



**TECHNICAL CELL, EPC MISSION,
PLANNING DEPARTMENT, LUCKNOW,**

**As Executing Agency of
Environment, Forest & Climate Change Department,
Government of Uttar Pradesh**

**E-Tender For
“Design, Engineering and Procurement for
Construction of Horticulture and Forestry University at
Gorakhpur,
Uttar Pradesh, INDIA on EPC basis”**

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TECHNICAL SPECIFICATIONS

All works shall be carried out as per

PART 1 - CPWD Specifications 2019 Volume I & Volume II with latest amendments for civil works of buildings and roads, external works.

PART 2 - CPWD General Specifications for Heating, Ventilation & Air-Conditioning (HVAC) 2017 including amendments

PART 3 - CPWD General Specifications of Electrical Works SCHEDULE 0 - Part-I Internal 2013 including amendments SCHEDULE 1 - Part-III-Lift & Escalators 2003

SCHEDULE 2 - Part-IV Sub Station 2013

SCHEDULE 3 - Part V Wet Riser & Sprinkler Systems 2020 SCHEDULE 4 - Part VI Fire Detection and Alarm System 2018 SCHEDULE 5 - Part VII D.G. Sets 2013

SCHEDULE 6 - Part VIII Gas Based Fire Extinguishing System 2013

PART 4 - CPWD General Specifications of Horticulture & Landscaping 2020

Refer drawings and schedules: Work shall be carried out with specifications in this document with project specific requirement and most stringent requirements shall be followed in case of discrepancy between documents such as specification, Scope of work. DBR, drawings. The minimum standards required to be achieved are defined here in this document. .

SECTION-01: EARTH WORK

1. EXTENT AND INTENT

The work under this section covers all operations listed below in connection with building construction and site development work.

- a. Clearing and grubbing
- b. Grading
- c. Excavation including removal of top soil.
- d. Filling and Back Filling
- e. Removal and disposal of surplus material
- f. Bringing sweet earth from outside where required
- g. Hard stone soling to floors and paving
- h. Anti-termite treatment to foundations and floors

The contractor shall provide all materials, labour, equipment, operations and incidental necessary and required for the completion of all aspects of work listed above as called for in the drawings and specifications.

2. GENERAL

The contractor shall visit the site, inspect the bore holes and decide for himself the nature of the ground and the subsoil to be excavated. No claim of extras will be entertained in consequence of any misunderstanding or in correct information or ignorance of existing conditions.

3. ANTIQUITIES

Any ancient carvings, relics, coins or other curiosity discovered during the excavation or other work, remain the property of the Owner and shall be handed over to the Consultant as called for under relevant clause of Conditions of Contract.

4. EXCAVATED MATERIALS

Any sand, gravel or similar useful materials obtained from excavation at site shall be the property of the Owner and shall not be disposed of or used in the construction of the works without prior written consent of the Consultant. It is the intention of this contract that all benefits accruing from materials within the site shall pass to the Owner and the fair market price of any such material disposed of or used shall be alleged to the Owner by the Contractor and the contract sum adjusted accordingly.

Borrow pits shall not be dug on the site without the prior written consent of the Consultant.

5. CLEARING

The contractor shall clear the site of all rubbish and buildings, remove all grass and low vegetation only after consultation with the Consultant as to which bush, trees and buildings shall be saved. All disused foundations drains, or other obstructions met with during excavation shall be dug out and cleared at contractor's own expense.

6. BENCHMARKS

The contractor shall erect sufficient permanent benchmarks in suitable locations for all the buildings before starting work, from which all important levels shall be laid out. Exact levels of all floors shall be set. A qualified surveyor shall be engaged by the contractor to locate all buildings, paths, roads, utility lines, etc. Contractor shall provide all pegs, flags, pillars and labour required for setting out.

7. EXCAVATION

Excavation for foundations, footings, trenches, paving, walkways, etc., as called for on the drawings shall be generally made to net widths required by the drawings. "Battering" or "Benching" to the sides of excavation shall have prior approval of the Consultant. Extra excavations (i.e. excavations beyond the limits required by the drawings), "Battering" and "Benching" carried out without the prior approval of the Consultant will not be measured, and such unauthorized excavations shall be filled up to the proper level with concrete of the same type and mix as for foundations or as ordered by the Consultant at contractor's own expense.

All soft spots and loose pockets shall be dug out and filled with cement concrete 1:4:8 well rammed and consolidated. Clear out all sludge and slush before laying foundation.

8. EXCAVATION IN ROCK

All rock excavation shall be carried out by crowbars, chiseling or burning. Blasting shall not be carried out without the written permission of the Consultant. Roughly level or shelf bottom as required and avoid shattering or removing rock beyond authorized lines and grades.

9. STACKING OF SOIL

Excavated materials shall not be placed within 1.5 meters of the edges of trench or half the depth of the trench, whichever is more.

10. WATER IN EXCAVATION

All water which may accumulate in excavation from all causes is to be baled, pumped out or otherwise removed. Adequate pumping or other facilities shall be employed to keep all excavation clear of water constantly. Care shall be taken to see the water is not discharged where it will cause damage to buildings or other property or cause inconvenience in the legitimate use of the property. During excavation the contractor shall take particular care to avoid damage to drains, water mains, underground work and services. Should any damage be done, the Consultant is to be notified immediately and the damage made good at the contractor's expense. Pipes, cables, etc., met with during the excavation are to be properly slung or otherwise supported.

11. NOTIFICATION TO CONSULTANT

The Contractor shall notify the Consultant when excavation is ready for inspection and no foundation shall be put in before the excavation has been approved by the Consultant. He shall give Consultant at least one working day notice.

12. PROTECTION

The contractor shall protect the excavation from the effect of in element weather or other damage or make good such damages to the satisfaction of the Consultant.

13. DRESSING

Pit and trench bottoms shall be smoothed and tightly rammed to a uniform surface.

14. FILL MATERIAL

Fill materials required for fill and back fill shall be subject to the approval of the Consultant. Fill materials shall be hard and free from all soft or spongy material. Clods or rocks over 20cm in greatest dimension shall not be placed within 30cm of grade. No material over 8cm in size shall be placed in the upper 15cm of fill. Fill under floors, terraces and concrete beds shall be free of saltpeter, white ants etc.

15. FILL COMPACTION

The fill shall be spread in layers not exceeding 15cm thick and each layer shall be watered and thoroughly consolidated with a ten (10) tonne roller. At locations where rolling is not possible, the filling shall be carried out in layers not exceeding 15cm thick and each layer rammed with heavy rammers till the required level is reached. The fill shall then be flooded with water for at least 24 hours, allowed to dry and then rammed and consolidated again. The finished surfaces shall be formed to correct lines, levels, slopes, shapes etc as required. Fills at building structures, walks, paths etc. shall not be executed until all foundations, footings etc. have been inspected and approved by the Consultant.

Return and fill in around foundations, walls etc., as described above and bring grades upto either original ground levels or as required by the drawings when different from original grades.

16. FINISH GRADING

Finish grading shall be done with fertile top soil over those are a noted as "planting" on the plans. Depths of top soil shall be 15cm minimum. Top soil shall be approved by the Consultant before placement.

17. REMOVAL

Removal of excavated materials includes the separation of the useful from the useless portion (what is useful and what is useless is left to the sole discretion of the Consultant) and depositing the former in regular heaps and removal of the latter. Surplus earth, if any and useless spoil shall be carted away from the "site" and disposed as directed at Contractor's cost. Disposal shall be at authorized dumping grounds only.

18. PLANKING, STRUTTING AND SHORING

The Contractor shall be responsible to adopt such measures as may be needed to uphold the sides of excavation and also protect excavation against the sides of public utilities and services and other structures. The rates for excavation shall include use and waste of timber or steel work, as planking and strutting including wales, struts and open or close poling boards as directed by the Consultant.

19. HARD-CORE

Hard-core (stone soling) under floors and other locations where called for, shall be approved hard broken stones 50mm and down.

The stones shall be hand packed in position, interstices between stones packed with smaller chips and the surface thoroughly, rolled with a 10 ton roller, with frequent watering. The surface shall then be blinded with moorum, watered thoroughly and consolidated with a 10 ton roller to required grade and profiles. Earth shall on no account to be used for making godor blinding purposes. Where rolling as described above is not possible, the consolidation shall be carried out using heavy hand rammers and light manually operated rollers. The consolidated thickness shall be as shown on the drawings.

20. ANTI-TERMITE TREATMENT

Designed Buildings shall be adequately protected against attack by subterranean termites by suitable chemical treatment measures. The work shall be carried out by a specialist pest control agency approved by the Consultant.

The pest-control agency to be selected by the Consultant shall be a member of the Indian Pest Control Associations.

The work to be carried out by the specialist firm shall carry a guarantee of the satisfactory performance of the treatment for a minimum period of TEN (10) YEARS.

The treatment shall be carried out generally in accordance with the stipulations laid down by IS:6313 (Part II)-1971 (Code of practice for Anti Termite Measures in Buildings - Part II - Preconstruction Chemical Treatment Measures) subject to the minimum requirements given in this specification.

Minimum Specification The earth filling immediately under the stone soling (under floors), bottom and side fills of all foundations (excepting RCC foundations) and soil along external perimeter all buildings shall be chemically treated against termites. The chemicals to be used for the treatment shall be DILDRIN, ALDRIN, HEPTACHLOR or CHLORDANE conforming to the requirements and concentration laid down in IS:6313 (part-II)-1971.

Application The chemical solution shall be prepared by mixing the chemical with the appropriate quantity of water to obtain a chemical emulsion of the correct concentration as stipulated above. The prepare emulsion shall be applied as described below.

Column Pits, Wall trenches, etc The bottom surface and sides of the excavations (upto a height of 30 cm from the bottom) made for column foundations, wall foundations, etc., (excepting RCC foundations) shall be treated with the chemical emulsion at the rate of 5 litres per sq.m. of surface area.

Treatment to Back-Fill

After the column foundations, wall foundation etc., have come up, the back fill in immediate contact with the foundation structure shall be treated at the rate of 15 litres per sq.m. of the surface of the sub-structure for each side. If water is used for ramming the earth fill, the chemical treatment shall be done after ramming operation is completed by rodding earth at 15 cm centres close to the wall face and spraying the chemical with the above doze. The earth is to be returned in layers and the treatment shall also be carried out in similar stages. The chemical emulsion shall be directed towards the masonry wall surfaces so that the earth in contact with these surfaces is well treated with the chemical. .

In the case of RCC walls and columns, the treatment shall start at the depth of 50 cm below natural ground level. From this depth the back fill around the RCC columns, walls, etc., shall be treated at the rate of 15 litres per sq.m. of the surface.

Top Surface of Plinth Filling: The top surface of the plinth fill (just below the stone soling) shall be treated with chemical emulsion at the rate of 5 litres per sq.m. of the surface before the stone soling is laid. If the filled earth has been well consolidated and does not permit the emulsion to seep through, holes upto 50 to 75 mm deep at 150 mm centres both ways may be made with crowbars to facilitate saturation of the soil with the chemical emulsion.

Junction of Wall and Floor: A channel of size 3 cm x 3 cm shall be made at all the junctions of walls and columns with the floor (before laying the soling) and rod holes made in the channels upto the ground level at 15 cm centres. The solution is poured into the channel at the rate of 15 litres per sq.m. of the vertical surface and allowed to soak through the holes so that the soil in contact with the column/wall is fully soaked with the chemical. The soil shall be tamped back into the channel and consolidated to original condition.

External Perimeter of Building: After the building is complete, holes shall be made along the external perimeter of the building at intervals of 15 cm and depths of 30 cm and the emulsion shall be allowed to soak through these holes fully at the rate of 5 litres per running meter of the perimeter wall.

Soil Surrounding Pipes: Wherever any service pipes enter the soil inside the area of the foundation of any buildings, the soil surrounding the point of entry of each pipe at the foundation, floor, etc., shall be fully soaked with the chemical solution for a distance of at least one meter from the point of such entry.

Expansion Joints: Soil beneath expansion joints at ground floor level shall be specially treated as directed. The joints itself shall also be treated by the Consultant.

Treatment under Aprons: The soil below the concrete or stone aprons to be provided around the perimeter walls of all buildings shall also be treated with the chemical solution at the rate of 5 litres per sq.m.

Treatment over DPC: Top of concrete damp proof in external and internal walls

Shall be given a liberal coat of chemical solution when the concrete is still green.

Spraying Equipment: To facilitate proper penetration of the chemical into the soil, a pressure pump of adequate capacity and sprayers shall be employed to apply the solution.

Payment: The contractor shall be paid on the basis of the plinth area of the building at ground floor, excluding open courts, aprons (paved or unpaved) for carrying out the work in accordance with his own specifications subject to the minimum requirements described above and in IS:6313 Part II) - 1971.

21. OTHER SPECIFICATIONS:

For specifications of items not included above and other related miscellaneous items, specifications shall be taken from latest relevant CPWD specifications.

SECTION-02::CONCRETE WORK – PLAIN & REINFORCED

1. Extent and intent:

The contractor shall provide all labour, materials, operations, equipment and incidentals necessary and required for the completion of all concrete work called for.

2. General:

It is the intent of this specification to ensure that all concrete placed at various locations on the job, should be durable and strong. It should wear well and be practically impervious to water. It should be free from such defects as shrinkage, cracking, honey-combing, and spalling of the surface. Unless otherwise called for in this specification, all plain and reinforced concrete shall conform in all respects to Indian Standard 456.

3. Materials

Cement: Ordinary/rapid hardening Portland cement conforming to IS: 269 shall be used. Cement shall have uniform colour. Cement shall be fresh when delivered at site. Consignment shall be used in order of delivery. Admixtures (such as accelerators, retarders, waterproofers, etc. shall be used only after approved by the ICT-SDEC Engineer and subject to IS: 456.

Water: Water used for mixing concrete shall be in accordance with IS: 456. The contractor shall produce test results for the mixing of water used on the job, when requested by the ICT-SDEC Engineer.

Aggregates: Aggregates (fine and coarse) should be hard and should not contain materials that are likely to decompose or change in volume when exposed to the weather or to affect the reinforcement. All aggregates shall be clean and free from organic impurities. The aggregates shall be free from coatings of dust and clay. Coarse aggregate shall be machine crushed hard stone and fine aggregate shall be coarse river or pit sand, and both obtained from approved source.

Sand shall be screened and washed by mechanically operated equipment, if the deleterious materials content exceeds 5 percent by volume. All aggregates used shall conform to IS:383. If aggregates are wet, due allowance shall be made for bulking in accordance with IS:2386 (partiii).

Unless otherwise specified, the size of coarse aggregates shall conform to IS:456.

All aggregates shall be suitably graded from the maximum certified gauge to the minimum. The contractor shall submit a sieve analysis of the aggregates to be used on the works and maintain a regular record of sieve analysis during the currency of the work. The grading of the aggregates will be determined from these sieve analysis so as to produce maximum density of concrete. All expenses of sieve analysis, mix design and trial mixes shall be borne by the contractor.

Fly ash: Upto 20% cement by weight may be replaced with fly ash during finalisation of mix design.

Admixture: Appropriate admixture for reduction of w/c ratio and retarder shall be used as per the approved mix design.

4. Storage

Cement shall be stored in accordance with IS:269. Any cement which has become wet, shows any sign of caking, or deterioration, or contamination of any kind shall not be used, and shall be immediately removed from the site. Fine and coarse aggregates shall be stored in separate open bins according to sizes. The bins shall have brick walls of adequate thickness and floor paved with flat bricks.

5. Design Mix Concrete

Design mix concrete is that concrete in which the design of mix i.e. the determination of proportions of cement, aggregate, and water is arrived as to have target mean strength for specified grade of concrete.

The contractor shall design the mix suitable for obtaining the specified strength and required workability. The mix designs proposed to be adopted by the contractor shall be submitted to the ICT-SDEC Engineer for his approval. All aggregates and cement shall be measured by weight in approved weigh batching equipment. Trial mix shall be tested for workability. With each trial mix at least 3 specimen test cubes should be made and crushed at 7, 14 and 28 days to ensure that the requisite density and strength is obtained. The cube strengths obtained from trial mix should be the recommended percent higher than the works cube strengths specified for the different categories of controlled concrete.

6. Mix proportions

All controlled concrete wherever specified on the drawings shall belong to one of the grades described below and shall meet with the strength requirements laid down in table ii of IS:456. The aggregate cement ratio and water cement ratio and water cement ratio to be used for obtaining the specified test cube strengths given below, shall be determined in accordance with the design of the mix.

All aggregates and cement shall be measured by weight in an approved weigh batching equipment and water in graduated litre cans.

Grade of Concrete	minimum compressive strength of 15cm cubes at 28 day	
	Preliminary(trial) Testcubes	works testcubes
M15	20 N/mm ² .	15 N/mm ²
M20	26 N/mm ² .	20 N/mm ² .
M25	32 N/mm ² .	25 N/mm ² .
M30	38 N/mm ² .	30 N/mm ² .
M35	44N/mm ² .	35 N/mm ² .

7. Water-cement ratio

The water-cement ratio shall be carefully controlled throughout the work. This calls for a regular check on the equipment used for measuring water. The water-cement ratio shall be as determined by the mix design shall be strictly adhered to. While determining the amount of mixing water, moisture content of aggregates shall be taken into account. Any additional quantity of water, if used to improve the workability shall be accompanied by an equal volume of cement, but in any case such additional use of water shall be subject to approval of the ICT-SDEC Engineer.

8. Mixing

All concrete, whether plain or reinforced, shall be mixed in a standard type batch mixer; The proportions shall be as per the recipe of the approved concrete mix. Water shall enter the mixer first but continue to flow while other ingredients are entering and water should enter well inside the mixer. Water charging shall be complete within first 25% of the mixing time. Cement shall be charged along with other materials but it shall be ensured that cement enters the stream after approximately 10% of aggregate is in the mixer. Admixtures shall be charged to the mixer at the same time in the mixing sequence for every batch. Liquid admixture shall be charged with water. Powdered admixtures shall be sprinkled into the mixer with other dry ingredients. When more than one admixture is used, they shall be batched separately and they shall not be premixed before entering the mixer.

9. Transportation

Concrete may be transported through Transit mixers and then through concrete pumps or directly pumped after batching plant to be poured in the desired location. When transporting concrete by transit mixers, delivery time shall be 1.50 hours from the time cement has entered the mixer to completion of discharge.

10. Pumping of Concrete

The pumping capacity of the pump should be sufficient for horizontal and vertical head so as to discharge the concrete at the desired location. However the minimum horizontal range shall not be less than 150m and minimum vertical range shall not be less than 50m. As a guideline the contractor may assume a discharge capacity of 15 cum/hour/pump.

All concrete carrying pipe lines shall be rigid pipe lines. Flexible pipe lines may only be used at discharge ends. Minimum pipeline diameter shall be 100 mm and shall have normal maximum length of 3m in each section connected through couplers; couplers to be used for connecting pipe line sections shall have adequate strength to withstand stresses due to handling, misalignments poor support to pipe line etc.

Before pumping concrete into the pipeline, the line shall be lubricated with properly designed mortar/ grout lubricant. This shall be ensured by starting the pumping operation with a properly designed mortar, or with a batch of regular concrete with the coarse aggregate omitted. As a guideline, for a 100mm dia pipe line of 100m length, 0.08 cum to 0.10 cum of mortar should normally be adequate but this shall not be taken as specified. The quantity of mortar that comes out of the delivery end shall not be used in place of the concrete work. However, with the approval of the ICT-SDEC Engineer this mortar may be used as bedding mortar against construction joints. The rest of the mortar shall be wasted.

The pump shall be placed as near the placement area as practicable. The surrounding area of the pump shall be free from obstructions to allow movement of concrete delivery trucks. The surface must be strong enough to withstand the loaded trucks operating on it and the vibrations made by the pumping pump.

It is essential that direct radio/ telecommunication be maintained between the pump operator and the concrete placing crew. Good communication between pump operator and the batching plant is also essential

11. Placing concrete

The forms shall be well wetted before placing concrete. Concrete should not be dropped from a height greater than 2 meters. A properly constructed chute shall be used in such cases where it is necessary to exceed this height. Concrete must be thoroughly worked into the forms so that they are entirely filled, reinforcing bars adequately and tightly surrounded and entrained air released from the mass of concrete. Placing shall be carried out by hand punning as well as vibrators in the manner directed by ICT-SDEC Engineer. Concrete should not be moved any considerable distance in the moulds, being consolidated as nearly as possible in the place where it is dumped. The full depth of any lift shall be placed at one pouring. In casting beams or other deep sections concrete shall not be placed in layers.

12. Consolidation

All plain and reinforced concrete shall be consolidated by means of mechanical vibration. Adequate number of vibrators shall be used to ensure full compaction of concrete in about 10 minutes of placing. If immersion vibrators are used, these shall be inserted at places not exceeding half meter apart until it is immersed to the full depth of concrete. Wherever possible shutter vibrators shall be used and the contractor shall design his shuttering so that this can withstand form vibration. Care shall be taken to ensure that concrete is not over vibrated so as to cause segregation. In addition to mechanical vibration, sufficient hand tools must be used to ensure full consolidation around reinforcement and at all edges and corners.

13. Construction joints

Construction joints shall be made only where shown in the drawings or approved by the ICT-SDEC Engineer. The procedure given in IS:456 shall be used for general guidance. All laitance shall be removed from the concrete before it is allowed to fully harden. The removal shall be effected by scrubbing the concrete surface with wire and bristle brushes and washing down to expose the aggregate clearly, care being taken to avoid dislodgement of particles of aggregate.

if the concrete has been allowed to harden excessively, the surface shall be chipped over its whole surface to a depth of at least 10mm and thereafter thoroughly washed. Before fresh concrete is added on the other side of a construction joint, the surface of the old concrete shall be thoroughly wetted and covered with a thin layer of cement mortar 1:2.

Vertical joints

At the ends of any day's work or run of concrete, the concrete should be finished off against temporary shutters top which should be vertical and securely fixed.

The stop should remove as early as the weather permits.

14. Testing

Testing of cubes: specimens of the concrete used in the work shall be taken at intervals for crushing strength and density measurements. Test cubes shall be made and tested strictly in accordance with IS:456 and IS:516. Three to six cubes should be made for each sampling, subject to minimum requirements specified in table v of IS:456. However, cubes shall be taken for all important structural members as directed by the ICT-SDEC Engineer regardless of the quantity of concrete involved in such members or volume of concrete laid on any particular day. They should be taken out of the moulds 24 hours after casting and stored in a moist condition until the time of test. The contractor shall carry out the tests as described above under the direction of the ICT- SDEC Engineer. All costs relating to sampling of concrete, preparation of cubes, testing and other incidentals shall be borne by the contractor.

All concrete, the test results of which fall below the "acceptance criteria for concrete" listed in IS:456 shall be classified as substandard concrete. All such substandard concrete shall be removed and replaced with concrete of specified strength at the contractor's own cost and risk.

All items of work related to such rejected concrete shall not be paid for.

15. Inserts

The contractor shall fix all necessary inserts such as steel plates, pipe sleeves, bolts, etc., and make provision for holes, pockets, dowels, etc., in the shuttering of concrete work, to enable subsequent fixing of supports, brackets, ceilings, precast members, etc., as indicated on the drawings or as required by the ICT- SDEC Engineer.

16. Curing of concrete

All exposed faces of concrete shall be covered with Hessian, sand or similar material which shall be kept continuously wet for a period of at least 15 days after casting. Horizontal surfaces shall be cured by impounding water in cement mortar bunds. After removal of Hessian or sand, all concrete surfaces shall be kept well wetted by applying water at intervals for a further period of at least three weeks.

17. Reinforcement

Steel reinforcement shall be either High Yield Strength Deformed bars or thermo – Mechanically Treated (TMT) with a guaranteed minimum yield strength of 500 N/mm² as called for on the drawings, conforming to IS:1786. Fabric reinforcement where called for in topping slabs or pre-cast concrete units shall be of hard drawn mild steel wire mesh conforming to IS:1566. Bars shall be free from millscale, loose rust, oil or paint. The reinforcement bar bending schedule shall be prepared by the contractor and submitted to the ICT-SDEC Engineer for his scrutiny and his concurrence obtained before commencing fabrication. Fabrication shall be accurately done to the dimensions, spacing and minimum cover as shown on structural drawings. All steel shall be rigidly held in place with 18 gauge annealed steel wire. Cement mortar (1:2) cover blocks of required shape, MS chairs and spacers bars shall be used in order to ensure accurate positioning of reinforcement.

All joints in mild steel reinforcement up to and including 16 mm dia, shall be overlapped. The lengths of overlap for tension and compression joints shall be as indicated on structural drawings. Joints in mild steel reinforcement above 16 mm dia may be welded if permitted by the ICT-SDEC Engineer in writing.

The rate for reinforced cement concrete includes straightening and un-coiling of rolls of reinforcement. No extra payment for straightening and/or un-coiling of reinforcement shall be payable.

18. Cover to reinforcement

Care shall be taken to maintain the correct cover to reinforcement. Unless otherwise specified on the drawings, the following minimum covers (exclusive of rendering or other decorative finish) shall be provided in all reinforced concrete work.

For concrete members exposed to the atmosphere, action or harmful chemicals (as in the case of concrete in contact with earth faces contaminated with such chemicals), acid vapour, saline atmosphere, sulphurous smoke etc., covers given above shall be increased by 15 mm to 40 mm as directed by the ICT-SDEC Engineer. For concrete members of water retaining structures, covers for reinforcement shall be as stipulated in IS: 3370-(part II).

19. Form work-general

Formwork shall be rigidly constructed of minimum 40 mm thick wrought, timber planking or steel plates or plywood. Timber used for shuttering shall be free from loose knots. Shuttering faces in contact with concrete shall be free from adhering grout, projecting nails, splits or other defects that may mar the concrete surface. The shuttering shall be erected on battens, beams and steel props properly cross braced or cup-lock system so as to make the formwork rigid.

The formwork shall conform to the shape, lines and dimensions as shown in the plan. It shall be sufficiently rigid and strong to maintain correct shape of the members during deposition of concrete and shall be able to resist forces caused by vibration of concrete and incidental loads, associated with men working over it. The shuttering shall have smooth and even surface and its joints shall not permit leakage of cement grout.

Formwork shall be erected true to line and levels and to the shapes required in the work and shall carry, without deformation, the full weight of wet concrete and other live loads. It should also withstand the effect of vibration without deflection, bulging, distortion or loosening of its component parts. The contractor shall be responsible for sufficiency and adequacy of all formwork, centering and moulds.

If at any stage of working during or after placing concrete in the structures, the formwork caves or bulges out beyond the required shape of the structure, the concrete shall be removed and work re-done with fresh concrete and adequately rigid formwork at Contractor's cost. Details of shuttering and centering shall be subject to the approval of the Engineer-in-charge. The completed formwork shall be inspected by the Engineer-in-charge, before the reinforcement bars are placed in position.

Camber: The shuttering on beam and slabs shall have camber of 4 mm per meter (1 in 250) or as directed by Engineer-in-charge, so as to offset the subsequent deflection. The cantilevers, the camber at free end shall be 1/50th of the projected

length or as directed by the Engineer-in-charge.

It may be necessary to make holes in the shuttering of RCC columns for projecting bars. The tendered rates shall include the cost providing the above-mentioned services, grooves etc. and no extra payment shall be made to the contractor for making these provisions nor any deduction shall be made on account of any saving in RCC due to these modifications.

The formwork for the RCC chhajjas will be so made that the Iriecoar band (including the parti and the drip) is cast along with the chhajjas. No extra payment shall be made for this drip course band.

Details of centering and form work shall be subject to approval of the ICT-SDEC Engineer. The completed form work shall also be subject to approval by the ICT-SDEC Engineer before placement of reinforcement.

The form work shall be designed so that the soffits of slabs and the sides of beams may be removed first leaving the form work to the soffits of beams and their supports in position. Wedges shall be so provided as to allow accurate adjustment of form works and its easy removal.

All joints shall be sufficiently tight to prevent leakage of grout. Chamfer fillets shall be provided at all corners wherever called for on the drawings. Clean-out holes shall be provided at the bottom of all column and pier form work and care shall be taken to remove any rubbish, wood shavings or any other foreign materials before concreting. Temporary supports shall be provided as required and/or ordered by ICT-SDEC Engineer.

Form work for walls of water tanks, basements and other locations and fascias, parapets and other similar vertical members shall be held together rigidly by means of form ties of suitable length. The form ties shall be approved design and type and have a minimum working strength of 1500 kg. The ties shall be free of lugs, cones, washers, etc., which level a hole larger than 20 mm dia or depressions back of exposed surface of concrete.

20. Exposed concrete formwork.

Formwork for exposed concrete work shall be of wrought hard wood timber planks, free from loose knots. The planks shall be 40 mm thick, 100mm to 125mm wide with tongue and groove joints, assembled to pattern approved by the ICT-SDEC Engineer. The formwork shall be so constructed, braced and styled as to remain absolutely rigid and true during and after pouring. The boards shall be planned and thickness in order that the surface against the concrete shall not be broken at joints between boards. Chamfers, grooves, drips, mouldings, bevelled edges, etc., shall be made in the form itself to the size, profiles and details called for on the drawings.

The contractor shall provide 19mm thick shuttering quality plywood of approved make in place of timber plank shuttering mentioned above for such locations as called for by the ICT-SDEC Engineer. The joints in the plywood shuttering shall be located as directed by the ICT-SDEC Engineer. The plywood shall be properly cut and adequately framed with timber to produce true surfaces and approved pattern.

21. Surface treatment of shuttering

The surfaces of shuttering coming into contact with concrete shall be coated with shuttering oil of approved manufacture. Shuttering oil shall be applied before placing reinforcement. The shuttering shall be thoroughly cleaned and oiled before each use.

22. Removal of formwork

All form work shall be kept in position until expiry of a minimum period after concreting as specified below:-

i	Forms supporting sides of beams, walls and columns	2days
ii	Bottom of slab upto 4.50m span	7days
iii	Bottom of slabs above 4.50m span	14days
iv	Bottom of beam up to 6.00m span	14days
v	Bottom of beam above 6.00m span	21days

22. Surface finish of concrete

All formwork, centering and shuttering used for unexposed concrete work shall be rigid and straight, so as to produce all concrete members true to line level and plumb within a tolerance of ± 3 mm. Only cement mortar rendering of maximum thickness 6mm may be permitted as finishing to concrete surfaces except where terrazzo, ceramic tile or other finishes are specified. Shuttering centering and formwork to be used for all exposed concrete work (like exposed columns, beams, ribs, slabs, chajjas, facias, etc.) Shall be of such finish and rigidity as to produce all faces fair and smooth true to line, level and plumb. No rendering or touching up shall be permitted on these faces.

24. Rates:

For all items of reinforcement concrete, the tendered rates shall include supplying and removal of scaffolding there required, supply of formwork, shuttering and centering etc. of approved design, their erection, dismantling, clearing and cleaning, etc. cutting, hooking, bonding, binding bending and straightening of steel section binding & placing in position of reinforcement etc. complete manufacturing the reinforcement required as per drawings, its placing in position as per plan, screening or washing the aggregate concrete mechanically and placing the same in position & use of equipments including mechanical mixers, vibrators etc. all watering during the work and curing for the prescribed period after works & finished exposed surface.

Ferrocement roofing sheets, U shaped cover strips, wall cladding panels, gutter sections both horizontal and vertical down take units and louvers shall be cast to the dimensions, shapes and thickness as shown in the drawings. To ensure better finish impermeability and uniform sections, the casting including vibration shall be done by semi-mechanized process, in covered casting yards.

Materials :

Cement: Ordinary Grey Portland as per IS:269

Sand : Well graded as per IS : 383 not exceeding 2.36mm size Mixture of coarse (Ganga) and fine river sand in equal proportions may be used.

Reinforcement: M.S. rounds 3 to 5mm size as per IS:432 (Grade I) double galvanised.

12mm Mesh of double annealed double galvanized 20 gauge wires.

Admixtures: Integral water proofing compound as per IS : 2645 or other approved equivalent compounds Plasticizers may be used for better workability.

Casting: Suitable moulds of concrete, ferrocement, plywood or GI sheet lined wood or steel may be used. Moulds shall be true to sizes and dimensions. To ensure smooth demoulding and proper surface, mould oil or plastic sheets may be used to cover mould surfaces. Reinforcement cages of bars & properly stretched mesh shall be rigid enough to withstand handling and retain their intended shapes while casting. Suitable M.S. inserts shall be kept at appropriate places in the reinforcement cage as per the drawings. Mix of cement mortar shall be 1:2 (1 cement : 2 sand) and water cement ratio assumed 0.4 to 0.5 depending upon the casting process employed. Uniformity of size particularly thickness shall be ensured. A cement slurry finishing coat shall be given to the exposed surfaces as approved. Curing shall be done by immersion in water for 28 days using suitable tanks/vats.

Handling of the units and stocking in store yard shall be done properly to avoid any damages to the units.

SECTION-03: BRICK /BLOCKWORK

1. EXTENT AND INTENT

The contractor shall provide all labour, materials, operations, equipment and incidentals necessary and required for the completion of all brickwork called for.

2. GENERAL

Bricks and tiles shall be of selected quality, thoroughly burnt without being vitrified, of uniform deep red or copper colour, regular in shape and size and shall have sharp and square sides and edges and parallel faces to ensure uniformity in the thickness of the courses of brickwork. They shall be free from cracks, chips, flaws, stone or lumps of any kind.

3. BRICKS & CONCRETE BLOCKS

Bricks shall be locally available first class M-150 bricks. Bricks shall be of size 9" x 4 3/8" x 2 3/4" (22.9cm x 11.2cm x 7.0cm) unless otherwise specified IN SUBSTRUCTURE.

Bricks used in superstructure masonry shall be locally available first class M-150 burnt clay bricks, conforming to relevant IS codes and CPWD specifications. Bricks shall be of standard size 9" x 4 3/8" x 2 3/4" (22.9 cm x 11.2 cm x 7.0 cm) unless otherwise specified. The bricks shall be well burnt, sound, true to shape, and free from cracks, flaws, stones, or other defects and shall have sharp edges and uniform colour. Brick masonry in superstructure shall be executed as per CPWD DSR Item 6.29, laid in specified cement mortar with proper bond, alignment, level, and plumb. Joints shall be properly filled and finished, and workmanship shall conform to CPWD Specifications for Brick Work.

Autoclaved Aerated concrete (AAC) blocks masonry with 150mm to 300 mm thick with Grade-1 AAC blocks of density 551 to 650 kg/cum conforming to IS:2185 (Part 3) in super structure above plinth level up to floor V level with RCC band at sill level and lintel level with approved block laying polymer modified adhesive mortar all complete as per direction of Engineer-in-Charge.

4. SAMPLES

Samples of each type of brick/ blocks and tiles taken at random from the load shall be deposited with the Consultant for his approval before being used in the work. All subsequent deliveries shall be upto the standard of the sample approved.

5. SOAKING OF BRICKS/BLOCKS AND TILES

If so instructed by the Consultant, all bricks and tiles shall be thoroughly soaked before use, in specially prepared vats, tubs or tanks for not less than two hours and until air bubbles stop being given off. The duration of soaking bricks and tiles shall be kept on wooden planks or brick platforms to avoid earth being smeared on them.

6. MORTAR

Mortar for all masonry work shall consist of cement and clean, sharp coarse sand.

7. CEMENT

Portland cement conforming to IS: 269-1967 shall be used, unless otherwise specified, Cement shall be fresh when delivered at site.

8. SAND

Sand shall be clean, not too fine nor too coarse and shall fall within the grading zones I to IV given in table III of IS:383-1963.

9. WATER

Water used for mixing mortar shall be in accordance with clause 4.3 of IS:456-1964.

10. MIX PROPORTION

The mortar shall consist of one part cement and 6 parts sand for brickwork and tilework 240mm thick and above. For brick piers, half brick walls and honey combed brickwork the mortar mix shall consist of one part cement and four partssand.

11. MORTAR MIXING

Mixing of mortar shall be done in a mechanical mixer. Hand mixing shall be resorted to only when specifically permitted by the Consultant. Cement and sand shall be mixed dry thoroughly and then water shall be added gradually. Wet mixing shall be continued till mortar of the consistency of a stiff paste and uniform colour is obtained. Only the quantity of mortar which can be used up within 30 minutes of its mixing shall be prepared at a time.

Mortar shall be used as soon as possible after mixing and before it has begun to setandinanyeasewithin30 minutes after thewateris addedtothe drymixture. Mortar left unused for more than 30 minutes after mixing shall be rejected and removed from the site of work.

