) CT ratio
      ii) CT secondary resistance
      iii) CT polarity check
   d) Check/test all releases/relays.
   e) Check mechanical interlocks.
   f) Check switchgear/control panel wiring.
   g) Check electrical interlocks.
   h) Checking of breaker/control circuits for
      i) Closing-local and remote (wherever applicable)
      ii) Tripping-local and remote (wherever applicable)

   Test reports shall be signed by both Contractor and Owner/Consultant.

32. Functional test
   All panels shall be IR Tested phase to phase, and phase to neutral with all switch gear in closed position and IR value shall be as follows.
   a. Tester: 1000 V IR Tester.
   b. IR value should not be less than 2.5 M ohms between phases.
   c. IR value should not be less than 1.5 M ohms between phase and neutral.

   All meters and relays shall be calibrated and tested at site by contractor before commissioning
through secondary injection tests. Tests shall be carried out in the presence of Consultant/Owner or his authorized representative.

All control / secondary wiring and apparatus connected therewith shall withstand 2000 V for one minute.

No charges on account of tests conducted shall be payable to the contractor by the Owner/Consultant. All the tests shall be conducted in the presence of the representative of the Owner/Consultant and to the entire satisfaction of the Owner/Consultant. If any additional tests are indicated by the Owner/Consultant's representative or if any of the tests results he may think as unsatisfactory shall be done by the contractor without extra charges. On satisfactorily completing the tests, the contractor shall furnish to the statutory bodies and authorities three sets of test certificates as required. Successful testing of the equipment does not relieve the responsibility of the contractor or manufacturer for the workmanship and material. The instruments used for conducting the tests shall be tested as functioning well by the concerned testing authority (ERT / Electrical Inspectorate, etc.) and shall hold a valid test certificate or stamp showing the serial No. and period of validity of the test result.

The contractor shall perform operating tests on all switchgear and panels to verify operation of switchgear/panels and correctness of interconnection between various items of the equipment. This shall be done by applying normal ac or dc voltage to the circuits and operating the equipment for functional checking of all control circuits, eg. closing, tripping, control interlock, supervision and alarm circuits. All connections in the switchgear shall be tested from point to point for possible grounds or short circuit.

All electrical equipment alarms shall be tested for proper operation by causing alarms to sound under simulated abnormal conditions.

The contractor shall arrange testing and calibration of relays. The testing equipment including primary and secondary injection sets (if required) etc. shall also have to be arranged by the contractor. Payment for above work shall be deemed to have been included in the erection of switch boards/control panels.
2.0 CABLING SYSTEM

1. Scope
The following specifications covers the standard requirement of erection, testing and commissioning of cabling installation as per the drawings, specification and other detail enclosed. Supply of required cables and materials for cabling shall be included under the scope of the contractor, only if specifically indicated in the schedule.

2. Supply of cables
If the supply of cables and cabling materials are included in the scope of the contractor, the cables shall be delivered directly from the manufacture only and factory test certificate in original shall be produced along with the cables. In case the contractor wishes to procure the cables from sources other than the manufactures, prior approval has to be obtained from the Owner/Consultant. The following documents are to be produced for verification.

a. Manufacture's test certificates in original.
b. Delivery Chelan of the original supplier showing the quantity, drum No., batch No, description, date of manufacture etc.

3. Standards and regulations
Cabling installation shall be carried out in accordance with the latest editions of relevant Indian Standards and the installation shall fully comply with the requirements of the Indian Electricity Rules and Regulations and Acts and other statuary regulations that are in force at the place of installation.

4. General
The Armour of the cables shall be effectively earthed at both end terminations through glands for PVC / XLPE cables. Paper insulated cables shall be laid in compliance with latest IS: 1255. As per as possible, joints at intermediate points in the through run of the cable should be avoided. Cables laid in formed trenches or tracks shall be provided with identification tags fixed to them at every 10 meters interval. Whereas cables buried shall be provided with identification tags fixed to them at every three meters interval. The tags shall be made from full hard aluminum discs not less than 3 mm thick and of size 50 mm x 75 mm for all incoming cables to switch boards and proportionally smaller size of tags for all other size of cables. Tags shall have holes on either side for tying around the cable using suitable binding wire. The cable nos. assigned in the cable schedule shall be punched on these tags.

5. Storage of cables
The site chosen for storage of cables shall be well drained and preferably have a concrete surface, which will prevent sinking and flange rot that can cause extreme difficulty in moving the drums.

The drums shall be stored in such a manner that there should be enough space between them for sufficient air circulation. It is desirable that the drums are made to stand on battens placed directly under the flanges.
In no case shall the drums be stored “on the flat side”, ie. with the flanges in the horizontal position. Cables should be protected from direct sun light.

6. Handling of cables

a) Before laying cables, these shall be tested for physical damage, continuity absence of cross phasing, insulation resistance to earth and between conductors. Insulation resistance tests shall be carried out with 500 V IR tester for LT cables, and 2000 V IR tester for HT cables.

b) The cables shall be supplied at site, wound on wooden drum as far as possible. For smaller length and sizes, cables in properly coiled form can be accepted. The cables shall laid by mounting the drum of the cable on drum carriage. Where the carriage is not available, the drum shall be mounted on a properly supported axle, and the cable laid out from the top of the drum. In no case the cable will be rolled on, as it produces kinks which may damage the conductor.

c) Sharp bending and kinking of cables shall be avoided. The bending radius for PVC insulated and sheath armoured cable shall not be less than 12 D for upto 1.1 kV, and above 1.1 upto 11kV 15D, where ‘D’ is overall diameter of the cable.

d) While drawing cables through GI pipes, conduits, RCC pipe, ensure that size of pipe is such that, after drawing cables, 40 % area is free. After drawing cable, the end of pipe shall be sealed with cotton/bituminous compound.

e) High voltage (11 kV and above), medium voltage (230 V and above) and other control cables shall be separated from each other by adequate spacing or running through independent pipes/trays.

f) Armoured cables shall never be concealed in walls/floors / roads without GI pipes, conduits RCC pipes.

g) Joints in the cable throughout its length of laying shall be avoided as far as possible and if unavoidable, prior approval of site engineer shall be taken. If allowed, proper straight through epoxy resin type joint shall be made, without any additional cost.

h) A minimum loop of 3 M shall be provided on both ends of the cable, or after every 50 M of unjointed length of cable and on both ends of straight through cable joint. This additional length shall be used for fresh termination in future. Cable for this loop shall be paid for supply and laying.

i) Cable shall be neatly arranged in the trenches/trays in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the Contractor.

j) All cable routes shall be carefully measured and cable cut to the required lengths and undue wastage of cables to be avoided. The routes indicated in the drawings is indicative only and the same may be rechecked with the Engineer-in-charge before cutting of cables. While selecting cable routes, interference with structures, foundations, pipe line, future expansion of buildings,
etc. should be avoided.

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

l) Wherever cable rises from underground/concrete trenches to motors/switchgears/push buttons, these shall be taken in GI pipes of suitable size, for mechanical protection upto 300 mm distance of concerned cable gland or as instructed by the Engineer-in-charge.

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

7. Laying of cables

Cables shall be cut to required lengths only after assessment of correct lengths required by actual measurement at site. The contractor shall ensure that wastage of cables as short length is minimized by resorting to most economical cable-cutting schedules. Wastage of cables in any case should not more than (1/2) half percent of the length of that cable. Excess length or loop after glancing is not permitted. The cables shall be arranged on trays / racks / arms / risers etc. as per cable layout and cable rack layout drawings.

8. Clamping of Cables

Power and control cables shall be properly segregated and clamped. Power cables (except larger than 400Sq.mm) can be laid touching. A clearance of 70mm shall be maintained between two adjacent 400Sq.mm cables on racks / risers. Common clamping can be done for a bunch of control cables or cables of lower size. Cables shall be clamped at every 900mm on the horizontal racks in the cable trenches and at 900mm on the overheads racks and 600mm on risers / bends at a tap off points and vertical racks etc. Cables leading to cable box of an equipment shall be supported at a distance of 450mm from cable gland/cable box. Cable shall be clamped only after the cables are neatly arranged, dressed, tailored and kept in position. Clamps shall be used for fixing of cable on the racks and its shall follow the profile of the cable. Type of cable clamps, fixing boards, nuts, washers, and materials of cable clamps shall be as specified for cabling.

Spacing of cable support for self supported cables on wall, ceiling or trenches shall be as follows:

<table>
<thead>
<tr>
<th>Area (sq.mm)</th>
<th>Horizontal run</th>
<th>Vertical run</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 10</td>
<td>350 mm</td>
<td>450 mm</td>
</tr>
<tr>
<td>16 to 95</td>
<td>450 mm</td>
<td>500 mm</td>
</tr>
<tr>
<td>120 to 400</td>
<td>700 mm</td>
<td>900 mm</td>
</tr>
</tbody>
</table>

a) Cables shall be fixed in cable trays in single tier formation and cables shall be clamped with aluminium flat clamps and galvanised bolts/unit.
b) Earthing flat/wire can also be laid in cable tray along with cables.
c) After laying of cables minimum 20 % area shall be spare.
9. **Cables directly buried in ground**

LT cables shall be laid directly in ground at least 750mm, and HT cables 1000mm below ground. Suitable trenches shall be excavated in the ground to the required sizes. Cables shall be laid in the excavated trench on the sand bed. After laying cables as per power or earthing layout drawings, the excavated trenches shall be back filled with layers of sand, well burnt bricks and riddled soil respectively. A clearance equal to the diameter of the largest cable shall be maintained between two adjacent power cables buried under ground. There shall not be any cross-over of cables when laid in the ground. Inspection chambers constructed from bricks and masonry complete with RCC slab cover shall be provided at all cable joints in the through run of the buried trench. Joined cable shall be looped in the inspection chamber to provide extra length of cable for purpose of re-termination in case earlier one fails. Necessary cable marker plates shall be fixed at every 10 meters interval and at all bends along the root of buried cable trenches at central line of the trench. Voltage rating of the cables shall be engraved on the marker plates.

10. **Laying of Cables under Floors**

   a) GI class B pipe shall be used for laying of outgoing cables from distribution boards to various equipment. Preferably one cable shall be drawn through one pipe. Size of pipe shall be such that after drawing of cable 40% area is free. If length of pipe is more than 30 M, free area may be increased to 50%.

   b) Use of elbows is not allowed at all and number of bends shall be kept minimum. Instead of using bends with sockets, pipe bending machine shall be used for making long smooth bends at site.

   c) Ends of pipe shall be sealed temporarily while laying with cotton/jute/rubber stopper etc. to avoid entry of building material.

   d) Exact locations of equipment shall be ascertained prior to laying of pipe.

11. **Laying of Cable in Masonry Trenches**

   a) More than one tier of cables can be provided in the same trench if the number of cables is more.

   b) Entry of cables in trenches shall be sealed with bituminous MASTIC compound to stop entry of water in trenches without any extra cost.

12. **Laying of Cables on Building Surface/Structure**

   a) Such type of cable laying shall be avoided as far as possible and will be allowed only for individual cables or small group of cables which run along structure.

   b) Cables shall be rigidly supported on structural steel/masonry using individual cast/malleable iron galvanised saddles and these supports shall be approximately 400 to 500 mm for cables upto 25 mm overall diameter and maximum 1000 mm for cables larger than 25 mm. Unsightly sagging of cables shall be prevented. Only aluminium/GI clamps with GI bolts/nuts shall be used.

   c) If drilling of steel structure must be resorted to, approval must be secured from the Engineer-in-charge and steel must be drilled where the minimum weakening of the structure will result.
13. Cables laid in pipes
Wherever cables are taken through metallic pipes, suitable bushes shall be provided at both the ends to avoid sharp edges of the pipes damaging the cables. Wherever cables pass through masonry, they shall be taken through suitable PVC or metallic pipes. After drawing the cables in the metallic / PVC pipes, the ends shall be sealed with suitable compound. Diameter of pipes/conduits shall be 1.5 times outer dia of cable.

14. Laying of Cables in Cable Racks / Trays
Cable Racks to be used for cables laid indoors except for single cables. The cable trays shall be of ladder type fabricated out of structural steel, MS, GI or Perforated as indicated. The cable racks shall be of adequate strength to carry the weight of cables without sagging. Structural bracket grouted in the build up trenches to support the cable such supports shall be at intervals of not less than 750 mm centres. All the structural steel work shall be finished with two coats of paint over primer.

Cable Trays shall be fabricated out of MS channels, angle iron, tee, bends, sections, flats and perforated sheet for different loads and number and size of cables as mentioned in the BOQ.

15. Cable trays, cable racks, cable risers, pedestals, etc.
The following specifications in this section covers the standard requirements for fabrication and installation of cable trays/racks/risers/frames/cable supports/pedestals/frames etc.

Standards and regulation
Fabrication and installation of cable trays/racks/frames shall be as per standard codes of practice and fully comply with the requirements of the Indian Electricity Rules & Regulations and also the standards that are in force at the place of installation.

Cable Trays
Cable trays shall be of ladder type/perforated steel section slotted angles as mentioned. The trays shall be complete with plates, Ts, elbows, risers, and all necessary hardware. The trays shall be galvanized as per IS 2629. The cable trays shall have suitable strength and rigidity to provide adequate support for all cables. It shall not present sharp edges, burs of projections, injurious to the insulation of the wiring and cables. The trays shall be adequately protected against corrosion and shall be made of corrosion resistant material. It shall have side rails or equivalent structural members. There shall be a continuous earth strip running on either side of the tray for earthing.

Cable trays shall be fabricated out of material as suitable for the operating environment, temperature, humidity and atmosphere specified.

Cable support system
The cable tray support system shall have the appropriate factory fabricated components. It shall be with ceiling support plates anchored with the ceiling with grip bolts. The perforated trays shall be supported with threaded studs with adjustable clamps and shall have nuts and washers accessories for leveling.
Installation of Cables Trays
Cables trays shall be installed as a complete system. Trays shall be supported properly from the building structure. The entire cable tray system shall be rigid and leveled.

Each run of the cable tray shall be completed before the installation of cables. In portions where additional protection is required, non-combustible covers / enclosure shall be used. Cable trays shall be exposed and accessible. Where cables of different system are installed on the same cable tray, non combustible, solid barriers shall be used for segregating the cables.

Cable trays shall be grounded by two numbers earth continuity wires. Cables trays shall not be used as equipment grounding conductors.

Cable trays shall be properly leveled and aligned as per the site conditions and a proper shop drawing shall be produced before starting the work and got approved by the Consultant / Owner.

The installation of cable tray support system shall be using the required accessories as mentioned above and using grip bolts for proper strength in fixing.

Wherever more than one layer cable racks / trays are used the spacing between them shall be 150mm or more depending on the cable sizes. Necessary holes (with threads wherever necessary) on the steel sections required of fixing of bolts, nuts etc. for clamping and mounting of equipment shall be provided before welding and fixing the same. The cable trays and sections shall be weighed in the presence of Owner/Consultant for billing purposes, if required.

The cable trays and bends are to be properly fixed to the tray supports using 12mm dia GI "J" bolts after the trays and bends are connected at joints using G.I Clamps having 2 Nos. GI flats and 2 Nos. GI nuts/bolts of suitable size. Wherever cable racks have been specified, it shall be of "Continuous Rack" type. These continuous cable racks shall be supported at proper intervals using angle iron cable supports with necessary cross-arms. The cable racks / supports have to be fabricated considering size of cable trenches, number of cables proposed in the racks. Wherever MS plate insert are not available, the contractor shall provide the same for fixing of cable racks / supports. All fabricated racks risers / frames / supports / insert etc. shall be treated properly for removal of rest dirt, grease, etc. before painting with one coat of anti corrosive zinc chromite primer coat after fixing the same, they shall be painted with a second primer coat and two coats of enamel or epoxy paint applied over the second primer coat.

Pedestal and frames
Pedestals required for mounting the push button stations and steel frames required for mounting of any other equipment such as fire buckets, distribution boards etc. shall be fabricated from similar steel sections used for cable racks / risers supports and fixed at relevant places. Post treatment and painting of pedestals / frames shall be similar that of cable racks.

Clearance, etc.
Clearance between cables of different services shall be: Power to control cable 0.2m, Power to communication cable 0.3m and power to gas/water mains 0.3m.
Identification strip shall be provided at 8-10m apart.
Cables shall be clamped using non-magnetic, non corrosive clamps at every 0.5 to 0.8m.
16. **Power Cable termination**

Cable termination shall be heat shrinkable type and the bushings shall be covered with adequate insulation with a provision for using the cable test rods for cable testing. 11 kV cable compartments for each circuit shall be separately enclosed. Cable termination shall be suitable for copper or aluminium conductor. Suitable cable termination kits and other accessories shall be included in the scope of supply.

Cables jointing shall be done as per the recommendations of the cable manufacturer. Bi-metallic plate washers should be provided wherever cables, lugs, and switch terminals are of different materials. Cables and cable lugs should be of same material where ever possible. The cable should be properly terminated to avoid stress on end termination. End termination must be done by an authorised cable jointer. All end terminations to be carried out by crimping type aluminum sockets with glands. Each terminations shall be carried out using brass compressions glands and cable sockets. Hydraulic crimping tool shall be used for making the end terminations. Cable gland shall be bonded to the earth by using suitable size earthing material.

17. **Joining of Cables**

Before joining the cables the insulation resistances of both sections of cable shall be checked by using suitable IR Tester. Individual conductors in cables shall always be joined number to number or color to color of the insulation over the conductors. During the preliminary stage of laying the cable, consideration should be given to proper location of the joint position so that when the cable is actually laid, the joints if any are made in the most accessible places. Joints shall not be made at passage ways and at road crossings. In cable trenches or in any other cable routes were there are two or more cables laid together, the joints if any shall be arranged to be staggered by two or more meters so as to reduce the possibility of one joint failure effecting the other. For joining armoured cables, hot pouring compound shall not be used. Only cold ceiling filling compound shall be used. All materials required for cable joining such as cable joining kit, compounds, insulation tape, cable legs, cable gland, fittings etc. and other consumable materials shall be arranged by the contractor wherever called for free of cost.

18. **Cable Termination**

Cable glands and boxes necessary for cable termination on the equipment shall be supplied along with the equipment. However the contractor shall supply suitable glands for all the other equipment. Wherever necessary holes are not drilled on the end plate of the switch boards or on the cable boxes of the equipment for fixing of cable gland, suitable holes shall be drilled at convenient locations for fixing the cable glands.

19. **Testing of Cables**

All cables shall be tested before and after joining / termination as per relevant Indian Standards. Joining/ terminations if found unsatisfactory it shall be rectified with out any extra cost to the Owner/Consultant. All cables shall be IR tested before and after joining.

a. Tester: 500 V IR Tester for LT cables, and 1000 V IR tester for HT cables.
b. IR value should not be less than 6 M Ohm for any cable.
All cables should also be tested for:
- Continuity
- Absence of cross facing
- Insulation resistance to earth
- Insulation resistance between conductors.

a) Before energising, the insulation resistance of every circuit shall be measured from phase to phase and from phase to ground. This requires 3 measurements if one side is grounded and 6 measurements for 3 phase circuits.

b) Where splices or terminations are required in circuits rated above 650 volts, measure insulation resistance of each length of cable before splicing and/or terminating. Report measurements after splices and/or terminations are complete.

c) DC High Voltage test shall be made after installation on the following:
   i) All 1100 Volts grade cables in which straight through joints have been made.
   ii) All cables above 1100 V grade.

For record purposes test data shall include the measured values of leakage current versus time.

The DC High Voltage test shall be performed as detailed below:
Cables shall be installed in final position with the entire straight through joints complete.
Terminations shall be kept unfinished so that motors, switchgear, transformer etc. are not subjected to test voltage.

The test voltage and duration shall be as per relevant codes and practices of Indian Standards Institution.

_Proforma for Testing Cables_

Proforma - A

a) Drum No. from which cable taken
b) Cable from ...... to ...........
c) Length of run of this table ...... metre
d) Insulation resistance tests:

   Voltage of IR Tester ...... Volts
   i) between core-1 to earth...... Megaohm
   ii) between core-2 to earth ...... Megaohm
   iii) between core-3 to earth ...... Megaohm
   iv) between core-1 to core-2...... Megaohm
   v) between core-2 to core-3..... Megaohm
   vi) between core-3 to core-1..... Megaohm
e) High voltage test …… Voltage ……… Duration
   i) between cores and earth
   ii) between individual cores

Proforma - B

Cable Laying

Voltage of IR Tester used:..............

<table>
<thead>
<tr>
<th>Continuity of cores</th>
<th>IR value (mega ohm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before laying</td>
<td>Before back filling</td>
</tr>
<tr>
<td>Between value</td>
<td>Between Value</td>
</tr>
</tbody>
</table>

1) From...............To................PVC/XLPE........sq.mm
LV/MV/HV cable..............m in length.
R-N                       R-N
Y-N                       Y-N
B-N                       B-N
R-Y                       R-Y
B-R                       B-R
Y-B                       Y-B
R-E                       R-E
Y-E                       Y-E
B-E                       B-E

Proforma - C

Cable Jointing
(To be shown for each cable separately, voltage wise)

Voltage of IR Tester used:..............

<table>
<thead>
<tr>
<th>Number of Joint</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of cable(s)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of joint (Indoor/Outdoor, straight through/termination, LV/MV/HV)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Insulation resistance (Mega ohm) before jointing

Cable I - (a) Between
   R & Y
   Y & B
   B & R
(b) Between
R & N
Y & N
B & N

(c) Between
R & E
Y & E
B & E
N & E

Cable II -
(a) Between
R & Y
Y & B
B & R

(b) Between
R & N
Y & N
B & N

(c) Between
R & E
Y & E
B & E
N & E

Insulation resistance (Mega ohm) of Jointed cable
Cable I -
(a) Between
R & Y
Y & B
B & R

(b) Between
R & N
Y & N
B & N

(c) Between
R & E
Y & E
B & E
N & E

Proforma - D
Testing Before Commissioning
(a) Cable Work
Date(s) of Test:..............

Details of high Voltage test conducted
System of supply..............
Test Voltage applied..........kV..........Minutes
Result of test-Satisfactory/Unsatisfactory.
Voltage of IR Tester used:-
Result of IR Tester testing:-
Testing of entire installation
On completion of an installation the following tests shall be carried out:-
1. Insulation Resistance Test.
2. Earth continuity Test.
3. Earth Electrode Resistance Test.

Insulation Resistance Test
The following tests shall be done:
The insulation resistance (IR) shall be measured by applying between earth and the whole system of conductors or any section thereof with all fuses in place and all switches closed, and except in earthed concentric wiring, all lamps in position or both poles of installation, a DC voltage of not less than twice the working voltage, provided that it does not exceed 500V for medium voltage circuits. Where the supply is derived from 3-wire (AC or DC), the neutral pole of which is connected to earth, the working voltage shall be deemed to be that which is maintained between the outer or phase conductor and neutral.

The insulation resistance shall also be measured in M Ohms and shall not be less than 50 divided by the number of points in the circuit, provided that the whole installation need not be required to have an insulation resistance greater than 1 M Ohm.

The term "outlet" includes every point along with every switch except that a switch combined with a socket outlet, appliance or lighting fitting is regarded as one outlet.

(i) Insulation resistance of the whole system of conductors to earth .... Megohms
(ii) Insulation resistance between the phase Conductor & neutral -
    Between phase R and neutral ..... Megohms
    Between phase Y and neutral ..... Megohms
    Between phase B and neutral ..... Megohms
(iii) Insulation resistance between the phase Conductors in case of poly phase supply
    Between phase R and phase Y .... Megohms
    Between phase Y and phase B .... Megohms
    Between phase B and phase R .... Megohms
**Earth continuity test**
The earth continuity conductor including metal conduits and metallic envelopes of cables in all cases shall be tested for electric continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance or earth leakage circuit breaker measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed One Ohm.

Maximum resistance between any point in the earth continuity conductor including metal conduits and main earthing lead = …… Ohm.

**Earth electrode resistance test**
Two auxiliary earth electrodes besides the test electrode are placed at suitable distance from the tests electrode. A measured current is passed between the electrode ‘A’ to be tested and an auxiliary current electrode ‘C’ and the potential difference between the electrode ‘A’ and auxiliary potential electrode ‘B’ is measured, and resistance of test electrode ‘A’ is calculated. Unless 3 consecutive readings of test electrode resistance with different spacing of the electrodes agree, the test shall be repeated by increasing the distance between ‘A’ and ‘C’ upto 50m.

On completion of an electric installation, a certificate shall be furnished by the contractor countersigned by the Consultant/Owner under whose direct supervision the installation was carried out.
3.0 EARTHING SYSTEM

1. Standard and regulations
   Earthing system installation shall be carried out in accordance with the latest edition of IS:3043 and the installation shall comply with the requirements of the Indian Electricity Rules & Regulations that are in force.

2. Earthing
   The system shall be TNS System with four wire supply system (R, Y, B, N and 2 Nos. E) brought from the main L T Panel. All metal parts of electrical installation and all metal conduits trunking, cable sheaths, switchgear, distribution panels, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All metal work such as pipe lines, stairways etc shall be bonded to earth.

3. Earthing conductors
   Earthing conductors shall be of copper or GI as specified in the BOQ and shall be protected against mechanical injury or corrosion.

4. Sizing of earthing conductors
   The cross sectional area of earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80 Sq.mm. If the area of the largest current carrying conductor or bus bar exceeds 160 sq.mm then two or more earthing conductors shall be used in parallel, to provide at least half the cross sectional area of the current carrying conductor or bus bars. All fixtures, outlet boxes, junction boxes and power circuits up to 15 amps shall also be earthed.

   All 3 phase switches and distribution panels upto 60 amps rating shall be earthed with 2 Nos. distinct and independent 6 mm dia copper wires. All 3 phase switches and distribution panels upto 100 amps rating shall be earthed with 2 Nos. distinct and independent 10 mm dia copper wires. All switches, bus bar, ducts and distribution panels of rating 200 amps and above shall be earthed with minimum of 2 nos separate and independent 25 mm x 3 mm copper strip.

5. Connection of earthing conductors
   Main earthing conductors shall be taken from the earth electrode at the main L T panel to an earth electrode with which the connection is to be made. All joints in tapes shall be with four rivets and shall be brazed, wires shall be connected with crimping lugs, all bolts shall have spring washers. Sub-mains earthing conductors shall run from the main distribution panel to the sub distribution panel. Final distribution panel earthing conductors shall run from sub-distribution panel.

   Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution panel. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to distribution panel at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of the equipment shall be earthed by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord. Switches, accessories, lighting fitting etc. which are rigidly secured in effective electrical contact with a run of
metallic conduit shall not be considered as a part of the earthing conductor for earthing purposes, even though the run of metallic conduit is earthed.

6. **Prohibited connections**
Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system. The electrical resistance measured between earth connection at the main L T panel and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate or circuit breakers, and shall not exceed 1 ohm. All switches carrying medium voltage shall be connected with earth by two separate and distinct connections. The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in GI pipe of adequate size. The overlapping in strips at joints where required shall be minimum 75 mm. The joints shall be riveted and brazed in an approved manner. Sweated lugs of adequate capacity and size shall be used for termination of all conductor wires above 6 sq.mm size. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned. Equipotential bonding of all metallic structures shall be done.

7. **Resistance to earth**
The resistance of earthing system shall not exceed 1 ohm.

8. **Earth Station**
The earth station shall be made by excavating the ground to a depth of not less than 2.5 m and the excess earth after back filling shall be removed from site. Ground with rocky strata, the depth of excavation shall be less. However additional earthing stations or earth matting to be provided to achieve the system earthing less than one ohm.

9. **Electrodes**
Various types of electrodes
i) Pipe electrode shall be buried in the ground vertically with its top at not less than 20 cm below the ground level. The installation shall be carried out as shown in the figure and as directed by the Engineer-in-charge.

ii) Plate electrode shall be buried in ground with its face vertical, and its top not less than 2 m below the ground level. The installation shall be carried out as directed by the Engineer-in-charge.

iii) When more than one electrode is to be installed, the distance between pipe electrodes shall be 5m and that between plates shall be 8m.

iv) a) The strip or conductor electrode shall be buried in trench not less than 0.5 m deep.

   b) If conditions necessitate the use of more than one strip or conductor electrode, they shall be laid as widely distributed as possible, in a single straight trench where feasible, or preferably in a number of trenches radiating from one point or as directed by the Engineer-in-charge.
10. **Earthing Conductor (Main earthing lead)**

The earth conductors shall be fixed to the wall/columns etc. at every 500 mm centres with 10 mm spacers. The total earthing system shall be mechanically and electrically connected to provide independent path to earth.

i) In the case of plate earth electrode, the earthing conductor shall be securely terminated on to the plate with two bolts, nuts, checknuts and washers.

ii) A double C-clamp arrangement shall be provided for terminating tape type earthing conductor with GI watering pipe coupled to the pipe earth electrode. Galvanised “C” shaped strips, bolts, washers, nuts and checknuts of adequate size shall be used for the purpose.

iii) The earthing conductor from the electrode up to the building shall be protected from mechanical injury by a medium class, 15 mm dia. GI pipe in the case of wire, and by 40 mm dia. medium class GI pipe in the case of strip. The protection pipe in ground shall be buried atleast 30 cm deep to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floors to adequate depth in due co-ordination with the building work.

iv) The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switch board by bolt, nut and washer.

11. **Earth bus and main earthing terminal**

i) The Main Earth bus shall be laid as directed by the Engineer-in-charge.

ii) Following conductors shall be terminated into the main earthing terminal/earth bus.
   a) Earth connection from the Sub station.
   b) Earthing conductor from electrode.
   c) Protective conductors;
   d) Equi-potential bonding conductors.

12. **Protective (Loop earthing /earth continuity) Conductor**

i) Earth terminal of every switch board in the distribution system shall be bonded to the main earth bus.

ii) Two protective conductors shall be provided for a switchboard.

iii) A protective conductor shall securely connect the earth connector in every distribution board (DB) to the earth bus.

iv) All metallic switch boxes and regulator boxes in a circuit shall be connected to the earth connector in the DB by protective conductor.

v) The earth pin of socket outlets as well as metallic body of fan regulators shall be connected to the earth stud in switch boxes by protective conductor.

13. **‘GI’ Earthing**

GI strips used for earthing shall be minimum 6mm thick and hot dip galvanized. If round GI conductors are used, it shall have double the calculated area of cross section. The minimum cross sectional area of the GI should be 50 sq.mm.

Joints shall be invariably done by means of welding. Barium chromate or zinc dichromate treatment should be done at the weld. After welding, joints should be provided with coating alternate layers of red oxide and aluminium. Joints are to be covered with hot bitumen.
In case of bolted joints can not be avoided, there should be a min. of 2 bolts for sizes upto 25x6mm, 3 bolts for sizes upto 31x6mm and zig zag bolting for large sizes.

14. Marking
i) Earth bars/terminals at all switch boards shall be marked permanently, either as E or as Main earth terminal shall be marked “Safety Earth – Do Not Disconnect”.

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IV. TESTING, COMMISSIONING AND HAND OVER

1 GENERAL

The entire works included in this Contract shall be fully tested in stages as the work proceeds and on completion of work as applicable.

The Contractor shall provide during normal working hours, all necessary labours, instruments, equipment, materials, fuel, power and maker's representatives, to carry out such tests as may be necessary to satisfy the Consultant that the installation meets the requirement and intent of the Specification as well as such tests required by Local Authorities.

All tests shall be made in the presence of the Consultant or his representative or any inspecting authority. At least seven working days notice in writing shall be given to the inspecting parties before performing any test.

Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

Tests described hereinafter and including all tests prescribed by the Authority having jurisdiction shall be carried out. Any tests proved unsatisfactory shall be repeated to the satisfaction of the inspecting parties.

The Contractor shall provide skilled technicians/engineer to commission the plant and associated controls to the satisfaction of the Consultant. The technicians / engineers will be required to demonstrate the correct procedures in starting and stopping the plant, running the various items of equipment under automatic and manual control and the correct maintenance of the plant.

Water flow rates of all equipment shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

2 FACTORY TESTS

Valves, Cocks and Fittings

`Type-Test' and approval certificate for pressure test and compliance with the regulations laid down by the local Water Authority/Project Manager.