12. LAYING BRICK/BLOCKWORK

All brick/ block work shall be built in English bond with (frog upwards). Each brick/ block shall be set with bed and vertical joints filled thoroughly with mortar. Selected bricks shall be used for the face work. The walls shall be taken up truly plumb. All courses shall be laid truly horizontal and vertical joints shall be truly vertical. Vertical joints in alternate course shall come directly over the other. The thickness of brick courses shall be kept uniform and for this purpose wooden straight edge with graduation giving thickness of each brick course including joint shall be used. Necessary tools comprising of wooden straightedge, mason"s spirit level, square, foot rule, plumb line and pins etc. shall be frequently and fully used by the masons to ensure that the walls are taken uptrue to plumb, line andlevels.

Both the faces of walls of thickness greater than 23/ 20 cm shall be kept inproper plane. All the connected brickwork shall be carried up nearly at one level and no portion of the work shall be raised more than one meter above the rest of the work. Any dislodged brick/block shall be removed and reset in fresh mortar. Before commencing any masonry work, the contractor shall confer with other trades to ensure that all pipes, conduit, drains, sleeves, bolts hangers, or any other materials necessary to be installed in the brickwork at the time it is built, have been fixed or provided for.

13. JOINTS

Bricks/ blocks shall be so laid that all joints are full of mortar. The thickness of joints shall be not more than 10mm. The face joints shall be raked to a minimum depthof 12mm byaraking tool during the progressof the workwhenthe mortar is still green, so as to provide proper key for the plaster or pointing to be done. Where plastering or pointing is not to be done, the joints shall be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and mortar droppings removed.

14. REINFORCED BRICK/BLOCKWORK

All brick work under 23 cm & blockwork under 20cm thick shall be reinforced

with hoop iron (16 gauge, 25mm wide) at every fourth course. The hoop iron shall be cleaned of rust and loose flakes with brush shall be embedded thoroughly in cement mortar at every fourth course. It shall be cast in or securely fixed to adjoining columns or walls.

15. CURING

All fresh brickwork shall be protected from the effects of sun, rain etc., by suitable covering. All brickwork shall be kept constantly moist on all the faces for at least ten days.

16. SCAFFOLDING

Unless otherwise instructed by the Consultant, double scaffolding having two sets of vertical supports shall be provided for all building work. The supports shall be sound, strong and tied together with horizontal pieces over which the scaffolding planks shall be fixed.

The contractor shall be responsible for providing and maintaining sufficiently strong scaffolding so as to withstand all loads likely to come upon it.

17. OPENINGS

Openings in brickwork for air-conditioning ducts, grills, pipes etc. shall be provided at the time of laying brickwork.

18. CAULKING

After installation of piping, conduits, grilles etc. all openings left around pipes, conduits, grilles etc. shall be checked and caulked with cement mortar to render the whole work vermin proof and tidily finished.

SECTION-04:: STRUCTURAL STEEL WORK

1. GENERAL

The Contractor shall furnish and erect all structural steelworks as called for on drawings. He shall provide all items, articles, materials, operations mentioned or scheduled on drawings, including all labour, materials, fixing devices, equipment and incidentals necessary and required for their completion and erection. All steel work shall be free from cracks, surface flaws, laminations, rough and imperfect edges and other defects impairing strength, durability or appearance and shall be well and cleanly rolled to the dimensions, sections and weights specified or required.

2. MATERIALS

2.1 Structural Steel

- a. Mild Steel: Structural steel used in the works, other than steel in reinforced concrete and rails and fastening shall comply with IS226 -“Structural Steel(Standard Quality)” or IS:2062-Structural Steel
- b. Steel Pipes: Steel pipes for columns, ties, bracing's, girders, roof shells, etc. shall be medium class pipes of appropriate diameter.

2.2 Threaded Fasteners

- a. General: All bolts and nuts shall comply with IS:1367-“Technical supply conditions for Threaded Fasteners”.
- b. Black Bolts and Nuts: Black bolts, nuts and screws shall be in accordance with IS:1353 “Black Hexagonal Bolts (6 to 39mm) with nuts and Black Hexagonal screws (6 to 24mm)”.
- c. High Tensile Special Quality Bolts and Nuts

High Tensile steel special quality bolts and nuts wherever specified shall comply with the provisions of IS: 800.
- d. High Strength Friction Grip Bolts
High strength friction grip bolts, wherever specified, shall comply with IS:3757-“High Tensile Friction Grip Fasteners for Structural Engineering Purposes”.
- e. Washers: All plain washers shall conform to the requirements of IS: 2016 - “Plain Washers”. Spring washers for bolts, nuts and screws wherever specified shall be in accordance with the provisions of IS:3063 “Spring Washers for Bolts, Nuts and Screws”.
- f. Coach Screws and Wood Screws:

Coach screws shall be in accordance with IS:1120 - “Square or Hexagonal head coach screws with gimlet points”. - Wood screws shall conform to IS:451 “Wood Screws”.

2.3 ELECTRODES

Electrodes shall be best heavy coated type and shall be in accordance with IS: 814- "Specification for Covered Electrodes for Metal Arc Welding of Mild Steel".

3. FABRICATION:

3.1 Shop Drawings:

The contractor shall prepare, wherever necessary, detailed shop drawings giving complete information necessary for the fabrication of the structures. All information shall be clearly given and the drawings shall be in conformity with the best modern practice. A marking diagram allotting distinct identification marks to each separate piece of steel work shall be prepared in sufficient detail to ensure convenient assembly and erection. Symbols for welding, used in the drawings, shall be in accordance with IS:813 "scheme of symbols for welding". The contractor shall prepare comprehensive bill of materials sheets for each shop drawing giving therein all the items shown on the drawing together with their weights, mark numbers, cutting lengths etc. Three copies of all working drawings and bill of material sheets shall be submitted for the approval of the Consultant.

Fabrication shall not commence until the approval of the relevant drawings has been obtained from the Consultant. While the shop drawings prepared by the Contractor and approved by the Consultant, are deemed to be done, the Contractor is not relieved of responsibility for accuracy of detailed dimensions shown thereon.

3.2 Templates

All fabrication shall be in accordance with IS: 800 "Code of Practice for use of Structural Steel in General Building Construction" and IS:1915 "Code of Practice for Steel Bridges". Extensive use of templates shall be made. The templates shall be steel bushed where considered necessary by the Consultant. In case actual members are used as templates for drilling similar pieces, it will be at the discretion of the Consultant to decide whether such pieces are fit to be incorporated in the finished structure. The Contractor shall arrange for corresponding parts of each unit manufactured from the same drawings to be inter-changeable, as far as economic manufacturing conditions permit, and shall seek approval of the Consultant, of the precise agreements made in this respect.

3.3 Straightening

All material shall be straight and, if necessary shall be straightened and/or flattened by pressure, unless required to be of curvilinear form and shall be free from twists. Heating of rolled sections and plates for purposes of straightening will not be permitted. Limited straightening may, however, be effected by local applications of heat with a gas torch.

3.4 Cutting

Gas cutting shall preferably be done by machine. Gas cut edges shall be free of gauges; any gauges that remain after cutting shall be removed by grinding. Gas cutting shall, normally, only be permitted for mild steel. Gas cutting of high tensile steel may also be permitted, provided special care is taken to leave sufficient metal to be removed by machining so that all metal that has been hardened by flame is removed. Hand flame cutting may only be permitted subject to the

approval of the Consultant. Rolled sections shall be sheared or cropped to size. Sawing, shearing and cropping shall be clean and free from any distortion; if necessary, the edges shall be ground afterwards.

3.5 Holing

Punching shall not be resorted to unless previously approved by the Consultant. Where punching is permitted, the hole shall be punched 3mm less in diameter than the required size and reamed after assembly to the full size. In any case, the thickness of material punched shall not be greater than 16mm.

Holes through more than one thickness of material or members, such as compound stanchions and girder flanges shall be drilled after the members are assembled and tightly clamped or bolted together. They shall be separated and the burrs removed, if so directed by the Consultant.

Holes for bolts shall not be more than 1.5mm/2.0mm (as the case may be depending upon whether the diameter of bolt is less than or more than 25mm) larger in diameter than the nominal diameter of bolt. Holes for bolts shall in no event be formed by gas cutting.

3.6 Assembly

All steel work, which is bolted together, shall be in close contact over the whole surface. Drifting done during assembly shall not distort the metal or enlarge the holes. Holes that must be enlarged due to mismatching shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified cambers, if any, are provided.

3.7 Bolting

All bolts shall be provided with washers under the nuts and the washers shall be tapered on the insides of the flanges of R.S. Joists and channels. Bolts and studs shall project not less than one full thread through the nut after tightening. Unless otherwise specified, the ends of the bolts shall be burred after erection to prevent the removal of the nuts.

4. WELDING

Welding, where called for on the drawing shall be metal arc welding conforming to IS: 816-1969.

Unless otherwise specified, all welds shall be 6mm, single fillet welds.

The welding shall be carried out by workmen skilled in the trade. The Contractor shall employ a certified welding to ensure that the standard of workmanship shall comply with the best practices of the trade.

The welding equipment shall be subject to the approval of the Consultant.

Preparation of Surfaces: Surfaces which are to be welded shall be free from loose mill scale, rust, paint, grease, gas cutting burns or any other foreign matter.

Workmanship: Welds shall be made in the flat position wherever practicable.

Are length, voltage and amperage shall be suited to the type of electrode and nature of work.

Before commencing welding the various members shall first be brought together and firmly held in position by spot welds at specified distance. The spot welds shall be strong enough to hold the parts accurately in place without any disturbance. Freedom of movement of one member of the joint shall be allowed wherever possible.

The sequence of welding shall be such that where possible the members which offer the greatest resistance to compression are welded first.

The electrode manipulation during welding shall ensure:

1. The base metal is in a fused state when filler metal makes contact with it.
2. The filler metal does not over flow upon any unused base metal.
3. The base metal is not under-cut along the weld edges.
4. The welds shall be free from cracks, discontinuity and other defects such as under size, under cutting and over-cutting etc.

The welding of the joint shall be so arranged that the resulting tensile and compressive stresses produced by each portion of the weld tend to balance each other.

The step back method of welding shall be adopted for continuous runs. Fusion faces shall be cut by shearing, chipping, machining or machine gas cutting. Hand cutting by gas may be permitted under special circumstances, provided the cutter shall be adequately guided so that the cut edge is clean and uniform. If the fusion face is rough it shall be dressed by chipping, filing or grinding to an approved finish.

All slag shall be removed from each run before a subsequent run is superimposed. When cold the final run shall be protected with clean boiled linseed oil and shall not be painted until approved by the Consultant.

All exposed welds shall be ground smooth. All welds which have not been ground shall be scrubbed with a 10% solution of hydrochloric acid which shall be washed off with water before painting is applied. All welds shall be subject to the inspection and approval by the Consultant. The welded joints shall be tested by the Dye Penetration or other methods to detect any inherent defect in welding, if so directed by the Consultant. The location and numbers of tests shall be as decided by the Consultant. Cost of such tests shall be borne by the Contractor. Any defects noticed as a result of above tests shall be rectified by the contractor at his own cost to the satisfaction of the Consultant including replacement of the components/members which might get damaged in the process of tests. The decision of the Consultant in this regard shall be final and binding.

5. SHOP ERECTION

Steel work shall be temporarily shop erected completely or as directed by the Consultant, so that the accuracy of fit may be checked before dispatch. Due notice shall be given to the Consultant in all cases when the work is ready for inspection and the assembly shall not be dismantled until it has been inspected and approved by the Consultant.

The parts shall be assembled with a sufficient number of parallel drifts to bring and keep the components in place. In the case of parts drilled or punched through steel jigs with holes resulting in similar parts being interchangeable for portions of the steel work, trial assembly shall be carried out to the extent required by IS:1915.

6. MATCH-MARKING

All erection marks shall be die-stamped and also distinctly stenciled in paint. The marking shall be as per the marking diagram approved by the Consultant.

7. DESPATCH OF MATERIALS

The Contractor shall deliver the fabricated steel work to place of erection as far as possible, in the same sequence as that of erection. Dispatches should be scheduled to avoid cluttering up of the site. The bolts required for erection shall be bagged according to size prior to dispatch.

8. ERECTION

8.1 Erection drawings

The Contractor shall prepare comprehensive erection drawings for the structural steel work. The drawings should be made in sufficient details to ensure convenient assembly and speedy and proper erection at site. The drawings should indicate, in detail, the sequence of erection that is proposed to be followed and the method being adopted. Three copies of all erection drawings shall be submitted for approval of the Consultant. Erection shall not commence until approval of the relevant drawings has been obtained from the Consultant. Such approval shall not absolve the contractor of any responsibility.

8.2 Plant and Equipment

The suitability and capacity of all plant and equipment used for erection shall be to the satisfaction of the Consultant.

8.3 Stacking and Handling

The Contractor shall ensure that steel work is not damaged due to careless or haphazard stacking. All structural steel work should be so stored and handled at the site that the members are not subject to excessive stresses. The steel work shall be stacked at site in such a manner that it shall be free from dirt.

Stacking shall, as far as practicable, be done in the sequence of erection but heavy members shall not be stacked on top of light ones. Arrangements shall always be made at the time of handling; the damaged piece will be rejected and shall be replaced by the Contractor at his own cost.

8.4 Method of Erection

All structural steel work shall be erected in accordance with IS:800 and IS:1915.

The steel work shall be erected true and plumb and temporary bracing or staging shall be introduced wherever necessary, to ensure that the structure is not overstressed and to take care of all erection loads. Attachment of such temporary steel work to the permanent steel work shall only be done with the approval of the Consultant. Temporary steel work, like bracing and staging, shall remain in position until the structure is stable and self-supporting and all the joints making the structure stable and self-supporting are permanently bolted or welded to the satisfaction of the Consultant. After removal of temporary steel work the permanent structure shall be made good, to the complete satisfaction of the Consultant. No riveting, permanent bolting or welding shall be done until proper alignment has been obtained. Erection of the parts with any moderate amount of reaming, chipping or cutting shall be immediately reported to the Consultant. The steel work shall be rejected unless corrective action is approved by the Consultant.

8.5 **Erection Tolerances**

Unless otherwise specified, the underside of base plates of steel members shall be within plus or minus 3mm from the elevations shown on the drawings. The lateral deviations of the base plates shall not exceed 5mm from the theoretical centreline.

Alignment of individual beams, girders, etc. shall not deviate more than plus minus 5mm from the location given on the drawings.

9. PAINTING

Painting i.e. the preparation of surfaces, phosphating, application of primer and finishing coats and other details shall be carried out in accordance with the requirements laid down under "Painting".

9.1 **Shop Painting**

The structural steel work shall be thoroughly cleaned, phosphated and painted with one coat of red oxide primer in the fabrication shop. Where two surfaces are to be in permanent contact after assembly and fabrication, each surface shall be thoroughly cleaned, phosphated and painted with one coat of red oxide primer.

9.2 **Final Painting**

Where called for, three coats of enamel paint of approved shade shall be applied to all steel work after erection. Particular care shall be taken to clean, wire brush, spot prime welded and other areas where priming coat has been marred during the course of erection before application of final painting.

SECTION- 05:: WATER PROOFING

1. INTENT

It is the intent of this specification to secure a 10(Ten) years guaranteed water tight Basement and Roof. The Contractor shall provide all materials, labour, plant, equipment, incidentals and everything necessary for securing a fully waterproof job as described above.

2. GENERAL

All damp proofing and waterproofing work shall be carried out by specialists approved by the Consultant. Installation and materials shall be as per best practices for obtaining water proof work and as recommended by the manufacturer.

Waterproofing work shall be commenced only after the surface is prepared, cleaned free of dirt, dust and foreign materials, inspected and approved. The vents and other projections through the roof shall be made absolutely secure before flashing.

3. WATERPROOFING OF BASEMENT

The work of basement and underground water tank waterproofing shall be carried out by approved specialised firm to their own specifications, adopting a combination of impregnation External Treatment (Box) method and grouting.

The "Injection Grouting" method treatment shall be carried out externally while from the inside all construction joints of Raft Slab and Walls shall be grouted with a mix of cement slurry and acrylic based chemicals. The grouting points shall be at one meter centers both ways preferably. A written guarantee shall be furnished by the Contractor that the waterproofing work installed by him/his sub- contractor shall be free from defects such as leakage and seepage of water, for a period of 10(Ten) years.

4. WATERPROOFING TO ROOF

Providing and laying roof treatment complete as per CPWD specifications and as directed by the Engineer-in-Charge.

Procedure:

1. Clean the roof surface thoroughly and remove dust, loose particles, oil or grease.
2. Apply a cement-based waterproof coating usually consisting of polymer modified cement slurry & Waterproofing chemicals.
3. The waterproofing material is applied in two coats: First coat: Base waterproofing layer & Second coat: Applied after the first coat sets to ensure full coverage and sealing.
4. Wash and clean the finished surface with water to obtain a neat finish.

Testing:

The treated surface shall be tested by ponding water to a depth of 150 mm for a minimum period of 72 hours to check for leakage.

Guarantee:

The waterproofing treatment shall carry a 10 (Ten) year guarantee against leakage, dampness, sweating, or any other defects.

5. GUARANTEE

All guarantees shall be furnished in the format approved by the Consultant, duly signed by the Contractor and the Sub-contractor.

6. WATER PROOFING TO TOILET FLOOR ETC.

Toilet and kitchen floors in upper floor shall be rendered waterproof by Providing and laying water proofing treatment in sunken portion of WCs, bathroom etc., by applying cement slurry mixed with water proofing cement compound consisting of applying :

(a) First layer of slurry of cement @ 0.488 kg/sqm mixed with water proofing cement compound @ 0.253 kg/ sqm. This layer will be allowed to air cure for 4 hours.

(b) Second layer of slurry of cement @ 0.242 kg/sqm mixed with water proofing cement compound @ 0.126 kg/sqm. This layer will be allowed to air cure for 4 hours followed with water curing for 48 hours.

The rate includes preparation of surface, treatment and sealing of all joints, corners, junctions of pipes and masonry with polymer mixed slurry.

The treatment shall carry a guarantee for 10 (Ten) years against leakage, seepage, dampness etc

SECTION-06:: DOOR & WINDOWS

1. GENERAL

The Contractor shall furnish all labour, materials, operations including fixing devices, equipment and incidentals necessary and required for the completion of all flooring and pavingwork. The contractor shall pave there as indicated on the plans and Schedule of finishes with materials therein called for. All doors & windows shall be laid to the best practice known to the trade. The door & windows shall be laid to the level except where slopes are called for on the drawings, Particular care shall be exercised to ensure all are perfectly matched for colour and finish.

2. SAMPLES

The Contractor shall furnish for approval by Consultant samples of each type of Door Frames, Flush Door, Aluminum Door and FRP Doors and Aluminium Window and UPVC windows

3. Doors Frames and Doors

Providing wood work in frames of doors, windows, clerestory windows and other frames, wrought framed and fixed in position: Second class teak wood

Providing and fixing ISI marked flush door shutters conforming to IS : 2202 (Part I) decorative type, core of block board construction with frame of 1st class hard wood and well matched teak 3 ply veneering with vertical grains or cross bands and face veneers on both faces of shutters. 35 mm thick including ISI marked Stainless Steel butt hinges with necessary screws with lipping with 2nd class teak wood battens 25 mm minimum depth on all edges of flush door.

The Hinges for wire gauge shutters using galvanized M.S. wire gauge of average width of aperture 1.4 mm in both directions with wire of dia 0.63 mm, for doors, windows and clerestory windows with hinges and necessary screws for 35 mm thick shutters With ISI marked stainless steel butt hinges of required size
Second class teak wood

For the TOILET doors: Frame:

Fiber Glass Reinforced plastic (FRP) Door Frames of cross-section 90 mm x 45 mm having single rebate of 32 mm x 15 mm to receive shutter of 30 mm thickness .The laminate shall be moulded with fire resistant grade unsaturated polyester resin and chopped mat . Door frame laminate shall be 2 mm thick and shall be filled with suitable wooden block in all the three legs. The frame shall be covered with fiber glass from all sides. M.S. stay shall be provided at the bottom to steady the frame.

Doors :30 mm thick Glass Fibre Reinforced Plastic (FRP) panelled door shutter of required colour and approved brand and manufacture, made with fire - retardant grade unsaturated polyester resin, moulded to 3 mm thick FRP laminate for forming hollow rails and styles, with wooden frame and suitable blocks of seasoned wood inside at required places for fixing of fittings, cast monolithically with 5 mm thick FRP laminate for panels conforming to IS: 14856, including fixing to frames.

Aluminium Doors:

Aluminium work for doors, and partitions with extruded built up of powder coated aluminium (minimum thickness of powder coating 50 micron) standard tubular sections/ appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/ neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass / stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge.

FIRE DOORS

Frame : fire resistant door frame of section 50 x 60 mm on horizontal side & 35 x 60 mm on vertical sides having built in rebate made out of 1.6 mm thick GI sheet (Zinc coating not less than 120gm/m²) suitable for mounting 120 min Fire Rated Glazed Door Shutters. The frame shall be filled with Mineral wool Insulation having density min 96Kg/m³ . The frame will have a provision of G.I.Anchorfastners 14 nos (5 each on vertical style & 4 on horizontal style of size M10 x 80) suitable for fixing in the opening along with Factory made Template for SS Ball Bearing Hinges of Size 100x89x3mm for fixing of fire rated glazed shutter . The frame shall be finished with a approved fire resistant primer or Powder coating of not less than 30 micron in desired shade as per the directions of Engineer - in- charge .

DOOR :Providing and fixing 60 mm thick glazed fire resistant door shutters of 120 min Fire Rating confirming to IS:3614 (Part II) or EN1634-1:1999, tested and certified as per laboratory approved by Engineer-in-charge, with suitable mounting on door frame, consisting of vertical styles, top rail & side rail 60 mm x 60 mm wide and bottom rail of 110 mm x 60 mm made out of 1.6mm thick G.I. sheet (zinc coating not less than 120gm/m²) duly filled mineral wool insulation having density min 96 kg/m³ and fixing with necessary stainless steel ball bearing hinges of size 100x89x3mm of approved make, including applying a coat of approved fire resistant primer or powder coating not less than 30 micron etc with panic bar / latch (Double point) fitted with a single body, Trim Latch & Lock on back side of the Panic Latch of reputed brand and manufacture to be approved by the Engineer- in- charge, all complete.all complete as per direction of Engineer-in-charge

Vision Panel : fixed panels & partitions etc., with G.I. beading made out of 1.6 mm thick G.I. sheet (zinc coating not less than 120 gm/m²) of size 20 x 33 mm screwed with M4 x 38 mm SS screws at distance 75 mm from the edges and 150 mm c/c , including applying a coat of approved fire resistant primer/ powder coating of not less than 30 micron on G.I. beading, & special ceramic tape of 5 x 20 mm size etc complete in all respect as per NBC 2016, IS 16231 (Part 3):2016 and as per direction of Engineer-in-charge with glass of required thickness having 120 minutes of fire resistance both integrity & radiation control (EW120) and minimum 20 minutes of insulation (EI20). The manufacturer have to give test report/certification of fire glass and the glass should have the stamp showing the value of E, EW & EI. The glass shall be tested in approved NABL

accredited lab or by any other accreditation body which operates in accordance with ISO/IEC 17011 and accredits labs as per ISO/IEC 17025 for testing and calibration scopes shall be eligible. The maximum glazing size shall not be more than 1100x2200 mm (w x h) or 2.42 sqm.

4. WINDOWS

Aluminum Windows:

Aluminium work for doors, windows, ventilators and partitions with extruded built up standard tubular sections/ appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/ neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass / stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge.

Powder coated aluminium (minimum thickness of powder coating 50 micron). The detailed drawing shall be approved before start of execution of work.

UPVC Windows:

UPVC glazed/wire mesh windows comprising of lead free uPVC multi-chambered frame, sash and mullion/coupler (where ever required) extruded profiles having minimum wall thickness of 1.70 mm for Series R1 and R2 profiles and 2.10 mm for Series R3 and R4 profiles conforming to EN: 12608 in any shape, colour and design duly reinforced with galvanized mild steel section made of required shape & size as per CPWD Specification, uPVC extruded glazing beads, interlocks and Inline sash adaptor (where ever required) of appropriate dimension, EPDM gasket, hardware, SS 304 grade fasteners of minimum 8 mm dia with countersunk head, comprising of matching polyamide PA6 grade sleeve for fixing frame to finished wall as per IS 1367 : Part 1 to 14, plastic packers, plastic caps and necessary stainless steel screws etc. Profile of frame, sash & mullion (if required) shall be mitred cut and fusion welded/mechanically jointed duly sealed at all corners, including drilling of holes for fixing hardware and drainage of water etc. After fixing frame the gap between frame and adjacent finished wall shall be filled with weatherproof silicon sealant over backer rod of approved size and quality, all complete as per approved drawing conforming to CPWD specification & direction of Engineer-in-Charge. Section of steel reinforcement and cross sections of uPVC profiles to be as per design approved by Engineer-in-Charge

Three track three panels sliding window with two glazed & one wire mesh panels with Aluminium channel for roller track, wool pile, nylon rollers with SS 304 body.

Using R3 series with frame (98mm & above) x (40mm & above) & both glazed and fly screen sash (30mm & above) x (55mm & above) with zinc alloy (zamak) powder coated handle on every glazed panel along with multi-point locking system. (Height upto 1.8m).

5. Glazing

Glazing in aluminium door, window, ventilator shutters and partitions etc. with EPDM rubber / neoprene gasket etc. complete as per the architectural drawings and the directions of engineer-in-charge (Cost of aluminium snap beading shall be paid in basic item): With float glass panes of 5.50 mm thickness

SECTION-07:: FLOOR FINISHES

1. GENERAL

The Contractor shall furnish all labour, materials, operations including fixing devices, equipment and incidentals necessary and required for the completion of all flooring and pavingwork. The contractor shall pave the areas indicated on the plans and Schedule of finishes with materials therein called for. All flooring shall be laid to the best practice known to the trade. The flooring shall be laid to the level except where slopes are called for on the drawings, in which case the slopes shall be uniform and arranged to drain into the indicated outlets. Particular care shall be exercised to ensure that all flooring, skirting and dados are perfectly matched for colour and finish.

2. SAMPLES

The Contractor shall furnish for approval by Consultant samples of each type of floor and dado finish.

3. GRANITE FLOORING

Granite stone flooring in required design and patterns, in linear as well as curvilinear portions of the building all complete as per the architectural drawings with 18 mm thick stone slab over 20 mm (average) thick base of cement mortar 1:4 (1 cement: 4 coarse sand) laid and jointed with cement slurry and pointing with white cement slurry admixed with pigment of matching shade including rubbing, curing and polishing etc. all complete as specified and as directed by the Engineer-in-Charge. Polished Granite stone slab colour of Black, Cherry/Ruby Red or equivalent AT REQUIRED PLACES AS PER SOF

4. WORKMANSHIP

The whole of the work of laying, making and finishing shall be carried out by tradesmen fully experienced in the class of work required. All granite shall be finished to true, even plans and the line with abutting edges flush and corner and joints true and square.

5. VITRIFIED TILES FLOORING

Vitrified floor tiles in different sizes (thickness to be specified by the manufacturer) with water absorption less than 0.08% and conforming to IS : 15622, of approved make, in all colours and shades, laid using 315 Plus - Single-component polymer based thin-set adhesive complying with IS 15477:2019 - Type 2T, ANSI A118.4ET, and EN 12004 / ISO 13007: C2TE. For interior floor/wall and exterior floor applications, including tile-on-tile renovation. Mix with water (~5-6 L per 20 kg bag), apply using 6 × 6mm square-notched trowel (3 mm bed, coverage ~55 sq ft per 20 kg). Includes substrate prep, mixing, application, adjustment, curing, cleaning, and protection —all as per manufacturer's TDS and Engineer's instructions, including grouting the joints with white cement and matching pigments etc., complete. (Size of Tile 600X600MM/800 x 800 mm) Colour shade & make approved by Architect-in-Charge FOR common areas and other as specified in SOF.

6. CERAMIC TILES FLOORING

Rectified Glazed Ceramic floor tiles of size 300x300 mm or more (thickness to be specified by the manufacturer), of 1st quality conforming to IS : 15622, of approved make, in colours White, Ivory, Grey, Fume Red Brown, laid on 20 mm thick cement mortar 1:4 (1 Cement: 4 Coarse sand), jointing with grey cement slurry @ 3.3 kg/ sqm including grouting the joints with white cement and matching pigments etc, complete AT TOILETS AND REQUIRED PLACES AS PER SOF.

7. KOTA STONE FLOORING

Kota stone slab flooring over 20 mm (average) thick base laid over and jointed with grey cement slurry mixed with pigment to match the shade of the slab, including rubbing and polishing complete with base of cement mortar 1 : 4 (1 cement : 4 coarse sand) : 25 mm thick

8. CHEQUERED FLOORING

Chequerred Precast Cement Concrete Tile 22 mm thick in footpath & courtyard, jointed with neat cement slurry mixed to match the shade of tiles, including rubbing and cleaning etc. complete, on 20 mm thick bed of cement mortar 1:4 (1 cement 4 coarse sand) light shade pigment using white cement. Colour shade & make approved by Architect-in-Charge.

9. MATERIALS

Cement: Ordinary grey Portland cement, white or colored cement conforming to IS:269.

Aggregates: Coarse and fine aggregate shall conform to the requirements of IS:383.

Water: Water shall be clean, free from oil, acid, alkali, soluble salts etc.

Workmanship: The whole of the work of laying, making, finishing, polishing and setting terrazzo, both in-situ and pre-cast form shall be carried out by tradesmen fully experienced in the class of work required. All terrazzo work shall be finished to true, even plane and line with shutting edge flush and corners and joints true and square.

Samples: The contractor shall submit samples of the various colors, if any, proposed to be used for approval before laying floors. The Consultant reserves the right to vary the proportions of materials in terrazzo until a satisfactory sample is submitted.

10. CURING

The surface shall be left dry for air curing for duration of 12 to 18 hours depending upon the atmospheric conditions. It shall then be cured for about ten days by allowing water to stand in pools over the floor.

11. GRINDING

The grinding and processing of KOTA shall be commenced about ten days after the KOTA is laid. The surface shall be watered and ground evenly with a grinding machine using carborundum stone grade 60. The surface shall then be washed clean and grouted with a group of cement and pigmented mixed in the same proportion as the topping. It shall then be allowed to dry for 24 hours and wet-cured for 7 days.

The grinding and grouting operation shall be repeated using carborundum stones grade 80 and 120 till a smooth finished surface exposing marble chips evenly is obtained.

After thoroughly cleaning the surface, grouting, and curing as described earlier, the final grinding shall be carried out using carborundum stone grade 320.

The surface shall again be washed clean, dusted over with Oxalic acid at 32gms per sq. meter, sprinkled with water, rubbed hard with cotton waste and wiped clean the following day.

Where use of machine for grinding is not feasible, rubbing and polishing shall be done by hand in the same manner as described above.

12. FINAL POLISH

When all construction and finishing work namely, painting, joinery work, electrical, plumbing work etc. are completed and just before the area is occupied, the floor shall be worked clean with dilute oxalic acid solution and dried. Non-slip wax polish shall then be applied with soft linen on the clean and dry surface and polishing machine fitted with felt or hessian bobs shall be run over the surface. Clean saw dust shall then be spread over the surface, polishing machine again applied, mopping up surplus wax and leaving glossy surface. Care shall be taken that the floor is not left slippery and that ordinary wax is not used under any circumstances.

13. CC FLOORING(52 mm)

Providing and laying 52 mm thick cement concrete flooring with hardener topping, comprising 40 mm thick CC 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) as base layer and 12 mm thick cement hardener top layer in proportion 1:2 (cement hardener mix : 6 mm graded stone aggregate), laid monolithically. The work shall include surface preparation, application of cement slurry for bonding, proper laying, compaction, finishing with steel trowel to a smooth and dense surface, and curing for minimum 7 days, complete as per manufacturer's specifications and directions of Engineer-in-Charge. Hardening compound shall be mixed @ 2 litres per 50 kg of cement or as recommended by manufacturer. The rate shall include cost of all materials, labour, tools & plants, curing, and incidental works, excluding nosing of steps, grooves, etc., complete.

14. CC FLOORING(40 mm)

Providing and laying 40 mm thick cement concrete flooring in 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size), including cement slurry for bonding and finished with a floating coat of neat cement to obtain a smooth and even surface. The work shall include surface preparation, laying, compaction,

finishing, and curing for minimum 7 days, complete as per specifications and directions of Engineer-in-Charge. The rate shall include cost of all materials, labour, tools & plants, curing, and incidental works, excluding nosing of steps, grooves, etc., complete

15. WOODEN FLOORING

Providing and fixing 12 mm thick engineered wooden flooring of use class 32/23, having AC5 abrasion resistance, IC2 impact resistance, and conforming to relevant EN standards, with 0.2 mm wear layer over high-density fiber core (density $\sim 948 \text{ kg/m}^3$), plank size approx. 1200 mm \times 120 mm, with lock & fold system and aqua-seal edges for moisture resistance. The flooring shall be laid over foam underlayment, including necessary accessories such as end profiles, transition strips, reducers, T-profiles, stair nosing, etc., and finished with EIR/Hand Sculpted surface texture. The work shall include surface preparation, proper laying, alignment, cutting, and finishing, complete as per manufacturer's specifications and directions of Engineer-in-Charge/Architect. The rate shall include cost of all materials, labour, accessories, and incidental works, complete.

SECTION-08:: WALL FINISHES

1. EXTENT AND INTENT

The Contractor shall furnish all materials, labour, scaffolding, equipment, tools, plant and incidentals necessary and required for the completion of all plaster and wall finishes. The Contractor shall be responsible to take proper precautions to protect already installed work from damage.

2. GENERAL

Plaster as herein specified shall be applied to all internal and external surfaces where called for. Glazed tiledado, terrazzo dado, and other wall finishes are to be provided where indicated on drawings and schedules. Areas called for on drawings and typical shall be considered to apply to appropriate, adjoining areas whether shown on same drawings or not and whether indicated or not. All plaster work and other wall finishes shall be executed by skilled workmen in a workmanlike manner and shall be of the best workmanship and in strict accordance with the dimensions on drawings.

3. PLASTER WORK

1. 15mm (Average) thick plaster on rough side (external wall) with polymer modified ready mix plaster of fine Grade portland, graded and polymer with water soluble additives, as per manufacturer's specification direction of Engineer-in-charge.
2. 12mm (Average) thick plaster on internal wall surface & 6mm on ceiling surface with one coat gypsum light weight plaster conforming to IS:2547 (Part)1976"

The primary requirements of the plaster work shall be to provide an absolutely water tight enclosures, dense, smooth and hard and devoid of cracks on the interior and exterior. The Contractor shall do all that is necessary to ensure this result. All plastering shall be finished to true plane, without imperfections and square with adjoining work and shall form proper foundations for finishing materials such as paint etc.

Masonry and concrete surfaces to which plaster is to be applied shall be clean, free from efflorescence, damp and sufficiently rough and keyed to ensure proper bond.

Wherever directed all joints between concrete frames and masonry in-filling shall be expressed by a groove cut in the plaster. Said groove to exactly coincide with the joint beneath.

Where grooves are not called for the joints between concrete members and masonry in-filling shall be covered by 245 gauge galvanised chicken mesh strips 40mm wide or as shown, installed before plastering.

4. CHASING

All chasing, installation of conduits, boxes etc. to be completed before any plastering or other wall finish is commenced on a surface. Chasing or cutting of plaster or other finish will not be permitted. Broken corners shall be cut back not less than 150mm on both sides and patched with Plaster of Paris as directed. All corners shall be rounded to a radius of 8mm or as directed by the Consultant.

5. SAMPLES

Samples of each type of plaster and other wall finish shall be prepared for approval by the Consultant

6. MATERIALS

Cement: As specified under Concretework. Water: As specified under Concrete work. Sand

For internal plaster - Washed Fine Sand

For external plaster - Washed fine sand and/or stone aggregate as called for - Sand and stone aggregate to conform to the requirements given under "Concrete Work"

Waterproofing Compound: CICO No.1 or approved equal

7. PROPORTIONS

The materials used for plastering shall be proportioned by volume by means of gauge boxes.

8. PREPARATION OF SURFACE

The joints in all walls, both existing and freshly built shall be raked into a depth of 15mm, brushed clean with wire brushes dusted and thoroughly washed before starting plaster work. Concrete surfaces shall be roughened by hacking over the entire surface as approved by the Consultant to ensure proper key for the plaster.

9. INTERNAL PLASTER TO WALLS

Plaster to internal faces of walls shall be 15mm/12mm thick as called for, consisting of 1 part cement and 6 parts clean fine sand.