3 ON-SITE TESTING AND COMMISSIONING

Prior to completion of the Contract Works, the Contractor shall liaise with the Electrical Contractors and submit for the Consultant’s approval a detailed programme for conducting on-site acceptance tests and commissioning.

The Contractor shall start up, operate, test and adjust the systems in accordance with the agreed programme. The setting shall be supervised by the manufacturer's representative, who shall remain on site until the equipment is operating satisfactorily and accepted by the Consultant. The Contractor shall advice and co-ordinate with the manufacturer's representatives so that all testing is carried out according to the agreed programme.

The whole installation shall be given the following tests to bring the systems into running order. The Consultant shall be given reasonable notice together with a copy of recorded test results, generally not less than seven (7) days, regarding the nature of tests, the time and location. Acceptance tests will only be witnessed by the Consultant when the submitted tests results are found satisfactorily.
All instruments, tools, material and labour required to perform these tests shall be provided by this Contractor.

Before the tests are carried out, the Contractor shall remove connected equipment and components which are liable to damage under test, and shall provide and fix all the necessary gauges, blanking flanges, etc.

Prior to the system start-up, the following inspection, tests and pre-commissioning treatment shall be carried out by the Contractor:

a  **Tanks and Level Switches**

Check sides and edges of sectional tanks for distortion. The tanks shall be thoroughly cleaned with water and drained.

Also before supply will feed in, the level switch shall be simulated for the various cut-in and cut-out settings.

b  **Hydrostatic Tests**

All parts of the water circuit shall be filled with water before hydrostatic pressure testing, and pump running tests for verification of pressure and flow rate, shall be conducted.

The hand jacking pump shall be applied to increase the system pressure to 2 times the working pressure or 1.5 times the working pressure. The pressure shall be maintained for a period not less than 24 hours.

Where any section of pipe work or equipment is found to be unable to withstand the maximum pipe work test pressure, it shall be isolated during the pipe work test then that section of pipe work or equipment shall be made good and re-tested at the appropriate test pressure.

The working pressure for various systems shall be as shown on the drawings.

c  **Cleaning, Flushing and Pre-Treatment**

Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.

All strainers shall be inspected and cleaned out or replaced.

When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre-treatment. The pre-treatment chemical shall:
• Remove oil, grease and foreign residue from the pipe work and fittings;
• Pre-condition the metal surfaces to resist reaction with water or air;
• Establish an initial protective film;
• After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.
• Details and procedures of the pre-treatment shall be submitted to the Consultant for approval.

e  **Pump Operating Test**

The Contractor shall ensure to the satisfaction of the Consultant that the installation or portion thereof which has been set to work complies with all requirements including the following:

That the plant and apparatus shall be of robust construction and of capacity for the duty specified.

That all valves, switches, controls and the like are properly regulated and capable of proper operation and in the case of valves are capable of being shut-off.

That all apparatus shall be silent.

That all instruments are correctly calibrated and read accurately.

That all services are tested in accordance with the details of the relevant clauses of this Specification.

4  **STATUTORY AUTHORITIES' TESTS AND INSPECTIONS**

The various statutory approvals including consent to operate, periodical analysis report for pollution control board and other statutory approvals if any, shall be in the scope of this contract.

As and when notified in writing or instructed by the Consultant, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Pollution Control Board Authorities and shall forthwith execute free of charge any rectification work ordered by the Consultant as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Contractor shall make all allowances in this respect.

The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Consultant for checking before submission.

The Contractor shall notify the Consultant at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the Consultant without delay.
5 PRELIMINARY COMMISSIONING CHECKS

The contractor shall ensure that all equipment is thoroughly cleaned, lubricated and checked for serviceability before setting to work. Particular attention is drawn to the removal of building debris from the pipe work systems.

Special attention is drawn to the need for thoroughly flushing out all pipe work systems to ensure that all foreign matter is removed.

All automatic controls and safety devices shall be inspected and checked for serviceability before the working fluid or electricity is applied to the system.

6 COMMISSIONING

When the various installations have been completed and the preliminary commissioning checks carried out, the Contractor shall set to work, regulate and calibrate all system in the entire installation. Special attention shall be paid to the following items:

That all valves, switches, controls, etc. are regulated and capable of proper operation and in the case of isolation valves that they are capable of tight shut off.

That all apparatus are silent in accordance with the requirements of this specification.

That all instruments are correctly calibrated and read accurately.

That all services are tested in accordance with the details in the relevant clauses of this specification.

Operate pumps, pressure reducing sets, etc. to ensure that all control systems are functioning correctly and are properly set, sequenced or interlocked.

7 FINAL ACCEPTANCE TESTS

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Consultant.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

8 REJECTION OF PLANT

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Consultant either in whole or in part as he considers necessary / appropriate. Adjustment and / or modification work as required by the Consultant so as to comply with the Authority's requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority / Consultant.
After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Consultant / Employer.

9 WARRANTY AND HANDOVER

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Employer.

10. HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Project Manager and all testing and commissioning documents shall be handed over to the Project Manager.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Project Manager.
### LIST OF DRAWINGS

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Drawing No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>GME 009 P0046</td>
<td>Details of Plant Layout</td>
</tr>
<tr>
<td>2.</td>
<td>GME 009 P0085</td>
<td>P &amp; I Diagram</td>
</tr>
<tr>
<td>3.</td>
<td>FEATS/NBCC/001</td>
<td>Site Plan</td>
</tr>
</tbody>
</table>
**LIST OF BUREAU OF INDIAN STANDARDS CODES**

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices given below. All equipment and material being supplied by the contractor shall meet the requirements of IS, Pollution Control Board, electrical inspectorate and Indian Electricity rules and other Codes / Publications as given below:

1. **General**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual on Sewage &amp; Sewage Treatment</td>
<td>CPH EEO; Govt. of India.</td>
</tr>
<tr>
<td>SP : 6 (1)</td>
<td>Structural Steel Sections</td>
</tr>
<tr>
<td>IS : 325</td>
<td>Three Phase Induction Motors</td>
</tr>
<tr>
<td>IS : 554</td>
<td>Dimensions for pipe threads where pressure tight joints are required on the threads.</td>
</tr>
<tr>
<td>IS : 694</td>
<td>PVC insulated cables for working voltages up to &amp; including 1100 V.</td>
</tr>
<tr>
<td>IS : 779</td>
<td>Specification for water meters (domestic type).</td>
</tr>
<tr>
<td>IS : 782</td>
<td>Specification for caulking load.</td>
</tr>
<tr>
<td>IS : 800</td>
<td>Code of practice for general construction in steel</td>
</tr>
<tr>
<td>IS : 1726</td>
<td>Specification for cast iron manhole covers and frames.</td>
</tr>
<tr>
<td>IS : 2379</td>
<td>Colour code for identification of pipe lines.</td>
</tr>
<tr>
<td>IS : 2629</td>
<td>Recommended practice for hot dip galvanizing on iron and Steel.</td>
</tr>
<tr>
<td>IS : 3114</td>
<td>Code of practice for laying of cast iron pipes</td>
</tr>
<tr>
<td>IS : 5329</td>
<td>Code of practice for sanitary pipe work above ground for buildings.</td>
</tr>
<tr>
<td>IS : 5455</td>
<td>Cast iron steps for manholes.</td>
</tr>
<tr>
<td>IS : 6159</td>
<td>Recommended practice for design and fabrication of material, prior to galvanizing.</td>
</tr>
<tr>
<td>IS : 8321</td>
<td>Glossary of terms applicable to plumbing work.</td>
</tr>
<tr>
<td>IS : 8419 (Part 1)</td>
<td>Requirements for water filtration equipment: Part 1 Filtration medium sand and gravel.</td>
</tr>
</tbody>
</table>
IS : 8419 (Part 2) Requirements for water filtration equipment: Part 2 under drainage system.

IS : 10221 Code of practice for coating and wrapping of underground mild steel pipelines.

IS : 10446 Glossary of terms relating to water supply and sanitation.

IS : 11149 Rubber Gaskets

2. **Pipes and Fittings**


IS : 1239 (Part 2) Mild Steel tubes, tubulars and other wrought steel fittings: Part 2 Mild Steel tubulars and other wrought steel pipe fittings.

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 : 1538 Cast Iron fittings for pressure pipes for water, gas and sewage.

IS : 1729 Sand Cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.

IS : 1879 Malleable cast iron pipe fittings.

IS : 2643 (Part 1) Dimensions for pipe threads for fastening purposes: Part 1 Basic profile and dimensions.

IS : 2643 (Part 2) Dimensions for pipe threads for fastening purposes: Part 2 Tolerances.

IS : 2643 (Part 3) Dimensions for pipe threads for fastening purposes: Part 3 Limits of sizes.

IS : 3468 Pipe nuts.

IS : 3589 Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).

IS : 3989 Centrifugally cast (sun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.

IS : 4346 Specifications for washers for use with fittings for water services.

IS : 4711 Methods for sampling steel pipes, tubes and fittings.

IS : 6392 Steel pipe flanges
3. **Valves**

<table>
<thead>
<tr>
<th>IS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS : 778</td>
<td>Specification for copper alloy gage, globe and check valves for water works purposes.</td>
</tr>
<tr>
<td>IS : 780</td>
<td>Specification for sluice valves for water works purposes (50 mm to 300 mm size).</td>
</tr>
<tr>
<td>IS : 1703</td>
<td>Specification copper alloy float valves (horizontal plunger type) for water supply fittings.</td>
</tr>
<tr>
<td>IS : 2906</td>
<td>Specification for sluice valves for water works purposes (350 mm to 1200 mm size)</td>
</tr>
<tr>
<td>IS : 3950</td>
<td>Specification for surface boxes for sluice valves.</td>
</tr>
<tr>
<td>IS : 5312 (Part 1)</td>
<td>Specification for swing check type reflux (non return) valves: part 2 Multi door pattern.</td>
</tr>
<tr>
<td>IS : 5312 (Part 2)</td>
<td>Specification for swing check type reflux (non return) valves: part 2 Multi door pattern.</td>
</tr>
<tr>
<td>IS : 12992 (Part 1)</td>
<td>Safety relief valves, spring loaded : Design</td>
</tr>
<tr>
<td>IS : 13095</td>
<td>Butterfly valves for general purposes.</td>
</tr>
</tbody>
</table>
## SCHEDULE OF TECHNICAL DATA

<table>
<thead>
<tr>
<th>1</th>
<th>SEWAGE PUMP &amp; CLEAR WATER PUMP</th>
<th>(Submit separate technical data sheet)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pump</strong></td>
<td>Make:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type &amp; Model:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Discharge in LPS/ GPM:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Head (Meters of WC):</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shut off head (Meters of WC):</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Efficiency (%):</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No. of stages:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suction end I.D. :</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delivery end I.D. :</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Details of N.P.S.H. :</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solid Handling size :</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vibration Isolation Detail :</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Skid Details :</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operating Weight :</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overall Dimension :</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mechanical Seal Detail :</td>
<td></td>
</tr>
</tbody>
</table>

### MATERIAL

| | Body : | |
| | Impeller : | |
| | Shaft : | |
| | Type of Impeller : | |
| | Is it suitable for direct coupling : | |
### MOTOR

<table>
<thead>
<tr>
<th>Description</th>
<th>:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make</td>
<td>:</td>
</tr>
<tr>
<td>Model</td>
<td>:</td>
</tr>
<tr>
<td>Power Requirement (HP/KW)</td>
<td>:</td>
</tr>
<tr>
<td>R.P.M.</td>
<td>:</td>
</tr>
<tr>
<td>Rating</td>
<td>:</td>
</tr>
<tr>
<td>Over Load Capacity</td>
<td>:</td>
</tr>
<tr>
<td>Class of Insulation</td>
<td>:</td>
</tr>
<tr>
<td>Details of additional protection in winding</td>
<td>:</td>
</tr>
<tr>
<td>Motor efficiency</td>
<td>:</td>
</tr>
<tr>
<td>If it suitable for direct coupling to pump?</td>
<td>:</td>
</tr>
<tr>
<td>Type of rotary movement</td>
<td>:</td>
</tr>
<tr>
<td>Method of starting</td>
<td>:</td>
</tr>
<tr>
<td>Size and type of cable for connections</td>
<td>:</td>
</tr>
</tbody>
</table>

### FILTER (Submit separate data sheet for various types of filters):

**Description:**

<table>
<thead>
<tr>
<th>Description</th>
<th>:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material of Construction</td>
<td>:</td>
</tr>
<tr>
<td>Diameter</td>
<td>:</td>
</tr>
<tr>
<td>Height on straight</td>
<td>:</td>
</tr>
<tr>
<td>Filtering media</td>
<td>:</td>
</tr>
<tr>
<td>Shell thickness</td>
<td>:</td>
</tr>
<tr>
<td>Dish end thickness</td>
<td>:</td>
</tr>
<tr>
<td>Service flow rate</td>
<td>:</td>
</tr>
<tr>
<td>Design pressure</td>
<td>:</td>
</tr>
<tr>
<td>Back wash duration</td>
<td>:</td>
</tr>
<tr>
<td>Back wash flow rate</td>
<td>:</td>
</tr>
<tr>
<td>Pressure drop across the filter</td>
<td>:</td>
</tr>
<tr>
<td>Maximum inlet turbidity (NTU)</td>
<td>:</td>
</tr>
</tbody>
</table>
3. CHLORINATION SYSTEM AND CHEMICAL DOSING SYSTEM (Submit separate Sheets for various systems)

**PUMP:**

- Pump model : 
- Pump Type : 
- Make : 
- Material of construction : 
- Flow rate : 

**TANK:**

- Capacity : 
- Material of Construction : 

4. DETAILS OF AIR DIFFUSER SYSTEM

- Type of diffusers : 
- Air flow rate : 
- Size : 
- MOC : 
- Membrane Type : 
- Make : 
- Oxygen Transfer Efficiency : 
- Babble size : 
- Quantity : 

5. pH CORRECTION SYSTEM

**PUMP**

- Pump Model : 
- Pump type : 
- Make : 

Sampling Point : 
Turbidity in filtered water :
Material of construction  :
Flow rate  :

TANK

Capacity  :
Material of Construction  :
ELECTRICAL WORKS
## ELECTRICAL WORKS

### INDEX

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
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<td>Special conditions of contract (SCC)</td>
</tr>
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<td>List of Indian Standards (IS)</td>
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<td>3</td>
<td>Technical specifications – Electrical works</td>
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<td>4</td>
<td>List of approved makes of equipment &amp; materials – Electrical works</td>
</tr>
<tr>
<td>5</td>
<td>Technical data confirmation sheet – Electrical Works</td>
</tr>
<tr>
<td>6</td>
<td>Bill of Quantities and Schedule of Rates</td>
</tr>
<tr>
<td>7</td>
<td>Drawings</td>
</tr>
</tbody>
</table>
SPECIAL CONDITIONS OF CONTRACT

(ELECTRICAL WORKS)

1. Introduction
These Special Conditions of Contract (SCC) shall be read in conjunction with other volumes/chapters. If there are any provisions in this SCC at variance with the provisions of other volumes, the provisions in this Special Conditions of Contract shall take precedence. The work shall be carried out as per the specifications, relevant IS standards and prevailing Local Statutory Rules amended upto date.

2. Standards and design criteria
Contractor shall regard all the relevant standards and specifications describing a complete functioning system. Nothing in these specifications shall be taken to state or imply “works by others” except where specifically so mentioned. The contractor shall at the time of tendering clearly indicate design criteria and facilities which he will provide for the works specified. Such features and facilities shall be clearly identified at the time of submitting his offer.

3. Governing standards
The systems shall be furnished and installed in accordance with National and Local Codes and Statutory Rules including latest amendments. The contractor shall inform the Owner/Consultant of any intended or required departure from the code requirements described. No degradation of the requirements is acceptable simply on the basis of the local code requirement. It is acceptable only when the above codes is in direct conflict with local code requirements and where latter is more stringent than the former. All relevant Indian Standards are provided separately.

4. Conformity to IE act, IE rules and Standards
The work shall be carried out in the best workmanlike manner in conformity with this specification, the relevant specification/codes of practice of the Bureau of Indian Standards or IEC recommendations(Except where specified otherwise) and other relevant standards with latest amendments, approved drawings and the instruction issued by the Engineer-In-Charge or his authorized representative, from time to time. Equipment meeting any other authoritative standard, which ensures an equal or better quality than the above standards, will also be applicable.

In addition to the standards, all works shall also conform to the requirements of the followings:-

i. All electrical works shall be carried out in accordance with the provisions of Indian Electricity Act 2003, Indian Electricity Rules 1956 amended upto date (Date of call of tender unless specified otherwise).
ii. The work shall also conform to relevant Indian Standard Codes of practice for the type of work involved.

iii. Materials to be used in work shall be ISI marked wherever applicable.

iv. Following shall also be followed.
   a) Relevant safety codes of practices.
   b) Fire Insurance Regulations/Tariff Advisory Committee.
   c) Regulation laid down by State/Central Electrical Inspectorate, State Electricity Board /Licensee.
   d) Regulation laid down by the Factory Inspector of the State.
   e) Any other regulations laid down by the local authorities.
   f) Installation & operating manuals of original manufactures of equipment.

5. Project Execution and Management
The contractor shall ensure that senior planning and erection personnel deployed from his organization exclusively for this project. They shall have sufficient experience in this type of installation works. Contractor shall appoint one Senior Engineer and one Senior supervisor at the site on full time basis for the works dealt in this chapter.

For quality control and monitoring of workmanship, contractor shall assign at least one full time engineer who would be exclusively responsible for ensuring strict quality control adherence to specifications and ensuring top class workmanship of the installation. The Contractor shall arrange to have mechanized and modern facilities of transporting & shifting material to place of installation for speedy execution of work as per site requirements.

The contractor shall submit his programme of installation at least one week in advance. The contractor shall submit a separate ‘Schedule of Chart’ for installation programme, mentioning man hours required so that the work can be scheduled accordingly.

The work has to be carried out in phases as approved by Owner/Consultant from time to time so that the total project can progress smoothly with least obstruction to the operations and also works of other Contractors/ agencies.

The Contractor shall submit to Owner/Consultant by the third day of every month, three copies of a report duly updated along with ‘Schedule of Chart’ in an approved proforma showing the progress made during the previous month. The Contractor shall also submit by the end of every month their planning schedule for all items of work for the following month in three copies in an approved proforma to Owner/Consultant.

6. License
The electrical installation work shall be carried out by a competent Electrical Contractor possessing a valid license issued by the State Electricity Licensing Board in the state where project site is situated for carrying out all electrical installation work in appropriate category of installation. Attested photocopy of the valid license shall be furnished and original shall be made available for verification as required.
All wireman, electricians and supervisors engaged by the contractor for the above work shall possess necessary valid license issued by State Electricity Licensing Board. These shall be made available for scrutiny of the Owner/Consultant.

The contractor shall be solely responsible for the acts, defaults and neglects of the subcontractor if any, his agents, employees or workmen as fully as if they were the acts, defaults or neglects of the contractor or his agents, servants or workmen.

7. Construction Power
The contractor shall make their own arrangement for construction power unless otherwise stated elsewhere. Non-availability of power from Electricity Board/Licensee will not be a ground for any delay in works or any claim for compensation whatsoever.

8. Construction Water
Water required for the construction will have to be provided by the contractor at their own cost. Non-availability of water from the owner's property will not be a ground for any delay in works or any claims for compensation whatsoever. The quality of water used for concrete and masonry works should have the minimum standards prescribed in the relevant BIS Codes.

9. Materials
All the materials required for this work should conform to relevant IS specifications. The copies of Purchase Vouchers & Gate Passes should be produced along with the materials. The type test certificates, routine test certificates and acceptance test certificates are also to be submitted.

Owner/Consultant reserves the right to inspect the materials at factory before dispatch. If inspection of equipment at the factory is to be done, 15 days prior intimation should be given in advance. All arrangements like travel, accommodation, etc. for conducting inspection/testing at the factory for two officials designated by the Owner/Consultant shall be arranged by the contractor free of cost.

For visual /destructive tests of materials at site, the Contractor shall provide samples of all the materials free of cost well in advance. All the materials to be used in and on every part of the works shall be subjected, from time to time, to such tests as Owner/Consultant may direct. Such tests shall be performed at the expenses of the Contractor. The samples for tests shall be in all cases selected by Owner/Consultant. If at any time, any material so tested, fails to meet the acceptance criteria, the same shall be removed from the site of works and other materials substituted. But in the absence of any specified test/acceptance criteria, the decision of Owner/Consultant shall be final and binding as to whether the said materials shall be accepted or rejected.

The Contractor shall produce on demand from Owner/Consultant necessary test certificates certifying that the materials conform to the technical specifications. However, this clause will not apply to routine testing of materials the laboratory of the Contractor at site.
All tools, instruments, plants and labour/operating personnel required for the tests shall be provided by the Contractor at his own cost. For any tests as directed by Owner/Consultant that have to be carried out at an outside laboratory, the same should be carried out by the Contractor without any cost to Owner/Consultant and the cost shall include cost of tests, transportation, freight etc.

10. **Samples**
The Contractor shall require to provide Owner/Consultant samples of all the materials sufficiently in advance free of cost to obtain approval of Owner/Consultant. Approved samples shall be retained by Owner/Consultant until the completion of the work and all materials and workmanship incorporated in the work are to conform to the approved samples in all respects. Rejected materials shall be removed from the site immediately under the supervision of Owner/Consultant.

11. **Consumption of materials**
Proper record of daily consumption of materials shall be maintained at the site of work for each item as directed by Owner/Consultant. This is also required to be done even if the contractor arranges these materials himself.

12. **Testing and measuring equipments**
Equipment for measurement of work and testing the installation shall be arranged/procured by the Contractor at his own cost as per the stipulated standards. The same shall also be made available to Owner/Consultant without any charges to Owner/Consultant.

13. **Detailed Execution SHOP drawings**
The detailed dimensioned ‘Execution Shop drawings’ are to be prepared by the contractor as per the relevant IS specifications and the State Electrical Inspectorate standards/specifications/guidelines and should be submitted to the Owner/Consultant for approval prior to fabrication/supply/execution. Drawings provided by Owner/Consultant, if any, shall at all times be properly correlated before execution. In case of any discrepancy, the same should be brought to the notice of Owner/Consultant immediately. However, the discrepancy in the item given in the Schedule of Quantities appended with the tender drawings relating to the relevant item, the former shall prevail unless and otherwise given in writing by Owner/Consultant.

A list of shop drawings to be prepared and submitted by the Contractor is given below. Within 4 weeks of receiving the Work Order/LOI, the Contractor shall submit 4 sets of following drawings for Consultant/Owners’s approval.

**Switch room**
1. Layout of switch room showing all panels with measurements, clearances, etc..
2. Spacing between panels.
3. Panels support details.
4. Cable & busbar layout
5. Supports for cable and busbar.
6. Entrance to switch room door details, its size.
7. Switch room exhaust requirement, if required.
8. Pumping of seepage water, if required.

**Transformer**
1. Elevation.
2. Transformer measurements.
4. Cross section
5. Cable/busbar entry
6. Cable/busbar out.
7. Protections.
8. Foundation details.

**DG Set**
1. Elevation.
2. Transformer measurements.
4. Cross section
5. Cable/busbar entry
6. Cable/busbar out.
7. Protections.
8. Foundation details.

**Panel boards**
1. Fabrication Scheme.
2. Control wiring scheme.
3. Elevation of panel boards showing all equipment, relays, indication lamps, makes, etc.
5. Panel measurements.
6. Cable entry.
7. Cable out.
8. Cross section
9. Support structure showing materials, thickness, length, etc. of frames.
10. If RCC foundation is required, its details.

**Busbar**
1. Layout of busbar showing all areas.
2. Bends, vertical bends, etc.
3. Support details showing how it will be supported, thickness, material, etc.
**Cable trays**
1. Layout of all cables and trays showing offset from wall, columns, etc.
2. Name of equipment / panel where cables will be terminated.
3. Cable make, size, etc.
4. Tray cross section support details showing how it will be supported, thickness, material, etc.
5. If through trenches, cross section details of trench like width, depth, covering required, etc.

**Earthing**
1. Layout of earth pits.
2. Cross section drawing showing specifications of earth pits.
3. Interconnection between pits showing material, size, etc.
4. Interconnection between panels, equipment, etc.

**Lightning Protection**
1. Layout of lightning protection system arrestors.
2. Layout of earth pits.
3. Layout of horizontal run on terrace, material, its size, etc.
4. Cross section drawing showing specifications of vertical and down comers.
5. Cross section drawing showing interconnection between lightning arrester and pits, materials, size, etc.

**Wiring**
1. Layout of Conduits showing make, size, offset from walls, columns, etc.
2. Supporting details showing clamps, intervals of clamps, etc.
3. Number of wires and its size per conduit.
4. Layout of light fittings, fans, plugs, etc. and its circuit wiring.
5. Point wiring showing how control of each light, fan, plug points showing MCB / switches.
6. A floor-wise list of light fittings, fans, plugs, etc. with quantity, connected load, etc.
7. Location of DBs.
8. Location of switches.

**Internal light fittings**
1. Layout of light fittings.
2. Spacing of fittings.
3. Offset from walls, columns, etc.

**External lighting**
1. Layout of external lights showing measurements.
2. Layout of wire / cables.
3. Spacing between the lights.
4. Wiring showing how control of each light point showing DB/ MCB / Switches.
5. General arrangement drawing of light poles.
6. Foundation details of poles.

**Electrical shaft**
1. Trays/ cable support details showing material, size, supports, etc.
2. Cross section of electrical shaft showing all cables, busbar, etc.
3. Shaft size.

14. Data / Drawings / Documents
The Contractor shall submit the following data/information /drawings/documents as indicated below:

   a) Descriptive literature of the various equipment offered with catalogue, if any.
   b) Guaranteed technical particulars of the equipment.
   c) Approximate dimensions and weights and preliminary G.A drawings.
   d) List of optional features with extra price.
   e) Make of various equipments and associated components/accessories.
   f) Wherever applicable, preliminary schematic of the equipment/system offered in the tender.
   g) Brief write up on control scheme and features

Within 4 weeks of order, contractor shall submit 4 sets of following documents for Consultant/Owners’s approval.

   a) Guaranteed technical and performance particulars.
   b) G.A drawings with dimensions and weight, plan and section and fixing/foundation details.
   c) Where applicable, control scheme drawings with write up and all terminal numbers for external hook up.

Subsequently, 4 sets of the revised documents shall be submitted incorporating Consultant’s comments as Final Drawings for Owner’s reference and records, before the equipment is offered for inspection.

**At Final Execution Stage**
The following shall be submitted after inspection but before despatch of the equipment

   a) “As built” drawings
   b) Routine and type test certificates
   c) Detailed operation and maintenance manual
   d) Detailed erection, testing and commissioning manual

15. Completion drawings
On completion of works, the contractor shall submit 5 sets of "As – Built" drawings (Hard copies), one set in CAD in CD to Owner/Consultant before submission of final bill. The approved shop drawings shall be revised and submitted for this purpose.
16. **Training**

The Contractor shall train Owner/Consultant’s staff during the erection and also familiarize them with the operation and maintenance of all the systems for a minimum period of three weeks to the full satisfaction of Owner/Consultant.

Training shall be provided for understanding and operation of all the hardware items and software, if any, related to all systems. Charge for training should be included in the total rates. The contractor shall also provide training materials to the staff prior to the commencement of the training.

17. **Statutory approvals**

It shall be the responsibility of the contractor to ensure that complete installation supplied and/or erected by him fully meets with the relevant standards, Acts, Rules, Regulations, etc. applicable.

It is responsibility of the contractor to get Initial and Final Approvals / NOC from the concerned Govt. Departments and Statutory Authority like EB, State Electrical Inspectorate, Public Roads Authority, etc. before commencing the work at site. All relevant documents and drawings as required by the Authority shall be prepared and submitted to the Owner/Consultant initially. If any change suggested by the Owner/Consultant, it shall also be incorporated accordingly. The contractor shall also do all liaison works with the departments for getting the approvals. All the incidental expenses in connection with the above shall be borne by the contractor with no extra cost to Owner/Consultant.

Any modification/rectification required by the Owner/Consultant /Electrical inspectorate or any other statutory authority resulting from the improper installation by the contractor or to make the same in full conformity with the relevant standards, Acts, Rules, regulations, etc. applicable for the installation, shall be carried out by the contractor without any extra cost to the Owner.

All testing/calibration etc., are to be carried out as per the requirements of Electrical Inspectorate and Electricity Board/Licensee.

If the current rating of any of the switchgears including circuit breaking mentioned in the “Schedule of Items of Work” is not available or is not in conformation to the Inspectorate standards, then it shall be rated to the nearest higher rating available with the current/fuse rating as specified.

It is the responsibility of the contractor to liaison with Electricity Board/Licensee for obtaining power supply to the installation executed by them. Necessary drawings, test reports, equipment details shall be submitted wherever needed.

For all approvals / NOC, statutory fees shall be paid by the contractor initially, however, it shall be reimbursed by the Owner/ on submission of documentary evidences.
18. Performance testing
The contractor should conduct performance tests and produce sufficient documentary proof that the system is operating at the rated capacity and as per requirements.

19. Handing over the site
The site shall be handed over in phases. Contractor shall plan the work as per the phasing decided by Owner/Consultant and no claim will be entertained for not handing over the entire area in one stretch. In case there are small patches which could not be handed over due to legal and technical reasons, this will not be considered as obstructions and no claim will be entertained for delays for such reasons.

20. Guarantee / warranty
All the items of equipment and installations shall be guaranteed to be free from defective workmanship or materials for a period of 12 months from the date of handing over. The Contractor at his own cost shall rectify any defect / replace material that may appear during the period.

During this period, the contractor shall without any extra cost, carry out all routine and special maintenance of the works executed by him and attend to any difficulties and defects that may arise in the day to day operation of the system within 24 hrs. of intimation.

The Contractor shall hold himself fully responsible for reinstallation or replace the damaged /defective items free of cost to the Owner/Consultant during the period as stipulated hereunder.

a) Any defective material supplied by the Contractor or defective workmanship of the Contractor.
b) Any material supplied by the Owner/Consultant which is proved to be damaged or destroyed as a result of defective workmanship by the Contractor.

21. Maintenance
The contractor shall maintain systems in a first class and safe manner during guarantee period. Such maintenance shall be for the entire systems except when failure occurs due to work performed by others. Responsibility entails periodic inspection by the supervisor / technician and unlimited call back service including during nights, weekends and holidays. Apart from the above, this maintenance shall include one visit by Engineer per month for the first 6 months from the date of acceptance of the system. Call back service shall be provided for emergencies and shall be responded within 2 Hrs.

Engineer’s Visits for the next 6 months shall be not less than 1 per month with visit timings adjusted so as not to coincide with the busiest usage period. Call back service shall be responded with in 2 Hours and service involving more than one stalled or erratic equipment shall be immediately provided regardless of the time of day or night. There shall be no compensation for call back service regardless of the time of day and for holidays etc.
22. **Painting**
All exposed metal work furnished under these specifications unless otherwise specified shall be shop primed and properly painted. Shop coats of paint that have become damaged during shipment or erection shall be cleared off with mineral sprits, wire brushed and spot painted over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surface.

23. **Import license**
Should any import license be required for import of any component, the contractor shall make his own arrangements for the same. The Contractor shall do all documentation works for importing the equipment as whole or in parts. The Owner/Consultant shall not undertake any responsibility for import of components/equipment. All payments shall be made in Indian rupees only.

24. **Structural requirements**
Contractor shall clearly indicate the structural and electrical requirements for the installation of Electrical Systems. Switch room, foundations, etc. shall be provided by the Owner/Consultant through other agencies. Other preparation work and all items of supply and Installation shall be the responsibility of the contractor. No structural member in the building shall be damaged/altered, without prior approval from Owner/Consultant. All requirements for cuttings made by the contractor in connection with the works shall be properly intimated to the Owner/Consultant in writing in advance and the same shall be filled by him without any cost to Owner/Consultant to the original finish.

During execution, the contractor shall provide well in advance details of all technical matters that required to be provided by the Owner/Consultant to the Contractor for the smooth progress of the work.

25. **Exclusions**
Any items excluded from the offer but functionally required, shall be clearly defined and listed by the tenderers, giving description of the items, quantity and cost and the reason for excluding the items.