10. MORTAR MIXING

Mortar shall be prepared as specified under "Brick Work". It shall be made in small quantities only as required and applied within 15 minutes of mixing.

11. APPLIANCES

Plaster application shall be commenced only after the preparatory work is approved by the Consultant. Correct thickness of plaster shall be obtained by laying plaster screeds (gauges) at intervals of 1.50 metres.

Mortar shall be firmly applied, well pressed into the joints, rubbed and finished as approved by the Consultant to give a smooth and even surface.

12. CURING

Finished plaster shall be kept wet for 10 days after completion. In hot weather walls exposed to sun shall be screened with matting kept wet or any other approved means.

13. COILING PLASTER

Plaster to ceiling, soffits of stair flight slabs and similar locations where called for shall be 6mm thick and consist of 1 cement and 4 parts clean fine sand.

14. PREPARATION OF SURFACE

The surface to be plastered shall be prepared by a close hacking with pointed chisel as directed, to provide necessary bonding for the plaster. The surface shall be brushed, swept clean and thoroughly wetted before plastering.

15. APPLICATION

Mortar shall be applied firmly, pressed to the surface, rubbed and finished to a smooth and even surface.

16. CHICKEN MESH TO WALLS

Galvanised chicken mesh (24 gauge, 12mm size) shall be provided at all junctions of concrete members and masonry walls besides other locations as called for, properly stretched and nailed, ensuring equal thickness of plaster on both sides of the mesh.

17. V GROOVES

Where called for V Grooves of size as approved shall be formed in the joints and finished neat as directed. The grooves shall be straight, of uniform width and depth and neatly formed and colour of all stone chips shall be subject to the approval of the Consultant.

The materials shall be mixed properly to a stiff consistency, applied firmly to the prepared base coat, to the required thickness and compacted with a wooden straight edge/trowel in approved manner.

After about 6 hours or more, if required, of the laying of the finishing coat, the surface shall be carefully washed down with water and rubbed with jute brushes so that the stone aggregates are completely exposed. The washing down and brushing operation shall be carried out when the plaster has set and hardened just sufficiently but not fully. The washing and brushing operations shall be very cautiously done so as to remove the mortar only but not to dislodge the aggregates. All work shall be done by workmen skilled in this type of work. Any loose particles shall be cleared away and the surface finished neat.

The finished surface shall show very little of matrix and maximum of exposed aggregates. The plaster shall be laid in panels of sizes as called for. The panels shall be clearly defined by 8mm wide square grooves. The grooves shall be of uniform width, straight and shall have clear, sharp edges as approved. Grooves

shall be so formed with slightly sloping sides that edges are not damaged while removal of formingstrips.

The finished surface shall be kept continuously wet for ten days.

18. POINTING TO BRICKWORK

External faces of all brick work shall be “struck” pointed with waterproof cement mortar 1:3 (1 parts washed coarse sand and approved waterproofing compounds at 1 Kg. per bag of cement). Before pointing, the joints shall be raked to required depth and well watered. The mortar shall be pressed into the raked out joints with a pointing trowel. The mortar shall not spread over the corners, edges or surfaces of the masonry. The pointing shall then be finished with pointing tool as directed. The superfluous mortar shall then be cut off from the edges of the lines and the surfaces of the masonry shall also be cleaned of all mortar. The completed work shall be kept wet for at least 7 days.

SECTION-09::METAL WORK

1. RAILING

SS 304 railing called for on the drawings shall be executed by craftsmen specially trained in the trade in a shop fully equipped to carry out all phases of fabrication in accordance with the best accepted practices and as shown on the drawings. All work, as far as possible shall be shop fabricated and brought on site for erection. The railings shall be assembled square true to proper plan or curved to the radius shown on the drawings. Joining methods shall be flush type designed to produce an adequately strong joint for a particular application, and approved by the Consultant.

Welding shall be executed from the non-exposed side, as far as possible and in each case the welds shall be ground smooth and finished with a texture matching the parent metal. All welds shall be finished smooth and square.

2. MILD STEEL WORK

Steel work in built up tubular (round, square or rectangular hollow tubes etc.) trusses etc., including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer, including welding and bolted with special shaped washers etc. complete. Hot finished seamless type tubes

3. PAINTING

All doors, windows, louvres, railings, etc., shall be phosphate and given two coats of red oxide primer in the shop before dispatch and shall be enamel painted as per specifications after installation.

SECTION-10 ALUMINUM STRUCTURAL GLAZING AND DOOR WINDOW

1. Extent and Intent

The Contractor shall furnish all materials, labour, accessories, equipment, tools and plant and incidentals required for providing anodised aluminum doors windows, claddings, louvers and other items as called for on the drawings. The drawings and specifications cover the major requirements only. The supplying of additional fastenings, accessory features, and other items not mentioned specifically herein, but which are necessary to make a complete installation, shall be a part of this contract.

2. General

Aluminum doors, windows, etc. shall be of sizes, sections and details as shown on drawings. The details shown on the drawings indicate generally the sizes of the components parts and the general standards. These may be varied slightly to suit the standards adopted by the manufacturers of the aluminum work. Before proceeding with any manufacture, the contractor shall prepare and submit complete manufacturing and installation drawings for approval of the Architect/ Project Manager and no work shall be performed until the approval of these drawings is obtained.

All Aluminum work shall be fabricated by/procured from reputed firms specialised in Aluminum work and approved by the Architect/ Project Manager.

3. Shop Drawings

The Contractor shall submit shop drawings and/or samples of each type of door, window, louver, cladding and other Aluminum work, to the Architect/ Project Manager for his approval. The shop drawings shall show full size sections of doors, windows etc. thickness of metal, details of construction, anchoring details, hardware as well as connection of windows, doors and other metal work to adjacent work. Samples of all joints and methods of fastening and joinings shall be submitted to the Architect/ Project Manager for approval well in advance of commencing the work.

4. Samples

Samples of each type of door, window, louver etc. shall be fabricated, assembled and submitted to the Architect/ Project Manager for his approval. They shall be of sizes, types etc. as decided by the Architect/ Project Manager.

5. Sections

Aluminum door and windows shall be fabricated from extruded sections of profiles as detailed on drawings. The sections shall be extruded by manufacturers approved by the Architect/Project Manager. These sections shall be extruded from Aluminum alloy H9, 6063 or approved equivalent, of commercial quality and free from all defects impairing appearance, strength and durability. The permissible dimensional tolerances of the extruded sections shall be such as not to impair the proper and smooth function/operation and appearance of doors and windows.

6. Fabrication

Doors, windows etc. shall be fabricated by a specialist firm approved by the Architect/ Project Manager and shall be of sections, sizes, combinations and details as shown on the Drawings. All doors and windows shall have mechanical joints. The joints shall be designed to withstand a wind load of 150 Kg. per SqM. All members shall be accurately machined and fitted to form hairline joints prior to assembly. The jointing accessories such as cleats, brackets etc. shall be of such material as not to cause any bi-metallic action. The design of the joint and accessories shall be such that the accessories are fully concealed. The fabrication of doors, windows, etc. shall be done in suitable sections to facilitate easy transportation, handling and installation. Adequate provision shall be made in the door and window members for anchoring to supports and fixing of hardware and other fixtures as approved by the Architect/ Project Manager.

7. Anodising

All exposed surfaces of doors windows, louvers, cladding, screens etc. shall be colour anodized after fabrication in a manner to conform to IS:1868-1968 and to approved finish. Anodic coating shall be of a minimum thickness of 0.025mm. Sulphuric acid shall be used as the electrolytic for the anodic process. The colour anodizing shall be carried out in an approved manner to achieve the desired colour. Prior to anodizing all Aluminum shall be rendered uniform in appearance free from disfiguring scratches, stains or other blemishes and etched in a caustic soda solution.

8. Protection of Anodized Finish

All Aluminum members shall be wrapped with self adhesive non-staining PVC tapes.

9. Handling and Stacking

Fabricated materials shall be crated in an approved manner to protect the material against any damage during transportation. The loading and unloading shall be carried out with utmost care. On receipt of materials at site, they shall be carefully examined to detect any damaged pieces. Arrangements shall be made for expeditious replacement of damaged pieces/parts. Materials found to be acceptable on inspection shall be re-packed in crates and stored safely.

10. Installation

Just prior to installation, the doors, windows etc. shall be uncrated and stacked on edge on level bearers and supported evenly. The frames shall be fixed into position true to line and level using adequate number of expansion machine bolts (RAWL BOLTS) of approved size and manufacture and in an approved manner. The holes in concrete/masonry members for housing anchor bolts shall be drilled with an electric drill.

The doors/windows assembled as shown on drawings shall be placed in correct final position in the openings and marks made on concrete members at jambs, sills and heads against holes provided in the frames for anchoring. The frames shall then be removed from the opening and laid aside. Neat holes with parallel sides of appropriate size shall then be drilled in the concrete members with an electric drill at the marking to house the expansion bolts. The expansion bolts shall then be inserted in the holes, struck with a light hammer till the nut is forced into anchor shell. The frames shall then be placed in final position in the openings and anchored to the supports through cadmium plated machine

screws of required size threaded to expansion bolts. The frames shall be set in the openings by using wooden wedges at supports and be plumbed in position. The wedges shall invariably be placed at the meeting points of glazing bars and frames.

11. Fixing through brackets:

Window/Door frames shall be fitted to supports through pressed steel sheet (14 gauge) channels bolted to M.S. brackets which are anchored to structural elements through expansion bolts. All M.S. brackets, out of 5mm flats fabricated to sizes and details shall be galvanised after fabrication. Brackets shall be of about 100mm length and spaced at about one meter center all around. Pressed steel sheet channel to be fitted to the brackets permits flexibility and adjustment in the final lining up and positioning of the Aluminum frame. The channel shall be fitted to the bracket with galvanised bolts, 8mm dia or as required. The channel shall be finished with Epoxy powder coating applied as per appropriate Indian Standards and/or best trade practice. The Aluminum frame is fixed to the channel through rivets all around the frames at approximate 250 mm centers.

Sizes, details, spacing, etc. given above are approximate and indicative only. They can be varied at Architect/ Project Manager's option to suit particular sizes and situations and the contractor shall carry out the instructions of the Architect/ Project Manager in this regard at no extra cost to the owner. The contractor may suggest alternative methods of fixing and anchoring for consideration by the Architect/ Project Manager while decision in this regard shall be final and binding.

In the case of composite windows and doors, the different units are to be assembled first. The assembled composite units should be checked for line, level and plumb before final fixing is done. Units may have to be assembled in their final location if situation so warrants.

Where Aluminum comes into contact with masonry, brickwork, concrete, plaster or dissimilar metals, it shall be coated with an approved insulation lacquer, paint or plastic tape to ensure that electro-chemical corrosion is avoided. Insulation material shall be trimmed off to a clean flush line on completion.

The Contractor shall be responsible for assembling composite, bedding and pointing with mastic inside and outside, at the transoms and mullions, placing the doors, windows, etc. in their respective openings and bedding with mastic. After the door/ windows have been fixed in their correct assigned position, the open hollow sections abutting masonry/concrete shall be filled with cement grout (1 cement : 3 coarse sand) densely packed and finished neat. Packing grout shall be of the expanding type made by approved additive.

The Contractor shall be responsible for the doors, windows etc. being set straight, plumb, level and for their satisfactory operation after fixing is complete.

12. Neoprene Gaskets:

Provide and install NEOPRENE gaskets of approved size and profile at all locations as shown and as called for to render the doors, windows etc. absolutely air tight and weather tight. Produce samples of the gaskets for approval and procure after approval only.

13. Mastic Cement:

The gaps between frames and supports and also any gaps in the door and window sections shall be raked out as directed and filled with mastic cement of approved colour and make to ensure complete water-tightness.

The mastic cement shall be of such colour, and composition that it would not stain the masonry/concrete work, shall receive paint without bleeding, will not sag, or run and shall not set hard or dry out under any conditions of weather. Mastic Cement shall be Polysulphide Sealant conforming to BS: 4254 and shall be applied with special gun as per manufacturer's recommendation by a specialist firm approved by the Architect/ Project Manager.

14. Fittings:

Hinges, stays, handles, tower bolts, locks and other fittings shall be of quality and manufacture as approved by the Architect/ Project Manager.

Fittings shall retain the casements rigidly in both the open and closed position. Hinges shall be wrapped and protected until after the completion of the building.

15. Final Cleaning:

The PVC tape wrapping, protecting the anodized finish shall be retained till the glazing work is commenced. After the glazing and all work connected with installation of doors/windows is complete, all Aluminum work shall be washed with a suitable thinner and left in a finished condition, in approved uniform appearance and free from all marks and blemishes.

SECTION- 11:: GLASS AND GLAZING

1. EXTENT AND INTENT

The contractor shall furnish all labour, materials, tools, appliances, equipment and incidentals required to complete the installation of all glass and related items.

2. GENERAL

All glass shall be of the type, quality and substance specified. All the drawings of Structural Glazing shall be IIT vetted from Govt IIT's in India before Execution of the work.

3. GLASS SIZES

The contractor shall cut glass sizes by field measurement or dimensionally approved shop drawings. The responsibility for correct glass sizes shall rest with the contractor. No cracked, chipped or disfigured glass shall be accepted.

4. GLASS BREAKAGE

The contractor shall replace all broken or damaged or disfigured glass caused in executing the work or by faulty installation, before acceptance of the building, without cost to the Owner.

5. MATERIALS

In DOORS AND ALUMINUM WINDOWS : Glass for all glazing work shall be plain sheet glass as called for in the drawings and schedules. Sheet Glass for windows shall be 5.5mm thick special selected quality glass as called for, manufacturer approved by the Consultant. Glass for North Light or other equivalent approved by the Consultant.

IN STRUCTURAL GLAZING : vision glass panels (IGUs) comprising of hermetically-sealed 6-12- 6 mm insulated glass (double glazed) vision panel units of size and shape as required and specified, comprising of an outer heat strengthened float glass 6mm thick, of approved colour and shade with reflective soft coating on surface # 2 of approved colour and shade, an inner Heat strengthened clear float glass 6mm thick, spacer tube 12mm wide, dessicants, including primary seal and secondary seal (structural silicone sealant) etc. all complete for the required performances, as per the Architectural drawings, as per the approved shop drawings, as specified and as directed by the Engineer-in-Charge. The IGUs shall be assembled in the factory/ workshop of the glass processor. face # 1 of the glass panels (excluding the areas of the grooves and weather silicone sealant) provided and fixed in position, shall be measured in sqm. (i) Coloured tinted float glass 6mm thick substrate with reflective soft coating on face # 2, + 12mm Airgap + 6mm Heat Strengthened clear Glass of approved make having properties as visible Light transmittance (VLT) of 25 to 35 %, Light reflection internal 10 to 15%, light reflection external 10 to 20 %, shading coefficient (0.25- 0.28) and U value of 3.0 to 3.3 W/m² degree K etc. Technical sanctioning authority as per the site requirement shall decide the properties of performance glass.

6. GLAZING COMPOUND

Glazing putty for setting glass shall be of approved quality approved suitable for use on metal windows and conforming to IS:420-1953.

7. PREPARATION OF FRAMES AND GLASS

Before installation the contractor shall ensure that:

- a) All glazing rebates are square, plumb and true in plane, clear, dry and dust free;
- b) All frame adjustments are made prior to glazing;
- c) All glass edges, are clean cut to exact sizes, allowing expansion tolerance as recommended by the glass manufacturer;
- d) All sashes shall be glazed in the closed position and shall not be opened until the compound is set;
- e) All materials are used in strict accordance with the manufacturer's instructions.
- f) Glass shall not be forced into place;

8. INSTALLATION

The glass shall be set on neoprene glazing blocks on all sides (at least two per side) as directed. Glass shall be bedded, back and face glazed and so installed as to achieve a completely water tight and rattle-free installation. The obscure glass where called for shall be set with smooth surface outside.

9. COMPLETION

Upon the completion of the work all glass shall be thoroughly cleaned, paint or other marks removed. Any cracked, scratched, chipped or other defective glass shall be removed and replaced without cost to Owner. Any loose glass shall be set to the satisfaction of the Consultant.

SECTION- 12:: HARDWARE

1. EXTENT AND INTENT

The intention of the contract is that the building as shown shall be completely equipped with required hardware. Any required item not noted or listed shall be finished in a grade equal to and in harmony with similar item listed.

The contractor shall furnish all labour, materials, tools, appliances and incidentals required to complete the hardware work specified herein or listed in the schedule of hardware, or as may be required by the actual conditions at the building. Include the necessary screws, special screws, bolts, expansion bolts and other devices necessary shall be of sufficient size to securely and permanently fix the hardware in place. No steel or iron screws shall be used. Screws shall match material and finish of article being fastened.

2. GENERAL

All hardware shall be of the best quality of its type and strictly in conformity with the materials and finish described in schedule of hardware. If called upon to do so the contractor shall arrange to get hardware specially manufactured to the design, requirements and standards laid down by the Consultant.

3. SAMPLES

Samples of each different item of hardware including screws or any particular item of hardware shall be submitted to the Consultant for approval.

4. QUALITY

All hardware shall be of perfect fit, uniform in finish and free from imperfections that affect serviceability or mar the appearance.

5. INSTALLATION

All hardware shall be installed by skilled workmen, equipped with proper and adequate tools. The hardware shall be installed true, plumb and square in accordance with the hardware schedule and the manufacturer's instructions.

6. PROTECTION

Hardware shall not be installed earlier than necessary and it shall be the responsibility of the contractor to protect all hardware, removing some when necessary for protection and deliver all in good working order and unblemished. Any defective or marred items shall be made good to the satisfaction of the Consultant without additional cost to the Owner.

7. GUARANTEE

The contractor shall be responsible for the proper working of all hardware, for a period of one year from the date of the completion and acceptance of the building.

SECTION-13:: CARPENTRY AND JOINERY

1. EXTENT AND INTENT

It is the intent of this specification to include all carpentry and joinery work in connection with doors, windows, glazing, partitions, ceilings, paneling, cabinets and other items of wood work called for in the drawings.

2. GENERAL

The carpentry and joinery work shall include the furnishing of all labour, materials, equipment, incidentals and appliances required to complete the work including the provision and installation of fastening devices and hardware in accordance with the drawings and the attached hardware schedule.

3. TIMBER

Teakwood where called for, shall be of selected best quality Indian teakwood. All timber shall be uniform in texture, free from large, loose, dead or cluster knots, wanes, injurious open shaken bore holes, rot, decay discolouration, soft or spongy spots, hollow pockets, pith or centre heart and all other defects and blemishes.

4. SAMPLES AND SHOP DRAWINGS

The contractor shall before proceeding with the work, submit to the Consultant for his approval complete samples of the various materials including hardware and fastening devices and shop drawings and large scale details covering all joinery work.

5. ROUGH CARPENTRY

Materials Unless otherwise called for, all framing and other concealed wood members shall be of first class Indian teakwood and shall be seasoned to a moisture content of not less than 10% or more than 15%. Wood of greater moisture content shall not be used in any part of the structure.

6. WORKMANSHIP

All carpenter's work shall be done by skilled workmen using proper tools. All joints shall as far as possible, be mortised and tenoned and glued with best quality approved waterproof glue. Where mortise tenon joints are not possible, the joints shall be securely nailed with the longest nails that may be used without splitting the wood. Wherever it is necessary or an adequate joint cannot be formed by nailing, the members shall be lapped or jointed by GI straps or extra wood blocks. All joints shall be done with neatness and as approved and directed by the Consultant. Cross bracing, solid blocking and bracing shall be provided according to best practice.

7. JOINERY

Materials: Finished wood work and joinery in teakwood, where called for shall be surfaced with straight grained best quality Indian teakwood free from knots and other blemishes and imperfections. All finished woodwork and joinery shall be seasoned to not less than 10% or more than 12½% moisture content. All

finished woodwork and joinery shall be wrought and planed smooth to the correct dimensions and profiles called for in the drawings.

All joinery work shall be securely mortised and tenoned and glued with best quality waterproof glue. Or all joinery work use of nails shall not be permitted, and wood screws of appropriate size and of approved make shall be used. Wherever practicable, means of fastening the various parts together shall be concealed. All work (both carpentry and joinery) shall be to the dimensions shown on the drawings.

All interior wood finish, doors and cabinet work shall be smoothly treated and sanded at the building after erection, until all defects are entirely removed. Any material showing splits, saw, sand paper or other defacing marks or other defects shall be rejected. All exposed wood and plywood shall be straight grained of matched grain and colour and shall be approved by Consultant before being fabricated.

Installation Doors, Windows, partitions and cabinet work shall be installed in position after the plaster in the section for which it is intended is sufficiently dry. All interior and exterior doors, partitions, glazing cabinet work and other fixed wooden equipment shall be properly installed, level, plumb and true. But joints shall be avoided wherever possible; if unavoidable the joints shall be beveled. All exterior angles shall be mitred. Adjoining interior wood members shall match and harmonise.

8. INTERIOR DOOR SHUTTERS

Interior wood door shutters, unless otherwise noted or specified, shall be 38mm thick solid core phenol formaldehyde resin bonded, flush shutters, commercial ply faced on both faces. Specification IS: 2202 (Part I)-1966.

Shutters shall be ordered on the manufacturer to sizes as called for and shall be provided with first class teakwood edging, glued and nailed on the edges of the shutter, as shown on drawings.

9. BLOCK BOARD AND PLY

Block boards and ply for partitions, cupboards and all other cabinet work shall be solid core, phenol formaldehyde resin bounded of approved make as called for.

Unless otherwise shown all block boards and ply shall be commercial ply veneered on both faces. Samples of flush doors, ply, block boards, etc., shall be submitted to the Consultant for his approval and all shutters, boards, etc., to be used in the work shall conform to the approved sample in all respects.

10. PARTITIONS AND CABINET WORK

General: Partitions, cabinets, etc., shall be fabricated and assembled in the workshop as far as practicable and then brought inside the building ready to set in place. The various members shall be worked in the best manner known to the trade, mortised and tenoned, dowelled, blocked and glued together so as to avoid the use of nails as much as possible. The details shall be closely followed, moulding clearly cut and miters accurately made. Free edge of shutters, shelves, partitions, sides, etc., shall be provided with first class teakwood edging, glued and nailed in approved manner. Shelves, where shown fixed, shall be supported

on aluminum or other cleats or in other manner as approved by the Consultant. Adjustable shelves shall have brass sockets and pins as detailed on drawings.

Drawer bottoms shall be of 6mm commercial ply, unless otherwise shown. Drawer front, sides and back shall be of first class teakwood. The drawers shall slide on wooden bearers as shown on drawings.

Timber skirting where called for shall be of first class teakwood, cut to required sizes, planed smooth on visible faces and fixed in position in approved manner. Cut-outs, openings, etc., shall be provided in the counters and cabinets to accommodate sinks, washbasins, cooking ranges, pipes, etc., as shown on drawings and as required at site.

11. HARDWARE FITTINGS

Hinges, handles, knobs, locks, ball catches, adjustable, shelf fitting, and other hardware fittings for doors and cabinet work shall be of the best quality and specified make as approved by the Consultant. The number, size, etc., shall be as per the hardware schedule and as shown on drawings.

12. PRESERVATIVE TREATMENT

All wood work in contact with masonry shall be painted with approved asphalt or bitumen paint before placing. Care shall be taken to keep exposed surfaces clear from tar, etc. The felt shall be used to isolate wood from masonry wherever practicable. All concealed wood etc., shall be treated fully and liberally with soling before placing in position.

13. A.C. GRILLES

A.C. Grilles wherever shown on drawings shall be of first class, fully seasoned, Indian teakwood, and of sizes and shapes as shown on drawings. The grilles fixed to teakwood framework as shown shall be installed in position true to line and level. Wherever so required, the grill openings shall be blocked by block boards/soft board painted mat black and placed at the rear of the grill as shown. The grill and the frames shall be wax polished as specified under "Painting".

14. PAINTING AND POLISHING

All exposed teak faces of partitions, glazing, doors, cabinet work etc., shall be painted/polished oiled to approved finish. Door shutters, internal faces of cupboards and cabinets, etc., shall be enamel painted to approved finish. Drawer bottoms, sides of drawers, etc., oiling, etc., shall be carried out as specified under "Painting".

15. PROTECTION OF WORK

The contractor shall be responsible for the temporary doors and closing in opening necessary for the protection of the work during progress. We shall also provide and maintain any other temporary covering required for the protection of finished wood work that may be damaged during the progress of the work if left unprotected.

SECTION- 13:: PAINTING

1. EXTENT AND INTENT

The contractor shall supply all materials, labour, tools, ladders, scaffolding and other equipment necessary for the completion and protection of all painting work. Painting, as herein specified shall be applied to all surfaces requiring painting throughout the interior and exterior of the buildings as given in the schedule of finishes or elsewhere. The painting shall be carried out by a specialist sub- contractor, approved by the Consultant.

2. STORAGE

Storage of materials to be used on the job shall be only in a single place approved by the Consultant. Such storage place shall not be located within any of the buildings included in the contract.

3. MATERIALS

Materials used in the work shall be of manufacture approved by the Consultant. Ready mixed paints, varnishes, enamels, lacquers, stains, paste fillers, distempers and other materials must be delivered to the job site in the original containers, with the seals unbroken and labels intact. Each container shall give the manufacturer's name, type of paint, colour of paint and instructions for reducing. Thinning shall be done only in accordance with directions. Remove rejected materials immediately from the premises.

4. COLOUR

All colours, as provided in the colour schedule, shall be approved by the Consultant. The contractor shall as far as possible use pre- mixed manufacturer's colours and shall prepare painted samples of the colours selected and submit same for approval by the Consultant. No work is to proceed until the Consultant has given his approval, preferably in writing, of the colour samples.

5. COMMENCEMENT OF WORK

Painting shall not be started until the surfaces to be painted are in a condition fit to receive painting and so certified by the Consultant.

Painting work shall be taken in hand only after all other builders work is completed. Buildings where painting work is to be commenced shall be thoroughly swept and cleaned up before commencement of painting.

6. SCAFFOLDING

Only double scaffolding having two sets of vertical supports shall be provided for all painting work. The supports shall be tied together with horizontal pieces over which the scaffolding planks shall be fixed.

All the vertical and horizontal members of the scaffolding shall be placed sufficiently away from the surfaces to be painted to ensure proper and uninterrupted application.

7. WORKMANSHIP

The workmanship shall be of the very best, all materials evenly spread and

Smoothly flowed as without runs and sags, using good quality tools, brushes, etc., as required. Only skilled painters shall be employed. A properly qualified foreman shall be constantly on the job whilst the work is proceeding. All surfaces to be painted shall be cleaned free of all loose dirt and dust before painting is started. All work where a coat of material has been applied must be inspected and approved before application of the succeeding specified coat. Each undercoat shall be distinct shade of the approved colour.

Before painting, remove hardware, accessories, plates and similar items or provide sample protection to all such items. Upon completion of each space, replace all fixtures removed. Remove doors if necessary to paint bottom edge. Use only skilled mechanics for the removal and replacement of above items.

8. CONCEALED SURFACES

All interior and exterior trim, door frames, doors, shelving, cabinet work shall be thoroughly and carefully back painted as all surfaces and edges which will be concealed when installed. Such surfaces shall be clean, dry, sanded and properly prepared to receive the paint. Tops, bottom and edges of doors shall be finished same as the rest of the door.

9. PROTECT AND CLEAN

Contractor shall protect not only his own work at all times, but shall also protect all adjacent work and materials by suitable covering during progress of his work. Upon completion of his work, he shall remove all paint and varnish spots from floors, glass and other surfaces. Any defaced surfaces shall be cleaned and the original finish restored. He shall remove from the premises all rubbish and accumulated material and shall leave the work in clean, orderly and acceptable conditions.

10. PREPARATION OF SURFACES

WOOD: Sand paper to a smooth even surface and then dust off and wipe clean. Touch up all knots and pit pockets with shellac on interior wood and without de-sealer on exterior work. After priming coat has been applied thoroughly fill all nail holes, irregularities and cracks. Use plaster wood filler for stained or natural finish and putty for painted work.

PLASTER WORK:

Fill all holes, cracks and abrasions with putty, properly prepared and applied and smoothed off to match adjoining surfaces. Do not use sand paper on plaster surfaces. Plaster shall be allowed to dry for at least 12 (twelve) weeks before the application of paint.

STEEL AND IRON:

All surfaces shall be washed with mineral spirits to remove any dirt or grease before applying paint. Where rust or scale is present, it shall be wire brushed and sanded clean. All cleaned surfaces shall be given one coat of approved phosphate before prime coat in accordance with the manufacturers instructions. Shop coats of paint that have become marred shall be cleaned off, wire brushed, and spot primed over the affected areas.

GALVANISED METAL:

Galvanised metal shall be thoroughly cleaned with naphtha and treated with a solution consisting of 5 gallons of 36% acetic acid,

1.36kg of blue vitriol and 1.36kg of powdered alum dissolved in 225 litres of water, prepared in a wooden container and applied with a brush. Allow to dry thoroughly and brush off before applying paint.

11. APPLICATION

The paint shall be continuously stirred in the container so that its consistency is kept uniform throughout.

The painting shall be laid on evenly and smoothly by means of crossing and laying off, the latter in the direction of the grain of the wood. The crossing and laying off consists of covering the area with paint, brushing the surface hard for the first time and then brushing alternatively in opposite directions, two or three times and then finally brushing lightly in a direction at right angles to the same. In this process no brush marks shall be left after the laying-off is finished. The full process of crossing and laying off will constitute one coat.

Where so stipulated, the painting shall be carried out using spray machines suited for the nature and location of the work to be carried out. Only skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner. Spraying shall be carried out only in dry conditions. No exterior painting shall be done in damp foggy or rainy weather. Surface to be painted shall be clean, dry, smooth and adequately protected from dampness. Each coat shall be applied in sufficient quantity to obtain complete coverage, shall be well brushed and evenly worked out over the entire surface and into all corners, angles and crevices allowed to thoroughly dry. Second coat shall be of suitable shade to match final colour, and shall be approved by the Consultant before final coat is started. Allow at least 48 hours drying time between coats for interior and 7 days for exterior work, and if in the judgments of the Consultant more time is required it shall be allowed. Finished surfaces shall be protected from dampness and dust until completely dry. Finished work shall be uniform, of approved colour, smooth and free from runs, sags, defective brushing and clogging. Make edges of paints adjoining other materials of colours sharp and clean, without overlapping.

In order to achieve a superior finished surface, putty paste fillers shall be used on all surfaces to be painted, to fill pores, dents, etc. The putty/paste fillers shall be approved quality and manufacture and shall be applied to the surface with a knife or other sharp edged tools after the priming coat as well as after each undercoat. The surface, after filling with putty/paste filler, shall be rubbed down with fines and paper and dusted off before the application of the subsequent coat.

Paste wood filler. When set, shall be wiped across the grains of the wood and then with the grain to secure a clean surface. Surface to be stained shall be covered with a uniform coat of stain wiped off if required.

FINISH:

The painted surfaces shall be finished to required texture. Matt finish shall be achieved by use of sponge rollers or stippling brushes as called for.

12. TYPES OF PAINT FINISHES

Enamel Paint:

- a) **Wood or Plastered Surfaces:** Pigmented priming coat followed by one undercoat and two more finishing coats of enamel paint. Paste filler to be applied after every coat excepting the final finishing coat and sanded.

- b) **Non-Galvanized Steel Surfaces:** Coat of red oxide primer after phosphating followed by the three or more coats of synthetic enamel paint. Paste filler to be applied after every coat excepting final finishing coat and sanded.
- c) **Galvanized Steel Surfaces:** Priming coat of galvanized metal primer after washing with galvanized metal cleaner, followed by three or more coats of synthetic enamel paint. Paste filler to be applied after every coat excepting final finishing coat and sanded.

Plastic Emulsion Paint:

Pigmented priming coat (emulsion thinned with water) followed by three or more finishing coats of plastic emulsion paint. Paste filler to be applied after every coat excepting the final finishing coat and sanded.

Exterior Rustic Paint

Pigmented primer (cement primer) coat followed by three or more finishing coats of oil bound distemper. Paste filler to be applied after every coat excepting the final finishing coat and sanded.

Exterior Wall Sealant

Exposed brick wall to be sealed by silicon based transparent deep penetrating sealer liquid

Oiling

Three coats of linseed oil (conforming to IS:75-1950) applied with brushes. Each coat to be applied after the previous coat is thoroughly dried. Grains to be filled with approved powder and surface rubbed smooth before oiling.

13. SPIRIT POLISHING

Polish: Polishing material shall be prepared by dissolving pure shellac, varying in shade from pale orange to lemon yellow, free from dirt and other materials, in methylated spirit at the rate of

0.15 kg. shellac to 1 liter of spirit. Suitable pigment to achieve the required shade of polish shall be added as directed by the Consultant.

Preparation of Surface: The surface, cleaned of all dirt, etc., shall be rubbed down smooth with sand paper and well dusted. Knots if visible shall be covered with a preparation of red lead and glue size laid on while hot. Holes and indentations shall be stopped with glazier's putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit at the rate of 1.5 kg of whiting to one liter of spirit. The surface shall again be rubbed down perfectly smooth with fine sand paper and wiped clean.

Application: Three or more coats of polish shall be applied over the above surface, to achieve a finish as approved by the Consultant. The polish shall be applied with a pad of woolen cloth covered by a fine cloth. The pad moistened with polish shall be rubbed hard on the wood surface in a series of overlapping movements, applying the material uniformly over the entire area to give an even finish. Subsequent coats shall be applied in a similar manner after the previous coat is allowed to dry. The finishing shall be done with a fresh piece of clean fine cloth, dampened with methylated spirit and applied by light rubbing. The finished surface shall have a uniform texture and high gloss.

14. WAX POLISHING

Wax polishing shall be done with ready made wax polish of approved brand and manufacture.

Preparation of Surface: The surface to be polished shall have been finished smooth. Knots, cracks and holes on the surface shall be cleaned and filled with wood putty (fine saw dust mixed with bees wax). The fittings when dry shall be rubbed down with a carpenter's file and then the entire surface shall be rubbed down perfectly smooth and wiped clean. In no case shall sand papers be rubbed across the grains so that even fine marks are not seen on the surface.

Application: The polish shall be applied evenly with a clean soft pad of cotton cloth in such a way that the surface is completely and fully covered. The surface is then continuously rubbed for half an hour. When the surface is quite dry a second and third coat shall be applied in the same manner and rubbed continuously until the surface is dry.

The final coat shall then be applied and rubbed for two hours more until the surface has assumed a uniform gloss and is dry, showing no sign of stickiness. The finished surface shall have a uniform glossy finish as approved by the Consultant.

15. PAINTING OF PLUMBING, HEATING AND ELECTRICAL EQUIPMENT

All exposed unfinished plumbing; heating, electrical equipment shall receive a painted finish as specified above. None of these items shall be painted without prior approval of the Consultant.

16. CLEANING

All rubbish waste or surplus material shall be removed from time to time, and all wood work, hardware, floors, or other adjacent work shall be cleaned unto the satisfaction of the Consultant.

All glass throughout shall have all paint or varnish spots and brush marks removed and upon completion of the painting work, shall be washed and polished on both sides. All glass that is scratched and damaged by contractor's work, or while cleaning off the paint from the glass shall be replaced by the contractor at his cost.

Hardware and other unpainted surfaces shall be cleaned using lacquer thinner or paint remover.

The contractor shall apply the final coat of paint to all internal walls and other surfaces just before the expiry of the defects liability period as directed by the Consultant.

Powder coat Paint-Base coat

Powder coating is sprayed with an electrostatic spray gun with a potential difference of about 270 Volts (approx.) after this the subtract/object is kept in an oven at a temperature of 180 degree C. for 30 minutes.

SECTION- 14:: FALSE CEILING

Aluminium Clip in Metal Ceiling System of 600x600/300x1200 mm or more module which includes providing and fixing 'C' wall angle of size 20x30x20 mm made of 0.7 mm thick pre painted steel along the perimeter of the room with help of nylon sleeves and wooden screws at 300 mm center to centre, suspending the main C carrier of size 10x38x10 mm made of G.I steel 0.7 mm thick from the soffit with help of soffit cleat 37x27x25x1.6 mm, rawl plugs of size 38x12 mm and C carrier suspension clip and main carrier bracket at 1000 mm c/c. Inverted triangle shaped Spring Tee having height of 24 mm and width of 34 mm made of Gl steel 0.45 mm thick is then fixed to the main C carrier and in direction perpendicular to it at 600 mm centers with help of suspension brackets. Wherever the main C carrier and spring T have to join, C carrier and spring T connectors have to be used. All sections to be galvanized @ 120 gms/sqm (both side inclusive), fixing with clip in tiles into spring T with :

Aluminum Metal Ceiling Clip in plain Beveled edge global white color tiles of size 600x600/300x1200mm or more and 0.7 mm thick with 25 mm height, made of Aluminum sheet having powder coating (both sides inclusive) electro statically polyester powder coated of thickness 60 microns (minimum).

Calcium Silicate False ceiling tiles:

15 mm thick fully perforated calcium silicate board made with Calcareous & Siliceous materials reinforced with cellulose fiber manufactured through autoclaving process to give stable crystalline structure with minimum compressive strength 225 kg/ sq. cm, bending strength 100 kg/sq. cm , of size 595x595 mm, having perforation of dia. 10 mm with minimum perforated area 18 % with non woven tissue on the back side, having an NRC (Noise Reduction Coefficient) of 0.85, with 50 mm thick rock wool of 48 kg /cum backing shall be used. Frame is made up of interlocking metal grid of hot dipped galvanized steel sections (galvanized @ 120 grams/ sqm, both side inclusive) consisting of main "T" runner with suitably spaced joints to get required length and of size 24x38 mm made from 0.30 mm thick (minimum) sheet, spaced at 1200 mm center to center and cross "T" of size 24x25 mm made of 0.30 mm thick (minimum) sheet, 1200 mm long spaced between main "T" at 600 mm center to center to form a grid of 1200x600 mm and secondary cross "T" of length 600 mm and size 24x25 mm made of 0.30 mm thick (minimum) sheet to be interlocked at middle of the 1200x600 mm panel to form grids of 600x600 mm and

wall angle of size 24x24x0.3 mm etc. complete. Main “T” runners to be suspended from ceiling using GI slotted cleats of size 27 x 37 x 25 x1.6 mm fixed to ceiling with 12.5 mm dia and 50 mm long dash fasteners, 4 mm GI adjustable rods with galvanized butterfly level clips of size 85 x 30 x 0.8 mm spaced at 1200 mm center to center along main T, bottom exposed width of 24 mm of all T sections shall be pre-painted with polyester paint, all complete for all heights as per specifications, drawings and as directed by Engineer-in-charge. false ceiling tiles of approved texture shall be laid in the grid including, required cutting/making, opening for services like diffusers, grills, light fittings, fixtures, smoke detectors etc. Manufacturers test certificate/ report of invoice shall be submitted for every delivery challan by suppliers.

POLYCARBONATE SHEET ROOFING:

Providing and Fixing of Multi cell Polycarbonate Panels 16mm thick with 5 cells - 6 walls structure over MS Supporting structures. Panel Width shall be 900mm to ensure best performance for wind uplift. The panels shall be uniform in color with an integral Microcell core with softlight finish to give diffused light. In a cross section, the core shall be constructed of microcells not exceeding 4mm x 4mm and shall be square/rectangular in appearance. Panels shall be coextruded with UV Protection layers with thickness and concentration to filter and block more than 99% of the UV rays (UVA and UVB) through a clear panel. The weight of the only panel shall not be less than 3250 gram per square meter. Panel shall have U value not more than 1.9 W/m²k and UV transmission of less than 0.1% with UV filtration test AS No.1067-1990. Panel and system should have impact and shock resistance with D1-10j -M 50 ,300 J -M 50 400 J. Panel should achieve minimum sound absorption level 20 DB with third party Test certificate. Panel system shall have Vertical Standing Seam 15mm at both sides and snap-on connector to interlock the panels with a grip-lock 2 tooth locking mechanism to ensure maximum uplift capability. Panels shall be fixed on Purlins (paid separately) with special SS Expansion fastener with design load 5000 Newtons per expansion fastener and polycarbonate U/2 connectors. Panel system shall be sealed with additional Tape / End caps / Aluminium U-Profile (mill finish) at the ends. Panel should pass through Sandbag impact test ASTM E 695-03 after 25,000 hours of environmental exposure and Hailstone impact test ASTM E 822-81. The panel system shall pass water penetration test ASTM E -331. The panel to have classification under B S1 D0 for reaction to fire as per test standard EN 13501 – 1:2002 tested by an independent, recognized testing laboratory. Panels shall have Yellowness Index as per ASTM D-1925; the change shall not be more than 10

points after 60 months of exposure in comparison to original. The Colour of the panel shall change no more than 3 units as per ASTM D2244 after 60 months of exposure in comparison to original. The Light Transmission of panels shall not change more than 10% after exposure of 60 months in comparison to original. The panels shall pass the cyclone test in accordance with BCA 2009 and conforming to the methods of testing requirement as per AS 4040.3- 1992. The Panels shall be manufactured with approved quality assurance as per ISO 9001 & ISO 14001 and manufacturer should have successful project reference in Indian sub-continent at least 10 years old. Translucent polycarbonate system Materials and Products shall be manufactured by a company continuously and regularly employed in the manufacture of translucent systems using polycarbonate panel systems for a period of at least twenty (20) years and the panels shall be warranted for ten (10) years. Third party test certificates to be submitted before supplying the material to Engineer in Charge.

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SECTION- 15:: GRC JALI

GRC (Glass reinforced plastic) Wall murals and GRC Jali, GRC fountains, along with accessories & sets of Bolts as per drawing provided by Architect. GRC product made by admixtures consisting of a matrix usually polyester Resin, Silica Sand and reinforcement of glass fibers, in addition with hardeners and accelerators, pigment for colouring, also includes MS pipe support for framing work held with fasteners of anchor and other accessories, Execution of work is done with skilled workers of height for installation Finishing & Painting of GRC products.

SECTION- 16:: ROAD WORK (Area As per Master Plan)

IRC STANDARDS:

1. IRC 10 Recommended practice for borrow pits for road embankments constructed by manual operation
2. IRC 29 Specification for bituminous concrete for road pavements
3. IRC 36 Recommended practice for construction of earth embankments for road works
4. IRC 60 Tentative guidelines for the use of lime flyash concrete as pavement base of sub base
5. IRC 88 Recommended practice for lime flyash stabilized soil base/ sub base in pavement construction
6. IRC 107 Tentative specification for bitumen mastic wearing courses

SUB-GRADE: PREPARATION AND CONSOLIDATION

In sub-grade composed of clay, fine sand or other soils that may be forced up into the coarse aggregate during rolling operation, an insulation layer of suitable thickness of granular materials or over size brick aggregate not less than 10 cm thick shall be provided for blanketting the sub-grade, which shall be paid for separately, unless otherwise specified in the agreement. In slushy soils or in areas that are water logged, special arrangements shall be made to improve the sub-grade and the total pavement thickness shall be designed after testing the properties of the sub-grade soil. Necessary provision for the special treatment required shall be made in the project and paid for separately. 16.2.1 Preparation of Sub-Grade The surface of the formation for a width of sub-base, which shall be 15 cm more on either side of base course, shall first be cut to a depth equal to the combined depth of sub-base and surface courses below the proposed finished level (due allowance being made for consolidation). It shall then be cleaned of all foreign substances. Any ruts or soft yielding patches that appear due to improper drainage conditions, traffic hauling or from any other cause, shall be corrected and the sub-grade dressed off parallel to the finished profile. 16.2.2 Consolidation The sub- grade shall be consolidated with a power road roller of 8 to 12 tonnes. The roller shall run over the sub grade till the soil is evenly and densely consolidated and behaves as an elastic mass (the roller shall pass a minimum of 5 runs on the sub grade). All undulations in the surface that develop due to rolling shall be made good with material or quarry

spoils as the cases may be and the sub-grade is rerolled. 16.2.3 Surface Regularity The finished surface shall be uniform and conform to the lines, grades and typical cross section shown in the drawings, when tested with the template and straight edge, the variation shall be within the tolerances specified in Table 16.11.

TABLE 16.11
Permissible Tolerances of Surface Evenness of Sub Grade

<i>Longitudinal profile maximum permissible undulation when measured with a 3 metre straight edge</i>	<i>Cross profile maximum permissible variation from specified profile when measured with a camber template</i>
24 mm	15 mm

GRANULAR SUB-BASE

Scope

This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer-in-charge. This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer-in-charge.

Materials:

The material to be used for the work shall be natural sand, crushed gravel, and crushed stone, crushed slag or combination thereof depending upon the grading required. Use of materials like brick metal, Kankar and crushed concrete shall be permitted in the lower sub-base. The material shall be free from organic or other deleterious constituents and shall conform to the grading given in Table 16.44 and physical requirement given in Table 16.45 Gratings III and IV shall preferably be used in lower sub-base. Grading V and VI shall be used as a sub-base-cum-drainage layer. The grading to be adopted for a project shall be as specified in the Contract. Where the sub-base is laid in two layers as upper sub-base and lower sub-base, the thickness of each layer shall not be less than 150 mm.

Preparation of Sub-Grade:

The surface of the sub grade to receive the Granular Sub-base shall be prepared to the specified lines and cross fall (Camber) as necessary and made free of dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled with 80 – 100 kN smooth wheeled roller until firm surface is obtained if necessary by sprinkling water. Weak places shall be strengthened, corrugations removed and depressions and potholes made good with suitable materials, before spreading the aggregate for GSB.

Where the existing surface over which the sub base of GSB is to be laid is black topped, to ensure effective internal drainage, furrows 50 mm x 50 mm (depth of furrows increased to reach bottom of bituminous layer where necessary) at one metre intervals shall be cut in the existing bituminous surface at 45 degrees to the central line of the carriageway at one metre intervals in the existing road before the GSB is laid.

Spreading and compacting:

The sub-base material of grading specified in the Contract, a suitable mixer equipped with provision for controlled addition of water, and mechanical mixing shall mix water mechanically. So as to ensure homogenous and uniform mix. The required water content shall be determined in accordance with IS:2720 (Part 8). The mix shall be spread on the prepared sub-grade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation, or other means as approved by the Engineer-in-charge. Moisture content of the mix shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted so that, at the time of compaction, it is from 1 to 2 per cent below the optimum moisture content (OMC).

Immediately after spreading the mix, rolling shall be done by an approved roller. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer upto 200 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional cross fall or on super elevation. For carriageway having cross fall on both sides, rolling shall commence at the edges and progress towards the crown.

Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and cross fall (camber) shall be checked and any high spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS : 2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise

defective areas shall be made good to the full thickness of layer and re-compacted.

WET MIX MACADAM (WMM) SUB-BASE/BASE

Scope:

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared subgrade/sub-base/base or existing pavement as the case may be in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Engineer-in-charge. The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the subbase course may be increased to 200 mm upon approval of the Engineer-in-charge.

Materials

Coarse aggregates shall be crushed stone. If crushed gravel/shingle is used, not less than 90 per cent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table below.

TABLE 16.46
PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR SUB-BASE/BASE COURSES

	Test	Test Method	Requirement
1.	Los Angeles Abrasion value	IS:2386 (Part-4)	40 per cent (Max.)
	or		
	Aggregate impact value	IS:2386 (Part-4) or IS:5640	30 per cent (Max.)
2.	Combined Flakiness and Elongation indices (Total)	IS:2386 (Part-1)	35 per cent (Max.)*

To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The value of flakiness index and elongation index so found are added up.

GRADING REQUIREMENTS OF AGGREGATES FOR WET MIX MACADAM

IS Sieve Designation	Per cent by weight passing the IS sieve
53.00 mm	100
45.00 mm	95-100
26.50 mm	---
22.40 mm	60-80
11.20 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600.00 micron	8-22
75.00 micron	0-5

Preparation of base:

The surface of the sub grade / sub base / base to receive the Wet Mix Macadam shall be prepared to the specified lines and crossfall (Camber) as necessary and made free of dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled with 80-100 kN smooth wheeled roller until firm surface is obtained if necessary by sprinkling water. Weak places shall be strengthened, corrugations removed and depressions and pot holes made good with suitable materials, before spreading the aggregate for WMM.

Where the existing surface over which the sub base of WMM is to be laid is black topped, to ensure effective internal drainage, furrows 50 mm x 50 mm (depth of furrows increased to reach bottom of bituminous layer where necessary) at one metre intervals shall be cut in the existing bituminous surface at 45 degrees to the central line of the carriageway at one metre intervals in the existing road before the WMM is laid.

Preparation of mix:

Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled, addition of water and forced/positive mixing arrangement like pugmill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

Optimum moisture for mixing shall be determined in accordance with IS:2720 (Part-8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

Spreading of mix:

Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared subgrade/sub- base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher.

The paver finisher shall be self-propelled of adequate capacity with the following features:

- (i) Loading hoppers and suitable distribution system. So as to provide a smooth uninterrupted material flow for different layer thickness from the tipper to the screed.
- (ii) (ii) Hydraulically operated telescopic screed for paving width upto 8.5 metre and fixed screed beyond this. The screed shall have tamping and vibrating arrangement for initial compaction of the layer.
- (iii) Automatic leveling control system with electronic sensing device to maintain mat thickness and cross slope of mat during laying procedure. In exceptional cases where it is not possible for the paver to be utilized mechanical means like motor grader may be used with the prior approval of the Engineer-in-charge. The motor grader shall be capable of spreading the

material uniformly all over the surface.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine panicles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials. The Engineer-in-charge may permit manual mixing and / or laying of Wet Mix Macadam, where small quantity of WMM is to be executed. Manual mixing / laying in inaccessible / remote locations and in situations where use of machinery is not feasible can also be permitted. Were manual mixing / laying is intended to be used, the same shall be done with the approval of the Engineer-in-charge.

Compaction:

After the mix has been laid to the required thickness, grade and crossfall/camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, a smooth wheel roller of 80 to 100 kN weight may be used. For a compacted single layer upto 200 mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 kN with an arrangement for adjusting the frequency and amplitude. An appropriate frequency and amplitude may be selected. The speed of the roller shall not exceed 5 km/h.

In portions having unidirectional cross fall/super elevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the Centre line of the road, uniformly over-lapping each preceding track by at least one-third width until the entire surface has been rolled. Alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding stop

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road uniformly overlapping each of the preceding tracks by at least one-third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted

Rolling should not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or subgrade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 metre straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and crossfall. In no case should the use of unmixed material be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part-8)

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and recomputed.

Ready Mix Concrete (RMC)

The contractor can be allowed to use Ready Mix Concrete (RMC) with the permission of Engineer-in-Charge, provided that the manufacturer assures that for RMC supplied for the particular work contains the minimum cement content and it is in conformity of approved design mix. The manufacturer of RMC has also to agree to the sampling and testing procedure as specified under DSR clause 20.1.7 or alternatively he can propose his own sampling and testing procedure which should in turn be approved by the Engineer-in-Charge. Normally, RMC supplied to site are mixed with certain admixtures which enables the concrete to be used within 3 hours of supply at site. In case RMC supplied is not consumed within 3 hours of supply the quantity of RMC remaining unused beyond 3 hours shall be rejected and removed from site.

Testing of Specimen:

The specimen shall be tested as described in IS 516.

SECTION- 17:: Pathway & Parking

FACTORY MADE CEMENT CONCRETE INTERLOCKING PAVER BLOCK

Base:

Interlocking paver block to be fixed on the bed 50 mm or specified otherwise thick of coarse sand of approved specification and filling the joints with the sand of approved type and quality or as specified and as directed by Engineer-in-charge.

Interlocking Paver Block

Factory made precast paver block of M-35 or otherwise specified grade to be used. Paver blocks to be of approved brand and manufacturer and of approved quality. Minimum strength as prescribed by manufacturer and as per direction of Engineer-in-Charge for the grade specified to be tested as per method mentioned in specification of subhead cement concrete

80 mm thick C.C. paver block of M-35 grade with approved colour design and pattern.

Location: It can be used for Pathway and Parking areas as specified in Master Plan .

KERB STONE (PRECAST)

Laying

Trenches shall first be made along the edge of the wearing course of the road to receive the kerb stones of cement concrete of specified grade. The bed of the trenches shall be compacted manually with steel rammers to a firm and even surface and then the stones shall be set in cement mortar of specified proportion.

The kerb stones with top 20 cm. wide shall be laid with their length running parallel to the road edge, true in line and gradient at a distance of 30 cm. from the road edge to allow for the channel and shall project about 12.5 cm. above the latter. The channel stones with top 30 cm. wide shall be laid in position in chamber with finished road surface and with sufficient slope towards the road gully chamber. The joints of kerb and channel stones shall be staggered and shall be not more than 10 mm. Wherever specified all joints shall be filled with mortar 1:3 (1 cement : 3 coarse sand) and pointed with mortar 1:2 (1 cement: 2 fine sand) which shall be cured for 7 days.

The necessary drainage openings of specified sizes shall be made through the kerb as per drawings or as directed by the Engineer-in-Charge for connecting to storm water drains.

Berms and road edges shall be restored and all surplus earth including rubbish etc. disposed off as directed by the Engineer-in-charge. Nothing extra shall be paid for this.

Boundary Wall:

The Boundary wall to be constructed at height of 2.4 metre with RCC Column, Bands at specified intervals as per Drawing.

SIGNAGE

The Aluminum Composite Material (ACM), used as the substrate for signage application shall have a

thickness of at least 4.0mm (excluding coating thickness).

(ii) The ACM shall be composed of thermoplastic core of “Low Density Polyethylene’ (LDPE) of 3.0mm thickness sandwiched between two thick sheets of aluminium, of 3003 grade and H18 temper and minimum thickness of 0.5mm each. The retro reflection sheeting must be applied on the top surface with aluminium surface with recommended surface preparation from sheeting manufactures. A fluorocarbon coating may be applied over the exposed surface of aluminum to ensure corrosion resistance and weather proof and thus shall confirm to relevant ASTM.

- (iv)** The ACM shall have a high-surface energy coating on the top surface, over which the retro reflective sheeting shall be applied.
- (v)** When measured after 24 hrs after application, the 90 peel-adhesion strength of the top surface of ACM with the retro reflective sheeting applied on it using a 2kg roller as per ASTM D3330 shall be at least 1.5 kg-f.
- (vi)** The front surface shall have no other coating other than the high-surface energy coating and shall be protected with a self-adhesive peel-off film. The retro reflective sheeting shall be applied only on the top surface with high-surface energy coating.
- (vii)** (vii) On the back surface, it shall have a polyester based service coating preferably grey in color to protect against possible corrosion and to avoid undesired glare from the rear side of the sign

SECTION- 18:: HORTICULTURE & LANDSCAPING

HORTICULTURE WORK

Horticultural operations shall be started on ground previously levelled and dressed to required formation levels and slopes. In case where unsuitable soil is met with, it shall be either removed or, replaced or it shall be covered over to a thickness decided by the Engineer-in-charge with good earth. In the course of excavation or trenching during horticultural operations, any walls, foundations, etc. met with shall not be dismantled without pre-measurement and prior to the written permission of the Engineer-in-charge.

2.0 TRENCHING IN ORDINARY SOIL

- 2.0.0 Trenching is done in order to loosen the soil, turn over the top layer containing weeds etc. and to bring up the lower layer of good earth to form a proper medium for grassing, regrassing, hedging and shrubbery. Trenching shall be done to the depth ordered by the Engineer-in-charge. The depth is generally 30cm for grassing and 60cm for regressing in good soil.
- 2.0.1 The trenched ground shall, after rough dress, be flooded with water by making small kiaries to enable the soil to settle down. Any local depression unevenness etc. shall be made good by dressing and/or filling with good soil.
- 2.0.2 Weeds or other vegetation which appear on the ground are then uprooted and removed and disposed off and paid.
- 2.0.3 Trenching

Trenching shall consist of the following operations:

- 1. The whole plot shall be divided into narrow rectangular strips of about 1.5 m width or as directed by the Engineer-in-Charge.
- 2. These strips shall be sub-divided lengthwise into about 1 m long sections. Such sections shall be excavated serially and excavated soil deposited in the adjacent section preceding it.
- 3. In excavating and depositing care shall be taken that the top soil with all previous plant growth including roots, get buried in the bottom layer of trenched area, the dead plants so buried incidentally being formed into humus.
- 4. The excavated soil shall be straight away dumped into the adjoining sections so that double handling otherwise involved in dumping the excavated stuff outside and in back filling in the trenches with leads is practically eliminated.

2.1 GOODEARTH

- 2.2.1 The earth shall be stacked at site in stacks not less than 50 cm high and of volume not less than 3.0 cum.
- 2.2.2 Measurements: Length, breadth and height of stacks shall be measured correct to a cm. The volume of the stacks shall be reduced by 20% for voids before payment, unless otherwise described.
- 2.2.3 Rate: The rate shall include the cost of excavating the earth from areas lying at distance not exceeding

one km. from the site, transporting the same at site breaking of clods and stacking at places indicated. The rate shall also include royalty if payable.

OILCAKE

Neem/Castor: The cake shall be free from grit and any other foreign matter. It should be undecorticated and pulverized. The material shall be packed in old serviceable gunny bags of 50 kgs capacity approximately. The weight of gunny bag shall be deducted@1kg per bag and payment shall be made for net quantity. The quality of cake should be got approved by the Engineer-in-charge before supply.

2.2 SUPPLY AND STACKING OF SLUDGE

- 2.3.1** It shall be transported to the site in lorries with efficient arrangement to prevent spilling enroute. It shall be stacked at site. Each stack shall not be less than 50cm height and volume not less than 3 cum.

2.4 ROUGH DRESSING OF THE TRENCHED GROUND

- 2.4.1** Rough dressing of the area shall include making kiaries for flooding.
- 2.4.2** The trenched ground shall be levelled and rough dressed and if there are any hollows and depressions resulting from subsidence which cannot be so levelled, these shall be filled properly with earth brought from outside to bring the depressed surface to the level of the adjoining land and to remove discontinuity of slope and then rough dressed again. The supply and spreading of soil in such depressions is payable separately. In rough dressing, the soil at the surface and for 75 mm depth below shall be broken down to particle size not more than 10 mm in any direction.

2.5 UPROOTING WEEDS FROM THE TRENCHED AREAS

- 2.5.1** After 10 days and within 15 days of flooding the rough dressed trenched ground with water, the weeds appearing on the ground shall be rooted out carefully and the rubbish disposed off as directed by the Engineer-in-charge.

2.6 FINE DRESSING OF THE GROUND

- 2.6.1** Slight unevenness, ups, and downs and shallow depressions resulting from the settlement of the flooded ground, in drying and from the subsequent weeding operations, shall be removed by fine dressing the surface to the formation levels of the adjoining land as directed by the Engineer-in-charge, and by adding suitable quantities of good earth brought from outside, if necessary.

2.7 SPREADING OF GOOD EARTH

- 2.7.1** Good earth shall be removed from stacks by head load and spread evenly over the surface to the thickness ordered by the Engineer-in-charge. It shall be spread with a twisting motion to avoid segregation and to ensure that spreading is uniform over the entire area.

2.7.2 SPREADING OF SLUDGE/MANURE

Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Engineer-in-Charge. The mixing shall be spread as described in 2.9.1 to the thickness ordered by the Engineer-in-Charge.

2.8 MIXING OF GOOD EARTH AND SLUDGE/MANURE

The stacked earth shall, before mixing be broken down to particle of sizes not exceeding 6 mm in any direction. Good earth shall be thoroughly mixed with sludge or manure in specified proportion as

described in the item or as directed by the Engineer-in-charge.

2.9 GRASSING WITH SELECTION NO.1 DOOBGRASS

- 2.9.0 The area from where the grass roots are to be obtained shall be specified by the Engineer- in- Charge at the time of execution of the work and no royalty shall be charged on this account from the contractor. Grass is to be arranged by contractor (cost of grass to be paid separately).
- 2.9.1 The soil shall be suitably moistened and then the operation of planting grass shall be commenced. The grass shall be dibbled at 10cm, 7.5cm, 5cm a part in any direction or other spacing as described in the item. Dead grass and weeded shall not be planted. The contractor shall be responsible for watering and maintenance of levels and the lawn for 30 days or till the grass forms a thick lawn free from weeded and fit for moving whichever is later. Generally planting in other direction at 15cm, 10cm, spacing is done in the case of large open spaces, at 7.5 cm spacing in residential lawn and at 5cm spacing for Tennis Court and sports ground lawn. Rates are including cost of labour and material (grass shall be paid separately.)

During the maintenance period, any irregularities arising in ground levels due to watering or due to trampling by labour, or due to cattle straying thereon, shall be constantly made up to the proper levels with earth as available or brought from outside as necessary, Constant watch shall be maintained to ensure that dead patches are replanted and weeds are removed.

2.10 UPROOTING RANK VEGETATION AND WEEDS AND PREPARING THE GROUND FOR PLANTING SELECTION NO. 1 DOOB GRASS

Initially the area shall be dug up to a depth of 30 cm. and weeds and rank vegetation with roots removed thereon by repeated forking. The whole area then shall be retrenched to a depth of 60 cm in the same manner as described in 2.1. Clods of excavated earth shall then be broken up to the size not more than 75mm in any direction. The area shall then be flooded with water and after 10 days and within 15 days of flooding, weeds shall be uprooted carefully. The rubbish arising from the above operations shall be removed and disposed off in a manner directed by the Engineer-in-charge, away from the site. The earth shall then be rough dressed and fine dressed as described in 2.6

2.11 EXCAVATION AND TRENCHING FOR PREPARATION OF BEDS FOR HEDGE AND SHRUBBERY

Beds for hedges and shrubbery are generally prepared to width of 60 cm. to 125 cm. and 2 to 4 meters respectively.

Beds for hedges and shrubbery shall be prepared in the following manner. The beds shall first be excavated to a depth of 60 cm. and the excavated soil shall be stacked on the sides of the beds. The surface of the excavated bed shall then be trenched to a further depth of 30 cm, in order to loosen the soil, in the manner described in 2.1. No flooding will be done at this stage but the top surface shall be rough dressed and levelled. The excavated soil from the top 60 cm depth of the bed stacked at the site shall then be thoroughly mixed with sludge over manner in the proportion 8:1 by ratio or other proportion described in the item. The mixed earth and manure shall be refilled over the trenched bed, levelled neatly and profusely flooded so that the water reaches even the bottom most layers of the trenched depth of the bed. The surface after full subsidence shall again be refilled with the earth and

manure mixture, watered and allowed to settle and finally fine dressed to the level of 50mm to 75mm below the adjoining ground or as directed by the Engineer-in-Charge. Surplus earth if any, shall be disposed off as directed by the Engineer-in-charge. Any surplus earth if removed beyond initially lead shall be paid separately. Stones, bricks bats and other foreign matter if met with during excavation or trenching shall be removed and stacked within initially lead & lift, such material as is declared unserviceable by the Engineer-in-charge shall be disposed by spreading and levelling at places ordered by him.

3.1 DIGGING HOLES FOR PLANTING TREES

In ordinary soil, including refilling earth after mixing with oil cake, manure and watering.

Holes of circular shape in ordinary soil shall be excavated to the dimensions described in the items and excavate soil broken to clods of size not exceeding 75 mm in any direction, shall be stacked outside the hole, stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth met with during excavation shall be separated out and unserviceable material removed from the size as directed. Useful material, if any, shall be stacked properly and separately. Good earth in quantities as required to replace such discarded stuff shall be brought and stacked at site by the contractor which shall be paid for separately. The tree holes shall be manured with powdered Neam/castor oil cake at the specified rate along with farm yard manure over sludge shall be uniformly mixed with the excavated soil after the manure has been broken down to powder, (size of particle not be exceeded 6 mm in any direction) in the specified proportion, the mixture shall be filled in to the hole up to the level of adjoining ground and then profusely watered and enable the soil to subside the refilled soil shall then be dressed evenly with its surface about 50 to 75 mm below the adjoining ground level or as directed by the Engineer-in-charge.

2.16 M.S. FLAT IRON TREE GUARD

2.16.1 M.S. Iron Riveted Tree Guard

2.16.1.1 The tree guard shall be 600mm in diameter and 2 meter high above ground level and 25 cm in below ground level.

2.16.1.2 The tree guard shall be framed of 4 nos. 25 x 6 mm M.S. flat 2 meter long excluding displayed outward at lower and upto an extent 10cm and 8 nos. 25x3mm vertical M.S. Flat Rivetted to 3 Nos. 25x6mm Flat iron rings in two halves, bolted together 8mm dia and 30mm long M.S. bolts and nuts. The entire tree guard shall be given two coats of synthetic enamel paint of approved brand and manufacturer of required shade over a priming coat of ready mixed steel primer of approved brand and manufacturer. The design of tree guards shall be shown in the drawing.

2.17 FILLING MIXTURE OF EARTH & SLUDGE OR MANURE

The separately specified earth and sludge shall be broken down to particles of size not exceeding 6 mm in any directions before mixing. Good earth shall be thoroughly mixed with sludge over manure in specified proportions as directed by Officer-in-Charge. During the process of preparing the mixture as above, trenches shall be flooded with water and leveled

2.20 EXCAVATION IN DUMPED STONE OR MALBA

2.21.1 Excavation operations shall include excavation and getting out water if required. During the excavation stone, brick bats and other foreign material if met shall be removed and stacked within 50 meter leads and lifts. Such material as is declared unserviceable by the Engineer- in-Charge be disposed within 50 m. The excavated surface shall be neatly dressed and levelled.

2.22 FLOODING THE GROUND WITH WATER AND MAKING KIARIES

2.22.1 The water for flooding shall be of soft water and free from chemical and good for growing the trees and shrubs etc. Before flooding the kiaries shall be made in required size and shape as per directions of Officer-in-charge. After uprooting weeds from the trenched area and uprooting vegetation, kiaries shall be dismantled.

2.23 CLEANING AND SWEEPING OF LAWN

The Cleaning of Garden shall cover to proper sweeping work including removing litter, debris, picking of leaves, papers, plastic bottles etc. & disposal of collected waste in dustbin/designated place as decided by officer in charge.

SPECIFICATIONS OF PLANTS(SH3TO10)

The plants included under Sub Head 3 to 10 should be as per following specification.

1. The plants should be full of fresh and healthy foliage.
2. The plants should be free from insect, pest and diseases.
3. Plant should be well developed and healthy.
4. The height of the plants will be measured from top of the pots.
5. The plants should be well settled and should not be newly shifted/Transplanted.
6. The plants should be true to the variety and Variety name should be tagged.
7. Moss stick used should be made on plastic pipe.
8. Moss stick should be straight and properly fixed in the pot.
9. The rejected plants materials should be removed from the site immediately.
10. Moss stick should be covered with the plants in case of plants supplied with moss stick.
11. The Plant should be well established and should have good foliage.
12. Good earth and manure used for filling the pot/poly bag should be free from any inert material and mixed to proper ratio.
13. Pot/Polybag used for filling the plants should be of proper size.
14. There should be proper drainage in pots for plants.
15. The flowering plants should also have proper flowering and should be true to the variety.
16. All plant should have the tendency of growth and should not be stunted or de-shaped.
17. There should be no stagnation of water in the pots.
18. Plant should not have any physiological disorder.

19. Tips of the Plants should have intact, there should not be any damages etc.
20. In case of flowering pots flower should be on budstage/semi bloom stage.
21. In case of potted plant pots should have uniformity/samesize and quality.
22. Plants of bigger height should be properly supported/stacked by bamboo stick.
23. Pots/Polybags soil should not be infectious and plant should have free from all kind of diseases.
24. Bulbs, seeds, seedling, suckers should properly treated with fungicides before supply.

TECHNICAL SPECIFICATION OF PLUMBING & FIRE FIGHTING

SECTION I

1.0 GENERAL REQUIREMENTS

1.1 Scope of Work

1.1.1 The form of Contract shall be according to the "Special Conditions of Contract". The following clauses shall be considered as an extension and not in limitation of the obligation of the Contractor.

1.1.2 Work under this contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the Plumbing and other specialized services as described hereinafter and as specified in the Schedule of Quantities and/or shown on the Plumbing Drawings.

1.1.3 Without restricting to the generally of the foregoing, the sanitary installations shall include the following:-

A. Plumbing Works

- a. Sanitary ware Installation
- b. Water Supply System (Hot & Cold).
- c. Under ground water tanks with all sleeves.
- d. Sewerage & Storm water drainage system.
- e. Garden Irrigation System.
- f. High side works.
- g. Sewage treatment plant.

B. Fire Fighting Works

- a. Hydrant System
- b. Sprinkler System
- c. Fire Extinguishers

1.1.4 Services rendered under this section shall be done without any extra charge.

1.2 Specifications

1.2.1 Work under this contract shall be carried out strictly in accordance with Specifications attached with the tender.

1.2.2 Items not covered under these Specifications due to any ambiguity or misprints, or additional works, the work shall be carried out as per Specifications of the latest Central Public Works Department with upto date amendments as applicable in the contract and or as per the requirement of the client or its representative.

1.2.3 Works not covered above in para 1.2.1 and 1.2.2 shall be carried out as per relevant Indian Standards and in case of its absence as per British Standard Code of Practice.

1.3. Execution of Work

1.3.1 The Contractor should visit and examine the site of work and satisfy himself as to the nature of the existing roads and other means of communication and other details pertaining to the work and local conditions and facilities for obtaining his own information on all matters affecting the execution of work. No extra charge made in consequence of any misunderstanding, incorrect information on any of these points or on ground of insufficient description will be allowed.

1.3.2 The work shall be carried out in conformity with the Plumbing drawings and within the requirements of Architectural, HVAC, Electrical, Structural and Other specialized services drawings.

1.3.3 The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction schedule.

1.3.4 On award of the work, Contractor shall submit a schedule of construction in the form of a PERT Chart or BAR Chart for approval of the Engineer-in-charge. All dates and time schedule agreed upon should be strictly adhered to, within the stipulated time of completion/commissioning along with the specified phasing, if any.

1.4 **Drawings**

1.4.1 Plumbing drawings are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the Architectural and other services drawings.

1.4.2 Architectural drawings shall take precedence over Plumbing or other services drawings as to all dimensions.

1.4.3 Contractor shall verify all dimensions at site and bring to the notice of the Engineer-in-charge all discrepancies or deviations noticed. Decision of the Engineer-in-charge shall be final.

1.4.4 Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small scale drawings.

1.4.5 All drawings issued by the Architects/Consultant for the work are the property of the Architects/Consultant and shall not be lent, reproduced or used on any works other than intended without the written permission of the Architects/Consultant/Engineer-in-charge.

1.5 **Inspection and Testing of Materials**

1.5.1 Contractor shall be required, if requested, to produce manufacturers Test Certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Indian Standards.

1.5.2 For examination and testing of materials and works at the site Contractor shall provide all Testing and Gauging Equipment necessary but not limited to the followings:-

- a) Theodolite, Steel tapes
- b) Dumpy level
- c) Weighing machine
- d) Plumb bobs, Spirit levels, Hammers
- e) Micrometers, Tachometers
- f) Thermometers, Stoves
- g) Hydraulic test machine
- h) Smoke test machine

1.5.3 All such equipment shall be tested for calibration at any approved laboratory, if required by the Engineer-in-charge.

1.5.4 All Testing Equipment shall be preferably located in a special room meant for the purpose.

1.5.5 Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the Engineer-in-charge or kept at site in a sample room as prepared by the owners. Any materials declared defective by Engineer-in-charge shall be removed from the site within 48 hours.

1.6 **Metric Conversion**

1.6.1 All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.

- 1.6.2 Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

1.7 Reference Points

- 1.7.1 Contractor shall provide permanent Bench Marks, Flag Tops and other reference points for the proper execution of work and these shall be preserved till the end of the work.
- 1.7.2 All such reference points shall be in relation to the levels and locations given in the Architectural and Plumbing drawings.

1.8 Reference Drawings

- 1.8.1 The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site. All important drawings shall be mounted on boards and placed in racks indexed. No drawings shall be rolled.
- 1.8.2 All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings. All changes to be made shall be initialed by the Engineer-in-charge.

1.9 Shop Drawings

- 1.9.1 The Contractor shall submit to the Engineer-in-charge three copies of the shop drawings.
- 1.9.2 Shop drawings shall be submitted under following conditions:-
- (a) Showing any changes in layout in the plumbing drawings.
 - (b) Equipment layout, piping and wiring diagram.
 - (c) Manufacturer's or Contractor's fabrication drawings for any materials or equipment supplied by him.
- 1.9.3 The Contractor shall submit two copies of catalogues, manufacturer's drawings, equipment characteristics data or performance charts as required by the Engineer-in-charge.

1.10 Completion Drawings

- 1.10.1 On completion of work, Contractor shall submit one complete set of original tracings and two prints of "as built" drawings to the Engineer-in-charge. These drawings shall have the following information.
- a) Run of all piping, diameters on all floors, vertical stacks and location of external services.
 - b) Ground and invert levels of all drainage pipes together with location of all manholes and connections upto outfall.
 - c) Run of all water supply lines with diameters, locations of control valves, access panels.
 - d) Location of all mechanical equipment with layout and piping connections.