26. **Tools and tackles**
All tools, tackles, supports, scaffolding and staging etc. required for erection and assembly of the equipment and installation covered by the contract shall be provided by the Contractor himself at his own cost. In addition, all other materials such as foundations bolts, nuts etc. required for installation of the equipment shall also be provided by the contractor at his own cost.

27. **Special Note**
The rates indicated for installation in the “Schedule of Rates” enclosed include charges for fabrication, installation, testing, commissioning as per enclosed specifications/drawings.
The installation charges indicated in “Schedule of Rates” shall be valid both for items supplied by the contractor and that supplied by the Owner.

In case of unit rate being different in figures and words, the unit rates in words shall be taken as final.

The quantities indicated in “Schedule of Rates” are only approximate.

All exposed MS parts included in the supply scope of the contractor shall be painted with two coats of enamel paint over suitable primer at no extra cost to the Owner.

The scope of work shall include painting feeder names, equipment numbers, circuit numbers etc. with suitable sized characters as directed by the Site-In-Charge on equipment, devices associated with this work.

28. Measurement and billing

1. All items of work under this Contract shall be executed strictly to fulfill the requirements laid down in the specifications, which shall include type of equipment, material, methods of installation, type of controls, approved shop drawings and the relevant standards.

2. The rate for each item of work in the Schedule of Quantities shall, unless expressly stated otherwise, shall also include the following:
   a. All fixing materials, accessories, appliances, tools, plants, equipment, transport, labour and incidentals required in preparation of and in the full and entire execution, testing, commissioning and completion of the work called for in the item as per Specifications and Drawings.
   b. Wastage on materials and labour.
   c. Loading, transporting, unloading, handling / double handling, hoisting to all levels, setting, fitting and fixing in position protecting, disposal of debris and all other labour necessary in and for the full and entire execution and to fully complete the job in accordance with the contract documents, good practice and recognized principles.
   d. Liabilities, obligations and risks arising out of Conditions of Contract.
   e. All requirements of specifications, whether such requirements are mentioned in the item or not. The specifications and drawings where available, are to be read as complimentary to and part of the Schedule of Quantities and any work called for in one shall be taken as required for all.
   f. In the event of conflict between schedule of quantities and other documents including the specifications, the specifications stringent shall apply and the interpretation of the Owner/Consultant/Consultants shall be final and binding.

3. The UNIT rate shall be all inclusive. It shall include cost of material, import duties, other duties & taxes, VAT, works contract tax, all Cess, tools and plants, transportation, freight, insurance, storage, incidental expenses, loading/unloading, shifting in position with
required hoists and equipment, labour, night labour, wastage, contractor’s profit, installation, testing, commissioning and other works required. In the case of imported items, in addition to the above, customs duties, freight, all insurance, port clearance charges, etc. are also to be included in the unit rate. The RATE shall be FIRM throughout the contract period.

4. The extension for (total) amounts against each item shall be based on the quantities indicated in this Schedule.

5. All equipment, quantities and technical data indicated in this Schedule are for the Contractors guidance only.

6. The quantities given in this schedule are provisional, the Owner/Consultant reserves the right to increase or decrease the quantities or to totally omit any items of work and the Contractor shall not be entitled to claim any extras or damages on these grounds.

7. No alteration whatsoever is to be made to the text or quantities of this Schedule unless such alterations is authorized in writing by the Owner/Consultant. Any such alterations, notes or additions shall unless authorized in writing be disregarded when tender documents are considered.

8. In the event of an error occurring in the amount column of the Schedule, as a result of wrong extension of the unit rate and quantity, the unit rate quoted by the Tenderer shall be regarded as firm and the extensions shall be amended on the basis of the rates.

9. Any error in totaling in the amount column and in carrying forwarded totals shall be corrected. Any error, in description or in quantity or omission of items from this schedule shall not vitiate this contract but shall be corrected and deemed to be a variation required by the Owner/Consultant.

29. Works to be measured
Consultant/Owner shall, except as otherwise stated, ascertain and determine by measurement the value in terms of the contract. He shall when he requires any part or parts of the works to be measured, give notice to the Contractor’s authorized agent or representative, who shall forthwith attend or send a qualified agent to assist the Consultant/Owner or his representative in making such measurement, and shall furnish all particulars required by either of them. Should the Contractor not attend or neglect or omit to send such agents, then the measurement made by Consultant/Owner or approved by him, shall be taken to be the correct measurement of the work. For the purpose of measuring such permanent work as is to be measured by record and drawings, Consultant’s representative shall prepare records and drawings month by month and the Contractor as and when called up on to do so in writing, shall within 14 days, attend to examine and agree such records and drawings with consultant’s representative and shall sign the same when so agreed. If the contractor does not so attend
to examine and agree such records and drawings they shall be taken to be correct if, after examination of such records and drawings, the contractor does not agree to the same or does not sign the same as agreed, they shall nevertheless be taken to be correct, unless the contractor shall, within 14 days of such examination, lodge with consultant's representative for decision by Consultant, notice in writing of the respects in which such records and drawings are claimed by him to be incorrect.

30. Mode of measurement
The work shall be measured as prescribed in the specification of work, notwithstanding any general or local custom, except where otherwise specifically described or prescribed in the Contract. Wherever not specifically mentioned in the Contract, the mode of measurement as prescribed in the relevant IS codes shall be applicable and binding to the contract. Only the latest editions of all the codes of practices including all latest official amendments and revisions shall be applicable.

31. Safety Practices
1. The contractor shall observe all statutory and legal requirement by Central and State Governments applying to the work as well as any local regulations applying to the site issued by Consultant/Owner or any other authority.

Particular attention is drawn to the following:
   a) In case of accident Consultant/Owner’s Safety Engineer/Engineer-In-Charge shall be informed in writing within 24 hours of occurrence of the accident. The contractor shall strictly follow regulations laid down by Factory Inspector and Government Authorities in this regard.
   b) Fencing all contractor’s plant, platforms, excavations etc.
   c) Compliance with all electricity regulations.
   d) Compliance with statutory requirements for inspection and test of all lifting appliances and auxiliary lifting gear.

2. Staircases, doors or gangways must not be obstructed in any way that will interfere with means of access or escape.

3. The contractor shall notify Consultant/Owner of his intention to bring on site any equipment or container holding liquid or gaseous fuel or other substances which might create a hazard. The Consultant/Owner will have the right to prohibit the use of such equipments or to prescribe the conditions under which such equipment may be used.

4. Where it is necessary to provide and/or store petroleum products or petroleum mixtures and explosives, the contractor shall be responsible for carrying out such provisions and/or storage in accordance with rules and regulations laid down in Petroleum and Carbide of Calcium Manual published by the Chief Inspector of Explosives of India. All such storage shall have the prior approval of Consultant/Owner. In case approvals are required from Chief inspector of Explosives or any statutory authorities, the contractor shall be responsible for obtaining the same.

5. The contractor shall be responsible for the safe storage and use of any radiographic
sources or those of his sub contractor.

6. ‘Work Permit’ in the prescribed pro-forma shall be obtained from Consultant/Owner’s safety Engineer/Engineer-In-Charge before carrying out any work within the project premises in the following situations.

   a) Any work involving open flames and sparks such as welding, gas cutting, soldering, grinding etc.
   b) Sand blasting.
   c) Entry into hazardous and potentially hazardous areas.

7. Good house –keeping must be practiced by contractor’s personnel at all times within the project area.

8. For the safe execution of certain works, personnel protective Safety devices as stipulated by Safety Codes/safety Engineer shall be provided and maintained by the contractor.

9. Any unsafe work practice/working conditions during execution of work shall be corrected immediately on bringing the same to the attention of contractor by Consultant/Owner’s Safety Engineer.

10. Contractor shall strictly adhere to safe traffic practices within project area with respect to speed limit, parking of vehicles etc.

32. Electrical Safety Regulations

   a) In no circumstances will the contractor interfere with fuses and electrical equipments belonging to the Owner or other contractors.

   b) Before the contractor connects any electrical appliances to any plug or sockets belonging to the other contractors or Owner he will:

      • Satisfy the Owner/Engineer-In-Charge that the appliances is in good working condition.
      • Inform the Owner/Engineer-In-Charge of the maximum current rating, voltage and phase of the appliance.
      • Obtain permission from Owner/Engineer-In-Charge for taking power connection from specified points.

   c) Permission for power connection will not be granted until Owner/Engineer-In-Charge is satisfied that the appliance is in good working condition and proper earthing connection provided.

   d) No electric cable in use by other Contractor/Owner will be disturbed without prior permission. No weight of any description will be imposed on any such cable and no ladder or similar equipment will rest against or be attached to it.

   e) No work must be carried out on any live equipment. The equipment must be made safe and a ‘WORK PERMIT’ issued by Engineer-In-Charge before any work is carried out.

   f) Contractor shall follow detailed Safety Procedure issued by Owner/Consultant at the time of commencement of work and updated from time to time.

Contractor shall have arrangement to transport his workmen, for medical attention, in the event of an accident at work site.
33. **Safety Conditions**

The contractor has to ensure every precaution for the safety of workers before starting the works on a daily basis. If the supervising authority while inspecting the site find any of the below given conditions not obeyed, the contractor will be imposed an appropriate fine. Before the work reaches 2m height from the ground level, the contractor has to store a minimum of 15 helmets and safety belts and to increase it to meet the total number of workmen engaged in such works. The safety conditions to be followed are;

a) Inside the site every person should wear the safety helmets, all should wear and tie the safety belts while working 2m and above the ground level.
b) Maximum vehicle speed inside the site shall be 20 km.
c) Taking liquor inside the site is strictly prohibited.
d) Openings shall be neatly & visibly barricaded.
e) All scaffoldings at heights shall be protected with hand rails.
f) Scaffolding shall be done by competent persons.
g) Only authorized persons are permitted to operate cranes, lifts, winches etc..
h) All electrical connections shall be taken through ELCB.
i) Ensure that all the new workmen are screened and they must attend the safety orientations.
j) Ensure the usage of safety helmets, safety belts and personal protection equipments.

34. **Testing and handing over**

i. The Contractor shall carry out test run of the installation in the presence of representatives of the Owner/Consultant, to establish satisfactory functioning of the installation.

ii. The installations shall be handed over to the Owner/Consultant’s site representative after satisfactory testing along with 3 sets of completion documents each consisting of :
   a. Certificates of approval from Statutory Local Authorities for the operating and maintenance of the installation and equipment, wherever such approval or certification is required.
   b. 5 sets of "As – Built” drawings (Hard copies), one set in CAD in CD.
   c. Certificate from the Engineer stating that the contractor has cleared the site of all debris and litter caused by him during the Construction.
   d. Documents showing that sufficient training have been given to the Staff.
   e. Detailed equipments data and catalogues.
   f. Test Certificates for major equipments.
   g. Manufacturer’s maintenance schedule chart including check chart, etc.

iii. Submission of the above documents shall form a pre-condition for the ‘final acceptance’ of the installation and final payment.

iv. Upon handing over, the Owner/Consultant’s site representative shall issue to the contractor necessary ‘Certificate of Acceptance’.
**LIST OF INDIAN STANDARDS (IS)**

<table>
<thead>
<tr>
<th>IS Number</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>IS 1646 - 1982</td>
<td>Code of practice for fire safety of buildings (general): Electrical installations</td>
</tr>
<tr>
<td>IS 2026 - 1977 to 81 (Part I to IV)</td>
<td>Power Transformers</td>
</tr>
<tr>
<td>IS 4146 - 1983</td>
<td>Application guide for voltage transformers</td>
</tr>
<tr>
<td>IS 11171 : 1985</td>
<td>Specification for Dry-Type Power Transformers</td>
</tr>
<tr>
<td>IS 10028</td>
<td>Code of Practice for Selection, Installation and Maintenance of Transformers</td>
</tr>
<tr>
<td>IS 7098 – 1985</td>
<td>Cross linked polyethylene insulated PVC sheathed cables. For working voltages from 3.3 KV up to and including 33 KV</td>
</tr>
<tr>
<td>IS 1255 - 1983</td>
<td>Code of Practice for installation and maintenance of Power Cables up to and including 33 KV rating (Second Revision)</td>
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<tr>
<td>IS 1554 - 1988</td>
<td>PVC insulated (Heavy Duty) electric cables for working voltages up to and including 1100 volts.</td>
</tr>
<tr>
<td>IS 694 - 1990</td>
<td>PVC insulated Electric cable for working voltage up to and including 1100 volts.</td>
</tr>
<tr>
<td>IS 14927 Part 1 : 2001</td>
<td>Cable Trunking and Ducting Systems for Electrical Installations</td>
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<tr>
<td>IS 10810 - 1988</td>
<td>Methods of test for cables.</td>
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<tr>
<td>IS 13032 : 1991</td>
<td>AC Miniature Circuit-Breaker Boards for Voltages not Exceeding 1 000 V</td>
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<tr>
<td>IS 13947</td>
<td>Specification for Low-voltage Switchgear and Control gear</td>
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<tr>
<td>IS 732 - 1989</td>
<td>Code of practice for electrical wiring and installation</td>
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<tr>
<td>IS 2071 - 1974 - 76</td>
<td>Methods of high voltage testing</td>
</tr>
<tr>
<td>IS 3427 – 1997</td>
<td>AC Metal enclosed switch gear and control gear for rated voltages above 1 KV and up to and including 52 KV.</td>
</tr>
<tr>
<td>IS 4722</td>
<td>Rotating Electrical Machines - Specification</td>
</tr>
<tr>
<td>IS 374 - 1979</td>
<td>Ceiling fans and regulators (3rd revision)</td>
</tr>
<tr>
<td>IS 1258 - 1987</td>
<td>Bayonet lamp holders (Third revision)</td>
</tr>
<tr>
<td>IS 1293 - 1988</td>
<td>Three pin plugs and sockets outlets rated voltage up to and including 250 volts and rated current up to and including 160 amps.</td>
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<tr>
<td>IS 1651 &amp; 1652 1991</td>
<td>Stationary cells and batteries, lead-acid type (with tubular positive plates)</td>
</tr>
<tr>
<td>IS 1913 – 1978</td>
<td>General and safety requirements for luminaries.</td>
</tr>
<tr>
<td>IS 2309 - 1989</td>
<td>Code of practice for the protection of buildings and allied structures against lightning</td>
</tr>
<tr>
<td>IS 2705 : Part 1 : 1992</td>
<td>Current transformers</td>
</tr>
<tr>
<td>IS 3837 : 1976</td>
<td>Accessories for rigid steel conduits for electrical wiring</td>
</tr>
<tr>
<td>IS 3480 - 1966</td>
<td>Flexible steel conduits for electrical wiring.</td>
</tr>
<tr>
<td>IS 4615 - 1968</td>
<td>Switch socket outlets.</td>
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<tr>
<td>IS 5133 – 1969 (Part -I)</td>
<td>Boxes for the enclosure of electrical accessories.</td>
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<tr>
<td>IS 8084 : 1976</td>
<td>Interconnecting busbars for ac voltage above 1 kV upto and including 36 kV</td>
</tr>
<tr>
<td>IS 8130 – 1984</td>
<td>Conductors for insulated electric cables and flexible cords</td>
</tr>
<tr>
<td>IS 8623</td>
<td>Specification for Low-Voltage Switchgear and Control gear Assemblies</td>
</tr>
<tr>
<td>IS 8828 - 1996</td>
<td>Electrical Accessories - Circuit Breakers for Over Current Protection for Household and Similar Installations</td>
</tr>
<tr>
<td>IS 9537 - 1981</td>
<td>Conduits for electrical installations</td>
</tr>
<tr>
<td>IS 1653 : 1972</td>
<td>Rigid steel conduits for electrical wiring</td>
</tr>
<tr>
<td>IS 1885 - 1971</td>
<td>Glossary of items for electrical cables and conductors</td>
</tr>
<tr>
<td>IS 5424 - 1969</td>
<td>Rubber mats for electrical purposes.</td>
</tr>
<tr>
<td>IS 2551-1982</td>
<td>Danger notice plate.</td>
</tr>
<tr>
<td>IS 13925, 13340, 13341</td>
<td>Capacitors for ac power systems having a rated voltage above 1000 V</td>
</tr>
</tbody>
</table>
ABBREVIATIONS

The following abbreviations have been used in the accompanying Specifications, drawings and Schedule of Quantities.

COP stands for Code of Practices
CU stands for copper.
GI stands for Galvanized Iron (Mild Steel)
V stands for Volts
KV stands for Kilo Volts
HV stands for High Voltage (>650V and <=33000V)
MV stands for Medium Voltage (>250V and <=650V)
LV stands for Low Voltage (<=250V)
HT stands for High Tension
LT stands for Low Tension
VCB stands for Vacuum Circuit Breaker
PVC stands for Polyvinyl Chloride
AMP stands for Amperes
KWH stands for Kilowatt Hours
KW stands for Kilo Watts
BIS stands for Bureau of Indian Standards
IS stands for Indian Standards
IE Act stands for Indian Electricity Act
IE Rules stands for Indian Electricity Rules
IEC stands for International Electrotechnical Commission
IEE stands for Institution of Electrical Engineers - London
NEC stands for National Electrical Code
ACB stands for Air Circuit Breaker
ELCB stands for Earth Leakage Circuit Breaker
MCB stands for Miniature Circuit Breaker
MCCB stands for Moulded Case Circuit Breaker
MFDM stands for Multi function Digital Meter
SP stands for Single Pole
DP stands for Double Pole
TP stands for Triple Pole
TPN stands for Triple Pole and Neutral
4 Pole stands for 3 phase and neutral of same capacity (size)
MDB stands for Main Distribution Board
SDB stands for Sub Distribution Board
FDB stands for Final Distribution Board
MCC stands for Motor Control Centre
TECHNICAL SPECIFICATIONS

ELECTRICAL WORKS

1.1 SCOPE OF WORK
The tenderer should note that the specifications furnished in the tender is of general nature only and it is the responsibility of the tenderer to supply, install and commission the equipment and services required for the satisfactory performance of the installation. All the items of equipment required for the safe and satisfactory operation of the installation shall be supplied and installed by the contractor.

The intent of this specification is to define the requirements for the design, manufacture, shop testing, supply, installation, testing and commissioning of the system.

The scope of work covers following.

a. The contractor shall do necessary arrangements to measure Soil Resistivity at the site by the Inspectorate, and shall submit the report to the Owner/Consultant/Client.

b. Prepare Electrical Scheme & all Drawings and documents as required by the Statutory Authority for getting their approvals.

c. Liaison works with them and obtain Initial & Final statutory approvals. For all approvals, statutory fees shall be paid by the contractor initially, however, it will be reimbursed by the Owner/Consultant on submission of documentary evidences.

d. Prepare all SHOP drawings for execution purpose as per list attached in the Special Conditions.

e. Co-ordinating with other agencies at site for satisfactory completion of the project.

f. Get approval from the Owner/Consultant/Client for all makes of items and its specifications before supply the same at site.

g. Supply, installation, testing and commissioning of the entire system.

h. Obtain final statutory approvals for commissioning.

i. Submiting ‘As built’ drawings (5 Hard copies and 1 in CAD in CD).

j. Handing over the site.

k. Providing guaranty / warranty.

1.2 Work Details
1. All electrical works shall only be carried out by Contractor, who holds valid license issued by Kerala State Electricity Licensing Board.

2. Civil works associated with the installation work such as excavation, dewatering, refilling of earth, dismantling of wall, removal of tree root if any for installing poles earth pits &
burying of cables etc., chipping, grouting, removal and installation of RCC slab over cable trench for laying cables etc. shall be also included in contractor's scope.

3. All structural steel associated with erection of electrics such as equipment erection, cabling, earthing and lightning protection, supporting arrangement etc. shall also be under contractor's scope.

4. All structural and civil work executed shall fully meet the requirements intended and shall conform to sound engineering practice.

5. Installation work is inclusive of supply of erection materials, hardware, consumables and sundry items required for installation.

6. It is the responsibility of the contractor to supply and install all items that are incidental and necessary for the completion of the installation, whether specifically mentioned or not, so that the installation complies with the standards and regulation specified. However, prior sanction is to be obtained from the engineer in charge in this regard.

7. The contractor shall furnish all labour (supervisory, skilled, unskilled and administrative), transport vehicles, generator sets, welding machines, gas cutters, erection tools and tackles, cleaners, crimping devices, blow lamp, handling equipment, testing equipment etc. and any other such equipments necessary for installation, testing and commissioning at no extra cost to the Owner.

8. It is the responsibility of the contractor to pay wages and salaries to the persons employed and ensure that all labour rules and acts are complied with. Contributions, fees, etc. necessary in this regard shall be paid and the contractor shall maintain all necessary records.

9. All consumable materials such as insulation tape, cleaning and paint brushes, welding electrodes, rust preventive materials, jute, cotton waste, hacksaw blades, bolts, nuts, corrosion inhibitive grease, fuel, lubricants etc. and other material required for carrying out the work shall be included in the scope of the contractor.

10. Work shall be started and carried out in accordance with the terms and conditions, approved drawings, specifications and requirements as set forth in this document and instructions of the Owner or his authorized representative from time to time.

11. Where supply of materials are involved, the scope shall include design, manufacture, assembly, testing and inspection at works, packing and delivery at site and before placing orders, it shall be got approved by Consultant/Owner.

12. Testing and commissioning works include calibration, all pre commissioning tests, checking of all wiring and connections for power, control, metering, protection, alarm, annunciation, lighting and earthing. Testing and commissioning of all the equipment covered in this contract shall be carried out as per relevant standards as directed by the Consultant/Owner.

13. Contractor shall carry out clearing of all construction waste materials and loose earth, which might have collected in and near the work site consequent to execution of the work under this contract. Also all temporary structures erected by the contractor shall be removed.

14. The scope of work shall include writing of feeder names, equipment numbers, circuit numbers etc. with suitable sized characters as directed by the Engineer-in-charge on equipment, devices associated with this work.
15. All MS/GI structural used for supports, cable trays etc. shall be painted as per specifications.
16. The contractor shall progressively mark the actual quantities installed at site on the relevant drawings/documents on a progressive manner and got certified by the Owner/Engineer-In-Charge of the consultant.
17. A site order book must be maintained and always be available at site to record the instructions by the Consultants/Owner or their representative. The contractor must see that the instructions noted therein are properly carried out.

1.3 Vacuum Circuit Breaker (VCB) Panel

VCB panel should be extendable type at both ends. Easy access must be available to parts of the VCB panel. The breaker with drawout carriage shall be accurately aligned and provided with wheels on roller bearings for easy removal. The circuit breaker shall be provided with integral earthing switch.

Electrically operated auxiliary switches shall be provided as required for the control and indicating purposes and in addition there shall be not less than 3 Nos. NO and NC contacts available as spare. Each circuit breaker shall have a mechanical ‘open/closed’ indicator. Anti pumping facility shall also be provided in the switch gear / control circuit.

Closing mechanism shall be spring assisted electrically operated (with a spring charger having spring charge indication). The spring charging motor should be of totally enclosed construction. Built in manual charging handle should be provided with every circuit breaker for effortless manual spring charging. Busbars shall be air insulated extensible type with SMC/DMC sleeved high conductivity and shall be designed for a temp. rise of 35° C over an ambient of 45° C. The busbars and interconnections shall be adequately supported to withstand thermal and dynamic overloads during system short circuit. The area of busbar should not be less than 0.8 A/sq.mm without considering derating factors. Switchgear shall be capable of withstanding high pressure tests on cable.

Separate compartment in the panel shall be provided for installing EB TOD meter, CT and PT.

The following safety arrangements shall be provided for the safety of the personal and to prevent mal operation.

a) Inter-lock to prevent the circuit breaker from being forwarded or reversed unless the breaker is off.
b) Inter-lock to prevent the truck from being withdrawn or replaced except in the fully withdrawn position.
c) Inter-lock to prevent the breaker from being closed unless it is fully engaged in service position.
d) Inter-lock to prevent earth connection from being made by the earthing device except than the circuit breaker is open.

e) Inter-lock to prevent the breaker from being made alive without its carriage in position.

The breaker should have test positions to facilitate testing of control circuit. Automatic dust-proof safety shutter assembly should be provided for shrouding of live terminals while the breaker is drawn out. The circuit breaker shall be designed for local/remote tripping and closing by normal means. The control circuits shall be designed to operate on 30 Volts D.C.

**Design Requirement**

The circuit breaker shall be suitable for 11 kV 50 Hz, horizontally isolated, horizontal draw out, flush front, single bus-bar, metal clad type accommodated in a sheet steel housing with all metal parts treated against corrosion. It should be of robust & vermin proof construction type Vacuum Circuit Breaker panel having the following specifications:

**Type** - Indoor

**Operating mechanism** - Motor charged Spring

**Rate Short time withstand current with duration** - 350 MVA, 1 sec.

**Charging time for motorised mechanism** - Maximum of 10 sec

**Standards**
- IEC60694
- IEC60056
- IEC60298

11kV insulated busbar with necessary supports. Each 11 kV vacuum circuit Breaker Panel should contain the following LED minimum indications and Push button stations.

**LED Indicators**

<table>
<thead>
<tr>
<th>LED Indicators</th>
<th>Breaker</th>
<th>Breaker</th>
<th>Breaker</th>
<th>Breaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-Phase - healthy</td>
<td></td>
<td>Breaker - Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y-Phase - healthy</td>
<td></td>
<td>Breaker – Service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-Phase - healthy</td>
<td></td>
<td>Spring – Charged</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Breaker - On</td>
<td>Auto Trip</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Breaker - Off</td>
<td>DC – On, etc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Push Buttons stations**

Breaker Close
Trip
Emergency Trip, etc.

**Testing**

The panel shall be tested as per details covered under ‘Switch Gears and Panel Boards’. Test reports shall be signed by both Contractor and Owner/Consultant.
2.0 TRANSFORMER

1) Description
The transformers shall be cast resin type 3 phase, indoor, dry type, copper winding, cast coil construction with the coils cast under full vacuum.

2) Construction
The transformers shall be self extinguishing, non toxic emission, environment friendly, impulse voltage proof, non hygroscopic, compact and maintenance free.

The transformers shall be designed, manufactured and tested in accordance with relevant IS Standards.

The magnetic core shall be made from laminations of cold rolled grain oriented, silicon steel, insulated with mineral oxide and should be protected against corrosion with a coat of varnish.

The windings shall be copper and shall be capable of being replaced at site by qualified transformer repair personnel. Primary and secondary windings shall be galvanically separated from each other. The temperature rise of the windings shall not exceed the limits specified in the relevant IEC Standard.

The high voltage and low voltage terminals shall be designed and manufactured for bus bar connections as well as for cable connections. The high voltage terminals shall be located at the upper third of the HV coil. The LV terminals shall be placed above the coil. HV & LV terminals shall be placed on opposite sides of the long axis of the transformer. The high voltage terminals shall be led to insulators, fixed at the upper core clamping device.

The transformer core and windings should be contained in a ventilated sheet steel enclosure (IP 23), painted with corrosion resistant paint. The base of the enclosure should consist of a metal mesh, to provide air inlet, and louvers should be provided on the enclosure for enhanced thermal performance. The transformer enclosure shall be equipped with rollers such that they can be moved easily in the direction of the long axis or perpendicular to the axis. The transformer frame shall rest on vibration isolator pads after the transformer is fixed in place to be ready for operation. The rollers are to be used only when the vibration isolator pads are removed.

The neutral terminal shall be insulated. The cross-section of the neutral terminal shall be of the same size as the line terminal and shall be provided for connection to grounding system. Danger notices should be fixed at the high voltage coils in accordance with the local statutory requirements. 1 set of instruction manual for installation, commissioning and maintenance shall be furnished.
3) **Characteristics**
   The transformer shall satisfy all ratings listed in technical particulars and in particular must comply with the values for impulse withstand and dynamic short-circuit withstand capability as required by the Standards.

   The possibility shall be provided to connect transformers of same ratios in parallel and to exchange them against each another. For this purpose, they have to be physically, mechanically and electrically identical units, in particular referring to their ratio, short circuit voltage and vector group.

   The tap position must be visible and recognizable from outside.

4) **Core Earthing**
   Provide a visible flexible earthing connection from the core steel to the frame so that the core is earthed at only a single point.

5) **Accessories**
   The transformers shall be equipped with a thermal protection device, which will comprise RTD (resistance temperature detectors) sensors and temperature monitoring unit at 3 phases.

6) **RTD sensors**
   The RTD sensors shall be supplied assembled and wired to the terminal block fixed on the upper part of the transformer. The converter shall be supplied with its wiring diagram. The sensors shall be installed so as not to lower the insulation strength of the winding, and to be properly insulated and protected from the HV bus or cables.

7) **Temperature monitoring unit**
   Temperature monitoring unit should be micro processor based suitable for temperature monitoring of HV and LV windings of transformers. The relay should have digital display showing measured temperature supported by interface software.

   **Input**
   1. RTD inputs for three wire probes type 3 Nos. for LV windings.
   2. Input channels must be protected against electromagnetic noise and spikes.

   **Output**
   1. Two Alarm relays (Alarm + trip)
   2. 1 Alarm relay for sensor or internal fault
   3. Output contacts capacity : 5A

   **Displaying and data management**
   1. 2 Display for displaying measured and set temperatures
   2. LEDs indicating reference channel
   3. Signal LEDs for Alarm
   4. Signal LED for trip
6. Alarm and trip levels programmable.
7. Three or four input selectable
8. Displaying of the channels at highest temperature
9. Maximum temperature and Alarm storage

8) General Characteristics

Accuracy : +1% full scale + 1 digit
Humidity : 90% non condensing

Self diagnostic circuit
Auxiliary power supply : 240 V AC
Frequency : 50 Hz
Burden : 5 VA

Type and Routine Tests
The Transformer shall be completely assembled and tested at the factory. If the Owner/Consultant selects to have a representative, all tests shall be witnessed by them. Tests shall be performed in compliance with latest IEC/ IS standards

9) Design Requirements

A. Specifications
1. Specification to be complied with : IEC 60726 / IS 11171
2. No. of phases : Three
3. Frequency : 50 Hz
4. Type : Indoor, cast resin, dry type, double wound, copper winding and core type
5. Rated voltage
   a) HV : 11000 volts
   b) LV : 433 volts
6. Vector group : DYN- 11
7. Tap changer : OFF Load Operation
8. Tapping
   a) Range : +5% to -10%
   b) % of steps : 2.5%
9. Winding connection
   a) HT : Delta
   b) LT : Star
11. Neutral terminals : Two, one brought out for earthing
12. Body earthing terminals : Two
13. Winding temperature class : F, 155°C
14. Noise level dBA (1m dist.) : 50
B. **Following accessories and fittings shall be provided**
   1. Rating and Diagram plate
   2. Earthing terminals 2 Nos.
   3. Lifting lugs - 2 Nos.
   4. Heat sensor with relay and alarm contacts
   5. Under base skids with bi-directional flat tread rollers.
   6. Jack lugs
   7. Suitable for both Busbar and Cable terminations on both sides.
   8. Additional neutral bushing
   9. Any other protective device stipulated by statutory authorities.
   10. Tripping by trip contacts of temperature indicating relay (note that relay shall trip LV main breaker first and then shall trip VCB immediately afterward).
   11. CTs for protection.

10) **Reference standards**
   1. The manufacture and testing at various stages should be strictly conform to IS:2026/1977 or latest IS:11171 (Specification for Dry-Type Transformers).
   2. The transformer shall be in compliance with the following standards:
      IEC 76-1 to 76-5 & IEC 726:1982
   3. Terminal arrangements : IS:3347 & IS:2099 Bushings for alternating voltages above 1 000 Volts / Busbars
   4. Impulse voltage level : VDE0532

11) **Testing**
   Minimum acceptable values for each test should be as per relevant BIS. Winding insulation resistance shall be measured from primary and secondary to ground and between primary and secondary. Test the operation of the tap changer, if any. Measure primary and secondary voltage ratios are as per name plates. Check the polarity of terminals and the phases sequence.

   Minimum following tests shall be conducted as per IS standards, and test reports submitted.

   1. Winding resistance.
   2. Short Circuit Test.
   3. Open circuit test.
   4. Induced over voltage test.
   5. Separate source voltage test.
   6. Insulation resistance test.
   7. Turn ratio test.

   (Test report shall be jointly signed by the Owner/Consultant/ Consultant and the Contractor).
3.0 DIESEL GENERATING SETS & ANCILLARIES

1. Scope
The scope of these specifications covers the supply, installation, testing and commissioning of 415 volts, 3ph, 4 wire diesel alternator set of rating as specified and given in Bill of Quantity. The synchronous speed of the set shall not be more than 1500 RPM.

It shall be common bed plate mounted and complete in all respect including the ancillary equipment such as batteries, auxiliary lube oil pumps, filters, exhaust piping oil storage tank etc. including piping required for interconnection between the set and the diesel tank which are mounted separately. The set shall be mounted in a sound proof enclosure.

Rating of the diesel alternator shall be based on the operation of the set when equipped with all necessary operating accessories. The complete set shall be capable of producing specified output continuously at the climatic conditions mentioned below.

Design of the equipment should take these conditions into account. The equipment shall be given tropical and anticorrosion treatment.

3. Diesel Engine

a) Construction
Engine shall be of robust construction suitable for continuous operation. Bearing housings shall be sealed against ingress of dirt and loss of lubrication. The diesel engine shall be four stroke, multi-cylinder type but not less than four cylinders. The engine should have over load capacity of 10% for 1 hour in any 12 continuous hours operation.

b) Material
The selection of suitable material shall be the responsibility of the contractor in accordance with accepted practices. Full details of the material of construction for major components shall be included in the offer.

c) Dynamic characteristics
An analysis be made of engine, couplings and driver/driven unit to ensure that complete installation starts, operates and stops free of vibrations and oscillations as per normal industrial standards. The Contractor shall provide calculations, etc. as evidence to support that such as analysis has been made.
d) Filters
The following filters shall be used.

i) Air - Paper type air filters for direct mounting on the engine air manifold.
ii) Fuel - Duplex fuel oil filters
iii) Lubricating oil - Simplex lube oil filters.

e) Flywheel
Flywheels shall be designed and manufactured to meet cyclic variation levels.

f) Governor
Governor should be Electronic type. Governor should maintain the speed within 1/8 cycles minimum, of 50 cycles from no load to full load generator output. The frequency at any constant load, including no-load, shall remain within a steady state bandwidth of rated frequency. The governor shall not permit frequency modulation to exceed one cycle per second.

g) Fuel System
Fuel system shall have gravity feed to engine driven fuel pump and a replaceable element fuel filter conveniently located for servicing. Contractor shall provide fuel oil tank of specified capacity with supports, gauge and connecting piping upto fuel oil pump suction header. The fuel tank should be of floor mounted type fabricated out of 3mm thick MS sheet steel painted and with standard accessories like fuel level indicator, fuel inlet and outlet air vent, drain plug inlet arrangement for direct filling and set of braided fuel hoses.

h) Lubricating oil
All lubricating points of the engine shall be connected to pressure oil system. The system shall be so designed that when the engine starts after prolonged shutdown, lubrication failure does not occur. Oil drippings from lubricating points shall have connections to the oil sump and get recirculated. Full flow strainer shall be fitted with level gauges for visual observation. Contractor shall provide motor driven lube oil pump to keep the bearings primed. Its power consumption to be indicated. The frequency and duration of the pump operation to be specified.

i) Starting System
Engine shall be started by D.C. starting motor engaging on the toothed ring of the flywheel.

j) Ladders and Platforms
Necessary platforms and railings shall be provided by the contractor around the engine if required.
k) Installation and Silencer
The foundation drawing of the D.G. Set shall be provided by the Contractor, and it is the responsibility of the contractor to provide all drawings, design calculations, etc. well in advance as per the manufacturer’s specifications and meeting statutory standards and requirements. Contractor shall provide skid mounting with common base plate and all mounting structure, shims, etc., for the diesel alternator set. Contractor has to mount the engine with alternator on the base plate and align and assemble the set. Suitable anti-vibration mountings as approved for the complete set shall be provided. Coupling (both halves) with guards shall be provided. Contractor shall provide insulated exhaust piping with Aluminium cladding for each set and there should be hood on top of the exhaust pipe and the work should be as per pollution Control specification.

l) Insulation of the exhaust pipe shall be carried out as follows.
   i) Surface shall be thoroughly cleaned with wire brush and rendered free from all foreign matter and grease.
   ii) 75 mm thick insulation fixed tightly to the surfaces butting all joints and tightened with lacing wire. (Type of insulation to be got approved by the Engineer-in-charge).
   iii) Insulation to be wrapped with aluminium sheet 26 gauge and joints overlapped and sealed with adhesive tape and in addition fixed with cadmium coated steel screws.

m) Instrumentation & Controls
Instrumentation shall be housed in the control panel of the DG set.

Following instruments shall be provided:
   i) Cooling water/ coolant temp. indicator (deg.C)
   ii) Lubricating oil temperature indicator (deg.C)
   iii) Lubricating oil pressure gauge (psig).
   iv) Tachometer
   v) Engine run hour and RPM meter
   vi) Engine over speed indicator (alarm & light)
   vii) Cooling water/ coolant temperature high (alarm & light)
   viii) Low lube oil pressure (alarm & light)
   ix) Engine start – stop control switch with keys
   x) Battery voltage indicator

Multifunction Electronic/ digital meters indicating the above parameters shall also be acceptable.

n) Controls
Following protective devices and equipment shall be provided for the engine protection
   i. Electronic over speed governor and shutdown device, visual and audible alarms and associated devices shall be provided to stop the engine in the event of any of these faults.
ii. Low lubricating oil pressure.
iii. Excessive cooling water/coolant temperature.
iv. Overspeed.

4. Alternator

a) Standards
Alternator shall be in accordance with the relevant Bureau of Indian Standards prevailing on date (IS 4722) with up-to-date amendments.

b) Type
The machine will be of rotating field stationary armature type, brushless, self-excited, and self regulated air cooled with IP classification 21. The excitation supply shall be obtained from a shaft mounted exciter, an A.C. generator, supplying the field winding through shaft mounted rectifier from the alternator terminals.

c) Rating
Specified ratings at 0.8 P.F. 415 V, 3 phase, 4 wire, 50 Hz, star-connected, solidly grounded neutral system under site conditions of ambient temperature and altitude.

d) Performance
The voltage regulation from no load to rated full load shall be within a band +1 to -1% of rated voltage. Steady state voltage modulation shall not exceed one cycle per second. For any addition of load up to and including 90% of rated load, the voltage dip shall not exceed 10% of rated voltage. The voltage shall recover to and remain in the steady band in not more than 1.5 seconds. The frequency regulation from no load to rated load shall be in accordance with that defined by the engine governor performance. For any addition of load up to 90% of rated load, the frequency shall recover to the steady state frequency band within 5 seconds. (the prime mover shall have an overload capacity of 110% for one hour in 12 hours operation).

e) Enclosure
Alternator stator enclosure shall preferably be totally enclosed fan cooled (IP 21). However, if this is not feasible, a screen protected drip proof (SPDP) enclosure may be accepted, provided special treatment is given to winding, such as double impregnation of windings. The stator frame shall be either of cast iron or of fabricated steel construction.

f) Terminal Boxes
The main terminal box for alternator output terminals shall be suited for termination and connection of aluminium conductor armoured cable. A control terminal box shall be provided on the base frame. All wirings from electrical/instrumentation equipment or devices on the engine alternator shall be brought up to this terminal box from where external wiring to other equipment shall be carried out. The terminal box should be suitable for termination of 1.1kV grade XLPE cables.
g) Earth Terminals
Two number 12 mm dia earth terminals to be provided on opposite sides of the alternator, complete with all hardware, including plain and spring washer for secure, vibration-proof connections; all hardware to be galvanised or plated and passivated.

h) Voltage Regulations
Contractor shall submit in his quotation the momentary voltage dips and period required for voltage to recover its normal value corresponding to loading performance of the set.

i) Winding
The alternator winding shall be of Copper and render them non-hygroscopic and resistant to acidic/alkaline vapours. Class ‘F or H’ insulation shall be used for stator and rotor winding.

j) Space Heaters
Anti-condensation space heaters shall be provided to maintain winding temperature 5 Deg. above ambient temperature. The heaters shall be suitable for operation on 240 V, 1 Phase, 50 Hz., A.C. Supply, Heater terminals shall be brought out to a separate terminal box. A caution name plate ‘Caution Live Terminals - Isolate Supply Elsewhere Before Disconnecting’ shall be affixed on the terminal box. The space heaters shall be of metal encased and low surface temperature type.

k) Base Frame
Engine and Alternator shall be coupled and mounted on a sturdy, fabricated, welded construction; channel iron base frame with coupling guard and anti vibration pads.

5. Tools & Tackles
A set of tools and tackles required for maintenance shall be supplied with DG set free of cost as part of equipment. This shall include box spanner, double end spanners & feeler gauge. A set of commissioning and operating instructions shall also be provided with DG set.

6. Inspection & Testing
Following tests shall be carried out the site in the presence of Owner’s and Manufacturer’s representatives.

The unit shall be visually inspected for any transit damage. All material / equipments offered / to be supplied shall be Type / Routine tested as per relevant IS / BS standard prior to assembly / dispatch. For carrying out tests on various equipments, Owner may depute his representative or appoint third party, to inspect any / or all major equipments / assembly requiring inspection at manufacturer’s works. The contractor shall intimate the date of testing of equipments at the manufacturer’s works before conducting the tests. The contractor shall give sufficient advance notice regarding the dates proposed for such test. The Owner / agency at his discretion may witness such testing. The contractor shall have to submit all the original
Engine
During the engine test, the following shall be noted & recorded:
   a. Load
   b. Speed
   c. Fuel consumption
   d. Lub-oil consumption
   e. Operating temperatures for fuel, lub. oil, coolant, exhaust gas etc.
   f. Checks for correct functioning of governors & over speed devices.
   g. Checks for protection & warming devices.
   h. Checks for automatic operation of temperature & pressure controls on engine.
   i. Functioning of governors.

Alternator
Alternators shall be tested at manufacturer’s works or at site as per IS:4722 or any other acceptable standards. During testing of alternators following shall be tested & noted:
   a. Residual voltage measurement.
   b. Voltage symmetry.
   c. Phase sequence test.
   d. Load characteristics.
   e. Set point potentiometer range / voltage adjustment range.
   f. Voltage regulator:
      (1) Voltage regulator adjustment.
      (2) Under speed protection adjustment.
      (3) Parallel operation adjustment.
   g. Short time overload.
   h. Winding test.
   i. Over speed test at 120% of rated speed.
   j. Type tests conducted
   k. Measurement of resistance
   l. Phase sequence test
   m. Regulation test
   n. Measurement of leakage reactance & reactance
   o. Measurement of open circuit characteristic
   p. Measurement of short circuit characteristic
   q. Efficiency test
   r. Temperature rise test
   s. Occasional excess current test
   t. Over speed test
   u. Insulation resistance test (both before & after high voltage test)
   v. High voltage test
   w. Determination of deviation of voltage waveform sinusoidal
x. Measurement of bearing current
y. Short circuit withstand test & measurement of reactance & time constants
z. Pressure test on coolers for closed circuit cooling
aa. Routine tests conducted.
bb. Measurement of resistance
c.c. Insulation resistance test
dd. Dielectric test
e.e. Unbalanced currents of alternator

Control panel & other panels
Following tests shall be conducted on control panel and other panels :-
a. Visual checks:
   (1) Layout of the equipment & BOM check & dimensional checks.
   (2) Clearance & creepage distance between bus bars, risers & also between bus bar, risers & earth.
   (3) Effectiveness of interlocks, locks etc.
   (4) Adequate contact of connections.
   (5) Identification of various individual circuits & their protective circuits, with regard to wiring diagrams, technical data etc.
b. Continuity test (For small wiring).
A point to point check shall be made to ensure the compliance of complete wiring as per the approved electrical schematic diagram.
c. Operational test
d. Testing of relays, meters, lamps etc.
e. Control wiring : Between all wiring terminals connected together & earth. For auxiliary equipment offered / used, such as valves / pumps/ fans, etc. for manufacturing / erection of DG set by the DG contractor, the manufacturer's test certificate will be acceptable. However the same are also type / routine tested as applicable & specified below.
f. Functioning of protection & warning devices.
g. Functioning of controls on engine and alternator.
h. Functional tests on engine control panel.
i. Functions of auxiliary systems like fans, pumps, space heater, etc.
j. Test for calculation of time for transfer of load from mains to DG set.
k. Time calculation for monitoring the resumed mains supply & transferring the load to mains.
l. Power quality monitoring & transfer of load to DG set on poor power quality.
4.0 Battery & Battery Charger

1) Functional Requirements
   The batteries shall provide DC voltage for operating the protection relays, HT equipment, remote position control of breakers, remote indication, signaling, interlocking and providing emergency supply to be installed in a suitable sheet steel enclosure. The battery charger is intend to charge the batteries and keep them in full charge.

2) Design Requirements
   **Batteries**
   Batteries should give a continuous output and should be connected in such a way as to give an output as specified in the BOQ.

   **Battery Charger**
   The type of Charger to be supplied shall be float-cum-boost type. Under normal conditions the battery shall be on float charge. The boost charger shall be capable to charge fully the discharged battery within 6 hours. The maximum output capacity shall not be less than 15A. The ripple content should be limited to 5%. The tap range for the primary of the charger transformer shall be +10% in steps of 2.5% and off load tap changing switch shall be provided for this purpose. Semiconductor fuses shall be provided in each arm of the converter. Line surge suppressor shall also be provided. Automatic voltage regulator shall have a current limiting feature to avoid blowing of fuse of semiconductor for current in rush at the time of charging. DC Ammeter and voltmeter should be provided to indicate the charging current and voltage. Indication lamps may be provided to indicate Mains ON. The supply should be complete with required length of battery chord with clamps suitably marked +ve and -ve.

   The service rectifier should be suitable for 3 phase AC 415 Volts (+5%) for feeding a DC continuous loading at maximum ambient temperature of 50°C DC output should be stabilised at 24 V. Ripple factor not to exceed 3%.

   **Trickle Charger:** This shall be suitable for working on 240 V, AC supply to float batteries, capable of supplying trickle charging current up to 1 A. DC output voltage will be stabilised at 28.8 Volts +12%, ripple not to exceed 5%.

   The DC Supply Panel Cubicle: This should be made from sheet steel of 14G which is duly treated and painted with chlorinated rubber paint of light grey shade. Louvers will be provided for ventilation and wire mesh jelly to make the panel vermin proof. Input and output terminals will be provided at the suitable place.
Alarm/annunciation will be provided for AC mains failure, service rectifier AC & DC fuse blown, trickle charger AC-DC fuse blown, boost charger AC fuse blown, service rectifier charger filter condenser fuse blown, service rectifier DC under voltage and over voltage, battery earth fault, battery under voltage etc. The battery charger shall have automatic output current limiting feature.

3) Components
The battery charger shall essentially comprise of the following.
   a) 1 No. double pole ON/OFF MCB at AC input.
   b) 1 No. pilot lamp to indicate charger ON.
   c) 1 No. Main Transformer: Double wound, naturally air cooled, copper winding.
   d) 1 set single phase full wave bridge rectifier consisting of 2 Nos. diodes and 2 Nos. SCRs, liberally rated, mounted on heat sinks and complete with resistor / condenser network for surge suppression.
   e) 1 No. rotary switch to select auto float / manual float / manual boost. During auto float mode automatic changeover shall take place from float mode to boost mode and vice versa.
   f) 1 set solid state constant potential controller to stabilize the DC output voltage of the float cum boost charger at ±2% of time set value for AC input voltage variation of 230 V ± 10%, frequency variation of ±5% from 50 Hz and simultaneous load variation of 0-100% and also complete with Current Limiting Circuit to drop the Float Charger output voltage upon overloads to enable the battery to take over.
   g) 1 No. electronic controller to automatically changeover battery charging from boost to float and vice versa.
   h) 1 No. DC ammeter and toggle switch to read charger output current and battery charge / discharge current.
   i) 1 No. moving coil DC voltmeter to read the DC output voltage.
   j) 2 set potentiometer to adjust the output voltage during manual /auto float and boost modes.
   k) 1 No. double pole ON/OFF MCB for Charger Output (24 V DC Rating).
   l) 2 set DC output terminals. 1 set for the load and the other set for the battery.

4) Alarm Annunciation
Visual and audible alarm with manual accept reset facility shall be provided for the following:
   a. AC mains fail
   b. Charger Fail
   c. Load / Output over volt.
5.0 SWITCH GEARS AND PANEL BOARDS

1. Scope
   The following specifications covers the general requirements for Design, Fabrication and Testing and Commissioning of medium Voltage switch boards.

2. Regulations
   The Switchboards to be supplied shall fully comply with the requirements laid down in the following rules and regulations as amended up-to-date.
   Indian Factories Act, Standards of Local Statutory bodies, Indian Electricity Rules, including special requirements of Electrical Inspectorate and the detailed specification mentioned below.

3. Standards
   Requirements laid down in the IS: 13947 (LV Switchgear and control gear) and other relevant Indian Standard shall be strictly adhered to.

4. Service and supply conditions
   The switch boards shall be designed to operate satisfactorily under service and supply conditions specified.

5. Construction
   The type of design and construction shall be single front / double front, floor mounting, wall mounting, fixed type or draw out type as specified. Protection provided to the enclosures shall conform to IS: 8623. The design of the switchboards shall be compact. However, it shall have ample space for the termination and support of cables and any maintenance work required on the switchboards. The design shall be such as to allow for extension at both the ends, if specified. The enclosure shall be in CRCA sheet of 14G thickness. All doors shall be hinged at one side with knobs for opening and closing and shall be bolted on the other three sides for single front switchboards. All hinges shall be of concealed design for elegant appearance. Adequate lifting facilities shall be provided on each section. Lifting eyes may be of removable / foldable design. The switch board shall be totally enclosed, dust, weather and vermin proof gasket of durable material shall be provided for doors and other openings. All hardware shall be corrosion resistant. All joints and connections shall be made out of galvanized zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers secured against loosening.

6. Drawout construction
   Wherever Fully Draw out type construction of switch board is specified it must be possible to drawout the incoming and outgoing feeders using special tools, without disconnecting any cables or busbar connections. The drawout modules should have distinct Service, Test and Isolated positions. In SERVICE position both power and control contacts shall be connected and it shall be possible to open and close the switch / breaker. In TEST position both power
contacts shall be isolated and control contacts shall be connected so that it should be possible to test the control circuitry whereas power is isolated. In ISOLATED position both power and control contacts shall be isolated. The drawout contacts should have adequate current carrying capacity and cross sectional area and shall also withstand the specified fault conditions of the switchboard without deterioration.

7. Busbars

The arrangement of bus bars shall be as per IS: 375. Bus bars shall be of uniform cross section and of high conductivity wrought Aluminium, Aluminium alloy or hard drawn copper as specified and shall be suitably sized for the service conditions. The horizontal and vertical bus bars shall be designed to withstand the same fault level specified. The Bus bars size shall be so selected that the maximum current density shall not exceed 0.8 Amp/sq.mm for Aluminium and 1.2 Amp/sq.mm for Copper busbars. The Bus bars shall be insulated using color coded heat shrinkable PVC Sleeves of Red colour for R-Phase, Yellow colour for Y-Phase, Blue colour for B-Phase and Black color for Neutral. The Bus bar supports and insulations used in the switchboards shall be made of SMC, DMC or FRP having sufficient mechanical strength, insulation resistance and dielectric strength. Hylam or any such hygroscopic materials are not acceptable. The vertical or dropper (sub-mains) busbars shall have a current carrying capacity of the largest incomer feeder. The busbars and busbar supports shall withstand the maximum dynamic, thermal and magnetic stresses and strains arising due to the maximum short circuit current (kA) corresponding to the fault level (mVA) indicated, without any deformation, deterioration or damage. While designing the busbars, due consideration shall be given for proximity effects, altitude factor, spacing between the insulators, strength of insulators, ambient temperature, strength of fasteners, yield strength of busbars, factors of safety etc. The contractor should furnish the detailed busbar calculation for the selection and arrangements of busbars insulators etc. if specially asked for by the Owner/Consultant at any stage of the construction. The connections of Aluminium bus links with Copper switch and starter terminals shall be specifically treated to avoid bimetallic corrosion. Wherever necessary suitable bimetallic connectors shall be provided.

8. Feeder Arrangement

There should be a barrier provided on all sides for feeders. The design of the switchboards should be such as to attain full compartmentalization for all feeders. Compartment sizes shall be integral multiples of one or two basic module sizes. Indicating lamps, meters and push buttons shall be mounted flush with the front hinged cover. The control components, except those coming on doors, shall be mounted on a common base plate, fixed with the frame of the vertical section. The incoming feeder shall be arranged preferably in the middle of each group of feeders, in such as way that loads are distributed equally on either side. The feeder arrangements shall be such that the operating height of the switch boards lies within 1850mm, but above 300mm from the floor level. The operating handles of switches and the positions of mounting of indicating meters shall be within the above specified levels. Each feeder shall be provided with name plates to represent feeder designation as per single line diagram. The labels shall be of white acrylic unbreakable sheets with 20mm size letters engraved in black color.
9. **Cable Compartments**
Cable compartments/ cable alleys shall be provided for easy termination of all incoming and outgoing cables. Adequate supports and facilities for clamping shall be provided for cables, wherever necessary. A horizontal wire-way, extending the entire length, shall be provided at the top/bottom for inter panel wiring. Removable gland plates, having a minimum thickness of 2mm shall be provided at cable entry side of the switchboards. Necessary holes shall be drilled on the gland plate in the manufacture’s work shop itself. Metallic knockouts /plugs of PVC or Rubber shall be provided for the gland holes. Cable glands shall be supplied loose along with the switch boards for fixing them at site.

10. **Cable termination**
All termination blocks shall be 650 V grade and have adequate current carrying capacity and shall conform to IS: 4237. Terminals should be compact, having high dielectric strength so as to prevent flash-over, and have thermal strength to prevent deterioration. All terminal shall be mounted on rails, with provision for addition of terminals. Identification numbering/lettering shall be provided for each terminal. Facilities shall be available for temporary or permanent short circuiting of terminals for earthing and testing.

11. **Wiring**
The switch board shall be completely pre-wired and ready for external connection at site. All control wiring shall be carried out through wire ways and these shall not cross the busbar chamber. All control wiring shall be easily accessible for maintenance. Power wiring shall be carried out with PVC insulated standard copper conductor of 650 Volt grade having adequate current carrying capacity. Ferrules shall be given to all wires and necessary color codes shall be adopted for power and control wiring for easy identification. Control wiring shall be single / multi core, PVC insulated flexible stranded copper conductor of 2.5 sq.mm cross section for current and relay circuits, and 1.5 sq.mm for potential circuits. Each control wire shall be identified at both ends with wire designation by means of unbreakable ferrules, in accordance with IS: 375. Control wiring wherever terminated shall be in single layer formation. Not more than two wires shall be in single layer formation. Double layer wiring shall never be adopted. Not more than two wires shall be connected to the terminal. Wherever ON/OFF controls, ON/OFF indications, interlocks etc. are proposed in remote control panel, terminals for the necessary wiring shall be brought from the individual outlets and be terminated at a common place near the bottom of each section for external connections. Gland plates with knockouts suitable for the multi core cables of sizes specified, shall be fixed adjacent to these group of terminals.

12. **Insulation**
All live parts of the switchboards shall be suitably shrouded using insulating materials for the safety of the operating personnel. Shrouding of live parts shall be done using FRP sheets only. All insulating materials shall be non-hygroscopic mould proof and treated with suitable varnishes. Hylam or such hygroscopic materials are not acceptable. Minimum clearance between phases or between connections of same phase separable electrically from each other or
between phases and ground shall be as per IS 4237 for parts of switchgear as well as bus bars. The insulation resistance and the dielectric strength of the Switchboards must be verified and confirmed to safe limits before transportation from the workshop. The insulation resistance if found low will have to be improved by increasing the clearances, using insulating materials and electrical equipments of sufficiently high insulation resistance etc. No additional costs will be permissible on account of this clause.

13. Painting
   All metal sheets shall undergo 7 tank metal treatment, thorough
   ➢ De-rusting.
   ➢ Rinsing.
   ➢ Degreasing.
   ➢ Rinsing.
   ➢ Phosphating.
   ➢ Rinsing and
   ➢ Passivation.

   All metal surfaces shall be thoroughly cleaned and degreased to remove all scales, rust, grease and dirt. Fabricated structures shall be pickled and treated to remove any trace of acid. The enclosure shall be painted with minimum two coats of zinc chromate primer and two coats of paint of approved make. The undersurface shall be made free from all imperfections before undertaking the final coat.

   After preparation of the under surface, the panel shall be spray painted with final two coats of approved enamel paint. Contractor shall obtain details of approved paint from the Engineer-In-Charge before final painting. The finished panels shall be dried in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, run-off paint etc. All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust, corrosion etc. Inside surface shall be painted with anti-corrosive paint if humidity is more than 30%. “Danger Notice” signs conforming to IS:2551 shall be provided conspicuously on all sides of the switchboards.

14. Name Plates
   Name plates for all incoming and outgoing feeders shall be provided on doors for each compartment. Name plates shall be fixed by screws only and not by adhesives. Special danger plates shall be provided as per requirement. Inside the panels, stickers should be provided for all components giving identification no. as per detailed wiring diagram.

15. Air Circuit Breakers (ACB)
   Air Circuit Breakers shall be manufactured as conforming to the relevant IS specifications. Air Circuit Breakers used as incomers shall be drawout type. Fixed Air circuit Breakers shall be used only for outgoing feeders for rating lower than 800A. Drawout type Air Circuit Breakers shall be fitted with an automatic closing type insulating shutter assembly for shrouding live parts while the Air Circuit Breakers is drawn out in position to protect the operating personal from
contact with live parts.

Drawout type Air circuit Breakers shall have Service, Test and Isolated positions. Air Circuit Breakers shall have built in CT Operated Bimetallic overload release and direct operating magnetic Short Circuit Release. Magnetic Short circuit release for Air Circuit breakers shall be interchangeable if so required to have time delayed tripping for grading with other Circuit breakers downstream or upstream. It must be possible to provide any of the following additional standard accessories for Air Circuit Breakers if specified as per the schedule of quantities. Under Voltage Release, Earth Fault Release, Shunt trip Closing release, Auxiliary Contact Block having N/O or N/C contacts. Operations of the Air Circuit breaker shall be using stored-energy operating mechanism by spring charging. The operating mechanism shall be rechargeable when the Air Circuit Breaker is the ON position so that it is possible to execute one OFF and one ON operation without the need to recharge in between. Electrically operated Breakers should have motor operated spring charged stored energy operating mechanism and shall also be provided with a closing release. Mechanically operated Visual indications for the ON, OFF and TRIP positions shall be provided to prevent inadvertent opening of the Air Circuit breaker compartment while the breaker is in ON position.

16. Moulded Case Circuit Breakers (MCCB)
Moulded Case Circuit Breakers shall be manufactured as conforming to IS specifications. Moulded Case Circuit Breakers shall have built in Bimetallic Overload release and magnetic short Circuit Release. It must be possible to provide any of the following additional standard accessories for Moulded Case circuit Breakers if specified as per the schedule of quantities. Under Voltage Release, Earth Fault Release, Shunt trip, Auxiliary Contact Block having N/O or N/C contacts. Visual indications for the ON, OFF and TRIP positions shall be provided for all Moulded Case Circuit Breakers. Moulded Case Circuit Breakers shall be provided with door interlock to prevent inadvertent opening of the breaker compartment while the breaker is in ON position. Operating handle shall be provided for all Moulded Case Circuit Breakers. The On and OFF function of the contacts of the Moulded Case Circuit Breaker shall be independent of the speed of operation of the handle.

17. Load break Switches & Switch Dis-connector Fuse Unit /Fuse Switch units
The Switches and Fuse units (FSUs) shall be Air break, heavy duty, double break motor duty (AC23) and industrial type, conforming to IS 4047, IS 5987 for Switch selection. The Switches and FSUs shall have quick-make, quick-break, fault make, load-break mechanism operated by an external insulated handle, complete with ON-OFF position indicator, dial plates etc. The ON and OFF functions of the contacts of the FSUs and Switches shall be independent of the speed of operation of the handle. The continuous ampere rating of switches shall not be less than continuous maximum rating of the switch inside the starter of that of the back-up fuses. Bolted type removable copper links of adequate size shall be provided for neutral in all incomer feeders and outgoing feeders with TPN switch fuse units or TPN Breaker units. Four Pole switchgears need not have removable copper links. Tinned copper switch links of adequate current carrying capacity of not less than that of the switch rating should be provided for all switches wherever required even if not specifically mentioned. The cubicle door be interlocked
(Door interlock) with the switch mechanism so that the door cannot be opened unless the switch is in OFF position. It must be possible to padlock the incomer feeder switch mechanism in the OFF position. In the event of an independent control circuit supply to the coils of the contactors, the main switch shall be provided with necessary inherent auxiliary contacts or isolation arrangement to disconnect this control supply as well, when the switch is turned to OFF position. Castle key type mechanism of mechanical interlock shall be provided between incomer switches to prevent paralleling, if so specified. Designation plates shall be provided for all switches.

18. Fuses
All fuses shall be HRC link type and shall conform to IS: 2208. Selection of fuses for motor feeders shall be as per IS 900. All power and control fuses shall be provided with distinct type operation indicators to show whether they have operated or not. For all fuses provided in the fuse holders, necessary viewing aperture shall be provided on the fuse holder for locating the blow-out fuses. Fuse holders and fuse bases shall be made of unbreakable noninflammable and non-hygroscopic material, preferably of phenolic mouldings. Set of fuse pullers required for inserting and removing HRC fuses shall be supplied for each switchboard free of cost.

19. Protective Relays
Relays shall conform to IS: 3842. Relays shall be flush mounted draw out type, and of a type and manufacture approved by the Owner/Consultant. All relays shall have reset type flag indicators and initiating contacts. Flag indicators shall be visible from front side of the panel. Protective relays shall be selected as suitable for the CTs secondary current rating, fault level at the installation, type of application etc. Test terminals blocks shall be provided for all relays if specifically indicated in the data sheet or schedule of quantities. All IDMT relays shall be rated to operate at a maximum time of 1.3sec with the time multiplier set at 1 with 10 times the rated setting current flowing through the CT secondary.

20. Current transformers
Current Transformers shall conform to IS: 2705 and IS: 4201. Current Transformers shall fully withstand the effects of maximum possible short circuit current at their primary for a minimum time of 1 second. The requirements of CT's for Ammeters, Energy meters, watt meters, Power factor meters and protective relays shall be in correlation to each other. Current Transformers shall be provided with polarity marking adjacent to terminals both for primary and secondary and these shall be legible. CTs shall be of 660 V grade with Class' B' insulation having a minimum of 1 Ampere rating at the secondary side. Burden of these CTs shall be a minimum of 5VA rating at the secondary side. The approximate length of Cables and Burden of remote ammeters shall be obtained form Owner/Consultant before finalizing the CT capacity. If the same CT is used for local and remote Ammeters, necessary shorting links shall be supplied. Separate CTs shall be used for metering purpose and shall have adequate capacity to cater to 130% of full load current. Metering CTs shall have instrument Security factor less than 5 and shall have an accuracy Class of 1 or as specified by the Electrical Inspectorate. Current transformers for protection purposes shall have sufficient accuracy, burden and accuracy limit factor for necessary relay co-ordination /discrimination for clearing faults. Accuracy limit factor...
for protection shall not be less than 10 and accuracy class shall be 5P.

21. Control voltage transformers

Control voltage transformers shall be provided on each bus section or each module as specified, wherever control voltage specified is different from the main voltage. Plus or minus 5% voltage tapping shall be available for control Transformers. It shall be supplied complete with isolators and protective fuses for primary and secondary sides. One of the secondary terminals shall be earthed. The transformer shall preferably be air insulated and air cooled. Where control transformers are provided in each bus-section, they shall have adequate capacity to feed all contactors coils (including those of spare panels) of a particular bus section and anyone of the adjacent bus sections also. i.e. in the event of failure of the control transformer of one bus section, control transformer feeding anyone of its adjacent bus sections shall have the capacity to feed this section also, in addition to its own section. Where control transformers are provided in each module, they shall have the capacity to feed the contacter coil and instruments in that module. It shall be possible to inter-connect the control transformers are provided bus section wise. Terminals shall be available side by side for temporary interconnection whenever one control voltage transformer fails. Where control transformers are provided bus section wise, the compartment housing the control transformer shall preferably be located towards the bottom of the switchboard, to facilitate maintenance and replacement.