No completion certificate shall be issued unless the above drawings are submitted.

- 1.10.2 Contractor shall provide two sets of catalogues, service manuals manufacturer's drawings, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment provided by him.

1.10.3 All "Warranty Cards" given by the manufacturers shall be handed over to the Engineer-in-charge.

1.11. **Contractors Rates**

1.11.1 Rates quoted in this tender shall be inclusive of cost of materials, labour, supervision, erection, tools, plant, scaffolding, service connections, transport to site, taxes, octroi and levies, breakage, wastage and all such expenses as may be necessary and required to completely do all the items of work and put them in a working condition.

1.11.2 Rates quoted are for all heights and depths and in all positions as may be required for this work.

1.11.3 All rates quoted must be for complete items inclusive of all such accessories, Fixtures and fixing arrangements, nuts, bolts, hangers as are a standard part of the particular item except where specially mentioned otherwise.

1.11.4 All rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete/water proofing of appropriate mix and strength as directed by Engineer-in-charge. Contractor shall provide holes, sleeves and recesses in the concrete and masonry work as the work proceeds.

1.11.5 The Contractor shall furnish the Engineer-in-charge with vouchers and test certificates, on request, to prove that the materials as specified and to indicate that the rates at which the materials are purchased in order to work out the rate analysis of non tendered items which he may be called upon to be carried out.

1.12 **Testing**

1.12.1 Piping and drainage works shall be tested as specified under the relevant clause(s) of the specifications. (Sub-sections)

1.12.2 Tests shall be performed in the presence of the Engineer-in-charge.

1.12.3 All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

1.12.4 Contractor shall perform all such tests as may be necessary and required by the local authorities to meet Municipal or other bye-laws in force.

1.12.5 Contractor shall provide all labour, equipment and materials for the performance of the tests.

1.13 **Site Clearance and Cleanup**

1.13.1 The Contractor shall, from time to time clear away all debris and excess materials accumulated at the site.

1.13.2 After the Fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints stains, stickers and other foreign matter of discoloration leaving the same in a ready to use condition.

1.13.3 On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done at Contractors risk and cost.

1.14 **License Permits and Authorities**

1.14.1 Contractor must keep constant liaison with the Municipal/statutory authority and obtain all approval of all drainage, water supply and other works carried out by him.

1.14.2 Contractor shall obtain, from the Municipal and other authority's necessary completion certificate(s) with respect to

his work as required for occupation of the building. Contractor shall obtain permanent water supply and drainage connections from authorities concerned. Employer shall pay all fees/deposits as required to be paid to the authorities towards connection charges.

1.15 Recovery of Cost for Materials issued to Contractors Free of Cost

- 1.15.1 If any materials issued to the Contractor free of cost, are damaged or pilfered, the cost of the same shall be recovered from the Contractor on the basis of actual cost to owner which shall include all freight and transportation, excise duty, sales tax, octroi, import duty etc. plus 100%. The decision on the actual cost given by the Employer shall be final and binding on the Contractor.

1.16 Cutting of Water Proofing Membrane

No walls, terraces shall be cut for making and opening after water proofing has been done without written approval of Engineer-in-charge. Cutting of water proofing membrane shall be done very carefully to ensure that other portion(s) of water proofing is (are) not damaged. On completion of work at such place the water proofing membrane shall be made good and ensured that the opening/cutting is made fully water proof as per specifications and details of water proofing approved by Engineer-in-charges.

1.17 Cutting of Structural Members

No structural member shall be chased or cut without the written permission of the Project Manager.

1.18. Materials Supplied by Owner

- 1.18.1 The Contractor shall verify that all materials supplied by the Employer confirm to the specifications of the relevant item in the tender. Any discrepancy found shall be brought to the notice of the Project Manager.

1.19 Materials

- 1.19.1 Unless otherwise specified and expressly approved in writing by the Engineer-in-charge, only materials of makes and specifications mentioned in the list of approved makes attached with the specifications shall be used.
- 1.19.2 If required, the Contractor shall submit samples of materials proposed to be used in the works. Approved samples shall be kept in the office of the Engineer-in-charge and returned to the Contractor at the appropriate time.

SECTION-II

SANITARY FIXTURES

2.1 SCOPE OF WORK

- 2.1.1 Work under this section shall consist of furnishing all material and labour as necessary and required to completely install all sanitary fixtures, brass and chromium plated fittings and accessories as required by the drawings and specified hereinafter or given in the schedule of quantities.
- 2.1.2 Without restricting to the generally of the foregoing the sanitary fixtures shall include all sanitary fixtures, C.P. fittings and accessories etc. necessary and required for the building.
- 2.1.3 Whether specifically mentioned or not all fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required.

2.2 GENERAL REQUIREMENTS

- 2.2.1 All 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 schedule of quantities, specifications, drawings or not.
- 2.2.2 All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per architectural/interior designer's requirements. Wherever necessary the fittings shall centered to dimensions and pattern desired.
- 2.2.3 Fixing screws shall be half round head chromium plated brass with C.P. washers wherever required as per directions of Engineer-in-charge.
- 2.2.4 All fittings and fixtures shall be fixed in a neat workmanlike manner true to levels and heights shows 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 or terrace shall be made good at contractors cost.
- 2.2.5 When directed, contractor shall install fixtures and accessories in a mock-up room for the approval of the Engineer-in-charge. Sample room fixtures may be reused on the works if undamaged, but no additional payment for fixing or dismantling shall be admissible.

2.3. INDIAN W.C.

- 2.3.1 Indian W.C. pan shall be Orissa pattern of size as specified in the schedule of quantities. Each W.C. shall be provided with a 100mm dia cast iron or porcelain P or S trap with or without vent horn.
- 2.3.2 W.C. shall be flushed by means of a C.I. high level flushing cistern or low level cistern of polyethylene body complete with accessories on an exposed or concealed type flush valve or as specified in bill of quantities.
- 2.3.3 The W.C. shall be fixed in level in a neat workmanlike manner. The W.C. and trap shall be set in cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size). Joints between W.C. and flush pipe shall be made with a putty or white lead and linseed oil and caulked well or with an approved rubber joint.

2.4 ANGLO INDIAN W.C.

- 2.4.1 Anglo Indian W.C. shall be wash down type 'P' or 'S' Trap set.
- 2.4.2 Each Anglo Indian W.C. set shall be provided with a solid plastic seat with cover of colour given in the schedule of quantities, rubber buffers and chromium plated hinges.
- 2.4.3 Plastic seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.
- 2.4.4 Each Anglo Indian W.C. shall be flushed with a porcelain flushing cistern or an exposed or concealed type flush valve. Flush pipe/bend shall be connected to the W.C. by means of a suitable rubber adapter.

2.5. EUROPEAN W.C.

- 2.5.1 European W.C. shall be wash down, single or double siphonic type, floor or wall mounted set, flushed by means of porcelain/PVC dual flushing cistern (3/6 liters), or an exposed or concealed type flush valve (dual flush 3/6), as specified in schedule of quantities. Flush pipe/bend shall be connected to the W.C. by means of suitable rubber adapter. Wall hung w.c. shall be supported by C.I. floor mounted chair.
- 2.5.2 Each W.C. seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.

2.6 URINALS

- 2.6.1 Urinals shall be lipid type half shall white glazed vitreous China of approx. size 630x420x380mm size or as specified in bill of quantities.
- 2.6.2 Half stall Urinals shall be provided with 15mm dia C.P. spreader, 32mm dia C.P. domical waste and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by one C.I. bracket and two C.I. wall clips as recommended by manufacturers complete as directed by Engineer-in-charge.
- 2.6.3 Half stall urinals shall be fixed with C.P. brass screws and shall be provided with 32mm dia domical waste leading to urinals trap.
- 2.6.4 Urinals shall be flushed by means of automatic porcelain/PVC flushing cistern or exposed or concealed type urinal flush valve (sensor type), as specified in schedule of quantities.
- 2.6.5 Flushing cistern for urinals shall be automatic type cast iron or vitreous china as given in the schedule of quantities. Each flushing cistern shall have a copper siphon and inlet noose cock to control the flow. Flushing cistern shall be fixed to wall with R.S. or C.I. brackets. Cast iron cistern and brackets shall be painted with two coats of white enamel paint. Cistern may be concealed in pipe shafts or false ceilings where required as directed by Engineer-in-charge.
- 2.6.6 Flush pipes of flushing cistern with sizes of main and branch flush pipes shall be as follows:

No. of Urinals in range	Capacity of cistern litres	Size of main flush pipe	Size of branch flush pipe	Size of Connection to urinal
One	5	--	--	15
Two	10	20	--	15
Three	10	25	--	15

2.6.7 Alternatively, urinals may be flush with flush valves, exposed or concealed type.

2.6.8 Waste pipes for urinals shall be any one of the following:

- a). G.I. pipes
- b). Rigid P.V.C.
- c). Lead pipes.

Waste pipes may be exposed on wall or concealed in chase as directed by the Engineer-in-charge. Specifications for waste pipes shall be same as given in sub-section III.

2.7 LAVATORY BASIN

2.7.1 Lavatory basins shall be white glazed vitreous china or polymarble of size, shape and type specified in the bill of quantities.

2.7.2 Each basin shall be provided with R.S. or C.I. brackets and clips and the basin securely fixed to wall. Placing of basins over the brackets without secure fixing shall not be accepted.

2.7.3 Each basin shall be provided with 32mm dia C.P. waste with overflow, pop-up waste or rubber plug and chain as given in the bill of quantities, 32mm dia C.P. Brass bottle trap with C.P. pipe to wall and flange.

2.7.4 Each basin shall be provided with CP fittings (push type) or mixing fitting as specified in the bill of quantities.

2.7.5 Basins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 79 cms above the floor or as directed by Engineer-in-charge.

2.8 SINKS

2.8.1 Sinks shall be of precast Terrazzo marble, or white glazed fireclay or vitreous china or stainless steel or any other material as specified in the schedule of quantities.

2.8.2 Each sink shall be provided with R.S. or C.I. brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable angle iron clips or brackets as recommended by the manufacturer. Each sink shall be provided with 40mm dia C.P. waste with chain and plug or P.V.C. waste. Fixing shall be done as directed by Engineer-in-charge.

2.8.3 Supply fittings for sinks shall be mixing fittings or C.P. taps as specified in the bill of quantities.

2.9 MIRRORS

2.9.1 Mirrors shall be electro coated copper 5.5mm thick of guaranteed reputed make. The size shall be as specified in the bill of quantities or shown on the drawings. The image shall be clear and without waviness at all angles of vision.

2.9.2 Mirrors shall be provided with backing of 12mm thick marine plywood sheet fixed with C.P. brass semi-round headed screws and cup washers or C.P. brass clamps as specified or instructed by Engineer-in-charge.

2.10 SHOWER SET

2.10.1 Shower set shall comprise of one/two C.P. Brass concealed stop cocks with two long body brass/C.P. brass bib cock, or bath spout or as given in the bill of quantities.

2.10.2 Each shower set shall also be provided with C.P. Shower arm with wall flange and shower head of approved quality as specified in the bill of quantities.

2.10.3 Concealed stop cocks shall be so fixed as to keep the wall flange clear off the finished wall. Wall flanges embedded in the finishing shall not be accepted.

2.11 ACCESSORIES

2.11.1 Contractor shall install all chromium plated and porcelain accessories as shown on the drawings or directed by Engineer-in-charge, and given in the bill of quantities.

2.11.2 All C.P. accessories shall be fixed with C.P. brass half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by Engineer-in-charge.

2.11.3 Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work.

2.12 URINAL PARTITIONS

2.12.1 Urinal partitions shall be white glazed vitreous china or 25mm thick marble of size specified in the schedule of quantities.

2.12.2 Porcelain partitions shall be fixed at proper heights with C.P. brass bolts, anchor fasteners and M.S. clips as recommended by the manufacturer and directed by Engineer-in-charge.

2.13 MEASUREMENT

2.13.1 Rate for providing and fixing of sanitary fixtures accessories, urinal partitions shall include all items and operations stated in the respective specifications and bill of quantities and nothing extra is payable.

2.13.2 Rates for all items under specifications para above shall be inclusive of cutting holes and chases and making good the same, C.P. screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning.

SECTION III
SOIL, WASTE, VENT & RAINWATER PIPES & FITTINGS

3. SOIL, WASTE, VENT & RAINWATER PIPES & FITTINGS

3.1 Scope of Work

- 3.1.1 Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as required by the drawings, and given in the Schedule of Quantities.
- 3.1.2 Without restricting to the generally of the foregoing, the soil, waste, vent pipes system shall include the followings:-
1. Vertical and horizontal soil, waste and vent Pipes, and fittings, joints, clamps, connections to fixtures.
 2. Connection of pipes to sewer lines as shown on the drawings at ground floor levels.
 3. Basement drainage, channels, gratings and floor drains.
 4. Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads /Khurras.
 5. Testing of all pipe lines.

3.2. General Requirements

- 3.2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Project Manager.
- 3.2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- 3.2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- 3.2.4 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.
- 3.2.5 Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance. Any access panel required in the Civil structure, false ceiling or marble cladding etc. shall be clearly reported to the Owner in the form of shop drawings so that other agencies are instructed to provide the same.

3.3 Piping System

3.3.1 Soil, Waste and Vent Pipes

- a) The soil and waste pipe system above ground has been planned as a "Two pipe system" having separate pipes for waste for kitchen sinks, wash basins, AHU's, condensate drains and floor drains and soil from the WCs and Urinals.
- b) All waste water from AHU's plant and pump rooms, floor channels in basements (if any) will be provided with a deep seal trap before connecting to the main drain or vertical stack.
- c) Vertical soil and waste stacks shall be connected to a separate horizontal drain / single horizontal drain at basement ceiling generally as shown on the drawings.
- d) Toilet layouts have been so arranged that the W.C outlets shall be with "P" trap above ground level.

- e) All soil/waste from areas in basement areas will be collected in sumps and pumped into sewer lines or as specifically designed.
- f) Head (Starting point) of drains and sewage/waste water sumps (as and where applicable) having a length of greater than 4m upto connection to the main drain or manhole shall be provided with a 80/100mm vent pipe terminating above roof / a Maxi-Filtra with an ACF cartridge shall be provided close to the MH as directed by the Project Manager.

3.4 **Rainwater Pipes**

- a) All open terraces shall be drained by rain water down takes.
- b) 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.
- c) Rainwater in open courtyards shall be collected in catch basins and connected to the storm water drains.
- d) Any dry weather flow from waste appliances e.g. AHU's, Parking and Drainage Sumps shall connected to the Storm Water Network and Sewerage Sumps will be connected to the Sewerage System.

3.5 **Balcony/Planter Drainage**

Wherever required, all balconies, terraces, planters and other formal 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.

3.6 **Soil Waste and Vent Pipes and Fittings above Ground**

3.6.1 Soil, waste, vent, anti-syphonage and rain water pipes shall be cast iron pipes.

3.6.2 All pipes shall be straight and smooth and inside free from irregular bore, blow holes cracks and other manufacturing defects. Pipes shall be centrifugally spun iron so pipes conforming to IS 3989-1979 and fittings shall be conforming to IS 3989-1979.

3.6.2 Fittings

3.6.2.1 Fitting shall conform to the Indian Standard as for pipes. Contractor shall use pipes and fittings of matching specifications.

3.6.2.2 Fittings shall be of the required degree of curvature with without access door.

3.6.2.3 Access door shall be up with 3MM thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal. The fixing shall be air and water tight.

3.6.4 Floor Traps & Urinal Traps

Floor traps shall be cast iron, deep seal with an effective seal of 50 mm. The trap and waste pipes shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1:2:4 mix (1 Cement: 2 Coarse sand: 4 stone aggregate 20 mm nominal size) and extended to 40 mm below finished floor levels. Contractor shall provide all necessary shuttering and centering for the block. Size of the block shall be 30 x 30 cms of the required depth.

3.6.5 CLEANOUT PLUGS

Contractor shall provide cast brass cleanout plugs as required. Cleanout plugs shall be thread and provided with key holes for openings. Cleanout plugs shall be fixed the pipes by a G.I. socket drip seal caulked. (Detail with sketch).

3.6.6 **Jointing (CI Soil Pipes & Fittings)**

Joints for cast iron soil, waste vent, anti syphonage and rainwater pipes shall be made with drip seal / pipe seal compound and sufficient skein of jute rope dipped in coal tar shall be caulked to leave a minimum space for the sealant compound.

3.6.7 **Cleanout Plugs**

Floor Clean Out Plug

Clean out plug for soil, waste or rain water pipes laid under floors shall be provided near pipe junctions bends, tees, "Yes" and on straight runs at such intervals as required as per site conditions. Clean out plugs shall terminate flush with the floor levels. They shall be cast brass suitable for the pipe dia. With screwed to a G.I socket. The socket shall be joined to the pipe with drip seal/pipe seal.

3.7 **Waste Pipe from Appliances**

3.7.1 Waste pipe from appliances e.g. washbasins, sinks, urinals shall be of galvanized steel in toilets, kitchens, pantries and service areas where so required, and as given in the Schedule of Quantities or as shown on the drawings.

3.7.2 All pipes shall be fixed in gradient towards the connection to stack or drains. Pipes inside all toilets room shall be in chase unless otherwise shown on drawings. Where so required and shown on drawings or directed by the Project Manager.

3.7.3 (a) **Galvanized Pipes** (Where specified or required at site for sump drainage only)

Pipes shall be galvanized steel tubes conforming to IS: 1239 (medium class) and quality certificates shall be furnished. Pipes shall be provided with all required fittings e.g. Tees, Couplings, Bends, Elbows, Unions, Reducers, Nipples, Plugs. All G.I. waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter. Pipes in chase shall be painted with two coats of black bitumen paint and exposed pipes with one coat of red oxide primer and two or more coats of synthetic enamel paint or as given in the Schedule of Quantities. G.I. waste pipes buried in ground or sunken slab shall be protected with multi layer bitumen membrane tape 3mm thick with a final coat of hot or cold applied bitumen. "Pykote" or equivalent.

3.7.3 (b) **uPVC Pipes** (Where specified or required at site for waste/rain only)

Pipes shall be uPVC confirming to IS: 4985-2000 (quick fit type) and quality certificates shall be furnished as required. Pipes shall be provided with all required fittings e.g. Tees, Couplings, Bends, Elbows, Unions, Reducers, Nipples, and Plugs. All waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter.

3.8 **Drainage under floor/above floor (service floors, basement ceiling etc.)**

3.8.1 All drainage lines passing under building, in exposed position above ground e.g. service floors, basement ceiling etc. shall be Multilayered as per details given in sub-clause 3.10 above or shall be as per details given below. Position of such pipes shall generally be shown on the drawings.

3.8.1 (a) **SOCKET PIPES**

3-layered reinforced polypropylene (PP) sewage pipes, halogen and lead free, with integral push-fit socket and factory-fitted lip ring, tested and monitored according to the Product Standard EN 1852 – 1, having internal layer of

PP in light grey color, intermediate layer of PP in grey/titanium-grey color, external layer of PP in copper brown color.

3.8.2 Fittings

3-layered reinforced polypropylene (PP) sewage pipes, halogen and lead free, with integral push-fit socket and factory-fitted lip ring, tested and monitored according to the Product Standard EN 1852 – 1. Fittings upto dimension DN/OD 200 are manufactured by injection molding (1-layer), above DN/OD 200 (250 and above)

The fittings are butt or extrusion welded by the manufacturer. Fabrication of fittings at site shall not be permitted.

3.8.4 Cleanout on Drainage Pipes (CO Plugs)

- a) Cleanout plugs shall be provided on head of each drain and in between at locations indicated on plans or directed by. Cleanout plugs shall be of size matching the full bore of the pipe but not exceeding 150mm dia. CO plugs on drains of greater diameters shall be 150mm dia. Fixed with a suitable reducing adapter.
- b) Floor cleanout plugs shall be cast brass as given in para 3.10.6 above.
- c) PP plugs of material as in item 3.12 above provided at ceiling level pipe shall be fixed to a socketed end piece.

3.8.5 Pipe Joints

Field-proven push-fit connection with improved and modified lip ring of high ageing-resistant shall be provided with the pipes and fittings for easy push-fit installation, installation procedure as given in clause 3.10 above shall be followed.

3.9 Encasing in Cement Concrete

3.9.1 Encasing of pipes is required to provide stability to the line and prevent its damage during construction.

3.9.2 Soil and waste pipes under floor

Pipes laid 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 graded stone aggregate 12mm size) 75mm in bed and all round. When pipes are running

well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height at intervals of 1.8m. All drainage pipes except when fixed above ground or in exposed locations shall be encased in cement concrete as specified above for soil and waste pipes. The bed and encasing thickness shall however be 150mm in bed and all round as shown on the drawing/specified in the BOQ.

3.10 Painting

3.10.1 Paints used shall be of approved quality and shade. Where directed pipes shall be painted in accordance with approved pipe color code.

3.10.3 G.I waste pipes buried in ground or fixed in chase shall be protected with 2mm thick bitumen membrane tape with a final coat of hot or cold applied bitumen. Exposed waste pipes shall be painted with two or more coats of synthetic enamel paint.

3.11 Cutting and Making Good

3.11.1 Contractor shall provide all holes cut outs and chases in structural members necessary and required for the pipe

work as building work proceeds. Wherever cut outs, holes are left in the original construction, they shall be made good with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20mm nominal size) or cement mortar 1:2 (1 cement : 2 coarse sand) and the surface restored as in original condition.

3.12 Sleeves/Cutouts

- 3.12.1 Contractor shall utilize all cutout and sleeves provided during construction to prevent breaking. The annular space between the pipe and the sleeve shall be filled up with approved type of fire hydrant sealant. When sleeves are misplaced or inaccurately located contractor shall make the holes in the wall or structural members at his own cost but only with the prior permission of the Project Manager.

3.13 Testing

- 3.13.1 Testing procedure specified below apply to all soil, waste and vent pipes above ground including Multilayered PP pipes laid in basement ceiling.
- 3.13.2 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. Contractor must have adequate number of expandable rubber bellow plugs, manometers, smoke testing machines, pipe and fitting work test benches and any other equipment necessary and required to conduct the tests.
- 3.13.3 All materials obtained and used on site must have manufacturers hydraulic test certificate for each batch of materials used on the site.

3.14 Measurements

3.14.1 General

- a) Rates quoted for all items quoted shall be inclusive of all work and items given in the specifications and Schedule of Quantities
 - b) Rates are applicable for the work in basements, under the ground, floors, in shafts at ceiling level area for all depths and building upto 45m in height.
- 3.14.2 Rates are inclusive of cutting holes and chases in masonry work and making good the same.
- 3.14.3 Rates are inclusive of pre testing and on site testing of the installations, materials and commissioning of the works.
- 3.14.4 Pipes (unit of measurement. Linear meter to the nearest centimeter)
- 3.14.5 Soil, waste, vent, anti syphonage, rain water pipes, and drainage pipes shall be measured net when fixed correct to a centimeter including all fittings along its finished length.
- 3.14.6 G.I. pipes/uPVC shall be measured per running meter correct to a centimeter for the finished work, which shall include fittings e.g. Bends, Tees, Elbows, Reducers, Crosses, Sockets, Nipples and Nuts. The length shall be taken along center line of the pipes and fittings. All pipes and fittings shall be classified according to their diameter, method of jointing and fixing substance, quality and finish. The diameter shall be diameter of internal bore.
- 3.14.7 Cement concrete around pipes shall be measured along the center of the pipe line measured per linear meter and include any Masonry Supports, Shuttering and Centering Cutting complete as described in the relevant specifications.
- 3.14.8 Slotted angles/channels shall be measured per linear meter of finished length and shall include support bolts and nuts embedded in masonry walls with cement concrete blocks and nothing extra will be paid for making good the same.

3.14.9 Fittings (excluding pipe fittings) (Unit of measurement by numbers)

Urinal traps, trap gratings, hoppers, cleanout plugs shall be measured by number per piece and shall include all items described in the relevant specifications and Schedule of Quantities.

3.14.10 **Painting**

Painting of pipes and fittings shall be measured per running meter.

3.14.11 **Excavation for soil pipes:**

No extra payment shall be admissible with respect to excavation, refilling and disposal of surplus earth for pipes laid below ground, in sunken slabs or over basement rafts.

3.15 **Air Admittance Valves (AAV)**

Air admittance valves shall be made in ABS/PVC capable of operating at temperatures between 0 degree c and 60 degree c. The AAV shall be of suitable for

flow rate and installed in main discharge stacks and / or branches. Design based on air flow capacity required in proportion to the discharge unit capacities. The vendor is to supply data sheet showing relevant calculations and drawings indicating location and type of AAV as required.

AAV's to have following performance parameter:

- Temperature range: -20 degree Celsius to 60 degree Celsius.
- Open pressure: -70 pa (-0.010 psi)
- Max. Pressure rating tightness: 10,000 pa (1 m/40" h2o) at 0 pa or higher

3.16 **Maxi Filtra:**

Maxi Filtra shall be in black ABS to be installed at the outlet of the vent pipe discharging gases in the atmosphere. They are fitted with active carbon filters with iodine being 1050mg/g. The replaceable carbon filters must be changed regularly as per manufacturer's specifications.

SECTION IV WATER SUPPLY SYSTEM

4. WATER SUPPLY SYSTEM

4.1 Scope of Work

- 4.1.1 Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the Schedule of Quantities.
- 4.1.2 Without restricting to the generality of the foregoing, the water supply system shall include the following:-
- a) Distribution system from main supply headers to all fixtures and appliances for cold/hot water.
 - b) Cold water supply lines from tube-wells and city water connections to fire and underground water tanks.
 - c) Municipal water and Bore-well connections to U.G. water tanks.
 - d) Garden Irrigation system
 - e) Excavation and refilling of pipes trenches.
 - f) Pipe protection and painting.
 - g) Control valves, masonry chambers and other appurtenances.
 - h) Connections to all plumbing fixtures, tanks, appliances and Municipal mains
 - i) Inserts for RCC tank.

4.2 General Requirements

- 4.2.1 All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Project Manager.
- 4.2.2 Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- 4.2.3 Short or Long bends shall be used on all main pipe lines as far as possible. Use of Elbows shall be restricted for short connections.
- 4.2.4 Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- 4.2.5 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.
- 4.2.6 Clamps, hangers and supports on RCC walls, columns and slabs shall be fixed only by means of approved made of expandable metal fasteners inserted by use of power drills.
- 4.2.7 All pipe clamps, supports, nuts, bolts, washers shall be galvanized MS steel throughout the building. Painted MS clamps & MS nuts, bolts and washers shall not be accepted.
- 4.2.8 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

4.3 Water Supply System

- 4.3.1 Contractor should study the site plan and water supply system diagram for an overview of the system.

4.3.2 Source

Water supply will be acquired from Municipal Corporation water mains to a service connection and captive tube-wells within the site and collected in water storage tanks located in basement.

4.4 **G.I. Pipes, Fittings & Valves (In Plant rooms and for Equipments)**

4.4.1 All pipes inside the buildings and where specified, outside the building shall be galvanized steel tubes conforming to I.S. 1239 of medium/ heavy class as specified in the BOQ.

4.4.2 Fittings shall be malleable iron with a reinforcing ring over the threaded ends upto 50mm dia and without reinforcing rings for sizes 65mm dia and above. Each fitting shall have manufacturer's trade mark stamped on it. Fittings for G.I. pipes shall include Couplings, Bends, Tees, Reducers, Nipples, Unions, and Bushes. Fittings shall conform to I.S:1879 (Part I to X).

4.4.3 Pipes and fittings shall be jointed with screwed joints. Care shall be taken to remove burr from the end of the pipe after reaming with a proper time.

4.4.4 Pipe threaded joints will be made by applying suitable grade of TEFLON tape used for drinking water supply.

4.4.5 All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. G.I. pipes inside toilets shall be fixed in wall chases well above the floor. No pipes shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other as shown on drawings.

4.5 **Pipe Supports**

4.5.1 All pipes clamps, supports, hangers, rods, pipe supports, nuts and washers shall be factory made galvanized MS steel or alternatively galvanized after fabrication to suit site requirements.

4.5.2 G.I pipes in shafts and other locations shall be supported by galvanized M.S clamps of design approved by pipes in wall chases shall be anchored by G.I hooks, pipes at ceiling level shall be supported on structural clamps fabricated from M.S structural steel. Pipes in typical shafts shall be supported on Galvanised slotted angles/channels as specified elsewhere.

4.6 **Clamps**

G.I. pipes in shafts and other locations shall be supported by M.S. clamps of design approved by Project Manager. Pipes in wall chases shall be anchored by iron hooks, Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. structural steel as described above. Pipes in typical shafts shall be supported on slotted angles/channels as specified.

4.7 **Anchor Fasteners**

4.7.1 All pipe supports, hangers and clamps to be fixed on RCC walls, beams, columns, slabs and masonry walls 230mm thick and above by means of galvanised expandable anchor fasteners in drilled holes of correct size and model to carry the weight of pipes. Drilling shall be made only by approved type of power drill as recommend and approved by manufacturer of the anchor fasteners. Failure of any fastening devices shall be the entire responsibility and contractor shall redo or provide additional supports at his own cost. He shall also compensate the owner for any damage that may be caused by such failures.

4.8 **Unions**

Contractor shall provide adequate number of unions on all pipes to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock, or check valve and on straight runs as necessary at

appropriate locations as required and/or directed by Project Manager.

4.9 Flanges

Flanged connections shall be provided on pipes as required or where shown on the drawings, all equipment connections as necessary and required or as directed by connections shall be made by the correct number and size of GI nuts, bolts & washers with 3 mm thick gasket. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by Bolt hole dia for flanges shall conform to match the specification for C.I. sluice valve to I.S.780. and C.I. butterfly valve to IS: 3095.

4.10 CPVC and UPVC Pipes and Fittings:

Chlorinated Poly Vinyl Chloride (CPVC) compound shall meet cell class 23447 B as defined by ASTM D 1784 and have a design stress of 2000 psi and a maximum service temperature upto 93 degree Celsius. Pipes shall be as per SD 11, material as per ASTM 1784, specifications as per ASTM D2846 and cpvc jointing solvent shall be as per ASTM F493. SCHEDULE PIPES 40 and 80 shall be as per ASTM F441. (for Hot water and Cold water applications)

Clamping for cpvc pipe shall be as per manufacturer's recommendations only.

4.11 Trenches

All water supply pipes below ground shall be laid in trenches with a minimum cover of 60 cms. The width and depth of the trenches shall be as follows

<u>Dia of pipe</u>	<u>Width of Trench</u>	<u>Depth of Trench</u>
15mm to 50mm	30 cms	75cms
65mm to 100mm	45 cms	100 cms

4.12 Sand filling

Pipes in trenches shall be protected with fine sand 15 cms all round before filling in the trenches.

4.13 Painting

All pipes above ground shall be painted with one coat of red lead and two coats of synthetic enamel paint of approved shade and quality. Pipes shall be painted to standard color code given in this document or specified by Project Manager.

4.14 Pipe protection

4.14.1 All GI pipes in wall chase and below floor in toilets (where so fixed) shall be protected against corrosion by the application of two coats of bitumen paint covered with polythene tape and a final coat of bitumen paint.

4.14.1 G.I. water supply pipes, if buried in ground or sunken slab, shall be protected with multi layer bitumen membrane tape 3mm thick with a final coat of hot or cold applied bitumen. "Pykote" or equivalent.

4.15 Valves

4.15.1 Ball Valves

Valves upto 50 mm dia. shall be screwed type Ball Valves with stainless steel balls spindle teflon seating and gland packing tested to a hydraulic pressure of 20 kg/sq.cm., and accompanying couplings and steel handles.(to BIS 5351)

4.16 Butterfly Valves – Slim Seal Type

4.16.1 Valves 65 mm dia and above shall be cast iron butterfly valve to be used for isolation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction with accompanying flanges and steel handle.

4.16.2 Butterfly valve shall be of best quality conforming to IS: 13095.

4.17 Non Return Valve (Dual Slim Type)

Where specified, non return valve shall be provided through which flow shall occur in one direction only.

Each Butterfly and Slim Type Swing Check (NRV) Valve shall be provided with a pair of flanges screwed or welded to the main line and having the required number of nuts, bolts and washers of correct length.

4.18 Storage tanks Underground & Overhead Tank. (Accessories & Connections)

4.18.1 Storage tanks for water supply shall be in reinforced cement concrete built by the building contractor.

4.18.2 Each tank shall be provided with a 560mm Dia Heavy Duty Cast Iron manhole frame and cover.

4.19 Storage Tanks

4.19.1 Underground

Underground storage tanks for water supply shall be reinforced cement concrete built by the building contractor.

Each tank shall be provided with a 560mm Dia Heavy Duty Cast Iron manhole frame and cover or as approved by local municipal authority.

4.20 Outlets and overflow

All nozzles for puddle flanges in RCC tank for inlet, outlet, overflow and scour etc. shall be provided by civil contractor or as given in the Schedule of Quantities, further connections and accessories shall be provided under this contract.

4.21 Testing

All pipes, fittings and valves, after fixing at site, shall be tested by hydrostatic pressure of 1.5 times the working pressure or 7 kg / sq.cm whichever is higher. Pressure shall be maintained for a period of at least thirty minutes without any drop. A test register shall be maintained and all entries shall be signed and dated by Contractor (s) and Project Manager.

In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes' or failure of fittings, to the building, furniture and fixtures shall be made good by the Contractor during the defects liability period without any cost.

After commissioning of the water supply system, Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves, which do not effectively operate, shall be replaced by new ones at no extra cost and the same shall be tested as above.

Hot water pipes chased into the walls shall be provided with a 6mm thick insulation with elastic flexible material having hermetic closed cell structure of expanded synthetic material rated for 60°C hot water supply.

4.22 **Measurement**

- a) Pipes above ground shall be measured per linear meter (to the nearest cm) and shall be inclusive of all fittings e.g. coupling, tees, bends, elbows, unions, flanges and U clamps with nuts, bolts & washers fixed to wall or other standard supports.
- b) Jointing with teflon tape, white lead, solvent, crimping and insertion gasket of appropriate temperature grade.
- c) Cutting holes, and chases in walls, floors, any pipe support required for pipes below ground & making good the same.
- d) Excavation, backfilling, disposal of surplus earth and restoring the ground & floor in original condition.

4.23 **Pipe Supports**

Fabricated and / or galvanised supports shall be measured by weight. Weight for each type of clamp shall be calculated on basis of the quantity of structurals and MS used from the theoretical weight calculated on basis of the components theoretical weight of the sections.

4.24 Rate quoted for supports & hangers shall be inclusive of :

- a) Expandable anchor fastens.
- b) Galvanising of all supports & hangers.
- c) Cutting holes in walls, ceilings on floors and making good where permitted.
- d) Nuts, bolts and washers for fixing and assembling.
- e) Wooden / PVC pipe saddles for vertical or horizontal runs.

4.25 **Valves**

Gunmetal, cast iron, butterfly and non return valves and puddle flanges shall measured by numbers and shall include wheels I caps, GI nuts, bolts, washers, insertion gasket.

4.26 **Painting/pipe protection/insulation**

Painting/pipe protection /insulation for pipes shall be measured per linear meter over finished surface and shall include all valves and fittings for which no deduction shall be made. No extra payment shall be made for fittings, valves or flanges.

SECTION V DRAINAGE

5. DRAINAGE (Sewers & Storm Water Drains)

5.1 Scope of work

5.1.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install all the drainage system as required by the drawings and specified hereinafter or given in the Schedule of Quantities.

5.1.2 Without restricting to the generality of the foregoing, the drainage system shall include:-

5.1.2.1 Sewer lines including excavations, pipelines, manholes, drop connections and connections to the existing sewer.

5.1.2.2 Storm water drainage, excavation, pipelines, manholes, catch basins, drain channels and connections to the existing storm water drain.

5.2 General requirements

5.2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of the Project Manager.

5.2.2 Drainage lines and open drains shall be laid to the required gradients and profiles.

5.2.3 All drainage work shall be done in accordance with the local municipal bye-laws.

5.2.4 Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority.

5.2.5 Location of all manholes, etc. shall be got confirmed by the Contractor from the Engineer-in-charge. As far as possible, no drains or sewers shall be laid in the middle of road unless otherwise specifically shown on the drawings or directed by the Project Manager.

5.3 Excavation

5.3.1 Alignment and grade

The sewer pipes shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by the Project Manager. No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except by the express direction in writing of the Project Manager.

5.3.2 Excavation in tunnels

The excavation for sewer works shall be open cutting only, unless the permission of the Project Manager is obtained for laying pipes in tunnel where sewers have to be constructed along narrow passages or difficult ground.

5.3.3 Opening out trenches

In excavating the trenches, etc. the solid road metalling, pavement, kerbing, etc. and turf is to be placed on one side and preserved for reinstatement when the trenches or other excavation shall be filled up. Before any road metal is replaced, it shall be carefully sifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Project Manager.

The Contractor shall grub up and clear the surface over the trenches and other excavations of all trees, stumps roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the Project Manager.

5.3.4 Obstruction of roads

The Contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit, he shall remove the materials excavated and bring them back again when the trench is required to be refilled. The Contractor shall obtain the consent of the Project Manager.

5.3.5 Removal of filth

All night soil, filth or any other offensive matter met with during the execution of the works, immediately after it is taken out of any trench, sewer or cess pool, shall not be deposited on to the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be at once put into the carts and remove to a suitable place to be provided by the Contractor.

5.3.6 Excavation to be taken to proper depths

The trenches shall be excavated to such a depth that the sewer shall rest on concrete as described in the several clauses relating thereto and so that the inverts may be at the levels given in the sections.

5.3.7 Refilling

After the sewer or other work has been laid and proved to be water tight, the trench or other excavations shall be refilled. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent work. The filling in the haunches and upto 75cms above the crown of the sewer shall consist of the finest selected materials placed carefully in 15cms layers and flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 15cms layers with materials taken from the excavation, each layer is being watered to assist in the consolidation unless the Project Manager.

5.3.8 Contractor to restore settlement and damages

The contractor shall, at his own costs and charges make good promptly during the whole period the works are in hand, any settlement that may occur in the surfaces of roads, berms, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by his other excavations and he shall be reliable for any accidents caused thereby. He shall also at his own cost and expenses and charges, repair any make of any damage done to the buildings and other property.

5.3.9 Disposal of Surplus Earth

The Contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and roadways and sides left clear.

5.3.10 Timbering of sewer and trenches

- a) The contractor shall at all times support efficiently and effectively the sides of the sewer trenches and other excavations by suitable timbering, piling and sheeting and they shall be closed, timbered in loose of sandy strata and below the surface of the sub soil water level.

- b) All timbering, sheeting and piling with their walling and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall be taken place.
- c) The contractor shall be held responsible and will be accountable for the sufficiency of all timbering, bracings, sheeting and piling used as also for, all damage to persons and property resulting from improper quality, strength, placing, maintaining or removing of the same.

5.3.11 Shoring of Buildings

The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from any accident.

5.3.12 Removal of water from sewer, trench etc

- a) The Contractor shall at all times during the progress of the work keep the trenches and excavations free from water which shall be disposed of by him in a manner as will neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any roads or streets, nor cause any interference with the use of the same by the public.
- b) If any excavation is carried out at any point or points to a greater width than the specified cross section of the sewer with its envelope, the full width of the trench shall be filled with concrete by the Contractor at his own expenses.

5.3.13 Width of trench

5.3.14 Recommended width of trenches at the bottom shall be as follows:-

100 mm dia pipe	55 cms
150 mm dia pipe	55 cms
225-250 mm dia pipe	60 cms
300 mm dia pipe	75 cms

Maximum width of the bed concrete shall also be as above. No additional payment is admissible for widths greater than specified.

5.4 Salt glazed stoneware pipes (Where applicable)

5.4.1 Stoneware pipes shall be of first class quality salt glazed and free from rough texture inside and outside and straight. All pipes shall have the manufacturers name marked on it and shall comply to I.S. 65.1

5.4.2 Laying and jointing of stoneware salt glazed pipes

- Pipes are liable to be damaged in transit and notwithstanding tests that may have been made before dispatch each pipe shall be examined carefully on arrival at the site. Each pipe shall be rung with a wooden hammer or mallet and those that do not ring true and clear shall be rejected. Sound pipes shall be carefully stacked to prevent damage. All defective pipes should be segregated, marked in a conspicuous manner and their use in the works prevented.
- The pipes shall be laid with sockets leading uphill and rest on solid and even foundations for the full length of the barrel. Socket holes shall be formed in the foundation sufficiently deep to allow the pipe jointer room to work right round the pipe and as short as practicable to admit the socket and allow the joint to be made.

- Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipe laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried too low it shall be made up with cement concrete at the Contractor's cost and charges.
- If the bottom of the trench consists of rock or very hard ground that cannot be easily excavated to a smooth surface, the pipes shall be laid on cement concrete bed to ensure even bearing.

5.4.3 Jointing of pipes

- Tarred gaskin shall first be wrapped round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid, the pipe shall then be adjusted and fixed in its correct position and the gaskin caulked tightly home so as to fill not more than one quarter of the total length of the socket.
- The remainder of the socket shall be filled with stiff mix of cement mortar (1 cement: 1 clear sharp washed sand). When the socket is filled, a fillet should be formed round the joint with a trowel forming an angle of 45 degrees with the barrel of the pipe. The mortar shall be mixed as needed for immediate use and no mortar shall be beaten up and used after it has begun to set.
- After the joint has been made any extraneous materials shall be removed from inside of the joint with a suitable scraper of "badger". The newly made joints shall be protected until set from the sun, drying winds, rain or dust. Sacking or other materials, which can be kept damp, shall be used. The joints shall be exposed and space left all round the pipes for inspection by the inside of the sewer must be left absolutely clear in bore and free from cement mortar or other obstructions throughout its entire length, and shall efficiently drain and discharge.

5.5 uPVC Pipes & Fittings.

- a) Upvc pipes shall be straight and smooth conforming to IS 4985-1983 of class as specified in Schedule of Quantities.
- b) Joints shall be done as per the manufacturer's recommendations. The pipes and fittings must have matching dimension for perfect joints in the system shall be with solvent cement as per manufacturers requirements.

5.6 Testing

- All lengths of the sewer and drain shall be fully 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 subjected to a test pressure of at least 1.5 meter head of water. The test pressure shall, however, not exceed 6 meter head at any point. The pipes shall be plugged preferably with standard design plugs with rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head.
- Sewer lines shall be tested for straightness by: (i) inserting a smooth ball 12 mm less than the internal diameter of the pipe. In the absence of obstructions such as yarn or mortar projecting at the joints the ball should roll down the invert of the pipe and emerge at the lower end. (ii) means of a mirror at one and a lamp at the other end. If the pipeline is straight the full circle of light will be seen otherwise obstruction or deviation will be apparent.
- The Contractor shall give a smoke test to the drains and sewer at his own expense and charges, if directed by the Project Manager.

A test register shall be maintained which shall be signed and dated by Contractor.

5.7 Gully traps

Gully traps shall be of the same quality as described for stoneware pipes in clause 5.4.1 above and used where shown on drawings.

Gully traps shall be fixed in cement concrete 1:5:10 mix (1 cement: 5 coarse sand: 10 stone aggregate 40 mm nominal size) and a brick masonry chamber 30x30 cms inside plastered with cement mortar 1:5 with 15x 15 cms grating inside and 30x30 cms C.I. sealed cover and frame weighing not less than 7.3 kg to be constructed as per standard drawing. Where necessary, sealed cover shall be replaced with C.I. grating of the same size.

5.8 Reinforced cement concrete pipes

- All underground storm water drainage pipes and sewer lines where specified (other than those specified cast iron) shall be centrifugally spun S & S RCC pipes of specified class. Pipes shall be true and straight with uniform bore, throughout. Cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, when directed a certificate to that effect from the manufacturer.
- **Laying**
R.C.C. spun pipes shall be laid on cement concrete bed or cradles as specified and shown on the detailed drawings. The cradles may be precast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12 mm below the invert level of the pipe properly placed on the soil to prevent any disturbance. The pipe shall then be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and bonding rods etc. Cradles or concrete bed may be omitted, if directed by the Project Manager.
- **Jointing**
After setting out the pipes the socket shall be centered over the spigot and filled in with tarred gaskin, so that sufficient space is left on either side of the collar to receive the mortar. The space shall then be filled with cement mortar 1:2 (1 Cement: 2 fine sand) and caulked by means of proper tools. All joints shall be finished at an angle of 45 degrees to the longitudinal axis of the pipe on both sides of the collar neatly.
- **Testing**
All pipes shall be tested to a hydraulic test of 1.5 m head for at least 30 minutes at the highest point in the section under test. Test shall also be carried out similar to those for stoneware pipes given above. The smoke test shall be carried out by the contractor, if directed by the Project Manager and a test register shall be maintained which shall be signed and dated by the Contractor/Project Manager.

5.9 Cement Concrete and masonry works (For Manholes and Chambers)

5.9.1 Materials

a) Water

Water used for all the construction purposes shall be clear and free from Oil, Acid, Alkali, Organic and other harmful matters, which shall deteriorate the strength and/or durability of the structure. In general, the water suitable for drinking purposes shall be considered good enough for construction purpose.

b) Aggregate for Concrete

The aggregate for concrete shall be in accordance with I.S. 383 and I.S. 515 in general, these shall be free from all impurities that may cause corrosion of the reinforcement. Before actual use these shall be washed in water, if required as per the direction of Project Manager. The size of the coarse aggregate shall be done as per I.S.383.

c) Sand

Sand for various constructional purposes shall comply in all respects with I.S 650 and I.S. 2116. It shall be clean, coarse hard and strong, sharp, durable, uncoated, free from any mixture of clay, dust, vegetable matters, mica, iron impurities soft or flaky and elongated particles, alkali, organic matters, salt, loam and other impurities which may be considered by the Project Manager.

d) **Cement**

The cement used for all the constructional purposes shall be ordinary Portland cement or rapid hardening Portland cement conforming to I.S. 269.

e) **Mild Steel Reinforcement**

The mild steel for the reinforcement bars shall be in the form of round bars conforming to all requirements of I.S. 432 (Grade I).

f) **Bricks**

Bricks shall have uniform color, thoroughly burnt but not over burnt, shall have plan rectangular faces with parallel sides and sharp right angled edges. They should give ringing sound when struck. Brick shall not absorb more than 20% to 22% of water, when immersed in water for 24 hours. Bricks to be used shall be approved by the Project Manager.

g) **Other Materials**

Other materials not fully specified in these specifications and which may be required in the work shall conform to the latest I.S. All such materials shall be approved by the Project Manager before use.

5.9.2 **Cement concrete (plain or reinforced)**

- a) Cement concrete pipes bedding, cradles, foundations and R.C.C. slabs for all works shall be mixed by a mechanical mixer where quantities of the concrete poured at one time permit. Hand mixing on properly constructed platforms may be allowed for small quantities by the rate for cement concrete shall be inclusive of all shuttering and centering at all depth and heights.
- b) Concrete work shall be of such thickness and mix as given in the Schedule of Quantities.
- c) All concrete work shall be cured for a period or at least 7 days. Such work shall be kept moist by means of gunny bags at all times. All pipes trenches and foundations shall be kept dry during the curing period.

5.9.3 **Masonry**

Masonry work for manholes, chambers, septic tanks, and such other works as required shall be constructed from 1st class bricks or 2nd class as specified in the Schedule of quantities in cement mortar 1:5 mix (1 cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

5.9.4 **Cement concrete for pipe support**

Wherever specified or shown on the drawing, all pipes shall be supported in bed all round or haunches. The thickness and mix of the concrete shall be given in the Schedule of Quantities. Width of the bedding shall be as per para 5.3.1.4.

Unless otherwise directed by the Project Engineer, cement concrete for bed, all-round or in haunches shall be laid as follows: -

	upto 1.5 m depth	upto 3 m depth	beyond 3 m depth
Stoneware pipes	All round	Haunches	All round

In open ground (no sub soil water)	(1:4:8)	(1:4:8)	(1:4:8)
R.C.C or SW (In sub soil water)	All round (1:3:6)	Haunches (13:6)	Haunches (1:3:6)
C.I Pipes (In all conditions)	All round (1:3:6)	Haunches (13:6)	Haunches (1:3:6)
R.C.C Pipes Or C.I Pipes Under or building	All round (1:3:6)	All round (13:6)	All round (1:3:6)
(Ratio refer to cement: coarse sand: stone aggregate 40 mm nominal size)			

R.C.C pipes or C.I. pipes may be supported on brick masonry or precast R.C.C or in situ cradles. Cradles shall be shown on the drawings. Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings.

5.10 Manholes and chambers

- 5.10.1 All manholes, chambers and other such works as specified shall be constructed on brick masonry in cement mortar 1:5(1 cement: 5 coarse sand) as specified in the Schedule of Quantities.
- 5.10.2 All manholes and chambers, etc. shall be supported on base of cement concrete of such thickness and mix as given in the Schedule or Quantities or shown in the drawings.

Where not specified, manholes shall be constructed as follows:- (all dimensions internal clear in cms)

Size of manhole type	90x80 Rect.	120x90 Rect.	91 dia Conical	122 dia Conical
Maximum depth	120	240	167	168
Average thickness Of R.C.C slab	15	15	-	-
Size of cover and frame cms	60x45	50 dia	50 dia	50 dia
Weight of Cover and frame	38 kg -----	116 or 208 kg	116 or 208 kg	116 or 208 kg

- 5.10.3 All manholes shall be provided with cement concrete benching in 1:2:4 mix. The benching shall have a slope of 10 cms towards the channel. The depth of the channel shall be full diameter of the pipe. Benching shall be finished with a floating coat of neat cement. (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nom. Size) as per standard details.
- 5.10.4 All manholes shall be plastered with 12mm thick cement mortar 1: 3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement inside. Manhole shall be plastered outside as above but with rough plaster mixed with water proofing compound.
- 5.10.5 All manholes with depths greater than 1 m. shall be provided with 20 mm square or 25 mm round rods plastic coated catch rings set in cement concrete blocks 25x10x10 cms in 1:2:4 mix 30 cms vertically and staggered. Foot rests shall be coated with coal tar before embedding.

5.10.6 All manholes shall be provided with cast iron/steel fiber reinforced plastic (SFRC) covers and frames and embedded in reinforced cement concrete slab. Weight of cover, frame and thickness of slab shall be as specified in the Schedule of Quantities or given above.

5.10.7 Road gullies, ramp drains, gratings in basement shall be cast iron with M.S. frame or Steel Fiber Reinforced Concrete (SFRC) with frame as specified in the Schedule of Quantities.

5.11 Making connections

5.11.1 Contractor shall connect the sewer line of the building to the main manhole by providing making holes and channels etc.

5.12 Measurement

5.12.1 Excavation

5.12.1.1 Measurement for excavation of pipe trenches shall be made per linear meter under the respective category of soil classification encountered at site and specified in the tender.

- A) Ordinary soil
- B) Hard soil (hard moorum & soft rock)
- C) Hard rock requiring chiseling
- D) Hard rock requiring blasting

5.12.1.2 Trenches shall be measured between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth up to 1.5 m or as given in the Schedule of Quantities.

5.12.1.3 Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the schedule of quantities and above the rate for depth up to 1.5 m.

5.12.1.4 Timbering and Shoring Timbering and shoring as described above shall be measured per sq m and paid for as per the type of timbering or shoring done at site and as per the relevant item in the Schedule of Quantities. Rate for timbering and shoring shall be for all depths and types of soil classifications including saturated soil.

5.12.1.5 Saturated Soil

No extra payment for pumping and bailing out water shall be made for excavation with an average depth of 1.5 m in saturated soil, surface water from rain falls or broken pipes lines, or sieves and other similar sources. An extra rate as quoted in the schedule of quantities shall be paid for excavation in saturated soil for pipe trenches above average depth of 1.5 m. No payment is admissible for water collected from surface sources and broken pipelines or sewers.

5.12.1.6 Refilling, Consolidation and Disposal of Surplus Earth

Rate quoted for excavation of trenches shall be inclusive of refilling, consolidation and disposal of surplus earth within a lead of 200 m.

5.12.2 Stoneware Pipes/RCC/C.I. pipes

Stoneware/R.C.C./C.I. pipes shall be measured for the finished length of the pipeline per linear meter i.e.

- (a) Lengths between manholes shall be recorded from inside of one manhole to inside of other manhole
- (b) Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole. Rate shall include all items given in the schedule of quantities and specifications.

5.12.3 Gully Traps

Gully traps shall be measured by the number and rate shall include all excavation, foundation, concrete brick masonry, cement plaster inside and outside, C.I. grating and sealed cover and frame.

5.12.4 Cement Concrete for Pipes

Cement concrete in bed and all-round or in haunches shall be paid per running meter between the outside walls of manholes at bottom of the trench. No additional payment is admissible in respect of concreting done for widths greater than specified, for shuttering or centering and concreting in sub soil water conditions.

5.12.5 Manholes, Catch basins & Ramp drains

- a) All manholes and catch basins shall be measured by numbers and shall include all items specified above and necessary excavation, refilling & disposal of surplus earth.
- b) Manholes with depths greater than specified under the main item shall be paid for under "extra depth" and shall include all items as given for manholes. Measurement shall be done to the nearest cm. Depth of the manholes shall be measured from top of the manhole cover to bottom of channel.
- a) Ramp drains shall be measured per meter length.

5.12.6 Making Connections

Item for making connection to municipal sewer shall be paid for by number and shall include all items given in the Schedule of Quantities and specifications.

SECTION VI GARDEN IRRIGATION

6.0 Garden Irrigation System

6.1 Scope of Work

Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to install garden hydrants and sprinklers and drip Irrigation water supplies system as required by the drawings, specified hereinafter and as given in the Schedule of Quantities (BOQ).

6.1.1 Without restricting to the generality of the foregoing, the water supply system shall include the following:-

- a) Connections from the water supply system to all hydrants, sprinklers and drip irrigation points.
- b) Garden hydrants, surface sprinklers & pipe emitters.
- c) Excavation and refilling of pipes trenches.
- d) Control valves, masonry chambers and other appurtenances.
- e) Connections to all pumps & appliances.

6.2 The System

6.2.1 The garden hydrant and sprinkler irrigation system will be new and fully working system in the complex.

6.4.1 System components shall be pipes, valves, controllers, various types of sprinklers and drip irrigation lines with emitters as approved by the Project Manager.

6.5 General requirements

6.3.1 All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Project Manager.

6.5.1 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

6.5.2 Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.

6.5.3 Pipes shall be laid in a manner as to provide as far as possible easy accessibility for repair and maintenance. Pipes under roads shall be laid in RCC pipe sleeves.

6.5.4 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

6.6 HDPE Pipes and Fittings.

6.6.1 Garden hydrant mains shall be HDPE pipes conforming to IS: 4984 of class specified. If class is not mentioned in the schedule of quantities the same shall be Material Grade PF100, unless other materials like uPVC schedule 40 or uPVC as per IS 4985 in accordance to specifications given above are specified in the BOQ.

6.6.2 Fittings for HDPE pipes shall be injection molded fitting suitable for thermal weld joints. Fittings must have suitable provision for expansion and shall be rated for the same working pressure as the pipeline, unless other materials like uPVC schedule 40 or uPVC as per IS 4985 in accordance to specifications given above are specified in the BOQ.

6.6.3 Thermal Joints shall be made in an approved manner as recommended by the manufacturer.

6.6.4 Provide flanges at intervals of 20-25 m. for all pipes 65 mm dia and above.

6.6.5 Provide suitable adapters for connection between pipes & valves.

6.6.6 Provide cement concrete supports and anchor blocks at all bends, tees and other locations as directed by the Project Manager. Connections at garden hydrant outlet, near valves must also be anchored.

6.6.7 **Drip Irrigation Pipes**

Pipes shall be LLDPE pipes of UC 7510 resin conforming to ASAE S-435 standard or as per landscape designer.

6.6.8 **G.I. Pipes & Fittings**

Vertical connection for garden hydrant points shall be galvanised steel tubes to IS12:1239 (medium class) with matching malleable iron fitting of approved make.

6.7 **Sprinklers**

Pop-up Sprinklers Pop-up sprinklers shall be underground with rugged plastic high impact case with precision jet spray guide arm control with brass head, Sprinklers shall be suitable for pressure and coverage given in the schedule of quantities.

SECTION VII

PUMPING AND WATER TREATMENT PLANT SYSTEM

7.0 SCOPE OF WORK

- a) Work under this section shall consist of furnishing all labour, materials equipment and appliances necessary and required to completely install all works described hereinafter and shown on the drawings.
- b) Without restricting to the generality of the foregoing the system shall include the following:
 - a. Raw water, Treated water, Soft water and drainage pumps.
 - b. Water filtration plant with pressure filter and chlorination plant.
 - c. Water Softening plant.

7.1 GENERAL REQUIREMENT

- 7.1.1 All materials shall be new as per approved makes complying with the appropriate Indian Standards.
- 7.1.2 All pump should be at least BEE 5 Star rated pumps/motors wherever available.
- 7.1.3 EFF1 class motors are recommended.
- 7.1.4 All equipment other than specified in approved makes shall be of the best available make manufactured by reputed firms to the entire satisfaction of Resident Engineer.
- 7.1.5 The sample of the items shall be provided on the request of engineer-in-charge.
- 7.1.6 All equipment shall be so installed on suitable existing foundations, true to level and in a neat work- man like manner.
- 7.1.7 Equipment shall be installed so as to provide sufficient clearance between the end walls & between equipment to equipment.
- 7.1.8 Shop drawings for equipment layout with associated piping, control panels and wiring of equipment showing the route of conduit / cable from equipment to control panel shall be submitted by the Contractor for approval to engineer-in-charge before starting the fabrication of panel and starting the work. On completion of the works, four sets of "As-installed" drawings incorporating all details like equipment layout, piping routes, location of panels etc. shall be furnished by the contractor.

7.2 WATER SUPPLY PUMPS

7.2.1 HYDROPNEUMATIC SYSTEM – Fresh Water Supply

- 7.2.1.1 Hydro pneumatic system pumps shall be multistage stage, vertical stainless steel pumps, having stainless steel casing, stainless steel pump foot and diffusers, stainless impeller, stainless steel shaft, ceramic bearings, tungsten carbide shaft protection bushes and hydro pneumatic pump make to mechanical seal driven by 2900 RPM, 220 Volts, 50 Cycles, AC 3 –phase TEFC vertical flange motor. Each pump shall be capable of operating within a performance pressure characteristics range sufficient below and above the required working pressure.
- 7.1.1.2 200 lits diaphragm tank fabricated from prime quality steel for long life the tanks are long lasting epoxy paint treatment for greater protection against atmospheric elements.

- 7.1.1.3 Pumps and motors shall be mounts on a common MS structural base plate.
- 7.1.1.4 Each pump shall be provides with a totally enclosed fan cooled induction motor of H.P and R.P.M specified in schedule of quantities.
- 7.1.1.5 Each pumping set shall be provides with a Gun Metal “Bourden” type pressure gauge with gunmetal isolation cock and connecting piping and also with pressure switch for its operation controlling.
- 7.1.1.6 Appropriate vibration eliminating pads shall be provides with each pump.
- 7.1.1.7 The pump set shall be provided with gun metal gate valve of appropriate sizes on delivery. a non-return valve of appropriate size and a pressure gauge with cock shall be provided on the delivery line.
- 7.1.1.8 Suction and delivery lines of the pumps shall be provided with double flanged reinforced Neoprene flexible pipe connectors. Connectors shall be suitable for a working pressure of each pump as specified in Schedule of Quantities.
- 7.1.1.9 Mega Control Device with one number variable frequency drive.

7.3 WATER TREATMENT PLANT FEED PUMPS

- 7.3.1 Treatment plant feed pumps shall be single stage, vertical stainless steel pumps, having stainless steel casing, stainless steel pump foot and diffusers, stainless impeller, stainless steel shaft, ceramic bearings, tungsten carbide shaft protection bushes and mechanical seal driven by 2900 RPM, 220 Volts, 50 Cycles, AC 3 –phase TEFC vertical flange motor. Each pump shall be capable of operating within a performance pressure characteristics range sufficient below and above the required working pressure.
- 7.3.2 Pumps and motors shall be mounts on a common MS structural base plate.
- 7.3.3 Each pump shall be provides with a totally enclosed fan cooled induction motor of H.P and R.P.M specified in schedule of quantities.
- 7.3.4 Each pump shall be provides with a Gun Metal “Bourden” type pressure gauge with gunmetal isolation cock and connecting piping.
- 7.3.5 Appropriate vibration eliminating pads shall be provides with each pump.
- 7.3.6 The pump set shall be provided with gun metal gate valve of appropriate sizes on delivery. a non-return valve of appropriate size and a pressure gauge with cock shall be provided on the delivery line along with suitable size of Y-strainer at suction side.
- 7.3.7 Suction and delivery lines of the pumps shall be provided with double flanged reinforced Neoprene flexible pipe connectors. Connectors shall be suitable for a working pressure of each pump as specified in Schedule of Quantities.

7.4 SUMP PUMPS

- 7.4.1 Pumps shall be submersible type as indicated in data sheet.
- 7.4.2 Pump shall be integral with submersible motor on a common shaft. The pumps shall have 2900 rpm synchronous speed unless stated otherwise in the data sheets.
- 7.4.3 The pump set shall be installed in vertical position in sumps with level controller cum operated float switches.
- 7.4.4 Pump casings shall be aluminum and impellers of SS. All pumps shall have combination ball and roller bearings and

shaft seals should be mechanical. Motor shall be submersible and shall be rated for minimum hp specified or the BHP absorbed in the operating range of the pump.

7.5 DOSING PUMP

Dosing Pump shall be provided for the working pressure of System where the solution is to be dosed.

Metering Pump shall be provided for operation on 220 V, 50 Hz., AC Power Supply.

Piping from the Main Water Supply Line to the doser shall be PVC flexible pipe branded.

All parts of the metering/dosing pump coming in contact with solution shall be of stainless steel of grade SS-304.

7.6 LEVEL CONTROLLER

Contractor shall provide and install low voltage transistorised level controllers as specified in Schedule of Quantities. Each level controller shall be provided with required number of PVC sheathed stainless steel probes with necessary wiring and conducting.

7.6.1 FOR FILTER FEED PUMPS

To cut off water treatment plant feed pumps on low water level in raw water tanks and high water level in ground floor treated water tank. To start pumps on low water level in treated water tanks.

7.6.2 FOR SOFTENER FEED PUMPS

To cut off water treatment plant feed pumps on low water level in Treated water tanks and high water level in ground floor Soft water tank. To start pumps on low water level in soft water tanks.

7.6.3 TREATED WATER TRANSFER PUMPS

To cut off treated water transfer pumps on low water level in treated water tank and high water level in overhead treated water tank and start sump on low water level in overhead treated water tank.

7.6.4 IRRIGATION WATER TRANSFER PUMPS

To cut off soft water transfer pumps on low water level in soft water tank and high water level in overhead soft water tank and start sump on low water level in overhead soft water tank.

7.6.5 FOR HYDROPNEUMATIC SYSTEM

To cut off hydro-pneumatic system pumps on low water level in ground level treated water tanks. To start pumps on opening of any taps.

7.7 WATER FILTRATION & SOFTENING PLANT

The water treatment equipment shall be based on the raw water criteria as mentioned.

S.No.	Parameters	Raw Water (Inlet) Properties of water	Unit	Desirable Limits Drinking Water as per IS 10500	Extended Limits Drinking Water as per IS 10500

1	Colour	< 1	Max	5	
2	Turbidity	0.2	NTU	5	
3	PH Value	7.6	Range	6.5 – 8.5	
4	Total Dissolved Solid	800	Mg/l		2000
5	Chlorides (as Cl)	180	Mg/l	250	1000
6	Sulphate as SO ₄	190	Mg/l		400
7	Fluorides(as F)	0.2	Mg/l	1	1
8	Magnesium as Mg	3.1	Mg/l		
9	Total Hardness, CaCO ₃	267	Mg/l		

7.7.1 WATER FILTERS

Water filters shall be sand / gravel pressure filters downward or upward flow type suitable for a rate of filtration given in schedule of quantities.

Filter shall be vertical type of required diameter. The shell shall be fabricated from M.S. plate suitable to withstand a working pressure given in schedule of quantities. The minimum thickness of shell will be 8 mm and dished ends shall be 10 mm. The filter shall have at least one pressure tight manhole cover. Each filter shall be provide with screwed or flanged connections for inlet, outlet individual drain connections and all other connections necessary and required. Filter shall be painted inside with two or more coats of non- toxic corrosion resistant paint and one coat of red oxide primer outside.

UNDER DRAIN SYSTEM: Each filter shall be provides with an efficient under drain system comprising of collecting pipes, gunmetal / poly propylene nozzles of manufacturer's design. The entire under drain system shall be provides on M.S. plate cement concrete supports.

FACE PIPING: Each filter shall be provides with interconnecting face piping comprising of inlet, outlet, and backwash complete with valves. Piping shall be cast iron double flanged to I.S.1536-1967 and C.I. Double flanged fittings to I.S. 1537-1967. Sluice valves 65 mm dia. and above shall be cast iron Double flanged sluice valves to I.S. 780. Valves 50 mm and below shall be screwed type gunmetal full way gate valves. Water softener must be of multiport valve.

ACCESSORIES: Each filter shall be provided with following accessories:

Air release valve with connecting piping.

100 mm diameter dial Bourden type gunmetal pressure gauges with gunmetal isolation cock and connecting pipes.

Sampling cocks on raw water inlet and filtered water outlet.

Individual drain connection with gunmetal full way valve.

Connection with valve for air scouring.

Flow meter or water meter (if required).

FILTER MEDIA

Each filter shall be provided with clean and washed filter media. Following is recommended:

Pebbles	13.6mm size	(100mm deep)
Gravel	6-2.5mm size	(100mm deep)
Coarse sand	2.5-.25mm size	(100 mm deep)
Fine sand	1.25-.08mm size	(650-750mm deep)
Activated		600mm

The above filter media arrangement may be altered to suit contractor's own design for the most efficient performance.

7.7.2 CHEMICAL DOSER (Alum Doser, chlorinator)

Chemical doser shall be displacement type complete with rubber bag in vessel duly painted of 50 liters capacity or as mentioned in the schedule of quantities.

Doser shall be suitable for working pressure mentioned in the schedule quantities.

Each doser shall be provided with orifice plate assembly injection and corrosion proof piping. Piping from the main water supply line to the doser shall be G. I. pipes to IS : 1239 (heavy class).

7.7.3 WATER SOFTNER

Softener vessel shall be designed in accordance with the code of unfired pressure vessel conforming to BIS.

Softeners shall be designed to give 'Soft Water' of quality of Commercial Zero i.e. hardness less than 5 ppm for soft water tanks and less than 150 ppm for treated water tank. Softener shall provide with suitable grade of CATION exchange resin in quantity to be considered by the Contractor at the time of quoting.

Softener shall be fabricated out of mild steel and suitable for self-supporting arrangement.

Softener shall have a set of face piping for inlet, outlet brine injection with all valves. Suitable drain shall be provided (with multiport valve preferably).

One set of hydraulic injector with control valve and brine delivery pipes.

One cylindrical PVC/HDPE brine saturator and mixing tank, provided with brine delivery piping with adjustable level indicating clamp and control valves complete. The tank shall be of capacity as given in the schedule of quantities.

The first charge of resin, chemicals, media & consumables shall be included in the cost of water softening plant.

7.8 INSTALLATION AND TESTING

All pumps, water treatment equipments, R.O. plants and solar heater shall be laid out generally in accordance with the shop drawings (submitted by contractor and approved by engineer-in-charge achieving economy of space and piping.

All pumps, water treatment equipments, R.O. plants and solar heater shall be tested for the rated performance in the presence of the employer's representative and got approved.

7.9 Mode of measurement

Pumps for water supply with valves on suction & delivery side, non-return valve on delivery, pressure gauge on delivery, set of high/low control including wiring, foundation bolts, nuts etc. shall be measured as one unit and paid.

Sump pumps with motor, water proof cable, gun metal valve, and non return valve in delivery all installed in position will be measured as one unit and paid.

Level controllers shall be measured by numbers.

Water filter, Softener, Chemical dosers shall be measured by number and shall include all items given in schedule of quantities.

7.10 **CATALOGUES & MANUAL**

The Contractor shall furnish the operation & maintenance manual/ technical literatures in duplicate to engineer-in-charge.

SECTION VIII

FIRE HYDRANT SYSTEM

- 1.0 Scope of work
- 1.1 The scope of work shall cover supply, fabrication, installation, testing and commissioning of the fire hydrant system covering the following but not limited to:
 - 1.1.1 Fire Hydrant pumps, electric and diesel driven as shown in the equipment schedule, drawings and as required.
 - 1.1.2 Jockey pump, electric driven as shown in the equipment schedule, drawings and as required.
 - 1.1.3 Engine Control Panel.
 - 1.1.4 Hydrant mains, external ring and yard hydrants.
 - 1.1.5 Wet risers in the building as specified and shown on drawings.
 - 1.1.6 Landing valves, hose reels, hose cabinets etc.
 - 1.1.7 Fire brigade breaching; inlet & outlet connections and connections to pumps and appliances.
 - 1.1.8 The contractor shall get the Fire Fighting System approved by the Chief Fire Officer of Delhi Fire Service.
- 2.0 Standards
 - 2.1 The fire hydrant installation shall conform to and meet with the requirements set out by the following:
 - 2.1.1 As relevant IS Code of practice for the safety of buildings (General) firefighting equipment and its maintenance.
 - 2.1.2 As relevant IS Code of practice for installation of internal fire hydrant in multi-storied building.
 - 2.1.3 Compliance with the local fire brigade and the fire enforcing authorities as specifically laid down by them.
- 3.0 Fire pump
 - 3.1 The fire pump shall be single stage / double stage suction centrifugal type with split casing type and direct driven by electric motor or diesel engine as specified. The pump rating and performance shall conform to the equipment schedule and meet the TAC duty requirements.
 - 3.2 Pump casing shall be of close grained cast iron with bronze impeller. The shaft sleeve shall be brass or SS 304 and the trim shall be brass or bronze.
 - 3.3 Pump shall be capable of delivering 150% of the rated capacity at 65% of the rated head and the no-delivery head shall be not more than 140% (150% in case of end suction type) of the rated delivery head. The pump casing shall withstand 1.5 times the no-delivery pressure or 2 times of the duty pressure whichever is higher.
 - 3.4 The pump shall be either electrically driven or diesel driven with direct flexible coupling.
 - 3.5 The electric drive motor shall be squirrel cage induction conforming to IS 325 - 1978 and rated for continuous duty (S1). Motor shall have not less than class F insulation and minimum enclosure of IP22. The starter shall be air cooled fully automatic star delta or auto transformer type. Starters shall conform to IS 8544 and rated for AC-3 duty conditions.
 - 3.6 Drive rating shall be based on the largest of the following:
 - a) Rated pump discharge at rated head
 - b) 150% of rated discharge @ 65% of rated head
 - c) Maximum power absorbed by the pump in its operating range i.e. no-delivery to free discharge.
 - 3.7 The diesel engine shall be naturally aspirated (non-turbocharged) and electrically started. The engine shall be complete with starting batteries full-wave selenium rectifier charger, isolator, leads, mounting frame etc. Engine rating shall be same as for the electric motor. The detailed specifications of the engine are at Clause no 6.0.
- 4.0 Accessories
 - 4.1 The Fire Pumps shall be complete with the following accessories:

- a) Suction and discharge eccentric reducers
 - b) Pump coupling guard
 - c) Common base frame, fabricated mild steel or cast iron.
- 4.2 Each pump shall have independent set of pressure switches. The pressure switch shall be snap action SP DT switch rated 10A @ 220 V operated through a stainless steel diaphragm. The switch shall have a pointer for manual adjustment of set point, and all electrical connections shall be terminated in a screwed terminal connector. The entire unit shall be encased in a cold drawn steel (heavy gauge) enclosure. The diaphragm shall be designed for a maximum operating pressure of the system. Each pressure switch shall be provided with a pressure gauge in parallel as shown on the drawings and all gauges and pressure switches shall be mounted in an instrument panel with necessary control piping and drainage facility.
- 5.0 System operation and control panels
- 5.1 The fire pump shall be started automatically on loss of pressure and the operation sequence of the booster and fire pumps shall be as follows:
- 5.1.1 Jockey Pump shall start when the system pressure drops by 0.35 kg/cm² and stop when the system pressure is re-established.
- 5.1.2 The Fire Pump shall start when the system pressure drops by 1.0 kg/cm² and shall continue to run till manually switched off.
- 5.1.3 Jockey and fire pump starting shall be indicated on the panel with a red indication lamp.
- 5.2 The motor starters (direct on line or star-delta) shall consist of electrically actuated contactors. The starter shall be complete with ON-OFF push buttons, timers and auxiliary contacts and shall be fully automatic. There shall be an indicating lamp with each of the pumps and an ammeter and selector switch with the fire pumps. Fire pump starting shall be annunciated through an electric siren.
- 5.3 The starter along with isolator shall be housed in a 14 SWG MS box duly rust inhibited through a process of degreasing and phosphating.
- 5.4 All cabling to and from the pumps to starter and control switch shall be carried out through armoured PVC cables of approved makes. Cables shall be laid in accordance with section "M V CABLING". The pump motors and panels shall be double earthed in accordance with IS 3043-1966 or as shown on drawings and as approved.
- 6.0 Fire hydrants and hose reels
- 6.1 Hydrants shall be provides internally and externally as shown on the drawings. Internal hydrants shall be provides at each landing of and escape staircase and additionally depending on the floor area as shown on drawings. Landing valve shall be single headed gunmetal valve with 63 mm dia outlets and 80mm inlet conforming to IS 5290-1969. Landing valve shall have flanged inlet and instantaneous type outlets and mounted at 1.0m above the floor level. Instantaneous outlets for the hydrants shall be of standard pattern approved and suitable for 63mm dia fire brigade hoses. Wherever necessary, pressure reducing orifices plate and shall be provided so as to limit the pressure to 3.5 kg/sqcm or any other rating as required by the Local Fire Authority.
- 6.2 Each landing valve shall have a hose reel cabinet as shown on drawings.
- a) Landing valve with single 63 mm dia outlet and 80 mm dia inlet.
 - b) First-aid hose reel with 30 m long 25 mm dia high pressure double braided rubber hose (IS:444 marked) with 25 m dia Ball Valve.
 - c) 2 Nos. 15.0 Meter long 63 mm dia Reinforced Rubber Lined (RRL) hoses with gun metal I.S. marked instantaneous couplings.
 - d) One gun metal branch pipe.
- 6.3 The First Aid Hose shall conform to IS 884-1969 and be wound on a heavy duty circular hose reel with a bracket. The hose shall be permanently connected on one end to the Wet Riser through a 25m Ball Valve with necessary hose adapter and a gun metal nozzle at the other end.
- 6.4 Hoses shall be in two lengths of 15.0 m each, of RRL type with instantaneous couplings, neatly rolled into bundles and held in position with steel brackets. Hoses shall be tested and certified by the manufacturer, to withstand an

internal water pressure of not less than 35 kg/sqcm without bursting. The hose shall also withstand a working pressure of 7 kg/sqcm without leakage.