22. Indicating instruments

Ammeters, Voltmeters. Frequency meters, Energy/ KW /PF meters etc. wherever specified in data sheet shall be supplied and mounted flush, 96x96 size, with the hinged cover of the panel. All meters shall be of reputed make and shall conform to relevant standards (IS: 2419, 722). Ammeters shall be of Direct/CT reading type Analogue AC of 90 deg deflection scale. Voltmeter shall be of AC Analogue of 90 deg deflection scale. A moving iron voltmeter having a range of 0-500 Volts AC shall be provided, along with a suitable selector switch, to read all line-to-line voltage on the incoming side of feeders. The selector switches shall have 3 way and OFF positions. Necessary facia plates to denote switch positions shall be provided. Necessary control fuses shall be provided in the voltmeter circuit. Voltmeter shall be of industrial Grade ‘B’ accuracy as per IS: 1248, and shall have suppressed scale for the lower values in the range. Ammeter having suitable range shall be provided, along with ammeter selector switch to read line currents for the incomer feeders. The selector switches shall have 3 way and off position. Necessary facia plates to denote switch positions shall be provided. These ammeter shall have uniform scale up to about full load current and suppressed end scale at least for 150% full load. Ammeter if provided for motor feeders shall have suppressed overload range (cramped end scale) to read the starting current of 600 -800% and 200-400% of normal full load current of motors for DOL starting or star-delta starting respectively. A red mark shall be provided on the ammeter dial corresponding to the full load current of the motor. Cushion stoppers and zero correction screws shall be provided for all meters. All ammeters shall be operated through current transformers and not directly connected. Calibration of the ammeters shall tally with the ratio of the current transformers. Ammeters shall be of Class -1 accuracy as per IS: 1248 and as specified by the Electrical Inspectorate. Energy meter, kilowatt meter and power factor meter if provided as per data sheet shall be operated through current transformer only. The rating
shall correspond to full load requirements. The multiplication factor of Energy meters shall be furnished and exhibited by the side of the meter. All meters shall be square type, as per the size indicated.

23. **Push buttons and switches**
Colour of push buttons shall be Red color for Off / Open Trip, green for On/Close, and Black color for Reset. All stop push buttons shall have 2N/C contacts and for Start push buttons, it shall have 2 N/O contacts in the case of contactor circuits. Wherever breakers are specified push buttons shall have 2 N/O contacts. All push buttons shall be provided with NO/NC contacts wherever starting is envisaged from more than one locations.

24. **Indication lamps**
All indicating lamps shall conform to IS: 1901. All lamps shall be rated for a maximum 10 watts and shall have series resistors.

25. **Space heaters**
Space heaters /anti condensation heaters shall be provided. Necessary ON/OFF isolators and HRC protection fuses (or MCB's) shall be provided for each space heater. For double front switchboards, space heaters if specified shall be provided on both the fronts.

26. **Control/Selector switches**
All control switches shall conform to IS 6875 Part 1 & II. Ammeter selection switches shall be so designed as to prevent open circuiting of the CT secondary Terminals while the different positions are being selected. Minimum rating of the Voltmeter and ammeter selection switch shall be 10Amps. All selector switches shall be rotary cam operated type. The rating, type and contact arrangement of the rotary switches shall be as per requirement. They shall also have proper designation plates. The operating handle of these switches shall be knob type and of black colour. All facia plates of selector switches shall be of black anodized Aluminium with white lettering.

27. **Earthing**
Earthing arrangement shall be in accordance with IS: 3034. A continuous earthing strip of tinned copper conductor as specified shall be provided for the entire length of the switchboard. A minimum of 2 terminals shall be provided on the strip for external connection to the main earth grid. The body of all switches, and breakers shall be earthed in duplicate using copper earthing conductor of the same cross sectional area as that of the main copper earth strip specified. The doors of switchboards shall be earthed using PVC insulated flexible cable with copper conductor.

28. **Special tools**
Necessary tools and tackles required for carrying out routine inspection, maintenance etc. shall be supplied along with the switchboards.
29. **Foundation bolts & base frame**

All the necessary foundation bolts, nuts and base channels shall be supplied along with the switch boards and shall be part of the supply.

30. **Testing and commissioning**

The switchboards shall be despatched only after successfully completing the routine tests as per requirements in the Indian Standards specifications. The following tests in particular shall be conducted satisfactorily by the contractor at his own cost, in the presence of Owner/Consultant. The results of these tests shall be got approved by the Consultant.

1. Dielectric test on main circuit. Power frequency high voltage withstand test of CBs at 28kV AC for 1 min. in trip and close conditions.
2. Dielectric test on auxiliary and contact circuits at 2 kV AC for 1 min.
3. Design, visual, wiring and functional checks.
4. Mechanical operating tests:
   5 Opening & 5 closing operation at 110% of control voltage.
   5 Opening & 5 closing operation at rated voltage.
   5 Opening operations at 70% control voltage.
   5 Opening operation at 85% of control voltage.

5. IR measurement of breaker
   - CB open end
   - R to Y
   - Y to B
   - B to R
   - RYB to E
   
   Busbar
   - R to Y
   - Y to B
   - B to R
   - RYB to E
   
   Breaker close with CT
   - R to Y
   - Y to B
   - B to R
   - RYB to E
   
   EB CT metering
   - RYB to E
31. Performa for Testing of Panel Boards

a) Circuit breaker or Supplier module designation/bus no.
b) Insulation resistance tests (contacts open, breaker racked in position).

a) Between each phase of bus  : Mega ohm
b) Between each phase and earth  : Mega ohm
c) DC and AC control & auxiliary circuits  : Mega ohm
d) Between each phase of CT/PT and CT & PT circuit if any  : Mega ohm
c) CT checks:
i) CT ratio
ii) CT secondary resistance
iii) CT polarity check
d) Check/test all releases/relays.
e) Check mechanical interlocks.
f) Check switchgear/control panel wiring.
g) Check electrical interlocks.
h) Checking of breaker/control circuits for
  i) Closing-local and remote (wherever applicable)
  ii) Tripping-local and remote (wherever applicable)

test reports shall be signed by both Contractor and Owner/Consultant.

32. Functional test

All panels shall be IR Tested phase to phase, and phase to neutral with all switch gear in closed position and IR value shall be as follows.
a. Tester: 1000 V IR Tester.
b. IR value should not be less than 2.5 M ohms between phases.
c. IR value should not be less than 1.5 M ohms between phase and neutral.

All meters and relays shall be calibrated and tested at site by contractor before commissioning through secondary injection tests. Tests shall be carried out in the presence of Consultant/Owner or his authorized representative.

All control/secondary wiring and apparatus connected therewith shall withstand 2000 V for one minute.

No charges on account of tests conducted shall be payable to the contractor by the Owner/Consultant. All the tests shall be conducted in the presence of the representative of the Owner/Consultant and to the entire satisfaction of the Owner/Consultant. If any additional tests are indicated by the Owner/Consultant's representative or if any of the tests results he may think as unsatisfactory shall be done by the contractor without extra charges. On satisfactorily completing the tests, the contractor shall furnish to the statutory bodies and authorities three
sets of test certificates as required. Successful testing of the equipment does not relieve the responsibility of the contractor or manufacturer for the workmanship and material. The instruments used for conducting the tests shall be tested as functioning well by the concerned testing authority (ERT / Electrical Inspectorate, etc.) and shall hold a valid test certificate or stamp showing the serial No. and period of validity of the test result.

The contractor shall perform operating tests on all switchgear and panels to verify operation of switchgear/panels and correctness of interconnection between various items of the equipment. This shall be done by applying normal ac or dc voltage to the circuits and operating the equipment for functional checking of all control circuits, eg. closing, tripping, control interlock, supervision and alarm circuits. All connections in the switchgear shall be tested from point to point for possible grounds or short circuit.

All electrical equipment alarms shall be tested for proper operation by causing alarms to sound under simulated abnormal conditions.

The contractor shall arrange testing and calibration of relays. The testing equipment including primary and secondary injection sets (if required) etc. shall also have to be arranged by the contractor. Payment for above work shall be deemed to have been included in the erection of switch boards/control panels.
6.0 CABLING SYSTEM

1. Scope
The following specifications covers the standard requirement of erection, testing and commissioning of cabling installation as per the drawings, specification and other detail enclosed. Supply of required cables and materials for cabling shall be included under the scope of the contractor, only if specifically indicated in the schedule.

2. Supply of cables
If the supply of cables and cabling materials are included in the scope of the contractor, the cables shall be delivered directly from the manufacture only and factory test certificate in original shall be produced along with the cables. In case the contractor wishes to procure the cables from sources other than the manufactures, prior approval has to be obtained from the Owner/Consultant. The following documents are to be produced for verification.

a. Manufacture's test certificates in original.
b. Delivery Chelan of the original supplier showing the quantity, drum No., batch No, description, date of manufacture etc.

3. Standards and regulations
Cabling installation shall be carried out in accordance with the latest editions of relevant Indian Standards and the installation shall fully comply with the requirements of the Indian Electricity Rules and Regulations and Acts and other statuary regulations that are in force at the place of installation.

4. General
The Armour of the cables shall be effectively earthed at both end terminations through glands for PVC / XLPE cables. Paper insulated cables shall be laid in compliance with latest IS: 1255. As per as possible, joints at intermediate points in the through run of the cable should be avoided. Cables laid in formed trenches or tracks shall be provided with identification tags fixed to them at every 10 meters interval. Whereas cables buried shall be provided with identification tags fixed to them at every three meters interval. The tags shall be made from full hard aluminum discs not less than 3 mm thick and of size 50 mm x 75 mm for all incoming cables to switch boards and proportionally smaller size of tags for all other size of cables. Tags shall have holes on either side for tying around the cable using suitable binding wire. The cable nos. assigned in the cable schedule shall be punched on these tags.

5. Storage of cables
The site chosen for storage of cables shall be well drained and preferably have a concrete surface, which will prevent sinking and flange rot that can cause extreme difficulty in moving the drums.

The drums shall be stored in such a manner that there should be enough space between them.
for sufficient air circulation. It is desirable that the drums are made to stand on battens placed directly under the flanges.

In no case shall the drums be stored “on the flat side”, i.e. with the flanges in the horizontal position. Cables should be protected from direct sunlight.

6. Handling of cables
   a) Before laying cables, these shall be tested for physical damage, continuity absence of cross phasing, insulation resistance to earth and between conductors. Insulation resistance tests shall be carried out with 500 V IR tester for LT cables, and 2000 V IR tester for HT cables.

   b) The cables shall be supplied at site, wound on wooden drum as far as possible. For smaller length and sizes, cables in properly coiled form can be accepted. The cables shall be laid by mounting the drum of the cable on drum carriage. Where the carriage is not available, the drum shall be mounted on a properly supported axle, and the cable laid out from the top of the drum. In no case the cable will be rolled on, as it produces kinks which may damage the conductor.

   c) Sharp bending and kinking of cables shall be avoided. The bending radius for PVC insulated and sheath armoured cable shall not be less than 12 D for upto 1.1 kV, and above 1.1 upto 11kV 15D, where ‘D’ is overall diameter of the cable.

   d) While drawing cables through GI pipes, conduits, RCC pipe, ensure that size of pipe is such that, after drawing cables, 40% area is free. After drawing cable, the end of pipe shall be sealed with cotton/bituminous compound.

   e) High voltage (11 kV and above), medium voltage (230 V and above) and other control cables shall be separated from each other by adequate spacing or running through independent pipes/trays.

   f) Armoured cables shall never be concealed in walls/floors / roads without GI pipes, conduits RCC pipes.

   g) Joints in the cable throughout its length of laying shall be avoided as far as possible and if unavoidable, prior approval of site engineer shall be taken. If allowed, proper straight through epoxy resin type joint shall be made, without any additional cost.

   h) A minimum loop of 3 M shall be provided on both ends of the cable, or after every 50 M of unjointed length of cable and on both ends of straight through cable joint. This additional length shall be used for fresh termination in future. Cable for this loop shall be paid for supply and laying.

   i) Cable shall be neatly arranged in the trenches/trays in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of
cables within the trenches/trays shall be the responsibility of the Contractor.

j) All cable routes shall be carefully measured and cable cut to the required lengths and undue wastage of cables to be avoided. The routes indicated in the drawings is indicative only and the same may be rechecked with the Engineer-in-charge before cutting of cables. While selecting cable routes, interference with structures, foundations, pipe line, future expansion of buildings, etc. should be avoided.

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

l) Wherever cable rises from underground/concrete trenches to motors/switchgears/push buttons, these shall be taken in GI pipes of suitable size, for mechanical protection upto 300 mm distance of concerned cable gland or as instructed by the Engineer-in-charge.

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

7. Laying of cables
Cables shall be cut to required lengths only after assessment of correct lengths required by actual measurement at site. The contractor shall ensure that wastage of cables as short length is minimized by resorting to most economical cable-cutting schedules. Wastage of cables in any case should not more than (1/2) half percent of the length of that cable. Excess length or loop after glanding is not permitted. The cables shall be arranged on trays / racks / arms / risers etc. as per cable layout and cable rack layout drawings.

8. Clamping of Cables
Power and control cables shall be properly segregated and clamped. Power cables (except larger than 400Sq.mm ) can be laid touching. A clearance of 70mm shall be maintained between two adjacent 400Sq.mm cables on racks / risers. Common clamping can be done for a bunch of control cables or cables of lower size. Cables shall be clamped at every 900mm on the horizontal racks in the cable trenches and at 900mm on the overheads racks and 600mm on risers / bends at a tap off points and vertical racks etc. Cables leading to cable box of an equipment shall be supported at a distance of 450mm from cable gland/cable box. Cable shall be clamped only after the cables are neatly arranged, dressed, tailored and kept in position. Clamps shall be used for fixing of cable on the racks and its shall follow the profile of the cable. Type of cable clamps, fixing boards, nuts, washers, and materials of cable clamps shall be as specified for cabling.
Spacing of cable support for self supported cables on wall, ceiling or trenches shall be as follows:

<table>
<thead>
<tr>
<th></th>
<th>Horizontal run</th>
<th>Vertical run</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 10 sq.mm</td>
<td>350 mm</td>
<td>450 mm</td>
</tr>
<tr>
<td>16 to 95 sq.mm</td>
<td>450 mm</td>
<td>500 mm</td>
</tr>
<tr>
<td>120 to 400 sq.mm</td>
<td>700 mm</td>
<td>900 mm</td>
</tr>
</tbody>
</table>

a) Cables shall be fixed in cable trays in single tier formation and cables shall be clamped with aluminium flat clamps and galvanised bolts/unit.
b) Earthing flat/wire can also be laid in cable tray along with cables.
c) After laying of cables minimum 20% area shall be spare.

9. **Cables directly buried in ground**
LT cables shall be laid directly in ground atleast 750mm, and HT cables 1000mm below ground. Suitable trenches shall be excavated in the ground to the required sizes. Cables shall be laid in the excavated trench on the sand bed. After laying cables as per power or earthing layout drawings, the excavated trenches shall be back filled with layers of sand, well burnt bricks and riddled soil respectively. A clearance equal to the diameter of the largest cable shall be maintained between two adjacent power cables buried under ground. There shall not be any cross-over of cables when the laid in the ground. Inspection chambers constructed from bricks and masonry complete with RCC slab cover shall be provided at all cable joints in the through-run of the buried trench. Joined cable shall be looped in the inspection chamber to provide extra length of cable for purpose of re-termination in case earlier one fails. Necessary cable marker plates shall be fixed at every 10 meters interval and at all bends along the root of buried cable trenches at central line of the trench. Voltage rating of the cables shall be engraved on the marker plates.

10. **Laying of Cables under Floors**
   a) GI class B pipe shall be used for laying of outgoing cables from distribution boards to various equipment. Preferably one cable shall be drawn through one pipe. Size of pipe shall be such that after drawing of cable 40% area is free. If length of pipe is more than 30 M, free area may be increased to 50%.
   b) Use of elbows is not allowed at all and number of bends shall be kept minimum. Instead of using bends with sockets, pipe bending machine shall be used for making long smooth bends at site.
   c) Ends of pipe shall be sealed temporarily while laying with cotton/jute/rubber stopper etc. to avoid entry of building material.
   d) Exact locations of equipment shall be ascertained prior to laying of pipe.

11. **Laying of Cable in Masonry Trenches**
   a) More than one tier of cables can be provided in the same trench if the number of cables is more.
b) Entry of cables in trenches shall be sealed with bituminous MASTIC compound to stop entry of water in trenches without any extra cost.

12. Laying of Cables on Building Surface/Structure
   a) Such type of cable laying shall be avoided as far as possible and will be allowed only for individual cables or small group of cables which run along structure.
   b) Cables shall be rigidly supported on structural steel/masonry using individual cast/malleable iron galvanised saddles and these supports shall be approximately 400 to 500 mm for cables upto 25 mm overall diameter and maximum 1000 mm for cables larger than 25 mm. Unsightly sagging of cables shall be prevented. Only aluminium/GI clamps with GI bolts/nuts shall be used.
   c) If drilling of steel structure must be resorted to, approval must be secured from the Engineer-in-charge and steel must be drilled where the minimum weakening of the structure will result.

13. Cables laid in pipes
   Wherever cables are taken through metallic pipes, suitable bushes shall be provided at both the ends to avoid sharp edges of the pipes damaging the cables. Wherever cables pass through masonry, they shall be taken through suitable PVC or metallic pipes. After drawing the cables in the metallic / PVC pipes, the ends shall be sealed with suitable compound. Diameter of pipes/ conduits shall be 1.5 times outer dia of cable.

14. Laying of Cables in Cable Racks / Trays
   Cable Racks to be used for cables laid indoors except for single cables. The cable trays shall be of ladder type fabricated out of structural steel, MS, GI or Perforated as indicated. The cable racks shall be of adequate strength to carry the weight of cables with out sagging. Structural bracket grouted in the build up trenches to support the cable such supports shall be at intervals of not less than 750 mm centres. All the structural steel work shall be finished with two coats of paint over primer.

   Cable Trays shall be fabricated out of MS channels, angle iron, tee, bends, sections, flats and perforated sheet for different loads and number and size of cables as mentioned in the BOQ.

15. Cable trays, cable racks, cable risers, pedestals, etc.
   The following specifications in this section covers the standard requirements for fabrication and installation of cable trays / racks / risers / frames / cable supports / pedestals / frames etc.

   Standards and regulation
   Fabrication and installation of cable trays / racks / frames shall be as per standard codes of practice and fully comply with the requirements of the Indian Electricity Rules & Regulations and also the standards that are in force at the place of installation.

   Cable Trays
   Cable trays shall be of ladder type / perforated steel section slotted angles as mentioned. The
trays shall be complete with plates, Ts, elbows, risers, and all necessary hardware. The trays shall be galvanized as per IS 2629. The cable trays shall have suitable strength and rigidity to provide adequate support for all cables. It shall not present sharp edges, burs of projections, injurious to the insulation of the wiring and cables. The trays shall be adequately protected against corrosion and shall be made of corrosion resistant material. It shall have side rails or equivalent structural members. There shall be a continuous earth strip running on either side of the tray for earthing.

Cable trays shall be fabricated out of material as suitable for the operating environment, temperature, humidity and atmosphere specified.

**Cable support system**

The cable tray support system shall have the appropriate factory fabricated components. It shall be with ceiling support plates anchored with the ceiling with grip bolts. The perforated trays shall be supported with threaded studs with adjustable clamps and shall have nuts and washers accessories for leveling.

**Installation of Cables Trays**

Cables trays shall be installed as a complete system. Trays shall be supported properly from the building structure. The entire cable tray system shall be rigid and leveled.

Each run of the cable tray shall be completed before the installation of cables. In portions where additional protection is required, non-combustible covers / enclosure shall be used. Cable trays shall be exposed and accessible. Where cables of different system are installed on the same cable tray, non combustible, solid barriers shall be used for segregating the cables.

Cable trays shall be grounded by two numbers earth continuity wires. Cables trays shall not be used as equipment grounding conductors.

Cable trays shall be properly leveled and aligned as per the site conditions and a proper shop drawing shall be produced before starting the work and got approved by the Consultant / Owner.

The installation of cable tray support system shall be using the required accessories as mentioned above and using grip bolts for proper strength in fixing.

Wherever more than one layer cable racks / trays are used the spacing between them shall be 150mm or more depending on the cable sizes. Necessary holes (with threads wherever necessary) on the steel sections required of fixing of bolts, nuts etc. for clamping and mounting of equipment shall be provided before welding and fixing the same. The cable trays and sections shall be weighed in the presence of Owner/Consultant for billing purposes, if required.

The cable trays and bends are to be properly fixed to the tray supports using 12mm dia GI "J" bolts after the trays and bends are connected at joints using G.I Clamps having 2 Nos. GI flats and 2 Nos. GI nuts/bolts of suitable size. Wherever cable racks have been specified, it shall be
of "Continuous Rack" type. These continuous cable racks shall be supported at proper intervals using angle iron cable supports with necessary cross-arms. The cable racks / supports have to be fabricated considering size of cable trenches, number of cables proposed in the racks. Wherever MS plate insert are not available, the contractor shall provide the same for fixing of cable racks / supports. All fabricated racks risers / frames / supports / insert etc. shall be treated properly for removal of rest dirt, grease, etc. before painting with one coat of anti corrosive zinc chromite primer coat after fixing the same, they shall be painted with a second primer coat and two coats of enamel or epoxy paint applied over the second primer coat.

**Pedestal and frames**

Pedestals required for mounting the push button stations and steel frames required for mounting of any other equipment such as fire buckets, distribution boards etc. shall be fabricated from similar steel sections used for cable racks / risers supports and fixed at relevant places. Post treatment and painting of pedestals / frames shall be similar that of cable racks.

**Clearance, etc.**

Clearance between cables of different services shall be: Power to control cable 0.2m, Power to communication cable 0.3m and power to gas/water mains 0.3m. Identification strip shall be provided at 8-10m apart. Cables shall be clamped using non-magnetic, non corrosive clamps at every 0.5 to 0.8m.

**16. Power Cable termination**

Cable termination shall be heat shrinkable type and the bushings shall be covered with adequate insulation with a provision for using the cable test rods for cable testing. 11 kV cable compartments for each circuit shall be separately enclosed. Cable termination shall be suitable for copper or aluminium conductor. Suitable cable termination kits and other accessories shall be included in the scope of supply.

Cables jointing shall be done as per the recommendations of the cable manufacturer. Bi-metallic plate washers should be provided wherever cables, lugs, and switch terminals are of different materials. Cables and cable lugs should be of same material where ever possible. The cable should be properly terminated to avoid stress on end termination. End termination must be done by an authorised cable jointer. All end terminations to be carried out by crimping type aluminum sockets with glands. Each terminations shall be carried out using brass compressions glands and cable sockets. Hydraulic crimping tool shall be used for making the end terminations. Cable gland shall be bonded to the earth by using suitable size earthing material.

**17. Joining of Cables**

Before joining the cables the insulation resistances of both sections of cable shall be checked by using suitable IR Tester. Individual conductors in cables shall always be joined number to number or color to color of the insulation over the conductors. During the preliminary stage of laying the cable, consideration should be given to proper location of the joint position so that when the cable is actually laid, the joints if any are made in the most accessible places. Joints shall not be made at passage ways and at road crossings. In cable trenches or in any other
cable routes were there are two or more cables laid together, the joints if any shall be arranged to be staggered by two or more meters so as to reduce the possibility of one joint failure effecting the other. For joining armoured cables, hot pouring compound shall not be used. Only cold ceiling filling compound shall be used. All materials required for cable joining such as cable joining kit, compounds, insulation tape, cable legs, cable gland, fittings etc. and other consumable materials shall be arranged by the contractor wherever called for free of cost.

18. Cable Termination
Cable glands and boxes necessary for cable termination on the equipment shall be supplied along with the equipment. However the contractor shall supply suitable glands for all the other equipment. Wherever necessary holes are not drilled on the end plate of the switch boards or on the cable boxes of the equipment for fixing of cable gland, suitable holes shall be drilled at convenient locations for fixing the cable glands.

19. Testing of Cables
All cables shall be tested before and after joining / termination as per relevant Indian Standards. Joining/ terminations if found unsatisfactory it shall be rectified without any extra cost to the Owner/Consultant. All cables shall be IR tested before and after joining.

a. Tester: 500 V IR Tester for LT cables, and 1000 V IR tester for HT cables.

b. IR value should not be less than 6 M Ohm for any cable.

All cables should also be tested for:
- Continuity
- Absence of cross facing
- Insulation resistance to earth
- Insulation resistance between conductors.

a) Before energising, the insulation resistance of every circuit shall be measured from phase to phase and from phase to ground. This requires 3 measurements if one side is grounded and 6 measurements for 3 phase circuits.

b) Where splices or terminations are required in circuits rated above 650 volts, measure insulation resistance of each length of cable before splicing and/or terminating. Report measurements after splices and/or terminations are complete.

c) DC High Voltage test shall be made after installation on the following:

i) All 1100 Volts grade cables in which straight through joints have been made.

ii) All cables above 1100 V grade.

For record purposes test data shall include the measured values of leakage current versus time.
The DC High Voltage test shall be performed as detailed below:
Cables shall be installed in final position with the entire straight through joints complete.
Terminations shall be kept unfinished so that motors, switchgear, transformer etc. are not
subjected to test voltage.

The test voltage and duration shall be as per relevant codes and practices of Indian Standards
Institution.

Proforma for Testing Cables

Proforma - A
a) Drum No. from which cable taken
b) Cable from ...... to ...........
c) Length of run of this table ...... metre
d) Insulation resistance tests:
   Voltage of IR Tester ....... Volts
   i) between core-1 to earth ...... Megaohm
   ii) between core-2 to earth ...... Megaohm
   iii) between core-3 to earth ...... Megaohm
   iv) between core-1 to core-2 ..... Megaohm
   v) between core-2 to core-3 ....... Megaohm
   vi) between core-3 to core-1 ...... Megaohm

e) High voltage test ....... Voltage ........ Duration
   i) between cores and earth
   ii) between individual cores
Proforma - B

Cable Laying

Voltage of IR Tester used:............

<table>
<thead>
<tr>
<th>Continuity of cores</th>
<th>IR value (mega ohm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before laying</td>
<td>Before back filling</td>
</tr>
<tr>
<td>Between value</td>
<td>Between Value</td>
</tr>
</tbody>
</table>

1) From...........To...............PVC/XLPE.......x.......sq.mm LV/MV/HV cable...............m in length.
R-N                   R-N
Y-N                   Y-N
B-N                   B-N
R-Y                   R-Y
B-R                   B-R
Y-B                   Y-B
R-E                   R-E
Y-E                   Y-E
B-E                   B-E

Proforma - C

Cable Jointing
(To be shown for each cable separately, voltage wise)

Voltage of IR Tester used:............

<table>
<thead>
<tr>
<th>Number of Joint</th>
<th>Location</th>
<th>Type of cable(s)</th>
<th>Type of joint (Indoor/Outdoor, straight through/termination, LV/MV/HV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Insulation resistance (Mega ohm) before jointing

Cable I - (a) Between

R & Y
Y & B
B & R

(b) Between

R & N
Y & N
B & N
(c) Between R & E
       Y & E
       B & E
       N & E

Cable II - (a) Between R & Y
            Y & B
            B & R

(b) Between R & N
      Y & N
      B & N

(c) Between R & E
     Y & E
     B & E
     N & E

Insulation resistance (Mega ohm) of Jointed cable

Cable I - (a) Between R & Y
        Y & B
        B & R

(b) Between R & N
     Y & N
     B & N

(c) Between R & E
     Y & E
     B & E
     N & E

Proforma - D
Testing Before Commissioning
(a) Cable Work Date(s) of Test:.............

Details of high Voltage test conducted
System of supply.............
Test Voltage applied..........kV..........Minutes
Result of test-Satisfactory/Unsatisfactory.
Voltage of IR Tester used:-
Result of IR Tester testing:-
Test reports shall be signed by both Contractor and Owner/Consultant.

**Testing of entire installation**
On completion of an installation the following tests shall be carried out:-
1. Insulation Resistance Test.
2. Earth continuity Test.
3. Earth Electrode Resistance Test.

**Insulation Resistance Test**
The following tests shall be done:
The insulation resistance (IR) shall be measured by applying between earth and the whole system of conductors or any section thereof with all fuses in place and all switches closed, and except in earthed concentric wiring, all lamps in position or both poles of installation, a DC voltage of not less than twice the working voltage, provided that it does not exceed 500V for medium voltage circuits. Where the supply is derived from 3-wire (AC or DC), the neutral pole of which is connected to earth, the working voltage shall be deemed to be that which is maintained between the outer or phase conductor and neutral.

The insulation resistance shall also be measured in M Ohms and shall not be less than 50 divided by the number of points in the circuit, provided that the whole installation need not be required to have an insulation resistance greater than 1 M Ohm.

The term "outlet" includes every point along with every switch except that a switch combined with a socket outlet, appliance or lighting fitting is regarded as one outlet.

(i) Insulation resistance of the whole system of conductors to earth ..... Megohms
(ii) Insulation resistance between the phase Conductor & neutral -
    Between phase R and neutral ..... Megohms
    Between phase Y and neutral ..... Megohms
    Between phase B and neutral ..... Megohms
(iii) Insulation resistance between the phase Conductors in case of poly phase supply
    Between phase R and phase Y ..... Megohms
    Between phase Y and phase B ..... Megohms
    Between phase B and phase R ..... Megohms
**Earth continuity test**
The earth continuity conductor including metal conduits and metallic envelopes of cables in all cases shall be tested for electric continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance or earth leakage circuit breaker measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed One Ohm.

Maximum resistance between any point in the earth continuity conductor including metal conduits and main earthing lead = ....... Ohm.

**Earth electrode resistance test**
Two auxiliary earth electrodes besides the test electrode are placed at suitable distance from the tests electrode. A measured current is passed between the electrode ‘A’ to be tested and an auxiliary current electrode ‘C’ and the potential difference between the electrode ‘A’ and auxiliary potential electrode ‘B’ is measured, and resistance of test electrode ‘A’ is calculated.

Unless 3 consecutive readings of test electrode resistance with different spacing of the electrodes agree, the test shall be repeated by increasing the distance between ‘A’ and ‘C’ upto 50m.

On completion of an electric installation, a certificate shall be furnished by the contractor countersigned by the Consultant/ Owner under whose direct supervision the installation was carried out.
7.0 EARTHING SYSTEM

1. **Standard and regulations**
   Earthing system installation shall be carried out in accordance with the latest edition of IS:3043 and the installation shall comply with the requirements of the Indian Electricity Rules & Regulations that are in force.

2. **Earthing**
   The system shall be TNS System with four wire supply system (R, Y, B, N and 2 Nos. E) brought from the main L T Panel. All metal parts of electrical installation and all metal conduits trunking, cable sheaths, switchgear, distribution panels, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All metal work such as pipe lines, stairways etc shall be bonded to earth.

3. **Earthing conductors**
   Earthing conductors shall be of copper or GI as specified in the BOQ and shall be protected against mechanical injury or corrosion.

4. **Sizing of earthing conductors**
   The cross sectional area of earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80 Sq.mm. If the area of the largest current carrying conductor or bus bar exceeds 160 sq.mm then two or more earthing conductors shall be used in parallel, to provide at least half the cross sectional area of the current carrying conductor or bus bars. All fixtures, outlet boxes, junction boxes and power circuits up to 15 amps shall also be earthed.

   All 3 phase switches and distribution panels upto 60 amps rating shall be earthed with 2 Nos. distinct and independent 6 mm dia copper wires. All 3 phase switches and distribution panels upto 100 amps rating shall be earthed with 2 Nos. distinct and independent 10 mm dia copper wires. All switches, bus bar, ducts and distribution panels of rating 200 amps and above shall be earthed with minimum of 2 Nos separate and independent 25 mm x 3 mm copper strip.