- 6.5 The hose cabinet shall be fabricated from 2mm mild steel sheet duly rust inhibited through a process of degreasing and phosphating. The cabinet shall have double flap hinged doors with 4mm clear glass and shall have necessary openings for riser main and brackets for all internals. The cabinet shall receive two coats of red oxide primer both inside and outside before two after coats of final paint of approved colour shade.
- 6.6 External hydrants shall be as per IS:5490 with hand wheel control and a 80 mm dia pipe stand post. Hydrants shall be located at least 2m away from and within 15m from the building wall.
- 6.7 Each hydrant shall be provided with a hose cabinet containing 2x15m 63 dia RRL hoses with couplings. The cabinet shall contain a branch pipe and nozzle. The cabinet shall be 900 x 600 x 400 fabricated out of 2 m mild steel sheet duly rust inhibited through a process of degreasing, phosphating etc. The cabinet shall receive two coats of red oxide primer, inside and outside, before 2 coats of final painting of approved shade. The cabinet shall be wall-mounted or free standing with its own steel legs depending on the site conditions and as shown on drawings and as approved.
- 6.8 The fire brigade connection shall consist of two / three/four headed as specified in BOQ 63mm dia gun metal outlets with built-in check valve and drain plugs connected to a 150mm dia outlet connection to the water reservoir or to the hydrant main. The fire brigade collecting head shall conform to IS 904-1965.
- 7.0 Test & commissioning
- 7.1 The fire pump starting and stopping shall be tested by opening the test valve and record the following and the valves should be as furnished below:

System pressure at start-up	:	2.0 kg/sqcm
System pressure at stop	:	3.5 kg/sqcm
Time elapsed from start to stop	:	2 Seconds

- 8.0 Mode of measurement
- 8.1 Hydrant pump with mounting frame, excluding concrete foundation shall be measured per unit.
- 8.2 Jockey pump same as hydrant pump.
- 8.3 Instrument panel with pressure gauges, pressure switches, control piping etc. shall be measured as one unit.
- 8.4 Control cabling from pressure gauge panel to the respective starters shall be measured in running meter and paid at unit rates.

SECTION – IX
PIPING FOR FIRE FIGHTING SYSTEM

- 1.0 Scope
- 1.1 The scope of work covers, supply, fabrication, laying, testing, painting and commissioning of the entire piping system for the fire fighting installation i.e. fire hydrant and sprinkler systems.
- 2.0 Piping
 - 2.1 External
 - 2.1.1 All External pipes shall be, unless otherwise specified, heavy quality mild steel tubes to IS 1239 using wrought GI steel heavy duty screwed fittings. Flanges shall be provided to mate with valves and other equipment and shall conform to IS 6392. Flanges shall be screwed type. Flanges shall be rated for 2.0 N/sqmm.
 - 2.1.2 Black mild steel pipes, when laid underground, shall be protected against corrosion by two coats of hot bitumen and 2mm thick wrapping of pypkote. Fittings shall be weld able wrought iron, suitable for butt welding and 10% of the welded joints shall be radio graphically tested and found in order. The welded joints shall be random selected for testing in consultation with the Engineer-in-charge. All flanges shall be slip-on welded type to IS 6392 with a 3mm fibre-reinforced teflon gasket and rated for 2.0 N/sq. mm.
 - 2.1.3 Underground mains shall be laid not less than 750 mm below the ground level and shall be at least 2m away from the building face and supported on concrete pedestals at every 3.5m and held on with galvanised iron clamps. Concrete thrust anchors shall be provided at all bends and tees as shown on drawing and as directed. All excavation for pipe laying shall be carried out with sufficient width for making proper joints. Backfilling shall be done only after the piping is hydro-statically pressure tested. Piping shall be constantly kept clean till tested.
 - 2.1.4 All valves shall be housed in brick masonry chambers over 150mm cement concrete (1:3:6) foundation. The brick walls of the chamber shall be plastered inside and outside with 20mm cement sand plaster 1:4 with a floating coat of neat cement. Chambers shall be 650 x 650 mm clear for depths upto 1200 mm and 1000 x 1000 mm for depths beyond. Each chamber shall have a cast iron surface box approved by the Engineer in-charge.
 - 2.1.5 Piping laid above ground shall be supported on cement concrete (1:2:4) pedestals raising the bottom of the pipe at least 150mm over the ground level and held to the pedestals with galvanised clamps. Pedestals shall be made at 3.0m centre to centre and as shown on drawings. Cement concrete 1:2:4 thrust anchors shall be provided at all tee-off points and change of direction as shown on drawings and as required. Pipes laid on walls and ceiling shall have galvanised steel brackets.
 - 2.2 Internal
 - 2.2.1 All internal pipes shall be, unless otherwise specified, heavy quality mild steel tubes to IS 1239 using wrought steel heavy duty screwed fittings. Flanges shall be provided to mate with valves and other equipment and shall conform to IS 6392. Flanges shall be screwed type. Flanges shall be rated for 2.0 N/sqmm.
 - 2.2.2 Valves shall be suitable for external piping.
 - 2.2.3 All pipes shall be of approved make and best quality without rust marks. Pipes and fittings shall be fixed in a manner as to provide easy accessibility for repair, maintenance and shall not cause obstruction in shafts, passages etc. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanship manner. Pipes shall be securely fixed to walls and ceilings by suitable supports at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceiling and walls.
 - 2.2.4 All pipes shall be adequately supported from ceiling or walls through structural supports fabricated from mild steel structural e.g. rods, channels, angels and flats generally as shown on drawings. Fasteners shall be shear type anchor fasteners in concrete walls and ceilings and wrought steel spikes of at least 75mm long in brick walls. All pipes supports shall be painted with 1 coats of red oxide primer and two coats of black enamel paint.
 - 2.2.5 All low point loops in the piping shall be provided with 25mm Ball Valves with rising spindle for draining the system. All valves shall have screwed brass caps. Likewise 25mm gun metal air vents shall be provided at all high point loops to prevent air-locking.
 - 2.2.6 All piping shall have flanged joints at about 25m intervals to facilitate easy maintenance.

- 3.0 Pipe Jointing
 - 3.1 **All pipes shall be provided with threaded joints up to 50mm diameter and welded joints for pipe above 50mm diameters. Hold tite shall be used for sealing.**
 - 3.2 **All welded joints shall be tested by radiography test.**
 - 3.3 **Joints between CI and GI pipes shall be made by providing a suitable flanged tail or socket piece and MS flange on the GI pipe. Flanges shall have appropriate number of holes and shall be fastened with nuts, bolts and 1.5mm thick compressed asbestos gasket.**
- 4.0 Valves and other accessories
 - 4.1 Gate Valves
 - 4.1.1 Sluice / Gate valves shall be used for isolation of flow in pipe lines For sizes upto 65 mm, gate valves shall be outside screw rising spindle type and shall be as per IS: 778 Class-I and Class-II, as applicable. For sizes 80 mm to 300 mm, gate valve shall be as per IS: 780, PN=1.0 and shall be of inside screw and non rising type and cast iron double flanged.
 - 4.1.2 Gate valves shall be provided with a hand wheel, draining arrangement of seat valve and locking facility (as required). Gate valves shall have back setting bush to facilitate gland renewal during full open condition.
 - 4.1.3 The Body, bonnet, Stuffing Box, cap and hand wheel shall be of cast iron to IS:210/70, grade FG 200 / 260. The non rising spindle shall be of solid forged high tensile brass or carbon steel to AISI 304 construction. The Body seating and wedge ring shall be of solid leaded gun metal. The Bonnet gasket shall be of high quality rubber.
 - 4.1.4 The Valve shall be PN 1.0 rated but shall withstand tests of upto 20 kg / cm². The ends shall be flanged. The batch number of the valve shall be punched on the top of the flange. The spindle shall be removable type, and shall be easily rotated.
 - 4.2 Pressure Switch
 - 4.2.1 The Pressure switches shall be employed for starting and shutting down operation of pumps automatically, dictated by line pressure. The Pressure Switch shall be diaphragm type. It shall be suitable for line pressures upto 15 kg / cm². The scale range for cut in and cut out shall be from 0 to 10 kg / cm².
 - 4.2.2 The Switch shall be suitable for consistent and repeated operations without change in values. It shall be provided with IP:66 water and environment protection.
 - 4.2.3 The enclosure shall be of aluminium and pressure element and wetted parts shall be of stainless steel. The switch shall be snap acting type with 1 number N O / N C contact.
 - 4.3 Air Vessel
 - 4.3.1 Air vessel shall be fabricated from 6 mm thick, 300mm x 1000mm MS plate suitable for 7kg/cm² working pressure complete with air release valve, safety valve, pressure gauge etc. as required. The air vessel shall be continuous welded construction and painted with two coats of Postal red enamel outside over a coat of primer and epoxy paint inside.
 - 4.4 Pressure Vessel
 - 4.4.1 The Pressure Vessel shall be provided to compensate for slight loss of pressure in the system and to provide an air cushion for counter acting pressure surges whenever the pumping set comes into operation. It shall be normally partly full of water, the remaining being filled with air which will be under compression when the system is in normal operation.
 - 4.4.2 Pressure vessel shall be fabricated from 8-10 mm thick MS plate with dished ends and suitable supporting legs. It shall be provided with a 50 mm dia flanged connections from pump, one 25 mm drain with ball valve, one water level gauge and 25 mm sockets for pressure switches. The pressure vessel shall be hydraulically tested as required.
 - 4.4.3 The Pressure Vessel shall be for Hydrant Systems. The Pressure Switches shall be mounted on the drain end of each Vessel. The Vessel shall also be provided with an air release valve mounted at the top.

4.5 Pressure Gauge

- 4.5.1 The Pressure Gauge shall be constructed of die cast aluminium and stove enameled. It shall be weather proof with an IP 55 enclosure. It shall be a stainless steel Bourden tube type Pressure Gauge with a scale range from 0 to 16 Kg / CM² and shall be constructed as per IS: 3624. Each Pressure Gauge shall have a siphon tube connection. The Shut off arrangement shall be by Ball Valve.

4.6 Ball Valve

- 4.6.1 The Ball Valve shall be made from die cast brass and tested to 14 Kg/cm² pressure.
- 4.6.2 The valve shall be internally threaded to receive pipe connections.
- 4.6.3 The Ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body- bonnet gasket and gland packing shall be of Teflon.
- 4.6.4 The handle shall be of chrome plated steel with PVC jacket. The handle shall also indicate the direction of 'open' and 'closed' situations. The gap between the ball and the teflon packing shall be sealed to prevent water seeping upto 14 Kg / cm² pressure.
- 4.6.5 The handle shall also be provided with a lug to keep the movement of the ball valve within 90 degree. The lever shall be operated smoothly and without application of any unnecessary force.

4.7 Non Return Valve

- 4.7.1 Non-return valves shall be cast iron spring action swing check type. An arrow mark in the direction of flow shall be marked on the body of the valve. The valve shall bear IS:531 certification.
- 4.7.2 The Valve shall be of cast iron body and cover. The internal flap in the direction of water shall be of cast iron and hinged by a hinge pin of high tensile brass or stainless steel. Cast iron parts shall be conform to IS:210 / 70, grade 200 / 260 type.
- 4.7.3 The gasket shall be of high quality rubber and flap seat ring of leaded gun metal to BS 1400 LG 2C. At high pressure of water flow the flapper shall seat tightly to the seat. The Valve shall be capable of handling pressure upto 15 kg / cm².

4.8 Butterfly Valve

- 4.8.1 The Butterfly Valve shall be suitable for waterworks and tested to minimum of 16 kg / sq cm pressure. The Valves shall fulfil the requirements of AWWA (American Water Works Association) C 504, API 609 and MSS-SP-67.
- 4.8.2 The body shall be of cast iron to IS:210 in circular shape and of high strength to take the minimum water pressure of 10 kg / cm². The disc shall be heavy duty cast iron with anti corrosive epoxy or nickel coating.
- 4.8.3 The valve seat shall be of high grade elastomer or nitrile rubber. The Valve in closed position shall have complete contact between the seat and the disc throughout the perimeter. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure. The shaft shall be of EN 8 grade carbon steel.
- 4.8.4 The Valve shall be fitted between two flanges on either side of pipe flanges. The Valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakage.
- 4.8.5 The Valves shall be supplied with manual gear operated opening / closing system by lever.

5.0 Pipe supports

All pipes whether horizontal or vertical shall be suitably supported using galvanized mild steel clamps/clevis hanger manufactured by M/s Hitech Support (India) Pvt Ltd or equivalent product of good quality as approved by engineer in-charge.

5.1 Vertical Pipes

- 5.1.1 **The pipes running vertical shaft shall be supported by galvanised mild steel rigid clamps fixed to wall with anchor bolts and studs.**
- 5.1.2 **When the horizontal distance between the centre line of two adjacent pipes is less than 300 mm a powder coated HITECH/or equivalent rail shall be fixed to wall the pipes independently clamped to the rail with 'U' bolt clamps.**

5.2 Horizontal Pipes

5.2.1 Pipes running horizontal shall be supported from structural beam/slab by using appropriate galvanised m.s. pipe clevis hangers.

5.2.2 The spacing of supports shall be as follows:

GI Pipes/MS Pipes		CI Spun Pipes	
Internal Dia (mm)	Spacing (mm)	Internal dia (mm)	Spacing (mm)
15	1800	75-150	2700
20,25	2400	200-250	3000
32	2700	300	3600
40-50	3000		
65-80	3600		
100	4000		
150	4500		

5.2.3 Supports for horizontal piping longer than 15m in a stretch shall be provided with swivel clamps. Otherwise, the clamps shall be universal clamps or rigid clamps as required by the project engineer.

5.3 Fixing of clamps/rails etc.

All clamps, rails and accessories shall be fixed to the structure (beam, slab, walls etc.) by using approved good quality anchor fasteners of appropriate size.

6.0 Painting

6.1 All exposed piping for fire fighting shall be distinctly painted 'Fire red' shade 536 to IS:5-1978. Pipes shall first receive two coats of red oxide primer uniformly applied and two coats of oil paint applied thereafter. All pipes supports shall be painted black as specified for support & clamps.

6.2 Painting Schedule

6.2.1 All equipment and piping shall be painted in accordance with the following colour code:

	Equipment	Colour	Distinguishing Mark
a)	Pump motors	Fire Red Shade No.536 to IS: 5 -1978	
b)	Internal piping	"	
c)	Landing valves & Hose reel cabinets	"	"
d)	External Hydrants	"	
e)	Fire brigade connection	"	
f)	Priming tank	"	
g)	Air vessel	"	
h)	Electric panels	Black & Red	
i)	Fire Alarm Panel	Black & Red	
j)	Repeater panel	Black & Red	
k)	Break Glass Unit	Fire Red	
l)	Hooters/Speakers	Fire Red	
m)	Sprinkler pipes	Fire Red	

6.2.2 All surfaces to be painted shall be thoroughly cleaned with wire brush to remove completely rust and other extraneous substances. Over the cleaned surfaces one coat of red oxide primer shall be applied completely covering the exposed surfaces. Finishing coat of enamel paint shall be applied one day after the prime coat, after ensuring that the paint is dry. The second coat shall be done before the installation is handed over and after approval to do so from the Engineer-in-charge.

7.0 Testing & commissioning

All piping after installation shall be tested for a hydrostatic test pressure of 10.5 kg/sqcm or 1.5 times the working pressure (whichever is less) maintained for 24 hours. All joints and valves shall be checked for leaks and rectified and retested. During testing all valves except drain & air valves shall be kept fully open.

8.0 Makes of materials

For makes of materials refer to list of approved makes of material.

9.0 Mode of measurement

9.1 All external piping shall be measured along the centre line of the pipe and paid per unit length and shall include:

9.1.1 All pipes & fittings

9.1.2 Bituminous coating

9.2 All internal piping shall be measured similarly but shall include for the pipe supports and clamps.

9.3 All valves, air valves, drain valves together with flanges or tail pieces shall be measured per unit.

9.4 All excavation and concrete supports and thrust blocks shall be measured as per drawing and paid for per cum.

9.5 The cost of pipe supports described above form part of the rate quoted for piping and no extra shall be payable on the account.

All painting shall form part of the cost of equipment piping etc. No separate payment shall be admissible.

SECTION - X
SPRINKLER SYSTEM

1.0 Pendant type Sprinkler Head

- 1.1 Sprinkler heads shall be of quartzoid bulb type with bulb, valve assembly, yoke and the deflector. The sprinkler shall be of approved make and type with 15 mm nominal dia outlets.
- 1.2 The bulb shall be made of corrosion free material strong enough to withstand any water pressure likely to occur in the system. The bulb shall shatter when the temperature of the surrounding air reaches at 68° C / 79° C.
- 1.3 The nominal bore shall be 15 mm dia and colour of liquid shall be Red / Yellow.
- 1.4 The Sprinkler head shall be approved by UL / FM.

2.0 Upright type Sprinkler Head

- 2.1 Upright sprinkler heads shall be similar to Pendant type in material construction and performance but designed to throw water Droplets upwards in umbrella fashion, to cool the underside of ceiling and extinguish any fire involving combustibles on the floor below.
- 2.2 The Sprinkler head shall be approved by UL / FM. The nominal bore shall be 15 mm dia and the colour of liquid shall be red.
- 2.3 Upright Sprinkler heads shall be use in lower and upper basement parking areas and above the false ceiling.

3.0 Side Wall type Sprinkler Head

- 3.1 Side wall sprinkler heads shall be similar to Pendant type in material construction and performance but designed to throw water Droplets horizontally.
- 3.2 The Sprinkler head shall be approved by UL / FM. The nominal bore shall be 15 mm diameter and the colour of liquid shall be red.
- 3.3 Side wall sprinkler heads shall be use in staircase landing and along the ramp.

4.0 Powder coated Sprinkler with Powder coated Twin plate Rosette.

- 4.1 Most areas below false ceiling shall be provided with powder coated pendant sprinkler with twin plate sliding rosette. The sprinkler head shall be same as Pendant type above but powder coated white. The sprinkler head shall be provided with a double plate powder coated rosette that shall seal the gap between the false ceiling and the sprinkler head.
- 4.2 The adjustment allowable shall be 12 mm. The lower part shall have flared ends that shall fit tightly into the upper piece.
- 4.3 The Sprinkler head shall be approved by UL / FM. The nominal bore shall be 15 mm diameter and the colour of liquid shall be red.

5.0 Installation Control Valve for Sprinkler

- 4.1 The Installation Control Valve shall be double seated clapper type check valve. The Body and cover shall be made from Cast Iron to IS:210 Grade FG 200. The seat and seat clamp shall be made from bronze to IS: 318, LTB II grade. The sealing to the seat shall be neoprene gasket. The hinges pin and ball shall be from stainless steel.
- 4.2 It shall be vertically mounted and the direction of water travel shall be indicated on the surface. It shall be rated to 12 Kg / cm² and tested to 25 Kg / cm² pressure.
- 4.3 A By-pass check valve shall be fitted to adjust minor and slow variations in water pressure for balancing so as to avoid any false alarm.
- 4.4 The valve shall also be provided with a Test Control Box. The Box shall house a lever to test and operate the ICV. A brass strainer shall also be provided at the point of water supply to the Alarm gong. A Retarding Chamber shall also be provided.
- 4.5 The Chamber shall be able to balance the water pressure in case of water line surges.
- 4.6 Each Installation Control Valve shall have two sets of Pressure Gauges with brass ball valve type shut off.
- 4.7 A Water Motor Alarm. shall also be provided. This shall be mechanically operated by discharge of water through an impeller. The drive bearing shall be weather resistant. A strainer shall be provided on line before the nozzle. The Gong piece shall be constructed from bronze to IS 318, 2 TB II Grade, and base of cast iron. The Motor Housing, Rotor and Housing Cover shall be pressure die cast aluminium.

6.0 Flow Switch

- 6.1 Flow switch shall have a paddle made of flexible material of the width to fit within the pipe bore. The terminal box shall be mounted over the paddle / pipe through a connecting socket. The Switch shall be potential free in either N O or N C

position as required. The switch shall be able to trip and make / break contact on the operation of a single sprinkler head. The terminal box shall have connections for wiring to the Annunciation Panel. The seat shall be of stainless steel. The Flow Switch shall have IP:55 protection.

- 6.2 The Flow Switch shall work at a minimum flow rate of 100 LPM. Further, it shall have a 'Retard' to compensate for line leakage or intermittent flows.

7.0 Makes of materials

For makes of materials refer to list of approved makes of material.

- 8.0 Mode of measurement

8.0 Sprinkler head including supports and clamps for fixing shall be measured as unit.

8.1 All alarm control valves including drain valves, butterfly valve and all other accessories together with flanges or tail pieces shall be measured per unit.

8.2 All floor control valves including drain valves, butterfly valve, sight glass and all other accessories together with flanges or tail pieces shall be measured per unit.

SECTION - XI
PORTABLE FIRE EXTINGUISHERS & EXIT SIGNAGES

- 1.0 Scope
- 1.1 The scope of work covers the supply and installation of portable fire extinguishers. The following types are envisaged in these specifications and provided as shown in the schedule of portable fire extinguishers.
- 1.0.1 Dry powder extinguisher
- 1.0.2 Carbon-dioxide extinguisher
- 1.0.3 Mono ammonia phosphate extinguisher
- 1.0.4 Water expelling type.
- 2.0 Standards
- 2.1 The following standards and rules and regulations shall be applicable:
- 2.1.1 Fire protection manual of the tariff advisory committee, Fire Insurance Association of India
- 2.1.2 IS:2176 :Portable fire extinguisher Dry power type
- 2.1.3 IS:2878 :Portable fire extinguisher carbon-dioxide type
- 2.1.4 Local Fire Brigade/Authority
- 2.2 All standards mean the latest.
- 3.0 Extinguishers
- 3.1 Dry powder type
- 3.1.1 The extinguishers shall be 2, 5, 10 kg capacity and cartridge type unless specified otherwise.
- 3.1.2 The body shall be of cold rolled carbon steel grade D and 1.5mm thick upto 5 kg and 2mm for 10 kg. The construction shall be similar to 'Soda Acid type' but of the following dimensions.
- | Capacity (kg) | Outside dia (mm) | Filler opening (mm) |
|---------------|------------------|---------------------|
| 2.00 | 100 | 45 |
| 5.00 | 150 | 45 |
| 10.00 | 175 | 45 |
- 3.1.3 The discharge fitting shall be with 500mm 10mm dia hose upto 5 kg and 750 mm 12.5 mm dia for 10 kg with a trigger controlled nozzle capable of discharging 85% of the contents as follows:
- | Capacity (kg) | Time (sec) | Throw (m) |
|---------------|------------|-----------|
| 2.00 | 8 - 10 | 2 |
| 5.00 | 15 - 20 | 4 |
| 10.00 | 23 - 30 | 6 |
- 3.1.4 A carbon dioxide cartridge conforming to IS:4947 shall be fitted in a cartridge holder with an inner shell. A spring loaded piercing device shall be provided in the cap for piercing the seal of the gas cartridge. A syphon tube of copper or PVC shall be provided for upright operation. The cap and neck ring shall be similar to Soda Acid type extinguisher.
- 3.1.5 All internal and external components and surfaces shall receive anti-corrosive coating of not less than 12 microns shall be applied uniformly as indicated below:
- | | | | |
|----|--------------------|--------------|------------------------------------|
| a) | Body | Mild steel | Tin alloy |
| b) | Cage for acid | Brass sheets | Lead or tin alloybottle and spring |
| c) | Discharge fittings | Leaded - Tin | Tin alloy |
| | | Bronze | |
| d) | Strainer | Brass sheets | Lead or Tin alloy |
- 3.2 Carbon dioxide type
- 3.2.1 The extinguishers shall be rated for 2.0 and 4.5 kg by weight or carbon dioxide, unless stated otherwise. The contents shall be with a filling ratio not exceeding 0.667.
- 3.2.2 The body shall be steel cylinder made according to IS:2872 and approved by the chief controller of explosives.
- 3.2.3 The discharge head shall be simple and safe to operate conforming to IS:3224 with a safety release to IS:5903 set to 18.0 to 20.0 N/sqmm. A syphon tube of copper or PVC shall be fitted. A non-conducting discharge horn and a high pressure hose (27.5 N/sqmm pressure) shall be fitted with each extinguisher.
- 3.2.4 The discharge system shall be designed to expel 95% of the contents in continuous discharge as follows:
- | Capacity (kg) | Time (Sec.) |
|---------------|-------------|
| 2.0 | 8 - 18 |
| 3.0 | 10 - 20 |
| 4.5 | 10 - 24 |
- 3.3 Mono ammonium phosphate type

- 3.3.1** The capacities envisaged are 2 kg & 5 kg. The filling pressure shall be 0.95 +/- 0.055 N/sqmm.
- 3.3.2** The body shall be cylindrical in shape and made of cold rolled carbon steel grade D/DD or hot rolled steel plate with radiographically tested welded construction. Plate thickness shall conform to IS:11108.
- 3.3.3** Discharge valve mechanism shall be a simple and safe squeeze grip valve. 4.5 kg and above capacity shall have a high pressure (0.5 N/sqmm) hose and non-conducting horn and shall also be provided with a pressure gauge. 95% of the contents shall be discharged as follows:
- | Capacity (kg) | Time (sec) | Throw (m) |
|---------------|------------|-----------|
| 2.00 | 8 - 16 | 2 |
| 5.00 | 15 - 24 | 4 |
- 3.3.4** The internal and external components and surface shall be treated for anti-corrosion as for dry powder type extinguishers.
- 3.3** Water CO2 Fire Extinguisher
- 3.3.1** The extinguishing medium shall be primarily water stored under normal pressure, the discharge being effected by release of carbon dioxide gas from a 60 gms cylinder.
- 3.3.2** The capacity of the cylinder when filled shall be 9 litres +/- 5 %.
- 3.3.3** The cylinder shall be fabricated from MS sheet, welded at seams, with dish and dome, being of same thickness and of size not exceeding the diameter of the body. The neck shall be externally threaded with leaded tin bronze.
- 3.3.4** The cap shall be of leaded tin bronze. The siphon tube shall of brass or GI. The cartridge holder, knob, discharge fittings and plunger shall be of leaded tin bronze and plunger of stainless steel with spring also of stainless steel. The discharge tube shall be of braided nylon, of 10 mm dia and 600 mm length with a brass nozzle.
- 3.3.5** The extinguisher shall be treated for anti corrosion internally and externally and painted fire red externally. The cartridge shall be IS marked. The Extinguisher body shall be tested to 25 bar pressure for 2 minutes. The Extinguisher shall be IS:940 marked.
- 3.5** General requirements
- 3.5.1** All extinguishers shall be standard products approved by the Tariff Advisory Committee and Local Fire Authority and manufactured and tested strictly in accordance with the relevant Indian Standard. All markings and test results shall be stamped in the appropriate colour markings accordingly to the Indian Standards.
- 3.5.2** All extinguishers shall have a structurally designed galvanised steel handle and also a suitable wall mounting bracket.
- 4.0** Illumination signs/EXIT signage
- The illuminated signs shall have the letters 'FIRE EXIT" or "NO FIRE EXIT" painted in red on a 6mm thick white perspex sheet as the front face of a sheet steel enclosure constructed with minimum 1.5mm thick sheet. The MS box shall be powder coated finished in white colour. The perspex sheet shall be back lit with a rechargeable maintenance free sealed battery integral with a battery charging circuit. The battery backup facility shall operate independent of the mains supply in the event of a mains failure. The batteries shall be of adequate rating so as to support the illumination of the signage for a minimum period of 1 hour without mains power. The preferred dimensions of the illuminated signs shall be 450 mm length and 225mm height with 100 mm high lettering. They shall be suitable for surface or recessed mounting or ceiling hung type as required including all arrangements for suspension, cutting/chasing and making good the defects etc. complete as approved.
- 5.0** Mode of measurement
- 5.1** Each extinguisher with its mounting bracket shall be measured per unit and paid for.
- 5.2** Exit signages with mounting plate shall be measured per sq.inch and paid for.
- 6.0** Makes of Equipment and materials
- Refer to list of approved makes.

SECTION - XII

ELECTRICAL WORK

1.0 Scope

- 1.1 The scope of this section comprises of fabrication, supply, erection, testing and commissioning of electric panels, wiring and earthing of all equipment components and accessories, including supply, installation and wiring of remote mounted push button stations.
- 1.2 All the electrical cables, termination, wires and accessories are also including in the Scope of Work. The main cable from the main distribution board will be supplied and erected by other Agency.

2.0 General

- 2.1 Work shall be carried out in accordance with the specifications of CPWD specifications, Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended up to date.

3.0 Construction Features

- 3.1 The control panel shall be metal enclosed sheet steel cubical, indoor type, floor mounting/wall mounting type as per BS 5486 Part 1, 190 & IEC 439-1. The control panel shall be totally enclosed, completely dust and vermin proof, Gaskets between all adjacent units and beneath, covers shall be provided to render the joints dust proof. Control panels shall be arranged in multitier formations. All doors and covers shall also have sealing & pad locking arrangement. All mild steel sheets used in the construction of control panels shall be minimum 2mm. thick or as specified and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all slag grounded off and welding pits wiped smooth with plumber metal.
- 3.2 All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal provided with hank nuts. Self threading screws shall not be used in the construction of control panels. Base channel shall be of 75mm x 40mm x 5mm thick shall be provided at the bottom. Minimum clear space of 250 mm between top of channel of control panel and bottom most unit shall be provided.
- 3.3 The control panels shall be of adequate size with a provision of 10% spare space to accommodate possible future additional switchgear. Knockout holes of appropriate size and number of cables shall be provided in the control panels in conformity with the location of incoming and outgoing conduits/cables. All equipment such as meters and indicating lamps, etc shall be located adjacent to the unit with which it is associated and care shall be taken to achieve a neat and symmetrical arrangement. Facility shall be provided for termination of cables from both above and below the control panel. Where cables enter below, cables boxes shall be fitted at the rear and arranged in tiers to facilitate making connections to the upper and lower units. Clamps shall be provided to support the weight of the cables. All incoming and outgoing feeders shall be brought out to a terminal block of adequate size at suitable location inside the control panel. All wiring inside the control panel shall be color coded and labeled with approved plastic beads for identification. Circuit diagrams showing the arrangement of circuits shall be pasted on the inside of the panel door and covered with transparent plastic sheet and all labeling shall be provided on the front face of the panel board.

4.0 Circuit Compartments

- 4.1 Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the 'ON' position. Safety interlocks shall be provided to prevent the breaker or Contactor from being drawn out when the breaker is in the draw out position of the panel. Instruments and indicating lamps shall not be mounted on the panel compartment door. Sheet steel barriers shall be provided between the tiers in a vertical section.

5.0 Instrument Accommodation

- 5.1 Separate and adequate compartments shall be provided to accommodate instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accident contact with live parts of the circuit breaker and bus bar.

6.0 Bus Bars and Bus bar Connection

- 6.1 The bus bar and interconnections shall be of aluminum and of rectangular cross sections suitable for full load current for phase bus bars and half rated current for neutral bus bars and shall be extensible on either side. The bars and interconnections shall be insulated with PVC heat shrinkable sleeve and color coded. All bus bars shall be supported on unbreakable, non-hygroscopic insulated SMC/DMC type supports at regular intervals not more than 400 mm, to withstand the forces arising in case of short circuit in the system. Bus bars shall be provided in separate chamber of main control panels shall be connected by clamping, no holes shall be drilled in bus bars. If holes have to be drilled for making connections, extra cross section of bus bars shall be provided.
- 6.2 All bus bar connections in smaller control panels shall be done by drilling hole and connecting by brass bolts and nuts. Additional cross section of bus bars shall be provided in small control panels to cover up the holes drilled in the bus bars.
- 6.3 All connections between the bus bar and breaker and between breaker and contactor shall be through copper strips of proper size to carry full rated current and shall be insulated with coloured PVC heat shrinkable sleeve.

7.0 Terminals

- 7.1 The outgoing terminals and neutral links shall be brought out to a terminal block suitably located in the control panels. The current transformer for instruments, metering and for protection shall be mounted on the terminal blocks. Separate cable compartment shall be provided for incoming and outgoing cables.

8.0 Wire ways

- 8.1 A horizontal wire way screwed covers shall be provided at the top to take in the connecting control wiring of different vertical sections.

9.0 Cable Compartments

- 9.1 Cable compartments/alley of adequate size shall be provided in the control panels for easy termination of all incoming and outgoing cables entering from bottom or top using detachable gland plates with proper knockouts. Adequate and proper DMC supports shall be provided in cable compartments to support cables. All incoming and outgoing terminals shall be brought out on terminal blocks in the cable compartment.

10.0 Materials

a) Rotary Switches

Switches up to 60 amps shall be rotary type with compact and robust construction, built up from one or more stacks with contacts and a positioning mechanism, with stop as required. The terminals shall be shrouded with insulation to prevent accidental contact with live parts. Rotary switches shall be backed up with moulded type HRC fuse fittings of appropriate rating.

b) Selector Switch

When called for, selector switches of rated capacity shall be provided in control panels, to give the choice of

operating equipment in selective mode.

c) Molded Case Circuit Breakers (MCCB)

MCCBs shall be quick make, quick break, and preferably double break contact system, arc extinguishing device, independent manual type with trip free feature with mechanical ON, OFF, and TRIP indications as called for in BOQ. A trip button shall be provided for tripping the breaker.

MCCB shall be a compact high strength, heat resistant, flame retardant; insulating molded case with high withstands capability against thermal and mechanical stresses. All MCCBs shall be capable of defined variable overload adjustment

d) Switches

Switches beyond 60 amps shall be panel mounted double break type and suitable for load break duty, quick make and break action. Switch contacts shall be silver plated and shall be back-up with HRC fuses of appropriate rating. The switch handles shall be located at the front.

e) HRC Fuses

Fuses shall be high rupturing capacity of not less than 20 MVA at 415 volts. The backup fuse rating of each motor/heater/equipment shall be so chosen that the fuse does not operate on starting of motor/heater/equipment. Fuses shall be of the same make as the switches.

f) Starters

Each motor shall be provided with a starter of suitable rating. Direct on line starters shall be provided for motors up to 10 HP.