5. **Connection of earthing conductors**
   Main earthing conductors shall be taken from the earth connections at the main L T panel to an earth electrode with which the connection is to be made. All joints in tapes shall be with four rivets and shall be brazed, wires shall be connected with crimping lugs, all bolts shall have spring washers. Sub- mains earthing conductors shall run from the main distribution panel to the sub distribution panel. Final distribution panel earthing conductors shall run from sub-distribution panel.

   Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution panel. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to distribution panel at which they originate, or otherwise at the commencement of the run by an earthing
conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of the equipment shall be earthed by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord. Switches, accessories, lighting fitting etc. which are rigidly secured in effective electrical contact with a run of metallic conduit shall not be considered as a part of the earthing conductor for earthing purposes, even though the run of metallic conduit is earthed.

6. **Prohibited connections**
Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system. The electrical resistance measured between earth connection at the main L T panel and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate or circuit breakers, and shall not exceed 1 ohm. All switches carrying medium voltage shall be connected with earth by two separate and distinct connections. The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in GI pipe of adequate size. The overlapping in strips at joints where required shall be minimum 75 mm. The joints shall be riveted and brazed in an approved manner. Sweated lugs of adequate capacity and size shall be used for termination of all conductor wires above 6 sq.mm size. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned. Equipotential bonding of all metallic structures shall be done.

7. **Resistance to earth**
The resistance of earthing system shall not exceed 1 ohm.

8. **Earth Station**
The earth station shall be made by excavating the ground to a depth of not less than 2.5 m and the excess earth after back filling shall be removed from site. Ground with rocky strata, the depth of excavation shall be less. However additional earthing stations or earth matting to be provided to achieve the system earthing less than one ohm.

9. **Electrodes**
Various types of electrodes
i) Pipe electrode shall be buried in the ground vertically with its top at not less than 20 cm below the ground level. The installation shall be carried out as shown in the figure and as directed by the Engineer-in-charge.

ii) Plate electrode shall be buried in ground with its face vertical, and its top not less than 2 m below the ground level. The installation shall be carried out as directed by the Engineer-in-charge.

iii) When more than one electrode is to be installed, the distance between pipe electrodes shall be 5m and that between plates shall be 8m.

iv) a) The strip or conductor electrode shall be buried in trench not less than 0.5 m deep.
b) If conditions necessitate the use of more than one strip or conductor electrode, they shall be laid as widely distributed as possible, in a single straight trench where feasible, or preferably in a number of trenches radiating from one point or as directed by the Engineer-in-charge.

10. Earthing Conductor (Main earthing lead)

The earth conductors shall be fixed to the wall/columns etc. at every 500 mm centres with 10 mm spacers. The total earthing system shall be mechanically and electrically connected to provide independent path to earth.

i) In the case of plate earth electrode, the earthing conductor shall be securely terminated on to the plate with two bolts, nuts, checknuts and washers.

ii) A double C-clamp arrangement shall be provided for terminating tape type earthing conductor with GI watering pipe coupled to the pipe earth electrode. Galvanised “C” shaped strips, bolts, washers, nuts and checknuts of adequate size shall be used for the purpose.

iii) The earthing conductor from the electrode upto the building shall be protected from mechanical injury by a medium class, 15 mm dia. GI pipe in the case of wire, and by 40 mm dia. medium class GI pipe in the case of strip. The protection pipe in ground shall be buried atleast 30 cm deep to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floors to adequate depth in due co-ordination with the building work.

iv) The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switch board by bolt, nut and washer.

11. Earth bus and main earthing terminal

i) The Main Earth bus shall be laid as directed by the Engineer-in-charge.

ii) Following conductors shall be terminated into the main earthing terminal/earth bus.
   a) Earth connection from the Sub station.
   b) Earthing conductor from electrode.
   c) Protective conductors;
   d) Equi-potential bonding conductors.

12. Protective (Loop earthing /earth continuity) Conductor

i) Earth terminal of every switch board in the distribution system shall be bonded to the main earth bus.

ii) Two protective conductors shall be provided for a switchboard.

iii) A protective conductor shall securely connect the earth connector in every distribution board (DB) to the earth bus.

iv) All metallic switch boxes and regulator boxes in a circuit shall be connected to the earth connector in the DB by protective conductor.

v) The earth pin of socket outlets as well as metallic body of fan regulators shall be connected to the earth stud in switch boxes by protective conductor.
13. ‘GI’ Earthing
GI strips used for earthing shall be minimum 6mm thick and hot dip galvanized. If round GI conductors are used, it shall have double the calculated area of cross section. The minimum cross sectional area of the GI should be 50 sq.mm.

Joints shall be invariably done by means of welding. Barium chromate or zinc dichromate treatment should be done at the weld. After welding, joints should be provided with coating alternate layers of red oxide and aluminium. Joints are to be covered with hot bitumen.

In case of bolted joints can not be avoided, there should be a min. of 2 bolts for sizes upto 25x6mm, 3 bolts for sizes upto 31x6mm and zig zag bolting for large sizes.

14. Marking
i) Earth bars/terminals at all switch boards shall be marked permanently, either as E or as Main earth terminal shall be marked “Safety Earth – Do Not Disconnect”.

15. Proforma for testing Earth Electrodes
i) Total number of earth electrodes.................
ii) Earth resistance of each earth electrode:

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Location</th>
<th>Value</th>
</tr>
</thead>
</table>

Test reports shall be signed by both Contractor and Owner/Consultant.
8.0 LIGHTNING PROTECTION SYSTEM

1. Scope
This heading covers the detailed requirements of installation of lightning conductor system for protection of buildings against lightning. For details not covered in these specifications, reference may be made to IS:2309 - 1989.

2. Principal Components
The principal components of a lightning protective system are:
   a) Air terminations
   b) Down conductors
   c) Joints and bonds
   d) Testing joints
   e) Earth terminations
   f) Earth electrodes.

3. Materials
The materials of air terminations, down conductors, earth termination, etc. of the protective system shall be reliably resistant to corrosion, or be adequately protected against corrosion. The material shall be of the following, as specified. All air terminations and down conductors shall be of copper/ GI /Al. as specified the BOQ.

The recommended shape and minimum sizes of conductors for use above and below ground shall be copper strip 20 mm x 3 mm conforming to relevant I.S. specifications as specified in the BOQ.

4. Layout
The system design and layout shall be done in accordance with IS:2309 - 1989 and specified in the tender documents. The work shall be carried out accordingly satisfying at the same time, the requirements given below.

5. Air terminations
   i) Air termination networks may consist of vertical or horizontal conductors, or combinations of both. For the purpose of lightning protection, the vertical and horizontal conductors are considered equivalent and the use of pointed air terminations, or vertical final is, therefore, not regarded as essential.
   ii) A vertical air termination, where provided, need not have more than one point, and shall project at least 30 cm, above the object, salient point or network on which it is fixed.
   iii) For a flat roof, horizontal air termination along the outer perimeter of the roof shall be used. For a roof of larger area a network of parallel horizontal conductors shall be installed. No part of the roof should be more than 9 m from the nearest horizontal protective conductor.
   iv) Horizontal air terminations should be carried along the contours such as ridges, parapets and edges of flat roofs, and where necessary, over flat surfaces, in such
a way as to join each air termination to the rest, and should themselves form a closed network.

v) All metallic projections including reinforcement, on or above the main surface of the roof which are connected to the general mass of the earth, should be bonded and form a part of the termination network.

vi) If portions of a structure vary considerably in height, any necessary air terminations or air termination network for the lower portions should be bonded to the down conductors of the taller portions, in addition to their own conductors.

6. Down Conductors

i) The number and spacing of down conductors shall be as specified, or as directed by the Engineer-in-charge.

ii) Routing
   a) A down conductor should follow the most direct path possible between the air terminal network and the earth termination network. Where more than one down conductor is used, the conductors should be arranged as evenly as practicable around the outside walls of the structures.
   
b) The walls of light wells may be used for fixing down conductors, but lift shafts should not be used for this purpose.
   
c) Metal pipes leading rainwater from the roof to the ground may be connected to the down conductors, but cannot replace them, such connections should have disconnecting joints.
   
d) In deciding on the routing of the down conductor, its accessibility for inspection, testing and maintenance should be taken into consideration.
   
e) Proper porcelain/DMC supports should be used to support the lightning conductor at regular intervals.

iii) Provision when external route is not available:
   a) Where the provision of external routes for down conductors is impracticable, for example, in buildings of cantilever construction from the first floor upwards, down conductors should not follow the outside contours of the building. To do so would create a hazard to persons standing under the overhangs. In such cases, the down conductors may be housed in an air space provided by a non-metallic and non-combustible internal duct and taken straight down to the ground.
   
b) Any suitable covered recess, not smaller than 76 mm x 13mm, or any suitable vertical services duct running the full height of the building may be used for this purpose, provided it does not contain an unarmoured or a non-metal sheathed cable.
   
c) In case where an unrestricted duct is used, seals at each floor level may be required for fire protection. As far as possible, access to the interior of the duct should be available.

The lightning protective system should be so installed that it does not spoil the architectural or aesthetic beauty of the building.
7. Aluminium Down Conductors
Aluminium should not be used below ground for connections to earth electrode. PVC covering shall be provided for Al. down conductor at the ground level. Where copper conductor is to joined to aluminium conductor, the joints should be tinned to prevent electrolytic action. Sharp bends required for al. strip should be formed by the use of a bending machine.

Al. to Al. joints on down conductor shall be arc welded using welding or tungsten inert gas arc or metal inert gas arc techniques. Oxy-acetylene gas welding or bracing shall also be allowed. Rectangular conductors can be joined or terminated by drilling and bolting and jointing compound applied immediately to both mating surfaces. The joints should be protected by bitumastic paint.

Earthing grid should be run at a minimum depth of 50cm below the ground.

8. General requirements
All the non-current carrying metal parts of Electrical equipments shall be earthed properly. Metallic conduits, Trunkings, Cable sheathes, Luminaries, fittings etc. shall be bonded together by means of earthing conductors of adequate sizes. Main earth bus shall form a continuous ring (closed loop) so that discontinuity in anyone point does not disconnect the connection to the earth and the earth electrodes shall be connected to the main earth bus. The main earth bus shall be connected to the main switch boards using duplicate earthing conductors of the same cross sectional area as that of the main earth bus. Duplicate earthing should be employed for all switch boards, and Electrical equipments which shall be directly connected to the Main earth bus. The selection of the cross sectional area of earthing conductors shall be as conforming to the requirements of the state Electrical Inspectorate and as per the fault level at the point. Earthing conductors shall be neatly taken along with the power cables on the cable trays/ racks / risers and there shall be clamped at every three meters interval on the horizontal racks in the cable trenches and at every 750mm interval on the vertical racks / risers / bends/ take points etc. Type of the clamps, bolts / nuts/ washers and material of the clamps etc. shall be as approved.

All earth conductors having round cross section shall be terminated using crimped type copper legs. Wherever aluminum conductors are taken out from the cable trenches, walls etc. or wherever bare aluminium conductors come in contact with the ground, wall, etc., they shall be taken through PVC or GI Pipes. Wherever earth conductors cross the road, it shall be taken through GI Pipes or formed trenches. At all termination of earth conductors on equipments, sufficient length shall be left for easy moment of the equipment from its position for alignment purposes. Wherever excavation of the earth pits shall be arranged, so as to avoid obstructions, crossings etc. according to convenience at site and shall be got approved by the Consultant. Wherever UG earthing conductors are specified, the same shall be buried after excavation of earth back filling with layers of the sand, well burned bricks and riddled soil respectively. For motors below 37.5 KW/50 HP looping earth connections shall be provided between the motors and the local push button stations, if provided. Where as for motors of 37.5KW (50 HP) and above, direct connection to earth bus shall be made from motors and push button stations.
9.0 INTERNAL WIRING AND LIGHTING

1. Scope
The following specifications calls for the standards to be followed during the execution of Electrical work involving lighting and its circuits. These specifications shall be read in conjunction with drawings and schedule of quantities as attached along with tender document. The complete wiring work shall generally conform to relevant IS standards, and comply with the Indian Electricity Rules, and meet the conditions for approval of the Electrical Inspectorate. Code of Practice for Electrical Wiring Installations shall be IS: 732.

2. Interior wiring
Unless otherwise specified the main circuit should be wired using minimum 2.5 sq.mm unsheathed PVC insulated single core copper wire and the branch circuit installation should be wired using 1.5 sq.mm PVC insulated single core copper wire. Power Points shall be wired using 4.0 sq.mm PVC Insulated single core copper wire depending on the rating and type of load. The outgoing circuits of the DBs in the system shall be numbered as given below:
   a) first two letters (digits) indicate the serial number of the DB.
   b) third letter (RY or B) indicate the phase of the circuit.
   c) The next two letters (digits) indicate the serial number of the way of the DB.

In all installations, the wires used shall be color coded as follows.
   Red – R phase
   Yellow – Y phase
   Blue – B phase
   Black – Neutral
   Green – Earth
   Gray – Control wiring.

Wiring from DB to the control switch of the first lighting fixture in the circuit should be done using 1.1 KV grade heavy duty PVC insulated Copper wire of 2.5 sq.mm size. Wiring from switch box of the first fitting to the switch box of the adjacent lighting fixture in the circuit shall only be done using PVC insulated copper wire of 2.5 sq.mm size. Looping back system of wiring shall be adopted. Looping of wires shall be carried out only from control switches or junction boxes and not from lighting fixtures. The wiring installation through out the building shall be such that different phases shall not be drawn in same conduit. Also, switch boxes or light / fan point circuits of different phases shall not be drawn in same conduit. 230V, 15/20A single phase socket outlet shall be wired with 4 sq.mm PVC insulated copper wires. Computer signal cables, Telephone cables etc. should be laid at a minimum clearance of 300 mm from electrical cables/wires.

3. Conduits
All the conduits used shall have ISI mark. Wherever wires/ cables are taken through masonry
works, roads crossing etc. they shall be protected by running them through rigid PVC conduits/GI pipes. After installation, walls, floorings, etc. shall be restored to the original condition by proper plastering free of cost. The size of the conduit shall be selected based on the overall diameter of the Cables/Wires/Earthing conductors and after leaving a free area of 40% of the overall cross section of the conduit. The total number of conduits crossing a particular point in the roof shall be limited so that the strength of the roofing concrete and the structure is maintained. Rigid PVC or metal conduits of suitable sizes may be used for Electrical conduits as conforming to IS 2509, 1653 or 3837. The conduits and accessories should conform to the following IS specifications as applicable. Maximum number of wires that can be drawn through PVC/steel conduits is given in Table-I.

<table>
<thead>
<tr>
<th>IS:</th>
<th>Specification</th>
</tr>
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<tbody>
<tr>
<td>2509</td>
<td>Rigid non metallic conduits</td>
</tr>
<tr>
<td>1653</td>
<td>Rigid steel conduits.</td>
</tr>
<tr>
<td>3837</td>
<td>Accessories for rigid steel conduits.</td>
</tr>
<tr>
<td>3419</td>
<td>Fitting for rigid steel conduits</td>
</tr>
<tr>
<td>2667</td>
<td>Fitting for rigid steel conduits</td>
</tr>
<tr>
<td>6946</td>
<td>Flexible non-metallic conduits</td>
</tr>
<tr>
<td>3480</td>
<td>Flexible steel conduits</td>
</tr>
</tbody>
</table>

4. **Laying of concealed conduits through brick walls**
   The conduits laid through brick walls should be installed inside and flush with the surface of the brickwork. The brick masonry work may be chased using electrical cutter only to enable concealed installation of the conduits. Thickness of the conduits through the wall should be always maintained to run vertically between mounting boxes and wiring points and horizontal laying shall be avoided as far as possible. Horizontal laying should be done over the ceiling prior to roof casting or through the floor prior to flooring. The horizontal conduits if unavoidable should run either at a clearance of 50mm from the ceiling or at a clearance of 600mm from the finished floor level so that inadvertent access to the conduits and Electrical lines are minimized.

5. **Laying of concealed conduits through partitions**
   Aluminium or Electro galvanized channels of required size may be screwed under the skirting of the partitions and conduits shall be installed by clamping to the channels. All the conduits used shall be properly earthed to provide shielding from the Electrical Cables.

6. **Laying of conduits over false ceiling**
   For installation of light fittings and other equipments mounted on the false ceilings, wires may be drawn through open conduits laid over the false ceiling. For drawing of wires over false ceiling, open type conduits may be used which will not be visible after the construction of the false ceiling. The conduits for wires including the fish wire for pulling the wires should be laid prior to the installation of the ceiling. Ceiling roses and terminations above the false ceiling should be avoided and wiring to the points should be directly terminated at the luminaries or fixtures as the case may be.

7. **Laying of concealed conduits through roof concrete**
   For drawing cables/wires through concrete, Rigid PVC, metal conduit having ISI mark shall be
used. The conduits used should have a minimum diameter of 20mm. Conduits should be laid through and between the top and bottom steel reinforcing members of the roof concrete so that there will be sufficient thickness of cement concrete in between. The conduits should be tightly sealed in order to prevent the cementing material from entering inside the PVC conduit. Solvent cement should be applied at the junctions and connections prior to casting. Conduits shall not be laid through sunken slabs. Droppers of PVC conduits from the roof concrete to the walls should be dropped only from center of the beams as required to avoid misalignment with the walls which will be built later. Droppers of PVC conduits from the roof concrete to the walls should be properly covered at the time of casting to prevent cementing material from entering and blocking conduits. All ends of the conduits should be fitted with a coupling of suitable size to facilitate continuity of the conduit through walls.

8. Junction / Pullout boxes for PVC conduits

Junction boxes shall be made of PVC or painted MS. A minimum of one Pullout box shall be provided for every six meters of laid up conduits or for every two bends in a single run of conduit for 20mm diameter concealed conduits. A minimum of one Pullout box shall be provided for every four meters of laid up conduits or for every bend in a single run of conduit for 25mm / 32mm diameter concealed conduits. Bending of the PVC conduits and offset connectors shall be done only by approved methods of bending by using special spring for this purpose. Junctions and pullout boxes of conduits shall not be laid under the sunken slabs of toilets etc. as there is possibility of water seepage. The junction boxes/ Pullout boxes should be mounted flush with the bottom surface of the roof concrete to enable opening of the same from the bottom. For this purpose, offset PVC connectors may be used for proper positioning and connecting of the junction box to the PVC Conduits. The junction boxes should be positioned and finished so that aesthetic appearance of the ceiling is maintained. In the case of conduits laid through beams the junction box/ Pullout box should be mounted flush with the side surface of the beam to enable opening of the same from the side only.

9. Ceiling roses/ fixtures, fan hooks, terminal connectors, etc

All ceiling roses should be three plate (three terminal) suitable for phase, neutral and earth. All terminals should have the provision for terminating the earth wire also. Ceiling roses and terminal connectors should be mounted in an accessible place on the Ceiling for maintenance and termination. The ceiling roses should conform to IS: 371 for ceiling roses. Fan hooks used for the installation of ceiling fans shall be fixed on the Ceiling during the time of roof casting. It is recommendable to use ready made metallic junction boxes with fan hooks for this purpose.

10. Cable end boxes

The cable-end boxes shall have sufficient wiring space in relation to size of cable / wire specified. In any case, the minimum internal size shall be 100x 100mm or 100mm diameter. Items supplied shall be complete with cable glands, cable boxes, conduit entries, termination etc. and any other accessory which are necessary for the satisfactory installation.

11. Switch / socket mounting boxes

Control switches and plug socket outlets shall be mounted on de-rusted, degreased and electro
galvanized MS box or PVC mounting boxes. Only one phase shall appear in a single mounting box. Switch / Socket Mounting Box may be placed at either of the following levels unless otherwise mentioned in the drawings. The Mounting boxes should be recessed and should remain flush with the finished surface of wall after installation. The following are the types of outlets that should be terminated and the preferred Mounting box height.

900mm
1. Computer socket points (LAN/WAN)
2. AC 6A UPS Sockets.
3. Telephone Sockets.
4. AC 32A DP Switch for Window Air Conditioners.

1350mm
1. AC 6A Sockets.
2. AC 6A Control Switches for light points, Fans etc.
3. AC 16A Power Sockets with Switch.
5. 5AC 32A DP Switch for cooking range in kitchens etc.

1850mm
1. AC 16A Power sockets for Geyser / Water Heater in Toilet etc.
2. AC 16A 2 Way Control Switches for Geyser / Water heater for toilets etc.
3. Terminal connectors provided in common areas.

Telephone, computer, TV signal cables whenever mounted at the same level along with 230V A.C supply shall be terminated in separate mounting boxes. LAN/WAN Computer cable terminating box should have a minimum clearance of 300mm from the 230V A.C. supply boxes. 230V A.C supply and 230V UPS supply whenever mounted together shall be terminated in separate mounting boxes. Different circuits shall have separate mounting boxes. Emergency point control switches shall be UPS /D.G. Set fed, and mounting boxes should be mounted at a position normally right above the nearby Control switch / Socket mounting box which is distinctly identifiable from the normal A.C. supply control switch mounting boxes. Separate Red coloured marking or band should be provided for Emergency circuit control boxes.

12. Light fittings/ ceiling fans/ exhaust fans
All the light fittings, ceiling fans, exhaust fans and any other such fittings shall be of approved make only. Respective circuit numbers shall be painted on the lighting fixture at a conspicuous place. On walls/columns inside buildings, lighting fixtures shall be mounted on suitable MS angle frames, painted as stated above. On walls/columns/outside the buildings and on hand rails the lighting fixtures shall be mounted by means of suitable GI pipes. Emergency (D.G Set/ UPS) fed light fittings shall be painted with a clearly visible red band of adequate width around the fittings, for easy identification. Locations of lighting fixtures shown in the drawing are indicative. They shall be located to suit the site conditions subject to the approval of Owner/Consultant. Where ceiling fans are provided, lighting fixtures shall be suspended by
means of pipes such that the fan blades are not below the lighting fixtures. All light fitting shall be installed at a height of not less than most point of the ceiling fan and the plane of the blades shall not be less than 300mm.

The Lighting fixtures and ceiling fans should conform to the following I.S. Specifications.
Light fittings IS: 5077, 4012, 4013, 8224, 2149, 3553, 1913, 2206, 1947, 1777, 3528.
Ceiling fans IS: 374.

13. Plug sockets
All sockets inside the toilets shall be mounted at such a location that there is no possibility of ingress of water in to the sockets mounted on the mounting box. The Plug sockets should conform to IS: 1293 for plug and socket outlets.

14. Controlling switches
Controlling switches for lamps and ceiling fans shall be mounted at locations providing maximum convenience to the user. At least one switch controlling a Lamp may be located outside and near the doors of the rooms to enable operating it from outside without inconvenience. As a general rule control switches shall not be located in areas near water and high temperature areas.

15. Distribution Boards DBs
In the case of DBs carry both Lighting and Power circuits, all distribution boards shall be marked "LIGHTING" or "POWER" as the case may be and also marked with the voltage and number of phases of the supply. Each DB shall be provided with a drawing giving details of each circuit with its controls, the current rating of the circuit, the rating of the MCBs. All emergency DBs should have the label “EMERGENCY, AC/DC, TPN/SPN’ as the case may be painted on it. Serial numbers if any allotted to each DB in the drawings shall be painted on it in red colour for Emergency DBs and in white colour for other DBs. The DBs shall be installed in a clean, dry and well ventilated area. The access to the board and the area in front of the board shall always remain free without any blockage or hindrance. The MCB DB shall be installed at a minimum height of 1500mm from the finished floor level. The MCB DB shall be installed recessed on the wall. The incoming cable shall be concealed and laid in a smooth curve. The MCB DBs if installed recessed on the wall should be mounted only on walls with a minimum thickness of 200mm

There should be facility in the MCB DB for the incoming PVC insulated Armoured Aluminium Cable and facilities for glancing and earthing of the cable. There should be an earthing bar with slots and screws for terminating the main DB earthing conductor (10 SWG) and the continuous copper earth wire (14/16 SWG) of the outgoing circuits. All ELCBs and MCBs used should have ISI mark. All ELCBs and MCBs should be separately tested and certified to be working by the Contractor. Motor rated MCBs with time delayed tripping shall be used for connecting Window Air Conditioners. MCBs for all heating and lighting loads shall be as suitable for lighting circuits. A suitably rated incomer having over current and Earth leakage protection (ELCB+MCB Combination) shall be provided on the incoming side of the Distribution board. All internal wiring
shall be terminated using proper crimped type solderless cable lugs. The connections shall be made in such a manner that there will be good electrical and mechanical contact. The DB enclosure shall be provided with two earthing terminals. There shall be an engraved identification label and a printed circuit list shall also be exhibited. The DB's shall have door of the manufacturer only if specified. All civil works in connection with the installation of the board shall be carried out by the contractor at his own cost and responsibility. Provision for this shall be made while quoting the rates. The Distribution Boards should conform to IS: 2675.

16. **Miniature circuit breaker (MCB)**

Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 230/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted type. The MCB shall be Current Limiting be type (Class-3). MCBs shall be classified (B, C, D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, 4P and TPN miniature circuit breakers shall have a common trip bar independent to the external operating handle.

17. **Residual current circuit breaker (RCCB/ELCB)**

Residual Current Circuit Breaker (RCCB) shall work on the principle of core balance transformer. The incoming shall pass through the toroidal core transformer. As long as the currents in the phase and neutral shall be the same, no electro motive force shall be generated in the secondary winding of the transformer. In the event of a leakage to earth, an unbalance shall be created which shall cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive miniature relay, which shall trip the circuit if the residual current exceeds a predetermined critical value. RCCB shall be current operated independent of the line voltage, current sensitivity of a minimum of 30 mA and a maximum of 300 mA at 240/415 volts AC and shall have a minimum of 20,000 electrical operations.

The moving contacts of the phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism. Hence, the closing /opening of all the three phases shall occur simultaneously. This also shall ensure simultaneous opening of all the contacts under automatic tripping conditions.

The neutral moving contact shall be so mounted on the common bridge that, at the time of closing, the neutral shall make contact First before the phases, and at the time of opening, the neutral shall breaks last after allowing the phases to open first. This is an important safety feature which is also required by regulations.
A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the RCCB and the operating handle shall move to the "OFF" position.

18. Earthing
An earth conductor of 14/10 SWG shall run through the conduit installation and shall be connected to the metallic parts of the electrical appliances or fittings as shall be connected to the main earthing system. All copper wire of green colour should be connected to the main earthing system. All copper earth conductors having round cross section shall be terminated using crimped type copper lugs. Gland and Armour of AYFY Cables shall be earthed using earthing conductor having the same cross sectional area as suitable for the fuse rating of the cable. Lighting fixtures, Earth point of plug socket outlets, body of all metal clad plug socket outlets, control switches, junction boxes etc. shall be earthed using 14/10 SWG copper conductor. Where 3 core cables are specified for wiring, the third core shall be used as earthing conductor. All conduits shall carry continuous earth wire. All metal parts of DBs and Switches shall be earthed in duplicate using bare copper conductor of 10SWG size. All Distribution Boards should be provided with an internal copper earth bus having the same cross sectional area as that of the phase bus. The earth bus should be connected in duplicate to the main earthing system through the earthing studs using bare copper conductor of 10 SWG size. All earth conductors used for down stream wiring shall be interconnected to the earth bus of the distribution Board. Both the DB earth bus and the earthing studs shall be separately connected to the earthing system. The earthing should be as per IS: 3043.

19. Testing and commissioning
The work will be considered complete only after the safety certificates are issued by the State Electrical Inspectorate and only after the following tests are conducted satisfactorily by the Contractor at his own cost, in the presence of Owner/Consultant and results of the following tests shall get approved.
1. Insulation resistance test.
2. Continuity test.
3. Polarity test.
4. Earth continuity test.

If any additional tests are indicated by the Owner/Consultant or if he may think that any of the tests results are unsatisfactory shall be conducted again by the Contractor without extra charges. On satisfactorily completion the tests, the contractor shall furnish to the statutory bodies three sets of completion certificates as required. Successful testing of the equipment alone does not relieve the responsibility of the Contractor and the manufacturer for the quality of workmanship and material. The instruments used for conducting the tests shall be tested as functioning well at the concerned testing authority (ERTL / Electrical Inspectorate, etc.) and shall hold a valid test certificate or stamp showing the serial No. and period of validity of the test result.
### TABLE- I
MAXIMUM NUMBER OF PVC INSULATED 650/1100 V GRADE ALUMINIUM/COPPER CONDUCTOR CABLE IN RIGID PVC/STEEL CONDUITS

<table>
<thead>
<tr>
<th>Size of wires Nominal Cross (Sq. mm.)</th>
<th>Maximum number of wires within conduit size(mm)</th>
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<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>1.5</td>
<td>5</td>
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<tr>
<td>2.5</td>
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<td>4</td>
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</table>

20. Fixing of lighting fixtures & accessories
The light fixtures and fittings shall be assembled and installed in position complete and ready for service, in accordance with details, drawings, manufacturer’s instructions and to the satisfaction of the Engineer-in-charge.

Scope of work under this section shall include receiving at site, safe storage, transportation from point of storage to point of erection, erection and commissioning of lighting fixtures and accessories including providing all necessary supports, brackets, down rods and painting etc as required.

**Fluorescent Tube Light / CFL Fittings**
All fixtures shall be complete with accessories and fixing necessary for installation completed in all respects. Fixtures connected to emergency lighting systems shall have distinct red markings. Fixtures shall be installed at mounting heights as instructed at site by the Consultant/ Owner.

Fixtures and/or fixture outlets boxes shall be provided with hangars to adequately support the weight of the fixture. Design of hangars and method of fastening shall be as approved by the Consultant / Owner unless otherwise specified in the drawings and tender specifications.

Pendant fixtures within the same room or area shall be installed plumb and at a uniform height from the finished floor level. Provision for adjustment of height during installation shall be made.

Flush mounted recessed fixture shall be installed so as to completely eliminate light leakage within the fixture & between the fixture and adjacent finished surface. Fixture mounted on outlet boxes shall be rigidly secured to a fixture stud in the outlet box. Extension pieces shall be installed where required to facilitate proper installation. Fixture shall be completely wired and
constructed so as to comply with the IS standards.

Wiring within the fixture and for connection to the branch circuit wiring shall be with wire of size as specified. Insulation of the wire shall suite the temperature conditions inside the fixtures.

Sheet metal used for manufacturing of lighting fixtures shall not be less than 22 SWG or heavier if so required to comply with the specification or standards. Sheet Steel reflectors shall have a thickness of not less than 20 SWG. Parts of fixtures shall be completely free from burrs and tool marks. Soldering shall not be used as mechanical fastening device on any part of the fixture.

Ferrous metal shall be given corrosion resistant phosphate treatment or other approved rust inhibiting primer coat to provide a rust-proof base before application of final coat of finish.

Non reflecting surface such as fixture, frame, etc. shall be finished with baked enamel paint, if specified. Light reflecting surface shall be finished baked white enamel having a reflection factor of not less than 80%. All parts of reflector shall be completely covered by the baked enamel finish and shall be free from irregularities in surface.

Fixtures with visible frames shall have concealed hinges and catches. Pendant fixtures and lamp holders shall be provided with ball type aligners or similar approved means for adjustments. Recessed fixture shall be constructed so as to fit an acoustic tile ceiling or plaster ceiling without distorting either the fixture or the ceiling. Plaster rings shall be provided for plaster ceilings. Fixtures with hinged diffuser doors shall be provided with spring clips or other retaining devices to prevent the diffuser from moving.

Recessed fixtures shall be constructed so that all components are replaceable without removing housing from the ceiling.

Lamp shall be supplied and installed in all lighting fixtures provided under this contract. Lamps used for temporary lighting service shall not be used in the final lamping of fixtures. Lamps for permanent installation shall not be placed in the fixtures until so directed by the Owner/Consultant, and this shall however be accomplished immediately before the building portions are ready for occupation.

Only single and or two lamp ballast shall be used in any one fixture. Ballasts shall be completely enclosed inside sheet steel casing, and shall have a corrosion resistant finish. Ballasts shall contain a thermosetting type compound not subject to softening or liquefying under any operating conditions or upon ballast failure. Compound shall not support combustion. All ballasts shall be copper wound/ electronic, as specified, and shall be of high power factor compensated to above 0.9 PF. Ballast temperature and sound rating rise shall be specified by the manufacturer and guaranteed. Ballasts shall be for operation at the voltages and frequencies indicated and under temperature conditions prevailing in the various locations of the premises.
All fluorescent fixtures shall be provided with separate wiring channel with cover plate and an earth terminal. All screws shall be chromium brass screws. Lamps and starter holders shall be out of tough mounted plastic with spring loaded rotor type contactors rendered shock and vibration proof. Condensers shall be of low oil paper impregnated hermetically sealed type complying with IS. Internal wiring is passing by the ballast in a suitable heat resistant barrier or sleeve shall be provided.

Surface mounted fixture longer than two feet shall have one additional point of support besides the outlet box fixture stud when installed individually. Pendants for individually mounted fixtures of 1.2m long and small shall be provided with twin stem/conduit hangars. Stems shall have ball aligners or similar devices and provision for a minimum of 25 mm vertical adjustment. Stems shall be of appropriate length to suspend fixtures at required mounting height. Lamps, starters and ballasts provided with each fittings shall match the lamp specified.

**Fans, Regulators and Clamps**

Ceiling fans including their suspension shall conform to relevant IS with secondary safety device incorporated against free fall of fans from their hooks.

All ceiling fans shall be wired to ceiling roses or to special connector boxes and suspended from hooks or shackles. There shall be no joints in the suspension rod.

In case of “I” beams, the suspension arrangements fabricated out of M.S. plates shall be shaped suitably to catch the flanges and shall be held together by means of laying bolts, nuts, check nut and split pin.

For concrete roofs, ceiling fans hooks shall be got buried in the concrete during construction.

Fan hooks made of MS rods of 15mm diameter shaped in ‘U’ form with their legs projecting horizontally on the top at east 19 cm on either side and tied over the top reinforcement of the roof shall be laid in the concrete slabs.

The suspension arrangement for the fans shall be so designed that the fans canopies shall completely hide suspension element.

Unless otherwise specified all ceiling fans shall be hung 2.75M above the floor.

In the case of measurement of extra down rod for ceiling fans including wiring, the same shall be measured in units of 10 cms & length less than 5 cm shall be ignored. The cost of wiring for extra down rod shall be paid as per supplying and drawing cable in existing conduits.

**Exhaust fans**

Exhaust fans shall be erected at the places indicated by the Consultant / Owner. For fixing exhaust fans a circular opening shall be provided in the wall to suit the size of the frame, which
would be fixed by means of rag bolts, embedded in the walls, opening shall be neatly plastered to the original finish of the wall. The exhaust fan shall be wired as near to the opening as possible by means of flexible cord. Care being taken that the blades rotate in the proper direction.

The exhaust fan for installation in corrosive atmosphere shall be painted with special PVC paint or chlorinated rubber paint. Installation of exhaust fan in kitchen, dark room and such other special locations shall be carried out giving due consideration for the specific requirements.

The body of the ceiling fan, exhaust fan and fan regulator shall be connected to the earthing system by proper earth leads.

**Street light fittings**

Street light fittings shall be of make and model as specified in the schedule.

In case of street light fittings, rates quoted against fittings will be excluded from the arm over the pole, but will include for lead wire from pole mounting box and all other hardware necessary to complete the work. Street light poles shall be conform to IS 2713-1969.

Sample of the pole shall be submitted and approval of Consultant/Owner obtained in writing before order is placed for the full quantity. Rate quoted against pole item shall include for excavation, concrete foundation, pole earthing studs, arm for fitting, fixing bracket for control gear, pole cap etc. all complete. Poles shall be erected absolutely vertical.

All buried portions of the poles shall be given a primer coat and two coats of bituminous paint. All exposed portions shall be given one primer coat and two coats of aluminium paint before erection, if specified. In addition, one more coat of aluminium paint shall be given after the fittings are erected and work completed.

The type of fittings shall be as specified in BOQ.

a) The contractors shall supply the specified model and make of the fittings. The standard constructional features of specified make and model as given in the tender document are acceptable. However, one sample of each of every fitting shall be produced for approval.

b) 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.

c) The contractors shall supply the specified type of lamp mentioned in the BOQ. All the accessories of the light fittings should be fitted with nut bolt and not to be riveted.

d) Unless otherwise specified, Copper chokes of Fluorescent Tube light Fittings shall be of super low loss type (Not more than 6 watts) or as specified in BOQ.

e) Unless otherwise specified, the degree of protection for the outdoor fittings shall be of IP65 or as specified in BOQ.

f) Ceiling fans including their suspension shall conform to relevant Indian Standards.

g) Wall Fans, Air Circulators, Exhaust fans etc shall conform to relevant Indian Standards.
21. TELEPHONE WIRING
Cables shall be of solid bare copper conductor, Polyethylene core insulation, every quad twisted into basic units, basic units and main unit twisted to form cable core, paper tape wrapping, laminated sheath of aluminium coated plastic tape, Polyethylene outer sheath.

Telephone Tag blocks shall be of 1.6 mm CRCA sheet steel box with lockable door.

The contractor shall supply the required men and material items for the work. Wiring should be carried out from the indoor DP points to various floors wherever required as per the instructions of Engineer-in-charge. Wiring should be neat and fault free and up to the satisfaction of the Engineer-in-charge of the work.

Wiring procedure for electrical wiring shall also be followed for telephone wiring.

22. CABLE TELEVISION WIRING
The co-axial cable used shall be of high quality for cable TV network. It shall be of low loss of signal quality, manage wide bank of frequencies due to low attenuation, high bandwidth, better clarity of transmission.

The central conductor shall be made of 99.97% pure solid electrolytic grade copper conductor which has distinct advantages over traditional copper. It shall be suitable for transmission of video and audio signals. It can handle greater number of TV channels, notch free attenuation values over wide bank of frequencies, low loss of signal quality, etc.

Wiring procedure for electrical wiring shall also be followed for video cable wiring.

23. Automatic Changeover Current Limiter (ACCL) Switch
ACCL Switch shall be suitable for automatic change over from Main Power to DG Power and vice versa in absence of any one. By default, it shall always be connected to Main power. In the absence of Main power, when DG power comes, it shall automatically switch over to DG power. When Main power reinstates, it shall automatically change over to Main power.

While running in DG power, when the load exceeds the set range, DG supply shall automatically trip. When the load gets reduced and it is in the range, it shall automatically restore DG power.
TECHNICAL SPECIFICATIONS

Fire Hydrant system
Sprinkler system
Fire Alarm system
1. **SCOPE WORK**

The scope of the work covers supply of materials, installation, testing and commissioning of Fire Hydrant System, Sprinkler system and Fire Detection & Alarm systems.

Copies of drawings of buildings and schedule of quantities are enclosed in the tender document. All the equipment and installation shall conform to specifications contained in Indian Standards.

The installation of the systems shall conform to norms as per NBC 2005 - Part 4, IS 3844 and TAC. The installation of Fire Detection & Alarm system shall comply with the latest edition of relevant NFPA 72 E and IS: 2189 standards. The scope of work also includes preparation and submission of drawings for obtaining approvals (NOC) for the system from local authorities like State Fire Dept. and liaison works with the departments. All incidental expenses in connection with the same shall be borne by the contractor. For all approvals / NOC, statutory fees shall be remitted by the contractor initially. However, it shall be reimbursed on submission of original receipt.
FIRE HYDRANT SYSTEM

1. **STANDARDS**

The manufacture, identification of material and testing of equipment covered in this specification shall comply with the latest editions as on date of opening of tenders of the appropriate standards of the following. Unless otherwise specified, Indian Standards are preferred. All the appliances and accessories shall carry IS or International certification and shall be of approved make.

- **IS: 1239** Mild steel, black ERW pipes, with fittings.
- **IS: 3589** Mild steel, black ERW pipes 200 mm dia, and above, with fittings.
- **IS: 10221** Code of practice for coating and wrapping of underground mild steel pipelines
- **IS: 823** Welding procedure
- **IS: 2062** Steel for General Structural Purposes

- **IS: 780** Cast iron sluice valve
- **IS: 903** Nozzle, Branch pipe, Female and Male couplings (Gun metal)
- **IS: 5290** Fire hydrant valve, gun metal with cap & GI chain.
- **IS: 908** Fire hydrants
- **IS: 8423** Water shield controlled percolation hose.
- **IS: 325** Induction motors
- **IS: 900** Installation of motors
- **IS: 13947** SDFUs
- **IS: 1554** PVCAPVC Al. power/control cables
- **IS: 1652** Batteries
- **IS: 694** PVC insulated cables (light duty) for working voltage upto 1100 volts.
- **IS: 1554** PVC insulated cables (heavy duty) for voltage upto 1100 volts.
- **IS: 1554** — do — for voltage 3.3 kV to 11 kV
In case where the offer deviates from the specified standards, the tenderer shall indicate clearly in the offer the alternative standards proposed to be adopted and details thereof.

Unless otherwise mentioned, all applicable codes and standards shall be of the latest editions as published by the Indian Standards and all other such as may be published by them during the tenure of the contract, and shall govern in respect of workmanship, properties of materials, installation and methods of testing. In case where suitable Indian Standards or TAC norms are not available, generally accepted codes and practices as approved by the Purchaser shall be adopted. Any changes or modifications directed by the Purchaser shall also be incorporated by the contractor during execution of the work.

2. **PUMPS AND ACCESSORIES**

Pumps shall be direct-coupled and not belt-driven. Parts of pumps like impeller, shaft sleeve, wearing sleeves, etc. shall be of non-corrosive metal such as brass or bronze. Pumps shall be capable of furnishing not less than 150% of the rated capacity at a head not less than 65% of the rated head. The shut-off rate shall not exceed 120% of the rated head in the case of horizontal pumps. Each pump shall be provided with a pressure gauge on the delivery side between the pump and the non-return valve and a name plate showing the delivery head, capacity and the RPM. Pumps shall be securely mounted on a robust bed plate of horizontal type, and shall be free from vibration at all varying loads.

The two electric driven main pumps shall be interconnected through pressure switches and panel board such that only one electric pump shall operate first in the event of low system pressure and the latter operates automatically in case of failure of the former within a specified switchover time or fall in pressure.
The Jockey pump shall have automatic starting and stopping arrangements to maintain the system pressure. In the event of low system pressure, the jockey pump shall operate to maintain the system pressure. Sequence of operation of pumps are mentioned in the section ‘Inspection and Testing’.

3. HYDRANTS SYSTEM AND PIPING

1. MS Pipes
   The MS pipes used shall be of standard IS 1239, heavy duty type (Class C), electric resistance welded and shall be free from scale, cracks, surface flaws and other defects. For pipes 200 mm dia. and above IS 3589 shall be applicable.

2. Above ground (AG) / Exposed pipes
   Above ground (AG) / exposed pipe lines and fittings shall be coated with two coats of zinc chromate primer and two coats of enamel paint as per IS approved colour code. The surfaces shall be properly cleaned before applying the primer. AG pipes shall be supported at regular intervals on masonry, RCC, truss, beams, roofs, trenches etc. Air release valves shall be provided in the hydrant lines at an interval of 50 m.

   The spacing of pipe supports shall be as shown below:
   Pipe dia. in mm
   80, 100 and 125 : 3.5 m
   150, 200 and 250 : 5.0 m

   around the pipes and the overlap is maintained at 15 mm. The material shall conform to IS 10221.

3. Hydrant valves
   The external/internal fire hydrant valves shall be of oblique type single headed of 63 mm dia. conforming to IS-5290 suitable for connecting to 80 mm pipe. The hydrant shall be complete with hydrant valve, orifice plate, other fittings, etc. The hydrant couplings shall be flanged gun-metal with instantaneous female spring-lock of 63 mm dia. and valves shall be of screw down type. Orifice plates of suitable design shall be provided for hydrants where pressure exceeds 7 Kg per Sq. cm.

   The number of fire hydrants in a main of 80 mm dia. shall not feed more than one hydrant, that having a dia. of 100 mm shall not feed more than two hydrants, that having a dia. of 125 mm shall not feed more than three hydrants. The pressure at the most highest end hydrant in the
hydrant mains shall be restricted to 3.5 Kg per Sq. cm. All hydrant outlets shall be situated 0.9 m above floor level.

4 **Hose pipes**

The hose pipes for hydrants shall be 15/7.5 m long, 63 mm dia. water shield controlled percolation canvas conforming to IS-8423 with gun metal 63mm size male coupling at one end and female coupling at other end conforming to IS:903. If hose is kept in hose boxes alongside hydrants, each box shall contain two lengths of hoses. For use of each hydrant in staircase landing or with each internal hydrant, two lengths of hose 7.5 m shall be provided and in case of external hydrants two lengths of 15 m shall be provided. All the hoses and branch pipes/nozzles shall be kept inside the boxes as per standard practices.

5 **Hose reel**

The hose reel shall consist of 30 m long 20 mm dia. high pressure braided rubber lined hose mounted on heavy duty circular MS drum complete with gun-metal shut-off valve, nozzle, etc. The hose reel bracket shall be of MS fabricated or cast iron swing type suitable for 90 deg. smooth and free rotation in vertical plane conforming to IS-884.

6 **Hose boxes**

The fire hose boxes shall be of size 750x250x600 mm, 16 SWG sheet steel with front side glass of 4 mm thick, lockable hinged door and painted with one coat of primer and two coats of synthetic enamel paint of approved colour..

7 **Couplings**

All couplings shall be of the instantaneous spring-lock type and the nozzles shall be of not more than 16 mm in dia. All couplings in the branch pipes and nozzles shall be of gun-metal and shall comply with IS-903. The hose shall be attached to the coupling.

8. **Foot valve**

It shall conform to IS:4038 standard and shall be of ball type, C.I. metallic and with G.M. trim & grey C.I. / galvanized steel perforated screen with flanged connection, nut bolts, gasket, washers etc. to be connected only for negative suction. It shall be tested certified for hydraulstatic test pressure, for Body : 8.5 kg/cm$^2$ and Seat : 2 kg/ cm$^2$.

9 **Fire brigade outlets**

The fire brigade collective breaching shall be with 150 mm flange outlet connection with gun-metal twin-Siamese collecting head having 4 instantaneous outlets with built-in check valves. The fire brigade breaching shall be connected to the sump and the main header.
10 **Air cushion tank**

The air cushion tank shall be of 300 mm dia. and 1500 mm height fabricated out of 8 mm MS sheet steel and shall be complete with 20 mm dia. air release valve and associated piping work, etc. It shall be constructed with air outlet at the top. Drain valves of gun-metal shall be provided at the lowest points of the piping work to enable draining of water from the system. The drain valves assembly shall include nipple and PVC rubber hose.

11 **Sluice Valve (SV)**

It shall be of IS 780 standards. Construction shall be of inside screw, non-rising stem for water purpose and flanged type. Pressure class shall be of PN 1.0 and tested to 15 kG/Sq.cm pressure. Seat ring shall be of gun metal as per IS 318. Gasket packing shall be of CAF / Graphited asbestos.

12 **Non Return Valve (NRV)**

It shall be of IS 5312 standards. Construction shall be of swing type with bolted cover for water purpose and flanged end construction. Pressure class shall be of PN 1.0 for water purpose and flanged type.

13 **Gun Metal Gate Valve**

It shall be of IS 778 standards. Construction shall be of globe and lift type with screwed bonnet and inside female screwed construction. Packing shall be of asbestos. Pressure class shall be of PN 1.0. End connection shall be of screwed type.

14 **Pressure gauges**

It shall be of dial type with Bourden tube element of SS 316. The dial size shall be 150 mm dia. and scale division shall be in metric unit marked in black on white dial. It shall be comprised with snubber, isolation coke, nipples, tail, connecting pipes, etc.

15 **Fittings**

Fittings installed shall be of MS conforming to IS-1239 (Part-I & II). All fittings shall be able to withstand atleast a pressure of 150 % of the maximum working pressure. Welded fitting according to the laid down welding procedure are permitted. Welded parts shall be suitably coated after welding as per the requirement of the areas. Welded joints are not permitted for fittings of less than 50 mm dia.

16 **Pressure switches**

It shall be of industrial type, single pole, double throw electric pressure switching designed for starting or stopping equipment within the pressure of the system drops or exceeds the pre-set limits. All switches shall have ¼” BSP (F) inlet connection and screwed cable entry for fixing cable gland.
17 Flanges

The flanges shall be of heavy duty type manufactured from material as per standards mentioned having flat face as per requirement and its dimensions shall also satisfy appropriate standards. All bolt holes in flanges shall be drilled. The drilling of each flange shall be in accordance with relevant Indian Standards. The gaskets used in all flange joints shall be of standard size and are to be approved, verified and checked before use. Fixing of gasket is to be as per standard procedures so as to ensure efficient and quality type joints. The flange faces shall be true and perpendicular to the axis of the pipes, and if due to other various reasons, such as, but not necessarily limited to the process and / or layout requirements, it is not feasible, the Contractor shall ensure that the joints shall be drawn up in order to provide even and adequate uniform pressure on gaskets. All flanges shall be installed such that the bolt holes straddle the normal centerlines.

18 Welding procedure

The welding procedure shall only be carried out by fully trained and experienced welders and shall conform to IS-823. Purchaser reserves the right to set the correct welding procedure, if not satisfied. The welding electrode shall be of reputed make with ISI mark, and shall have suitable coating complying with relevant Indian Standards.
INSPECTION AND TESTING

(Hydrant System)

1 Inspection - General

All site fabricated work/material shall be subject to inspection in cleaned condition, prior to erection. At no event, site fabricated work/material shall be installed in position without inspection and approval by Purchaser. The Contractor shall ensure that each stage of fabrication is carried out in compliance with the procedures specified in the TAC manual and IS standards as applicable and/or specified in this document.

The contractor shall conduct sample tests of all the materials supplied at reputed laboratories/agencies as directed by Purchaser at his own cost and test reports are to be submitted. Inspecting officials of Purchaser and Local Authorities shall have the right to access the premises of the work at any time with or without giving prior notice. All the formalities or procedures for conducting the inspections by the authorities as required by them shall be arranged by the contractor free of cost.

All testing shall be carried out in the presence of Purchaser/statutory authorities and test registers shall be maintained by the contractor. The contractor shall provide all material, tools, equipment, instruments, services and personnel required to perform the tests and remove debris/water resulting from cleaning and after testing free of cost.

The original test certificates of all tests conducted are to be forwarded to Purchaser. After conducting the tests, any defects found on materials, equipment, piping, etc. shall be got rectified/repai red by the Contractor without any extra cost.

2 Testing

Before energising electrically operated equipment, care shall be taken to meet the local electrical rules and regulations, earthing of the body, verifying availability of safe insulation resistance value, etc. Also confirm the motor enclosure to the level of protection required for the particular application.

a. Pumps

The pumps shall be tested according to the standard recommendations of the manufacturer. The following parameters are to be recorded and plotted and submitted to the Purchaser.

a. Discharge Q
b. Pressure P or Head H
c. Motor voltage and current.
d. Efficiency

The power consumption is to be computed and cross-checked with manufacturers data. Any abnormalities, if noted, shall be brought to the notice of the manufacturer and necessary corrective action be taken before commissioning and handing over, without any extra cost. Manufacturers test certificates shall also be submitted to Purchaser for verification.

b. Piping

All piping shall be tested by filling water, removing air locks, foreign materials, etc. and applying pressure at 1.5 times of the maximum working pressure and see that the pressure drop is within 0.5 Kg per Sq. cm over a period of 2 hours. The testing shall be carried in sections by blocking both ends or closing the valves provided. After completion of the installation and connecting to the mains of pumping system the installation shall once again tested and rectify breakage if any or replace the defective material, free of cost.

At least 10% of the total weld joints on pipes shall be tested by radiography as per TAC requirement. Holiday tests for wrapping and coating of MS pipes is essential as per IS-10221. Holiday tests may preferably be carried out by flexible and detachable ring probe which shall enable the entire 360 deg. of the surface of the pipe to be scanned.

c. Electrical system

The following tests are recommended:-

i) Earth resistance

ii) Cable Insulation

iii) Trial run and testing of diesel engine.

iv) Resistance of metal conduits/sheaths (Earth continuity test)

Insulation of the cables shall be not less than one mega ohm when tested with a 500 volts meggar for any particular section of the wiring.

In case of cables encased in metal conduit or metallic sheathing, the total resistance of the conduit or sheathing from the earthing point to any other position in the completed installation shall not exceed 2 Mega Ohms.

d. Hydrant system

The entire hydrant system shall be tested in the presence of Purchaser to ascertain the functioning of each system, equipment, etc. as desired
by Purchaser. The contractor shall hand over the system only if it is proved that the system performs as per the specifications.

SEQUENCE OF OPERATION OF PUMPS

The electric driven pumps shall be interconnected through pressure switches and panel board such that only main pump operates in the event of low system pressure and the stand by pump operates automatically in case of failure of the former within a specified switchover time or fall in pressure.

The starter panel shall continuously monitor the mains supply on all the 3 phases for total/ partial failure and system pressure through pressure switches.

The electric driven pumps shall start both in auto /manual modes. The pumps shall not be stopped automatically afterwards and it shall be stopped manually.

The contractor shall carry out necessary arrangements for the supply and installation of items like timer, sensors, control cabling, etc. in the panels to function the pumps as described.

The Jockey pump shall have automatic starting and stopping arrangements to maintain the system pressure. Jockey pump shall not be in operation while the main pump is in operation. Jockey pump shall be operated by both auto /manual modes. Under normal conditions, the water pressure in the hydrant lines shall be 9 kg/sq.cm. and the auto/manual switch shall be in the auto mode. When the pressure drops to 8 kg/sq.cm., the jockey pump shall start automatically through pressure switches arrangements and when pressure develops to 9 kg/sq.cm the pump shall stop automatically.
SPRINKLER SYSTEM

1. Sprinklers

The design of sprinkler system is designed for a Design Density of 5 lpm/Sq.m and Assumed Maximum Area of Operation (AMAO) is 360 Sq.m. The minimum sprinkler discharge pressure shall be 0.35 bar and ‘K’ factor shall be 80. Sprinkler shall not be reconditioned or repaired. Defective sprinklers shall be replaced with new ones. Sprinklers and multiple controls shall not be painted except for the identification purpose. Sprinklers shall be of ‘Conventional Pendant’ type with size 15 mm dia. It shall produce a spherical type of discharge with a proportion of water being thrown upward the ceiling. Sprinklers shall have temperature rating for 68 deg. C with Red colour code. It shall be of Quartzoid Bulb suitable for installation indoor as well as outdoor and shall have a maximum coverage of 12 Sq.m per sprinkler.

Arrangement of sprinklers

Sprinklers shall be installed with the deflector parallel to the slope of the ceiling. Sprinklers shall be not spaced at less than 2 m. The distance between the boundary and sprinklers when measured along the range pipe shall not be more than 0.5 times the spacing between the sprinklers and range pipes. As far as possible, sprinklers shall be located away from the columns. Sprinklers shall not be connected directly to distribution and main pipes. Sprinklers shall not be provided in the following areas of the building:

- Stairs, spaces below stair headings.
- Toilets.
- Rooms containing electric power distribution apparatus.
- Control rooms.

Number of sprinklers that can be installed on range pipes is as given below:

- 25 mm dia. Range pipe: 2 nos. max.
- 32 mm dia. Range pipe: 3 nos. max.
- 40 mm dia. Range pipe: 4 nos. max.
- 50 mm dia. Range pipe: 9 nos. max.
Number of sprinklers that can be installed on distribution pipes is as given below:

32 mm dia. distribution pipe: 3 nos. max.
40 mm dia. distribution pipe: 6 nos. max.
50 mm dia. distribution pipe: 9 nos. max.
65 mm dia. distribution pipe: 18 nos. max.

2. **Alarm valve**

Alarm valves shall be fitted on the main supply pipe immediately above the main control valve leading to the sprinkler installations. The alarm valve shall have the following accessories:

Main Stop Valve - 1 No. shall be fitted immediately downstream of the alarm valve and shall be at fire brigade access level.

Test Valve - 1 No. shall be provided to test the hydraulic alarm or any electric alarm pressure switch if provided by drawing water from the downstream side of a wet alarm valve. It shall be installed close to the alarm valve.

Drain valve - 1 No. shall be fitted to allow drainage from immediately downstream of the alarm valve.

Water motor alarm – 1 No. shall be fitted as close as possible to the alarm valve. It shall be installed with its gong on the outside of an exterior wall. A strainer readily accessible for cleaning shall be fitted between the motor nozzle and alarm valve connection. The water outlet shall be positioned so that any flow of water can be seen. The pipe work to the water motor shall be galvanized. Any device to reduce the frequency of false or intermittent alarms fitted to the installation shall be suitable for sprinkler service.

Pressure gauge - No. shall be fitted immediately downstream of the alarm valve. Pressure gauges fitted shall comply with relevant IS standards. The scale sub-division shall not exceed 0.2 bar for a maximum scale value upto and including 10 bar.

3. **MS Pipes**

The MS pipes used shall be of standard IS 1239, heavy duty type (Class C), electric resistance welded and shall be free from scale, cracks, surface flaws and other defects. For pipes 200 mm dia. and above IS 3589 Class ‘2’ shall be applicable.
a. **Exposed/Above ground (AG) pipes**

Exposed/Above ground (AG) pipe lines and fittings shall be coated with two coats of zinc chromate primer and two coats of enamel paint as per IS approved colour code. The surfaces shall be properly cleaned before applying the primer. AG pipes shall be supported at regular intervals on masonry, RCC, truss, beams, roofs, trenches etc. Air release valves shall be provided in the hydrant lines at an interval of 50 m.

The spacing of supports shall be as shown below:

<table>
<thead>
<tr>
<th>Pipe dia. in mm</th>
<th>Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80, 100 and 125</td>
<td>3.5</td>
</tr>
<tr>
<td>150, 200 and 250</td>
<td>5.0</td>
</tr>
</tbody>
</table>

b. **Fittings**

Fittings installed shall be of MS conforming to IS-1239 (Part-II). All fittings shall be able to withstand atleast a pressure of 150 % of the maximum working pressure. Welded fitting according to the laid down welding procedure are permitted. Welded parts shall be galvanised or suitably coated after welding as per the requirement of the areas. Welded joints are not permitted for fittings of less than 50 mm dia. Air release valves are to be provided in the main ring wherever necessary to permit air locks in the delivery side of the pipe lines.

c. **Flanges**

The flanges shall be of heavy duty type manufactured from material as per standards mentioned having flat face as per requirement and its dimensions shall also satisfy appropriate standards. All bolt holes in flanges shall be drilled. The drilling of each flange shall be in accordance with relevant Indian Standards. The gaskets used in all flange joints shall be of standard size and are to be approved, verified and checked before use. Fixing of gasket is to be as per standard procedures so as to ensure efficient and quality type joints. The flange faces shall be true and perpendicular to the axis of the pipes and if due to other various reasons, such as, but not necessarily limited to the process and / or layout requirements, it is not feasible, the Contractor shall ensure that the joints shall be drawn up in order to provide even and adequate uniform pressure on gaskets. All flanges shall be installed such that the bolt holes straddle the normal centerlines.
d. **Supports for sprinkler piping system**

Sprinkler pipes shall be supported from the building structure which itself shall be capable of supporting the water filled pipe work and shall not impair the performance of sprinklers under fire conditions. Pipe work shall not be used to support any other loads. Supports shall not be welded or fastened directly to the pipe work. The thickness of all parts of pipe supports shall not be less than 3 mm. Wherever possible, pipes shall be supported from non-combustible building elements. Pipe works in corrosion areas shall be of either stainless steel or suitably protected against corrosion. Standard pipe hangers such as solid ring, swivel ring, clip, band hanger, bracket, ceiling flange, clamp, etc. shall be used for supports. The spacing between the pipe supports measured along the line of connected pipes shall not be less than the following:

- Up to 65 mm : 4.0 m
- 65 mm to 100 mm : 6.0 m
- 100 mm : 6.5 m

e. **Welding procedure**

The welding procedure shall only be carried out by fully trained and experienced welders and shall conform to IS-823. Engineer-in-Charge reserves the right to set the correct welding procedure, if not satisfied. The welding electrode shall be of reputed make with ISI mark, and shall have suitable coating complying with relevant Indian Standards. Welded joints shall not be permitted for pipes having diameter less than 50 mm, but it shall be screwed using sockets.
INSPECTION AND TESTING
(Sprinkler system)

Sprinklers
It shall be factory tested for operation characteristics and chemical tests. Necessary test results shall be submitted before supply. If required the above tests shall be conducted as per the requirement of the Engineer-in-Charge at the time of installation at no extra cost.

Sprinkler alarm valve
The pump shall start automatically and the supply pressure at the appropriate flow rate. The drain valve fitted above the alarm valve shall be opened and the time taken for the alarm gong to operate be noted. There shall not be a significant variation in the timing. The pressure at the “C” gauge of the alarm valve shall be noted at the full load condition of the pump and the value should match with that of the specification. The proper functions of the alarm gong associated with the alarm valve and its level of audibility shall be checked. An audibility level of 85 db above the background noise level is required. Necessary testing equipment shall be arranged by the contractor free of cost.

While conducting the tests, the water flowing through the test valve shall be equivalent to the flow through one sprinkler. It should auto start the pumps and activate the alarm motor and gong. When the test valve is closed, the water flowing through the test valve should stop.
FIRE ALARM SYSTEM

1. **Manual Call Points (MCPs)**

   It shall be of 'break glass’ type, and 1.5mm thick welded sheet steel or 3 mm thick cast aluminium. The front glass shall be breakable. The MCPs shall be recess mounted suitable to support the fire panel. It shall form an integral part of the fire detector system. The housing shall be dust/vermin proof properly sealed with rubber lining. The glass frangible element shall keep a push button pressed inside such that in the event of breaking the glass, the push button is released to actuate an alarm in the control panel.

   Where sheet steel is used for, this shall be thoroughly cleaned off dust, dirt, grease and rust if any and two coats of anti rust primer shall be given both inside and outside. This shall be followed by two coats of synthetic enamel paint in fire red colour on the external surface that will be visible on installation. In the case of cast aluminium body for a call box, the surface shall be neatly finished with red colour paint. The following words shall be painted on the front of the call box in contrasting colour with a letter size of not less than 5mm.

   "BREAK GLASS IN CASE OF FIRE"

   Installation requirements:-

   Manual call points shall be located at exit space and shall be installed at a height of 1.4 m above the floor at an easily accessible position. They shall be installed at easily accessible, well illuminated positions, preferably in a contrasting background so that they are easily noticeable from either direction. They may be semi-recessed so as to project by 10mm. They shall be installed free from obstructions.

2. **Hooters**

   The loop hooters shall be so arranged that when any alarm operates all the hooters through out the premises shall be activated. The hooters at the fire alarm shall be electronic type having frequency of suitable frequency range. The hooters shall be capable to produce a sound output of 90 db at 1 m. Hooters shall be of loop powered and no separate power is required.
Fire alarm hooters shall not be used for any purpose other than for fire operations. When installed flush with a false ceiling these shall match the ceiling surface. Necessary provisions such as metal/wooden boxing or framework, if required, to accommodate the hooters shall be provided in the ceiling. It shall be installed at a height not lower than 2.4 m, except when recessed in a false ceiling of lower height, in such cases the hooters shall be recessed at false ceiling level.

The panel hooters in the respective panels shall be actuated automatically as soon as fire alarm signal is initiated from any trigger device connected to them. These shall also be sounded when there is a fault alarm signal within their areas of control. The sound shall be continuous and of the same characteristics from all fire alarm hooters in a building.

The isolator module shall mount in a standard suitable size electrical box or in a surface mounted back box. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

3. Fire Alarm Control Panel

The fire alarm control panel shall be designed to give reliable and continuous operation for long time with several advantages features. The panel shall be conventional type suitable for 2 wire loops system. Being modular in design, it shall be very easy for maintenance and testing of the system. Fire Alarm panel consists of following plug in type modules

1. Power module.
2. Charger module.
3. Control module.
4. Loop modules.

The fire alarm control panel shall be housed in a steel enclosure. It shall also be finished with hard wear textured epoxy paint/powder coated. Cable entries shall be provided on the top and bottom of the panel.

The system capacity shall be based on the number of devices and control modules. Each devices in the system shall be identified by its unique address position on the two wire loop. The panel retains
command over the alarm process, LED indicators, automatic test feature and loop hooters.

a. Basic system Functional Operations

When a fire alarm/trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

• The system Alarm LED shall flash or the system trouble LED shall flash.
• A local piezo-electric signal in the control panel shall sound.
• The LCD display shall indicate all information associated with the fire alarm/trouble condition, including the type of alarm point and its location within the protected premises.

b. Enclosures

The control panels shall be housed in cabinets suitable for surface or semi-flush mounting. Cabinets shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.

The back box and door shall be constructed of min. 16 gauge sheet steel with provisions for electrical conduit connections into the sides and top.

The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side.

The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

c. Power supply

The power supply units shall operate on 240 Volts AC, 50Hz, and shall provide all necessary power for the smooth operation of system. In case of failure of main power supply the power supply unit shall draw power from a set of standby batteries. The capacity of the battery set shall be sufficient to meet the required hours full functioning of the complete system under alarm conditions.

It shall provide a battery charger using dual-rate-charging techniques for fast battery recharge. It shall charge completely discharged batteries within a 12-hour period. It should provide meters to indicate battery voltage and charging current.
d. **Batteries and External Charger**

**Battery**

Battery shall have sufficient capacity to power the fire alarm system for not less than two hours in alarm condition and at least 8 hours in normal condition. The batteries are to be completely maintenance free.

**External Battery Charger**

Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 230 volt 50 hertz source. It shall be rated for fully charging a completely discharged battery within 12 hours while simultaneously supplying any loads connected to the battery. It shall have protection to prevent discharge through the charger. It shall also have protection for overloads and short circuits on both AC and DC sides.

4. **Control Cable**

The control cable for wiring fire alarm system shall be 2 x 1.0 sq.mm PVC Copper cable. Cables shall be laid as per relevant installation standards. The size of these cables are specified in schedule of requirements.

5. **Conventional Detectors**

All types of detectors shall be of manually programmable type using dip-switches or handheld programmer or from fire control panel. The detector shall have no moving parts of components subject to wear. It shall be possible to test the detector in the field. The response of a detector shall always be clearly visible from outside by a flashing light on the base. The detector shall connect to the control unit via a fully supervised two-wire circuit. A built barrier shall prevent entry of insects into the sensor. The detector shall be designed for fast and simple cleaning.

All electronic circuits must be solid state devices and virtually hermetically sealed to prevent their operation from being impaired by dust dirt or humidity. All circuitry must be protected against usual
electrical transients and electromagnetic interference. All radioactive parts of the source, if any, shall be fully gold plated. The detector shall be inserted into or removed from the base by a simple push-twist mechanism to facilitate easy exchange for cleaning and maintenance.

The smoke & heat detectors shall fit into a common type standard base. The standard base shall be supplied with a seal plate, preventing dirt, dust, condensation or water reaching the wire terminals or the detector points. Detectors shall be provided with a MS box for entry and termination of armoured cable and to protect detector terminals.

At the time of installation and prior to commissioning, every detector shall be allotted an identification number. Detectors shall not be either partially or totally recessed in ceiling or wall. Detectors shall be suitably protected where they are liable to be subjected to mechanical damage. Detectors shall not be painted or coated or covered in any manner after installation as this will adversely affect the sensitive of operation.

**Smoke detectors**

It shall be of optical type. Smoke detectors shall quickly respond to smoke containing small particles normally produced and automatically adjusts sensitivity without needing operator intervention.
TECHNICAL SPECIFICATIONS

FOR

LIFTS
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TECHNICAL SPECIFICATIONS FOR ELEVATORS

1. PASSENGER, SERVICE & FREIGHT ELEVATORS

Elevators shall include all elements conforming to specifications or as amended herein. Elevators covered by this specification shall be provided, installed, tested, commissioned, certified and approved as per statutory requirements by Lift Inspectorate.

Notes:

a. One Fireman’s switch for each set of elevator shall be provided.

b. Elevator shall be provided with short duration emergency lighting in each cab which shall be through local dry cell rechargeable battery with necessary changeover relays. Light output shall be minimum 50 LUX at floor level.

c. Provision of additional weight for interior finishes shall be kept for passenger elevator as specified in the Datasheet. In case interior finishing materials in cab exceeds this provision, then the elevator contractor shall clearly identify the loss of carrying capacity, if any. Recess in platform of 25 - 30 mm shall be provided in floor for receiving stone flooring in the passenger elevator as specified in the Datasheet.

2. HOIST GEAR

Hoisting machines for passenger elevators shall be of geared / gearless type operating at speed as per Datasheets

3. EMERGENCY CRANKING

The hoisting machines shall be provided with a set of special tools including a hand crank to allow release of hoist brake and provide for manual movement of the car in case of emergency. These tools shall be hung up on a tool board fitted to a wall in the elevator machine room, with instructions for their use clearly written on the board both in English and the local language. The elevator system supplier shall qualify his bid with respect to manual cranking. An automatic switch shall be provided to interrupt power to the elevator mains. Upon withdrawal of crank and manual resetting of power monitor switch, power shall be restored.

4. BRAKE

Brakes with non-asbestos lining shall be spring loaded and shall close and open electrically. Brake shall be applied using variable input frequency to insure smooth stopping.

5. AUTOMATIC SELF-LEVELING

The elevator shall be provided with automatic self-leveling feature that shall bring the elevator car level to within ±3 mm for passenger / service elevators and ± 5 mm for freight elevator of the landing floor regardless of load or direction of travel. The automatic self-leveling feature shall compensate for over travel and rope stretch.

6. HOISTWAY MATERIALS

Hoistway materials shall be non-flammable except traveling cable which shall be flame resistant. All other electrical cables shall also be flame resistant and housed in metal conduit or other metal enclosures.
7. HOISTWAY ENTRANCES & CAR DOOR

All landing hoistway entrance door shall have center opening horizontal sliding type doors suitable for a clear opening as indicated in Technical Data for each type of elevator and shall include flush doors of hollow metal construction, extruded aluminium sill with anti slip grooving and hanger supports and hanger cover shall be provided. Exposed surfaces of doors and frames shall be finished as directed by the Interior Designer.

Sheave type two point suspension ball bearing door hangers and tracks shall be furnished for each hoistway opening. Sheaves shall not be less than 58 mm diameter and adjustable ball bearing rollers shall take the up thrust of the doors.

Each car and hoistway door leaf shall be fitted with minimum two nos. teflon or nylon gibes as bottom door stabilizers.

8. CAR AND HOISTWAY DOOR OPERATOR

For each elevator door, an electric VVVF door operator or PWM DC door operator shall be furnished to simultaneously open the car and hoistway doors when the car is at a landing. The doors shall be closed simultaneously by motor power. Emergency key provision shall be made to open doors at all landing from outside of the hoistway.

In the event of interruption of electric power or failure of the door operator, it shall not be possible to open the car door manually from within the car.

An electric contact for the car door shall be provided which shall prevent elevator movement away from the landing unless the door is in the closed position. Each hoistway door shall be equipped with a positive electromechanical interlock and auxiliary door closing device so that the elevator can be operated only after the interlock circuit is established.

The doors shall open automatically while the car is leveling at the respective landing. The doors shall automatically close after a predetermined time interval has elapsed, but the momentary pressure of the “door open” button provided in the car shall reverse the motion and reopen the doors and reset the time interval unless overridden by the electronic door monitor.

9. PHOTO ELECTRIC DOOR MONITORS

An Electronic Door Monitor device shall be installed on each passenger elevator. This device shall monitor traffic across the threshold of the door and shall initiate door closing 2 seconds after interruption, thus overriding door open period. There shall be no dead zone in the entire opening which is not monitored by the device. The door detection density shall be preferably …... m.

10. DOORS

Doors, threshold and door hangers shall be, as a system, fire rated for not less than 1.0 hours.

11. DOOR OPEN CLEARANCE

Clear door opening on passenger service/freight elevators shall be as indicated in technical data. Any other dimension requires Owners approval. Finishes shall be as specified under finishes.

12. CAR TOP STATION

A car top operating station shall comprise of key operated switch and constant pressure up/down buttons which shall be provided on each elevator. Car shall respond to up/down command at inspection speed. The elevator contractor shall provide electrical fixture of 36 watt enclosed fluorescent or enclosed 2 x 18 Watt compact fluorescent switched from car top station.
13. SHEAVES

Sheaves shall be machined, balanced and shall maintain cable / sheave ratio well within requirements. Lubrication points shall be extended to a location that is easily accessible.

14. CARFRAME AND SAFETY

A car-frame fabricated from formed or structural steel members shall be provided with adequate bracing to support the platform and car enclosures. The car safety shall be integral with car-frame or shall be mounted on the bottom members of the car-frame, and shall be of the flexible guide clamp type designed to stop and hold a fully loaded car which exceeds descending speed. Safeties shall conform to ANSI/ASME/CENEN-81 or local codes if more stringent.

15. SPEED GOVERNOR

The car safety shall be operated by a mechanical centrifugal speed governor located in the machine room at the top of the hoistway. The governor shall actuate a switch when excessive descending speed occurs, disconnecting power to the hoist motor and applying the brake prior to deployment of the safeties. Governor sheave in elevator pit shall be enclosed in a wire cage to a height of 2.40 m.

16. WIRING

All wiring and electrical interconnections shall comply with governing codes. Wiring shall be PVC insulated 1100 volt grade flame retardant and shall run in metal conduit, tubing or approved electrical raceways. Travelling cables shall be flexible and suspended to relieve strain on individual conductors. A minimum of 10% spare conductors shall be provided in travelling cable.

17. VOLTAGE FLUCTUATIONS

All electrical equipments supplied by the lift contractor shall withstand an incoming supply voltage fluctuations of +10% - 10%.

18. HOISTWAY OPERATING DEVICES

Redundant series wired terminal stopping devices shall be provided to slow down and stop the car automatically at the terminal landings. Resetting a tripped device shall be done manually only.

19. PIT SWITCH

An emergency stop switch shall be located in the pit which when operated shall stop the car regardless of position in the hoistway.

20. BUFFERS

Buffers shall be provided in the pit in compliance with ANSI/ASME/CENEN-81 or local code if more stringent. Clearance from underside of car resting on a fully compressed buffer shall be not less than 1.20m. Buffer shall be designed for design speed + 15%. Oil buffers shall be provided for the passenger elevators for speeds of more than 1.7 mps and spring buffers for lower speeds or in case of specifically asked for in technical data. The oil buffers shall be self resetting type and shall be provided with means for determining the oil level.

21. GUIDE RAILS

Steel guide rails shall be installed to guide the car and counterweight, erected plumb and securely fastened to the building structure, fitted to ensure smooth joints. The guide rail shall be minimum 16 mm, tongued and grooved type.
22. GUIDES
Rubber encased coil spring tension adjusted roller guides shall be provided for passenger elevators with speed of 1.75 mps or greater, mounted on top and bottom of the car frame, and on top and bottom of the counterweight frame to engage their respective guide rails. Service elevators and low speed elevators can have sliding guides on car and counterweights.

23. CABLE ANCHOR
Cable shall conform to ANSI/ASME/CENEN-81 and shall anchor to the frame by means of an equalizing device to insure uniform cable loading. Cable safety shall conform to ANSI/ASME/CENEN-81 or governing code if available.

24. TRAVELLING CABLE
Travelling cable shall be secured to the car’s underside. Cable shall be clear of all obstructions while car is in motion. Cable jacket shall be suitable for immersion in water, salt water and oil. Jacket shall minimize strain on conductor. Travelling cable shall have 4 cores spare after providing for music, car access control, phone, TV, etc.

25. INTERLOCKS
Hoistway openings shall be provided with electro-mechanical locks.

26. COMPENSATING ROPE
Compensating ropes shall be furnished and installed for all elevators with speed over 2.0 m/sec, and travel in excess of 30 m, to compensate for the shifting weight of the hoist ropes. A device shall be provided to tie the car and counterweight together to limit the jump of the car or counterweight. Compensating chain where provided shall be enclosed in a plastic flame resistant jacket to minimize noise.

27. COUNTERWEIGHT
A structural steel frame with cast iron or steel plate filler weights shall be furnished to provide proper counterbalance for smooth operation.

28. COUNTERWEIGHT GUARD
A metal counterweight guard shall be furnished and installed at the bottom of the hoistway, and shall wrap around counterweight rails for a height of no less than 1.80 m in order to protect accidental contact.

29. ROPES
Hoist ropes shall be traction steel of size, construction and number to insure proper operation of the elevator and give satisfactory and safety assurance. Governor ropes shall be steel. All ropes shall consist of at least eight strands wound about a hemp core center. All ropes shall conform to ANSI/ASME/EN-81 or more governing codes or regulations. The minimum factor of safety for ropes shall be 10.
30. **PLATFORM**

The car platform shall be of Aluminium/ Stainless steel plate as asked for in the BOQ. The entire platform shall rest on rubber pads, so designed to form an isolating cushion between the car and carframe. Platform deflection shall be limited to maximum 3 mm under maximum normal operating conditions. Platform shall conform to ANSI/ASME/EN-81 or more stringent local codes.

31. **HEAVY LOADING PLATFORM (SERVICE ELEVATOR & FREIGHT ELEVATOR)**

The platform shall be provided with slip resistant Aluminium/Stainless Steel chequered plate flooring. The platform shall be arranged to accommodate one piece load if mechanical / electrical equipment, etc.

32. **OVER-LOAD FEATURE**

Elevators shall be fitted with the load weighing feature to illuminate “Over-Load” and defeat the car’s operating circuits when car load reaches 110% or more of rated load. Car platform may require stiffening to minimize margin of error resulting from excessive deflection. Overload feature and/or circuit defeat for elevators shall conform to governing code.

33. **CAR SPEED**

Car speed shall be based on the travel distance and number of floors. This has been specified in Schedule of Quantities.

34. **SYSTEM PERFORMANCE**

The bidder shall do the traffic analysis and submit the same with his tender. The study shall confirm that under normal operating conditions, maximum waiting time at any landing shall not exceed 35 seconds, if not possible contractor shall propose most economical modification to achieve that.

35. **ACCELERATION / DECELERATION**

Acceleration / Deceleration shall be linear and smooth. Stops shall be without cable oscillations. Acceleration & Declaration shall be site adjustable.

36. **NOISE LEVELS (PASSENGER ELEVATOR)**

Noise from moving equipment including door operation, car motion, fan, etc. shall not intrude into adjoining spaces by more than 20 dB and adjoining occupied areas by not more than 10 dB. (All octave bands).

Noise level inside the car shall not exceed 50 dB, without car cabin fan running.

Noise level inside the car shall not exceed 55 dB, in case of door opening / closing. The noise level shall be measured at ‘Zero Activity’.

37. **LATERAL QUAKING & VERTIVCAL VIBRATIONS**

Lateral quaking and vertical vibrations should not exceed 20 gal and 85 dB respectively. Contractor to demonstrate these parameters at site with performance analyzer.

38. **EMERGENCY CAR LIGHTING & INTERCOM**

Provision shall be made in the car for lighting, low speed and low noise fan, status indication and communication. Wiring cabling for the above facilities shall be provided along with travelling cable. Elevator contractor shall provide and install hand free communication unit above the car operation panel. Other units shall be installed in the control room and the machine room. Fan shall be low noise and shall be approved by the Architect / Consultant. Speaker shall be provided for emergency announcement and background music.
39. **CAR POSITION INDICATOR (PASSENGER CARS)**

Scrolling alpha numeric car position indicator shall be installed above each operating panel. The position of the car in the hoistway shall be shown by illuminating the corresponding landing at which the car is stopped or passing.

40. **LIGHTING**

The cab manufacturer shall make all provisions for installation of lighting fixtures specified by interior designer, including integration of emergency lighting fixtures.

41. **HALL BUTTONS (ALL CARS)**

For elevators hall buttons shall be provided at each terminal landing. A single micro movement push button shall be provided at top most and the lowest floor landing, two micro movement buttons on a single plate shall be provided at each intermediate floor. When a hall call is registered by momentary pressure on a landing button, that button shall become illuminated and remain illuminated until the call is answered.

42. **CALL BUTTON**

Selection for call button for passenger car shall be as per Architect selection. Freight elevator call buttons shall be as per manufacturer’s standard product. The catalogues of the buttons offered shall be submitted along with the tenders.

43. **FIXTURE FINISHES**

The metal faceplates of the signal and operating fixtures in the cars and at the landings, along with the metal accessories in the cars, shall be hair line stainless steel or as selected by the Architect. Push button fixtures at the landings shall be of design approved by the Architect. All fixtures, form and finishes, etc. shall be subject to the Architect’s and interior designer’s approval.

44. **CAB CLADDING AND FINISHES**

a. **Freight**

Flooring shall be of 5 mm thick Aluminium\steel chequered plate as specified in the datasheet with all seams for liquid tightness. Walls shall be of stainless steel sheet. Interior finishes shall be brushed stainless steel to full height.

b. **Passenger Elevator**

Flooring shall be stainless steel chequered plate with all welded seams for liquid tightness. Flooring shall have 25 – 30 mm drop for flooring by others. Walls and the interior of the car shall be out of specified options.

45. **AUTOMATIC ELEVATOR RETRIEVAL SYSTEM (FIRE PHASE- I)**

All elevators shall be equipped with automatic elevator retrieval system which shall, upon signal from the central fire alarm system or manually operated key switch, cause all elevators to be dispatched automatically to the ground floor. Elevators shall, open their doors and remain at the ground floor. All floor and car buttons shall be rendered ineffective until the system is manually reset. A smoke detector shall be placed in close proximity to each elevator bank on the ground floor. If this device senses smoke, system shall land elevators at a preselected, alternate, landing floor. A key operated switch shall be provided at the ground floor to activate and reset the retrieval system manually.

a. Emergency operation shall return the elevator/s to a designated floor, most commonly, the Lobby, by means of a signal from the automatic fire alarm system.
b. On initiation from the fire alarm system, control panel, all elevators travelling away from the lobby floors shall stop and reverse without opening their doors indicating fire mode-operation to passengers, ignoring all car and hall calls and express to the lobby or assigned floor.

c. Cars travelling toward lobby shall express to lobby ignoring all car and hall calls. Cars parked on intermediate floors shall close their doors and express to lobby. Cars parked at lobby shall open their doors ignoring car and hall calls. All hall and car buttons shall extinguish and shall accept no further hall or car registration.

d. All elevators shall, in addition and where allowed by code, be provided with a key operated switch for use by in-house fire brigade.

e. The elevator contractor shall coordinate and cooperate with the fire detection & alarm system supplier / installer for his system interfacing responsibilities.

**Fireman Emergency – Phase - II**

Actuation of fire mode shall put all car functions as described here under fireman control by means of a key switch.

a. Hall button giving car call indication shall cause the doors to close.

b. Applying constant pressure to the door open button shall cause door to begin to open. Releasing the button before door is fully open shall cause the door to close.

c. Hall buttons shall be rendered inoperative.

d. Car position indicator shall indicate floor when car is within door operating range, and if in motion it shall indicate nearest floor by flashing. When a car is within operating zone, the position indicator shall light uninterrupted.

e. All electrical door safety locks shall remain effective.

f. Car position, direction of travel and floor conditions shall be displayed on the car position monitor in the lobby, and at elevator system monitor in engineering room.

g. Returning the car to the designated landing floor, deactivating the lobby switch shall render the car to original pre fire mode condition.

h. Resetting the Fire Alarm contacts in the car monitoring panel shall restore the system to normal condition.

**46. INSPECTION OPERATION - ALL ELEVATORS**

A switch shall be provided in the car to permit operation of the elevator from top of the car for inspection purposes, with car and hall buttons inoperative. Car shall travel at inspection speed not exceeding 0.5 m/sec. Motion of car shall require constant pressure to directional button.

**47. INDEPENDENT SERVICE (ALL CARS)**

A key operated switch shall be provided in the car operating station which, when actuated, shall disconnect the elevator from the hall buttons and permit operation from the car buttons only.

**48. HOIST GEAR**

The hoisting machine shall be gearless type for speed more than 1.7 m / sec and geared type for speeds of 1.5 m/sec or lower with motor, brake and traction drive sheave compactly
mounted on a continuous bed-plate and set on steel beams. Sound isolating pads shall be installed beneath the machine bed-plate to reduce vibration or air borne noise.

The hoisting machine shall be single worm geared traction type with motor, brake, gearing and driving sheave assembled on a steel base plate. The motor shall be reversible type particularly designed for elevator service with high starting torque and low starting current. Sound reducing material shall be installed under machine.

The machine shall be located directly above the hoistway. Foundation bolts shall be provided by the elevator contractor for building into the foundation furnished by others. Suitable beams shall be furnished for mounting deflector pulleys, if required by the elevator contractor.

Requirements for permanent lifting hooks hoisting beams and access hatches shall be indicated on the drawings by the elevator system, supplier / installer.

49. PASSENGER ELEVATORS

Passenger elevators shall conform to all details in these standards stipulated, unless otherwise differently arranged hereunder.

49.1 Elevator Cab

Cab dimensions shall be as detailed under technical data of this tender.

The car sill shall be flush with finished floor. Sill to sill space shall be as per manufacturer’s standard and not exceeding 25 mm. Cab height shall be as per technical data indicated in the tender.

49.2 Car Platform

Shall conform to ANSI/ASME/CENEN-81 specifications. To suppress the noise and drumming effects, the floor must be stiffened and preferably lined with fire retarded plywood or other material which will suit the proposed finish. All finishing materials shall be fireproof or fire resistant conforming to applicable codes.

The platform shall be mounted on rubber pads supported on an auxiliary steel frame fastened to the car frame. This arrangement shall form an isolating cushion between the car and frame for vibration and load weighing transducers.

49.3 Car Doors

Car doors shall, unless specifically stated, be center parting, automatic power operated, variable frequency door operator or PWM DC door operator and electronic door detector. Infrared light beams shall be provided to act as a safety curtain across the door entrance to monitor the door closing and function as a safety edge infra red light system to initiate door closure about 2 seconds after last light beam interruption. Light sensor shall override designated “door open period” on top and intermediate floors and shall on the lower level be inactive until the car has been designated as “next up” and given signal to close its doors.

Car doors shall be hung plumb and even, to within 1 mm. with minimum number of 4 gibbs per leaf. Floor gibbs shall be well fitted so as to prevent popping noise as a car passes structural members, or car in motion in a shared shaft, etc. Hoistway doors shall be hung plumb and show a maximum of 6 mm joint at sides, top and bottom and 2 mm at centre joint. Narrow door frame or jamb panel shall be supplied by elevator contractor. A soft chime shall ring prior to doors closing and opening.

49.4 Door Operation.

Upon the car reaching landing in response to a hall or car call, a soft chime in the car shall sound. Door opening shall commence when the car is 25 mm from the levelling. Door open period shall be adjustable to within a range of + 1 second. Door-open-period on all floors
except lobby floor shall be shortened to the extent that door closure will commence 2 seconds (field adjustable) following the sensor beam interruption by the last boarding or disembarking passenger. This period shall be adjustable to 1.5 seconds ± 1.0 seconds. Normal door-open-period at lobby floor shall be monitored by the car’s CPU. Door closure shall override “door-open-period” where car loading has reached by pass limit, or when another car approaches the lobby floor.

a. Doors shall be arranged to remain open for a time period sufficient to meet handicapped requirements. (Optional).

b. The time interval for which the elevator doors remain open when a car stops at a landing shall be independently adjustable for response to car calls and response to hall calls.

c. An approved positive interlock shall be provided for each hoistway entrance which shall prevent operation of the elevator unless all doors for that elevator are secured and shall maintain the doors in their closed position while the elevator is away from the landing. Emergency access to the hoistway as required by governing codes shall be provided.

49.5 Monitor Door Operation

Stopping in response to hall or car call, doors shall be normally kept open for a predetermined period of time. With Monitor operation, the door closing period is automatically shortened to approximately 1.0 seconds. Time open period feature must be field adjustable. Door open period shall be increased when the light ray senses a passenger leaving or entering the car.

50. CAR OPERATING PANEL

The car operating panel shall contain a bank of micro movement illuminated buttons marked to correspond to the landings serviced. It shall include a series of push buttons corresponding to the floors served, along with an emergency stop and switches required. Operating panel shall incorporate the following: floor buttons, door open/close, emergency stop/alarm, up/down in manual mode, man/auto key switch and seismic operation.

The emergency alarm button shall be connected to the 12 volt rechargeable battery circuit. A locked compartment integral with operating panel shall contain:

a. Auto/manual/inspection key operated switch.

b. Up/down button.

c. Fan switches

d. Synthesized voice announcements

On sounding of general fire alarm, the elevator shall if in motion, express to the ground floor. If stopped, the elevator shall open its doors and remain there until reset. Emergency talk-back system shall be provided, installed in integral cabinet and connected to the EPABX by the low tension contractor.

All Passenger Elevators of 13 passenger capacity and above shall be provided with 2 Nos. Car operating panels and freight elevator with 1 No. Car Operating Panel.

51. AUTOMATIC LOAD BYPASS

Transducers in the car platform shall monitor passenger load which shall override “pre-programmed door open period” and despatch the loaded car from the low terminal. The load weighing device shall also function in the same manner on all intermediate and top floors and in addition shall express to the next car call and ignore all hall calls. Hall calls
which are bypassed shall not be canceled. The automatic load bypass device shall be field adjusted for 50% - 75% of rated load.

51.1. **Operation – One Car Simplex (Passenger or Service)**

a. Operation shall be automatic by means of the car and landing buttons. Stops registered by the momentary actuation of the car or landing buttons shall be made in order in which the landings are reached in each direction of travel after the buttons have been actuated. All stops shall be subject to the respective car or landing button being actuated sufficiently in advance of the arrival of the car at that landing to enable the stop to be made. The direction of travel for an idle car shall be established by the first car or hall button actuated.

b. “UP” landing calls shall be answered while the car is travelling in the up direction and “DOWN” landing calls shall be answered while the car is travelling down. The car shall reverse after the uppermost or lowermost car or landing call has been answered, and proceed to answer calls and landing calls registered in the opposite direction.

c. If a car without registered car calls arrive at a floor where both up and down hall calls have registered, it shall initially respond to the hall call in the direction that the car was travelling. If no car call or hall call is registered for further travel in that direction, the car shall close its doors and immediately reopen them in response to the hall call in the opposite direction. Direction lanterns shall indicate the changed direction and initiate gong when the doors reopen.

51.2. **Operation**

Group Control for Passenger Elevators

a. The building shall be divided into three (3) zones with one car assigned to the “Lower” zone and the other car assigned to the top zone. Each car shall park in its assigned zone when there are no unanswered calls.

b. The lower zone shall include the lobby, lower levels, and adjacent floors immediately above the lobby. The remainder of the floors shall be divided between the top zone and the middle zone. Either car may answer calls in the middle zone, but neither car shall park in that zone.

c. The first car entering a parking zone without hall or car calls shall be assigned to that zone. The car in the lobby zone shall park at the lobby or other pre-designated floor. The car entering the top zone with no calls registered shall stop at the lowest floor in that zone.

d. Optimized response to hall calls shall be achieved by computing a relative system response (RSR) time for each registered hall call. The computation of each car’s RSR time to a call shall be based on, but not limited to, such relevant factors as distance, service to previously assigned car and hall calls, car load, direction, door and car motion status, and coincidence of car and hall calls. The car with the least RSR shall have such a call assigned to it.

e. RSR computations for each hall call shall be repeated several times a second and the hall call assignment might be changed if a more suitable car is found available.

f. A car arriving at a floor to park shall not open its doors. Cars shall open their doors only when stopping in response to a car or hall call.

g. If for any reason the doors are prevented from closing and the car is unable to respond to a call, it shall lose its zone assignment and the call shall be transferred to the other car.
h. When a car is filled to a predetermined load setting, it shall no longer stop for hall calls. Any registered hall call shall remain registered for the next elevator to respond.

i. When the independent service switch in the car operation station is actuated, that elevator shall be disconnected from the hall button riser/s and operate independently from car buttons only.

52. EXPANDED LOBBY ZONE ARRANGEMENT FOR HEAVY DOWN PERIOD

The group supervisory control system shall be arranged to include a number of consecutive floors above the main floor as part of the lowest zone. Upon completion of travel within the expanded lobby zone, the car assigned to that zone shall return to a predesignated floor.

52.1 Car to Lobby Operation

Provide a key operated switch for each elevator at the main floor which, when actuated, shall cause the corresponding elevator to make a trip to the lobby as soon as the car is available for response to the special call.

52.2 Next Car Up

“Next Car Up” shall be indicated by flashing of lantern for the car so designated at the lobby. Other cars shall remain parked with doors closed until each car, in turn, is assigned as “Next Car Up”.

52.3 Express Feature

Express feature shall be extended to hall call of 30 seconds or longer due to bypassed floors.

52.4 Express Priority Service (Optional)

a. A key switch and signal light shall be provided at each selected landing for the purpose of providing an express priority service to each such landing. The control system shall compute the relative response times (RST) of all available designated elevators to service the call, based on the position and direction of the elevator relative to the priority floor, and also based on its door status, and select the car which has the shortest predictable response time (SPRT). Each car may be assigned to only one priority call at a time, and all cars which are designated to provide express priority service which are in service, and which have not already been selected and assigned to a call, may be selected simultaneously. The cars which are to provide express priority service shall be designated by contract.

b. Should the selected car fail to respond to its assigned priority call within an allowable time interval (due to unpredictable circumstances, such as the failure of its doors to close), selection shall automatically be passed on to another car, based on the aforementioned computations.
c. Each selected car shall cancel all registered car calls and bypass all hall call on its way to its assigned priority landing. When the car arrives at the priority landing, it shall remain with doors open for a predetermined period of time. If not placed in service the doors shall close, and the car shall automatically return to normal operation.

d. The signal lights shall be illuminated while a car is responding to a priority call, and shall be extinguished when the car has opened its doors at its assigned priority landing.

53. DESPATCH SYSTEM

The dispatch system shall be micro processor based. The system’s main computer shall communicate with each car’s computer. Microprocessor shall be intelligent in that it learns traffic patterns and applies best solution to each traffic condition, as determined by shortest predictable response. The CPU shall monitor demand on the system and shall execute the most economical assignment of cars.

54. ELEVATOR CAB

Car shall be detailed by the Architect or Interior Designer.

The cab manufacturer shall make provisions for ventilation inlets at the bottom of the cab (concealed from passenger’s view) and exhaust fan (concealed) at ceiling.

The car sill shall be flushed with finished floor. Sill to sill space shall not exceed 25 mm. Cab height, conditions permitting, shall be as per specification. The elevator contractor shall coordinate with electrical contractor to provide normal and emergency power and lighting to each elevator.

55. BUILDING AUTOMATION SYSTEM REQUIREMENTS

The Elevator Panel should have the following Provisions

1) It shall be able to accept signal from the Fire Alarm Panel in case of fire and automatically ground the elevator on receipt of this signal.
2) Potential free contact to indicate elevator trip status.
3) Potential free contact to indicate elevator alarm status.
4) Potential free contact to indicate Emergency Activation Switch status.

FAS contractor shall provide necessary cabling up to Elevator Panel and termination shall be done by Elevator contractor.

Software Interface.

The Lift microprocessor panel should be compatible with BAS and should be able to communicate with the BAS in any of the following standard protocol like MODBUS, LONWORKS, BACNET etc. In case of multiple lifts having individual microprocessor panels it should be possible to network all microprocessors panels and be connected to a master controller. BAS communication cable can be integrated directly to the master controller or in case master controller is not available it should be possible to integrate each Microprocessor controller to the BAS system. It should be possible to monitor the following data points through software integration.

1) Elevator car position.
2) Fire Emergency signal monitoring.
3) Elevator Attendant Mode.
4) Elevator Alarm Mode.
In case of fire it should be possible to control the life through software interface. All necessary hardware including interface card and accessories necessary for integration with the BAS system has to be provided by BAS contractor.

56. ADDITIONAL INFORMATION

Tenderer shall enclose with their offer the following additional information:

a. List of installation of 1.0 mps & above installation completed by the tenderer during the last 5 years.

b. Details of “In-House” facilities for testing and inspection of elevator materials.

c. Details of service facilities in India.

d. Confirm that elevator may be operated on DG sets and provide power characteristic to design the generator capacity.

Tenders shall submit details / samples / photographs / catalogues for following. These shall be relevant to the project and the contractor shall indicate which of these are being offered in the bid.

a. Hall Lantern

b. Car Operating Panel.

c. Hall Buttons

d. Group Indication panel.

e. Option for stainless steel finishes