Operating coils of contactors shall be suit able for 220/415 +/- 10% volts AC, 50 cycles supply system. The contactor shall drip out when voltage drops to 90% of the rated voltage.

g) Over Load Relays

Contactors shall be provided with a three element, positive acting ambient temperature compensated time lagged hand-reset type thermal over load relay with adjustable setting.

h) Current Transformers

Current Transformer shall be of accuracy class - I and suitable VA burden for operation for the connected meters and relays.

i) Single Phase Preventor

Single phase preventor shall be provided for all the starters. Single phase preventor shall act when the supply voltage drops down to 90% of the rated voltage or on failure of one or more phases.

j) Indicating Lamp and Metering

The meters shall be flush mounted and draw-out type. The indicating lamp shall be neon type and of low burden. Each phase indicating lamp shall be backed up with 2 amps fuse.

k) Push Button Stations

Push button station shall be for manual starting and stopping of motors/equipment as called for. Red and Green colour push buttons shall be provided for starting and stopping operations. Push buttons shall be suitable for panel mounting and accessible from front without opening door.

m) Cables

M.V. cables shall be PVC insulated aluminium conductor armoured cables suitable for laying in trenches, duct, and on cable trays as required.

n) Wires

650/1100 volts grade PVC insulated copper conductor wires in conduit shall be used.

11.0 Cable Laying

11.1 Easy access to all cables shall be provided to allow cable withdrawal/replacement in the future. Where more than one cable is running, proper spacing shall be provided to minimize the loss in current carrying capacity with necessary saddling/clamps.

12.0 Earthing

12.1 The earthing of MCC and equipment shall be as per BIS Specification and considered in the main electrical panel. The loop earthing shall be carried out with G.I/Copper Strips/wires.

13.0 Painting for Panel

13.1 All sheet steel work shall undergo a process of seven tank treatment and painting with powder coating paint of approved shade.

14.0 CABLE WORK

This section covers detailed requirements for supply, laying, testing and commissioning of cables.

14.1 GENERAL

MV cable shall be supplied inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Indian Standards Specifications and cable manufacturer's instructions. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drum.

14.2 MATERIAL

14.2.1 The MV power cable of 660/1100 V. grade shall be PVC insulated Aluminium conductor armoured cable conforming to IS : 1554 (part - I). MV cable shall be 3.5/4 core of size and type as specified.

14.2.2 The MV control cables shall be PVC insulated copper conductor armoured cable.

14.3 STORAGE AND HANDLING

14.3.1 All cables shall be inspected upon receipt at site and checked for any damage during transit.

14.3.2 Cable drums shall be stored on a well drained, hard surface, preferably of concrete, so that the drums do not sink in the ground causing rot and damage to the cable drums.

- 14.3.3 During storage periodical rolling of drums once in 3 months through 90° shall be done. Rolling shall be done in the direction of the arrow marked on the drum.
- 14.3.4 It should be ensured that both ends of the cable are properly sealed to prevent ingress/absorption of moisture by the insulation.
- 14.3.5 Protection from rain and sun shall be ensured. Sufficient ventilation between cable drums, should be ensured during storage.
- 14.3.6 The drums shall always be rested on the flanges and not on the flat sides.
- 14.3.7 Damaged battens of drums etc. should be replaced, if necessary.
- 14.3.8 When cable drums have to be moved over short distances, they should be rolled in the direction of the arrow, marked on the drum.
- 14.3.9 For transportation over long distances, the drum should be mounted on cable drum wheels strong enough to carry the weight of the drum and pulled by means of ropes. Alternatively, they may be mounted on a trailer or on a suitable mechanical transport.
- 14.3.10 When unloading cable drums from vehicles, a crane shall preferably be used. Otherwise the drum shall be rolled down carefully on a suitable ramp or rails, where necessary.
- 14.3.11 While transferring cable from one drum to another, the barrel of the new drum shall have a diameter not less than that of the original drum.
- 14.3.12 The cables shall not be bent sharp to a small radius. The minimum safe bending radius for all types of PVC cables shall be taken as 12 times the overall diameter of the cable. Wherever practicable, larger radius should be adopted. At joints and terminations, the bending radius of individual cores of a multi core cable shall not be less than 15 times its overall diameter.
- 14.3.13 Cable with kinks and straightened kinks or with similar apparent defects like defective armouring etc. shall be rejected.
- 14.3.14 Cables from the stores shall be supplied by the contractor as per the site requirement in pieces cut in the stores.

14.4 INSTALLATION

14.4.1 GENERAL

The cable installation including necessary joints shall be carried out in accordance with the specifications given herein. For details not covered in these specifications, I.S.:1255 shall be followed. No straight through joint shall be permitted in the system. The cables shall be supplied as per cable schedule submitted by the contractor & approved by Engineer-in-Charge.

14.4.2 ROUTE

14.4.2.1 Before the cable laying work is undertaken, the route of the cable shall be decided by the Engineer-in-charge in consultation with Owner representative.

14.4.2.2 While shortest practicable route shall be preferred, cable runs shall generally follow fixed developments such as roads, foot-paths etc. with proper offsets so that future maintenance, identification etc. are rendered easy. Cross

country run to shorten the route length is not desirable as it would lead to route identification and maintenance problems, besides posing difficulties during later development of open areas etc.

14.4.2.3 While selecting cable routes, corrosive soils, ground surrounding sewage and effluent etc. shall be avoided. Where this is not feasible, special precautions as approved by the Engineer-in-charge shall be taken.

14.4.2.4 As far as possible, the alignment of the cable route shall be decided taking into consideration the present and future requirements of other agencies and utility services affected by it, the existence of any cable in the vicinity as may be indicated by cable markers or cable schedules or drawing maintained for that area, possibilities of widening of roads/lanes, storm water drains etc. Cable routes shall be planned away from the drains and should be within the property.

14.4.2.5 Whenever cables are laid along well demarcated or established roads, the MV cables shall be laid further from the kerb line than HV cables.

14.4.2.6 Cables of different voltages and also power and control cables shall be kept in different trenches with adequate separation. Where available space is restricted, MV cables shall be laid above HV cables.

14.4.2.7 Where cables cross one another the cable of higher voltage shall be laid at a lower level than the cable of lower voltage.

14.5 WAY LEAVE

14.5.1 It may be necessary to obtain way leave for the cable route from the appropriate authorities some of whom are listed below:

- a) Drainage, Public Health and Water Works.
- b) Telephones and Telegraphs.
- c) Gas works.
- d) Other Undertakings.
- e) Owners of properties.

14.5.2 Where necessary, joint inspection with representatives of other authorities may be arranged so that mutual interests are safeguarded. In case of private property, Section 12/51 of the Indian Electricity Act shall be complied with.

14.6 PROXIMITY TO COMMUNICATION CABLES

Power and communication cables shall as far possible cross at right angles. Where power cables are laid in proximity communication cables the horizontal and vertical clearances shall not normally be less than 60 cms.

14.6.1 LAYING METHODS

14.6.1.1 Cables shall be laid direct in ground or in pipes/closed ducts, in open ducts or on cable trays suspended from slab depending on site conditions.

14.6.2 Laying in Pipes/Closed ducts :

14.6.2.1 In location such as road crossing, entry to building, on poles, in paved areas etc. cables shall be laid in pipes or closed ducts.

14.6.2.2 GI or Hume Pipes (spun reinforced concrete pipes) shall be used for such purposes. In the case of new construction, pipes as required shall be laid along with the Civil works and jointed according to the instructions of the Engineer-in-Charge as the case may be. The size of pipe shall be as indicated in the electrical drawings. GI pipe shall be laid

directly in ground without any special bed. Hume pipe (Spun reinforced concrete pipe) shall be laid over 10 cm. thick cement concrete 1:5:10 (1 cement : 5 coarse sand : 10 graded stone aggregate of 40mm nominal size) bed, after which it shall be completely embedded in concrete. No sand cushioning or tiles need be used in such situations. Unless otherwise specified, the top surface of pipes shall be at a minimum depth of 1mtr. from the ground level when laid under roads, pavement etc.

14.6.2.3 Where steel pipes are employed for protection of single core cables feeding AC load, the pipe should be large enough to contain both cables in the case of single phase system and all cables in the case of polyphase system.

14.6.2.4 The pipes on road crossing shall preferably be on the skew to reduce the angle of bends as the cable enters and leaves the crossings. This is particularly important for high voltage cables.

14.6.2.5 Manholes of adequate size as decided by the Engineer-in-Charge shall be provided to facilitate feeding/drawing in of cables and to provide working space for persons. They shall be covered by suitable manhole covers with frame of proper design. The construction of manholes and providing the cover is not in the scope of this Contract and shall be got executed and paid for by the Engineer-in-Charge through another agency.

14.6.2.6 Pipes shall be continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothened to prevent injury to cable insulation or sheathing.

14.6.2.7 Pipes for cable entries to the building shall slope downwards from the building and suitably sealed to prevent entry of water inside the building. Further the mouth of the pipes at the building end shall be suitably sealed to avoid entry of water. This seal in addition to being waterproof shall also be fireproof.

14.6.2.8 All chases and passages necessary for lying of service cable connections to buildings shall be cut as required and made good to the original finish and to the satisfaction of the Engineer-in-Charge.

14.6.2.9 Cable grips/draw wires and winches etc. may be employed for drawing cables through pipes/closed ducts etc.

14.6.3 Laying on Cable Trays

14.6.3.1 Cables, where indicated in approved shop drawings, shall be laid on overhead cable trays which are suspended from ceiling or supported from wall, by anchor fasteners as required.

14.6.3.2 The Contractor shall provided for all accessories for the installation of the cable trays, such as bends, tees, reducers coupler plates, trifoil clamps and structural steel members (comprising of channels, angles, flats, rods) to be fabricated at site for structural supports for cable trays racks etc.

14.6.4 Termination

Brass single compression glands shall be provided for MV cables termination

14.6.5 Testing

14.6.5.1 All 650/1100 Volt grade cables before laying shall be tested with a 500 V megger or with a 2,500/5,000 V megger for cables of higher voltages. The cable cores shall be tested for continuity, absence of cross phasing, insulation resistance to earth/sheath/armour and insulation resistance between conductors.

14.6.5.2 All cables shall be subject to above mentioned tests during laying, before covering the cables by protective covers and back filling and also before the jointing operations.

15.0 CABLE TRAYS

- 15.1 Prefabricated Cable trays of ladder type and associated accessories, tees, bends, elbows & reducers shall be fabricated from 12 gauge (2.6 mm thick) mild steel. Perforated cable trays and associated accessories tees, elbows, and reducers shall be fabricated from 14 gauge (2 mm thick) MS steel.
- 15.2 Cable trays and accessories and covers shall be painted with one shop coat of red oxide zinc chromate primer and two coats of Aluminium alkyd paint.
- 15.3 The Contractor shall provide for all accessories for the installation of the cable trays, such as bends, tees, reducers coupler plates, trifoil clamps and structural steel members (comprising of channels, angles, flats, rods) to be fabricated at site for structural supports for cable trays racks etc.

16.0 EARTHING

This section covers detailed requirements for earthing.

16.1 GENERAL

- 16.1.1 The non-current carrying metal parts of electrical installation shall be earthed properly. All metallic structure, enclosures, junction boxes, outlet boxes, cabinets, machine frame, portable equipments, metal conduits, trunking, cable armour, switchgear, distribution boards, lighting fittings and all other parts made of metal in close proximity with electrical circuits shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All earthing will be in conformity with the relevant Indian Electricity Rules 1956 and Indian Standard Specification IS : 3043. Every item of equipment served by the electrical system shall be bonded to earthing system.
- 16.1.2 Every switch, lighting fixture and 5 Amp outlets shall be provided with insulated copper conductor of 1.5 sq. mm for earthing. The computer workstations shall be earthed with 2.5 sq.mm. insulated copper conductor wire.
- 16.1.3 Separate copper earth pits shall be provided for UPS, EPABX & Networking equipment.
- 16.1.4 The raceways shall not be used as a grounding conductor.

16.2 CONNECTION OF EARTHING CONDUCTORS

- 16.2.1 Main earthing conductor shall be taken from the earth connections at the PDB to the earthing pit. 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 boards or to an earth leakage circuit breaker. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to switch boards 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 equipment shall be earthed with 2 no. G.I. strips/wires and non-current carrying metallic parts with, 1 no. G.I. strips/wires.
- 16.2.2 Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures cables and conductors, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in earthing system. The Electrical resistance of metallic enclosures for cables and conductors measured between earth connections at the main switch boards and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate circuit breakers and shall not exceed 1 OHM.

16.3 EARTH CONNECTIONS

All metal clad switches and other equipment carrying single phase circuit, shall be connected to earth by a single connection. All metal clad switches carrying 3 phase shall be connected with earth by two separate and distinct connections. The earthing conductor inside the building wherever exposed shall be properly protected from

mechanical injury by running the same in GI pipe of adequate size. The earthing conductor shall be painted to protect it against corrosion. Earthing conductor outside the building shall be laid 600 mm below finished ground level. The over lapping in G.I. strips in joints shall be welded. Lugs of adequate capacity and size shall be used for all termination of conductor wires. Lugs shall be bolted to the equipment body to be earthed after the metal is cleaned of paint and other oily substance and properly tinned.

16.4 PROTECTION FROM CORROSION

Connection between copper and galvanised equipment shall be made on vertical face and protected with paint and grease. Galvanised fixing clamps shall not be used for fixing earth conductors. Only copper fixing clamp shall be used for fixing earth conductors. When there is evidence that the soil is aggressive to copper, buried earthing conductors shall be protected by suitable serving and sheathing.

16.5 EARTHING STATION

16.5.1 PLATE ELECTRODE EARTHING

16.5.1.1 Earthing electrode shall consist of a Copper plate of 600 mm X 600 mm X 3 mm or G.I. plate of 600mm x 600mm x 6.3 mm as called for in the Schedule of Quantity. The plate electrode shall be buried as far as practicable below permanent moisture level but in any case not less than 3 meters below ground level. Wherever possible, earth electrode shall be located as near the water tap, water drain or a down take pipe as possible. Earth electrode shall be kept clear of the building foundations and in no case shall it be nearer than 2 meters from the outer surface of the wall.

16.5.1.2 The earth plate shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture. A 20 mm dia GI pipe shall run from the top edge of the plate to the ground level. The top of the pipe shall be provided with a funnel and a mesh for watering the earth through the pipe. The funnel over the GI pipe shall be housed in a masonry chamber approximately 300 mm x 300 mm x 300 mm deep. The masonry chamber shall be provided with a cast iron cover resting over a CI frame. Test facility shall be provided with test links for the earthing station.

16.5.2 PIPE ELECTRODE EARTHING

Earthing Electrode shall consist of G.I. medium class. 40 mm dia 4.5 m long pipe (without any joint) G.I. pipe Electrode shall be cut, tapered at the bottom and provided with holes of 12 mm dia drilled not, less than 7.5 cm from each other upto 2 M of length from the bottom. Pipe electrode shall be buried in the ground vertically with its top at not less than 200 mm below the ground level. When more than one pipe is to be installed a separation of not less than 2 M shall be maintained between two adjacent electrodes as called for in the drawings. Wherever possible, earth electrode shall be located as near the water tap, water drain or a down take pipe as possible. Earth electrode shall be kept clear of the building foundations and in no case shall it be nearer than 2 meters from the outer surface of the walls. The pipe electrode shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture. A 40 mm x 20 mm reducer shall be used for fixing of funnel with mesh. The funnel and mesh have been provided for watering the earth through the pipe. The funnel over the G.I. Pipe shall be housed in a masonry chamber 300mm x 300mm x 300mm. deep. The masonry chamber shall be provided with a cast iron cover resting over a CI frame. The broken earth pit will be provided with test links in suitable enclosures.

16.5.3 ARTIFICIAL TREATMENT OF SOIL

If the earth resistance is too high and the multiple electrode earthing does not give adequate low resistance to earth, as specified in Clause no. 7 then the soil resistivity immediately surrounding the earth electrodes shall be reduced by adding sodium chloride, Calcium chloride, sodium carbonate, copper sulphate, salt and soft coke or charcoal in suitable proportions.

16.5.4 RESISTANCE TO EARTH

The resistance to each earthing system shall not exceed 1.0 ohm.

COMMISSIONING & GUARANTEE

1. 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.

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

On award of work, Contractor 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 his representative 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.

Contractor 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 contractor shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rotameters. Contractor shall also supply all required pressure gauge, temperature gauge & rotameter for system commissioning and balancing. The balancing shall be to the satisfaction of Consultant / Project Manager.

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.

2 PRECOMMISSIONING

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

2.1 Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fittings 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.

- a) All strainers shall be inspected and cleaned out or replaced.
- b) Check all clamps, supports and hangers provided for the pipes.
- c) 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. Thereafter conduct & hydro test of the system as for (b) above.
- d) 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 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 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 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.

4 REJECTION OF INSTALLATION / 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 Engineer-in-charge either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Engineer-in-charge 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/Engineer-in-charge.

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 Engineer-in-charge/Employer.

5. 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 Owner.

6. HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner's site representative and all testing and commissioning documents shall be handed over to the Owner's site representative.

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 Owner's site representative.

8. PIPE COLOUR CODE:

S.No.	Pipe Lines	Ground / Base Color	First Color Band	Second Color Band
1	Drinking Water (All cold water lines after filter)	Sea Green	French Blue	Single Red
2	Treated Water (Soft Water)	Sea Green	Light Orange	
3	Domestic Hot Water	Sea Green	Light Grey	
4	Drainage	Black		

Color code to confirm to IS: 2379:1990

LIST OF STANDARD CODES

S.No.	IS Code No.	Description
1.	IS:1729:1979	Specification for sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories (1st rev.) (Amendment 4)
2.	IS:651:1992	Specification for salt glazed stoneware pipes and fittings (5th rev.) (Amendment 1)
3.	IS:456:1978	Code of practice for plain and reinforced concrete (3rd rev.) (Amendment 2)
4.	IS:3114:1994	Code of practice for laying of CI pipes (2nd rev.) (Amendment 2)
5.	IS:782:1978	Specification for caulking lead (3rd rev.)
6.	IS:783:1985	Code of practice for laying of concrete pipes (1st rev.)(amendment 1)
7.	IS:4127:1983	Code of practice for laying of glazed stoneware pipes (1st rev.)
8.	IS:780:1984	Specification for sluice valve for water works purposes (6th rev.) (50 to 300 mm size) (amendment 3)
9.	IS:1172:1993	Code of basic requirements for water supply, drainage & sanitation (4th rev.)
10.	IS:1200 (Part-16):1979	Code of practice for methods of measurements of building and civil engineering works: Part 16 laying of water and sewer lines including appurtenant items (3rd rev.)
11.	IS:1200(PART-19):1981	Code of practice for methods of measurements of building and civil engineering works: part 19 water supply, plumbing and drains (3 rd rev.)
12.	IS:1742:1983	Code of practice for building drainage (2nd rev.)
13.	IS:13095:1991	Butterfly valves for general purposes
14.	IS:5312 (part 1) :1984	Swing heck type reflux valves (non-return valve): part 1 single door pattern (1 st rev.)(amendment 1)
15.	IS:1726:1991	CI manhole covers & frames (3rd rev.)
16.	IS:884:1985	Fire aid hose reel for fire fighting
17.	IS:901:1988	Coupling double male and female instantaneous pattern for fire fighting
18.	IS:903:1984	Fire hose delivery coupling, branch pipe, nozzles and nozzles spanner
19.	NBC-SP-7-1983 Part IV	National building code of India 1983, amendment No. 3
20.		Central public works division (CPWD) Part-V, wet riser system for fire fighting 1985, Govt. of India
21.	IS:3844-1989	Code of practice for installation and maintenance of internal fire hydrants and hose reels on premises
22.	IS:2190:1992	Code of practice for selection and maintenance of first-aid fire extinguisher
23.	IS:6382:1984	Code of practice for design and installation of fixed system carbon dioxide fire extinguishing system
24.	SP:35 (s&t)-1987	Hand book on water supply & drainage by bureau of Indian standards
25.		National Building code (sec-ix)
26.	IS:2065:1983	Code of practice for water supply in buildings
27.	IS:933-1989	Specifications for portable chemical from fire extinguisher
28.	IS:2171-1985	Specifications for portable fire extinguishers, dry power

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS PLUMBING

<u>S.No</u>	<u>Item</u>	<u>Make at PAR</u>
1.	Vitreous China Sanitary ware	ROCA/PARRYWARE/ HINDWARE
2.	Concealed Cistern	GEBRIT/ VIEGA
3.	Plastic W.C. seats Covers	ROCA/PARRYWARE/ HINDWARE
4.	Stainless Steel Sinks	JAINA/ STAR
5.	C.P. Fittings & Accessories	ISENBERG/ JAQUAR
6.	Rubber Insulation	ARMAFLEX/ VIDEOFLEX
7.	CPVC pipes/fittings and valves	FINOLEX/ASHIRWAD/ASTRAL
8.	G.I. Pipes /M.S.Pipes IS 1239/3589	JINDAL HISSAR/PRAKASH SURYA
9.	G.I.Fittings (Malleable cast iron)	DRP-M/UNIK
10.	Soil, Waste & Rain water pipes & Fittings – CAST IRON (IS: 3989)	RIF/NICO
11.	Soil, Waste & Rain water pipes & Fittings – UPVC/PP.	JAIN/ SUPREME / astral
12.	S.S. Hinged Grating	GMGR/ CHILLY
13.	Check Valves (Dual Slim type)	VEESON /SANT/ KARTAR
14.	Butterfly Valve	VEESON /SANT/ KARTAR
15.	Ball valves (15 to 40mm)	DRP/SANT/AIP
16.	Gate Valve	DRP/ LEADER/ KARTAR
17.	Gunmetal valve (full way valve) Class-I	DRP/ LEADER/ KARTAR
18.	C.I. double flanged sluice valve	KIRLOSKAR/ SHIVA-DURGA
19.	Diaphragm Valve	As approved by water treatment manufacturer's
20.	Foot Valve	DRP/ KIRLOSKAR/ KARTAR
21.	Pressure Reducing Valve (PRVs)	DRP/ KARTAR
22.	Stoneware Pipes & Gully - IS 651	Locally ISI approved
23.	RCC Pipes IS 458	Locally ISI approved
24.	C.I. Manhole cover & frame IS 1726	RIF/SKF
25.	SFRC Manhole COVERS ETC	KK/PRAGATI/SUPER WIRE/ISI
26.	Anti corrosive tape for pipe protection	PYPKOTE/MAKPOLYKOTE
28.	Garden Irrigation System	JAIN/HARVEL
29.	Anticorrosive Bitumastic Paint	ISI
30.	Epoxy Paint	ISI
31.	Hydro-Pneumatic System	
I	Pumps	KSB/GRUNDFOSS/ NOCHI
ii	PLC	AS PER MANUFACTURERS SPEC'S
iii	Pressure Vessel	AS PER MANUFACTURERS SPEC'S
iv	Pressure Sensor	AS PER MANUFACTURERS SPEC'S
32.	Clear Water Pumps	KSB/GRUNDFOSS/EBARA/NOCHI
33.	Submersible Drainage Pumps	KSB/GRUNDFOSS/EBARA/NOCHI /KSB
34.	Filter/Softener	SEKHUI WATER TREATMENT /ION EXCHANGE/PENTAIR
35.	PH Meter	VATS/ HANNA (italy)
36.	Water Meter	kaycee/ kent
37.	Electrical Switchgear & Starters	L&T OR EQUIVALENT

38.	Cable Trays	SLOTCO OR EQUIVALENT
39.	1100 Volt Grade XLPE Cables	ISI
40.	PVC Insulated Copper Wires	ISI
41.	Lugs (Tinned Copper)	EQUIVALENT
42.	Power Aux. Contactors	EQUIVALENT
43.	Vibration Eliminator Pads & Connections	RESISTOFLEX
44.	Suction Strainer/Pot Strainer	VENUS/LEADER/EMERALD/ZOLOTO
45.	Meters, Indication Lamp	ENERCON OR EQUIVALENT
46.	Forged Steel Fittings	DRP /VS
47.	Pressure Gauge	FIEBIG/GURU
48.	Measuring Instruments	EQUIVALENT
49.	Electrical Panels	IMPACT ENGINEERS/ELEGANT
50.	Air Admittance valves	STUDOR/McALPINE
51.	Fire fighting equipment (Hydrant, Hose Drum, F.B Inlet, Branch)	NEWAGE / SAFE GUARD / SUPREX
52.	Fire Extinguishers	CEASE FIRE SAFE/GUARD/SUPREX
53.	Fire fighting first-aid hose reel tubing	NEWAGE/JYOTI/DUNLOP
54.	Fire pumps	MATHER + PLATT /KIRLOSKAR
55.	Motors	KIRLOSKAR/SIEMENS/ABB
56.	M.S. Pipes	PRAKASH SURYA/JINDAL HISSAR
57.	Sprinkler heads	VIKING/TYCO/H.D./NEWAGE/GRINNELL
58.	M.S. FORGED FITTINGS	DRP-M / V.S.
59.	C.I. Double Flanged Non-Return Valves. (80mm diameter and above)	VEESON / AIP / SANT
60.	Welding Rod	ADWANI/ VICTOR
61.	Alarm Control Valve	NEWAGE/ VIKING/TYCO
62.	Flow Switch	DANFOSS/ VIKING
63.	Dash Fasteners	HILTI/ canon
64.	Automatic Air Vent	DANFOSS/ IBP
65.	Water level indicator & controller	ITAL/ TECHNIKA
66.	Pipe Clamps / Hangers / Support	CAMRY/ CHILLY
67.	Clamps & Support	CAMRY/ CHILLY
68.	Paint	Shalimar/ Asian
69.	SOLAR WATER HEATER	SOLARIZER/ SOLAHART/ TATA IBP/ENMAX

Proposed Construction of Horticulture & Forestry University at Gorakhpur.

TECHINICAL SPECIFICATION OF ELECTRICAL & LV WORKS

1.0 ELECTRICAL GENERAL PROVISIONS

1.1 GENERAL

1.1.1 Work Description

The scope of works for all electrical works and ELV system comprises of design, engineering, supply, delivery, installation, testing and commissioning, handover, training, maintenance and warranty all as described or reasonably implied in the Contract. The EPC Contractor is obliged to provide fully functioning works and systems in conformance with the requirements of the Contract and approved design and development documents prepared by the EPC contractor.

In the event certain items are not fully described or indicated in the Contract, but deemed essential by the EPC contractor for the performance of the works and systems then the provision of such items shall form part of the EPC Contractors scope of works at no additional cost to the Owner.

The drawings and documents from consultant shall be used as guidance for the EPC contractor in producing his detail design and shop drawings for carrying out works at site.

The EPC Contractor shall be responsible to co-ordinate the equipment and services and shall produce properly coordinated shop drawings to demonstrate the installation comply with the performance requirement with shop drawings, calculations and details. The Consultant shall monitor the process of shop drawings and document preparation.

Shop drawings shall take into account actual measurement and setting out dimensions/levels obtained and determined by the EPC Contractor on site, actual equipment / material used, actual routing of services, co-ordination with all installation, and site conditions/constraints.

Scope of Work:

The Electrical HT, LT and ELV shall generally include the following:

Common Services:

Liaison with Client to obtain and coordinate provision of incoming electricity supply.

Design, Supply, installation, testing and commissioning of complete 11KV HT power distribution system, 2 nos. 33KV incoming electrical supply feeder from State Electricity Board grid station to SEB meter room located at proposed location as per drawing, 33KV cabling from SEB meter room to Main HT Panel board, main HT panel board and further to distribution 33/0.433KV CSS, 33/0.433KV Oil type outdoor transformers, Main LT distribution system and associated accessories and arrange SEB acceptance upon completed

Complete central earthing systems for connection with component electrical systems.

Internal Services:

Complete LT distribution system including main LT switchboard, automatic IGBC, Hybrid power factor system devices, sub-boards and distribution boards, utility services panel boards, UPS and associated distribution main and sub-main cabling and associated accessories.

Complete lighting and power installation including all final circuiting work and associated accessories and lighting automation system.

Normal and emergency lighting supply and installation and associated accessories.

Complete earthing system.

Complete lightning protection system and associated accessories.

Complete telephone cabling system and associated accessories.

Complete wiring work to external & landscape & facade and public area architectural/special lighting as per lighting design and associated accessories.

Complete internal cable system and outlets for Telephone and MATV system and associated works.

Complete Security systems

Miscellaneous works like providing and fixing of rubber mats, fire buckets, first aid box, fire extinguishers, gas flooding etc.

All associated interfacing power supply work to other mechanical installations.

Addressable Fire Alarm & Voice evacuation System

Voltage drop, transformer losses, power factor and other parameter shall be as per ASHRAE 90 and GRIHA requirement.

Lighting density shall be furnished through energy simulation carried out for GRIHA rating 3 star.

IP CCTV and Access control system, Audio Visual system, IT Data & Voice Networking system including Passive, Active, Wi-Fi and EPBAX system

All associated interfacing works with other M&E installations.

Additional Hume pipes for future block services etc.

Other works as shown on the Drawings and described elsewhere in the Contract documents.

All equipment shall be of the class most suitable for working under the conditions specified and shall withstand the atmospheric conditions without deterioration.

EPC Contractor shall co-ordinate with all other agencies working at site for interconnection and safety aspects.

Also the EPC Contractor shall furnish combined guarantee minimum for 1 year from the date of successful commissioning from the manufacturer. In case there is any defect, the free replacement of any part or in whole will be made immediately at no extra cost to Owner.

Fee, Permits & Tests:

The EPC contractor shall obtain all sanctions and permits required for the above said works from all the relevant authorities. On completion of the work, the EPC Contractor shall obtain

N.O.C from concerned authorities including, Chief Electrical Inspector. The original of the same shall be delivered to the Owner through Consultant.

The Owner shall have full power regarding the Equipment's/materials get tested by authorized/recognized independent agency at the EPC contractor's expense in order to prove their soundness and adequacy. The EPC contractor will rectify the defects/suggestions pointed out by independent agency through Owner at EPC contractor's expense.

The installation shall comply in all respects with the requirements of Indian Electricity Act 1910, Indian Electricity Rules (IER) 1956 and other related Laws and Regulations (for F.F. etc.) as amended up to date, there under and special requirements, if any, of the State Electricity Boards etc. The EPC contractor shall be liable to furnish the list of authorized licensed persons/ employed/deputed to carry out the works/ perform the assigned duties to fulfill the requirement of Rule 5 of IER 1956 as amended up to date.

Codes & Standards:

The design, manufacture, inspection, testing and performance shall comply with all the currently applicable statutes, safety codes, relevant Bureau of Indian Standards (BIS), British Standards (BS), International Electro Technical Commission (IEC) publication, CPWD, NEMA & VDE Standards amended up to date.

The design engineering, manufacturing and the installation shall be in accordance with established codes, sound engineering, practices and specifications. Further, the same shall conform to the statutory regulations applicable in the country. EPC Contractor shall obtain all approvals from statutory authorities, e.g. electrical inspector, SEB or any other agency as applicable before commissioning of electrical system & above system including ELV system etc. if required.

Some of the relevant Indian and British Standards are listed below.

Indian Electricity Act.

Indian Electricity Rules.

Factory Act.

UPPCL Supply codes.

CPWD Specifications etc.

Any other standard may be followed provided it is equivalent or more stringent than the standards specified above.

In case of any deviation/conflict with the codes & standards, the following order of precedence shall govern

Recommended Design guidelines of consultant

International standards & requirements.

Local codes of practice

Approved design development documents

Design:

The EPC Contractor shall be fully responsible for the complete design of all works for the Contract, including all temporary works.

It is the responsibility of the EPC Contractor to ensure that his design does not compromise the design intents of the consultant's approved design development documents, all authority's compliances and approvals.

The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The equipment offered by the EPC contractor shall be complete in all respects.

Any materials or accessories, which may not have been specifically mentioned, but which are usual and necessary for the completion of the system and satisfactory & trouble free operation and maintenance of the equipment shall be provided without any extra cost to the Owner. This shall also include spares for commissioning of the equipment.

This specification defines the basic guidelines to develop a suitable electrical system as necessary for the Complex. All data required in this regard shall be taken in to consideration to develop a detailed engineering for the system. Site conditions as applicable are mentioned elsewhere.

EPC contractor shall be responsible for:

Detailed co-ordination with other services, shop drawings for various electrical layouts such as equipment layouts, cabling layouts, earthing layouts, including equipment installation and cable termination details etc. prior to start of work.

Preparation of bill of materials for all works.

Protection co-ordination drawings/tables for complete power system.

Shop inspection and testing procedures.

Field-testing and commissioning procedures.

Preparation of as built drawings.

EPC contractor shall also be responsible for:

Any other work/activity which is not listed above however is necessary for completeness of electrical system.

Date of Completion and Completion Period:

The EPC contractor shall be allowed admittance to the site on the date of commencement as described in the General Conditions and he shall there upon and forth with begin the works and shall regularly proceed with and complete the same on or before the date of completion subject, never the less to the provisions for the extension of time. The time being the essence of the contract, the EPC Contractor will adhere to the time, progress chart and project schedule and will give proportional output/progress in proportional time.

Schedule and Manner of Operations:

Time being the essence of this Contract, the EPC Contractor will be expected to furnish all labor and materials in sufficient quantities and at appropriate times, expedite and schedule the work as required and so manage the operation that the work will be completed within the time stated in the Contract.

Coordination of Work

Contract documents establish scope, materials and quality but are not detailed installation instruction.

Coordinate work with related trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.

The drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction and the work of other divisions will permit. Provide off-sets, fittings, and accessories which may be required but not shown on the drawings. Investigate the site, and review drawings of other divisions to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.

The locations of thermostats, switches, panels and other equipment indicated on the drawings are approximately correct. Exercise particular caution with reference to the location of panels, thermostats, switches, etc., and have the precise and definite locations accepted by the Engineer before proceeding with the installation.

The drawings show only the general run of services and approximate location of equipment, outlets, panels, etc. Any significant changes in location of equipment, outlets, panels, etc., necessary in order to meet field conditions shall be brought to the determine attention of the Consultant for review before such alterations are made. Modifications shall be made at no additional cost to the Contract. Carefully check space requirements with other division works to ensure that equipment can be installed in the space allotted.

Wherever work interconnects with work amongst different installation, coordinate with other trades to insure that they have the information necessary so that the EPC Contractor may properly install the necessary connections and equipment. Identify items requiring access in order that the Ceiling Trade will know where to install access doors and panels.

Furnish and set sleeves for passage of risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each riser passing through building surfaces.

Provide fire stopping around all pipes, conduits, ducts, sleeves, etc., which pass through fire compartments.

Provide required supports and hangers for equipment suitably so as not to exceed allowable loading of structures.

Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Engineer for review. At completion include a set of these drawings with each set of record drawings.

Coordinate with the local utility companies/authorities for their requirements for service connections and provide all necessary provisions, grounding, materials, equipment, labor, testing, and appurtenances.

Before commencing works, examine adjoining works on which this work is in any way affected and report conditions which prevent performance of the works. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

The EPC Contractor is responsible to any modifications required due to service not properly coordinated.

Electrical Power Supply Interfaces

The EPC Contractor shall provide power supply points/isolators at certain designated locations within the development for all mechanical and electrical installations as indicated on the drawings. It is the responsibility of the Contractor to coordinate and make connections to these power supply points/isolators and to provide all the necessary 'down-stream' power supply distribution board/network to the mechanical system's control panels, equipment, sensors, field devices, etc.

Interfacing with All Services and Systems

General

The EPC Contractor shall provide all necessary provisions for interfacing amongst installation, services, and equipment. All necessary sensors, current/voltage transformers, voltage-free contacts, relays, auxiliary contacts, terminals, transducers etc. for interfacing works shall be provided by the EPC Contractor.

All control/monitoring wiring from sensors, equipment, and components for the interfacing shall be terminated at a separate interfacing compartment located at the respective equipment/system's switchboard or control panel. The interfacing compartment shall be completed with all necessary connectors, terminals, and with proper identifications to allow interfacing works to be easily carried out. The compartment shall clearly indicate "Extra Low Voltage Cable Only. No Power Cable Connection". Where there is no equipment/system switchboard or control panel involved, the EPC Contractor shall provide separate interfacing panels with provisions same as the interfacing compartment as described above. The locations of the switchboard/control panels and the interfacing panels shall be properly coordinated.

For every control panel and each module of the switch board, at least Ten(5) spare Terminals shall be provided for future interfacing works.

Wiring and cables for interfacing with the fire alarm system and other fire protection and life safety systems shall be fire rated to comply with Civil Defense's requirements.

All the interface provisions shall be DC operated and rated not more than 50mA.

The EPC Contractor shall provide and make all power cable connections from mechanical equipment, local control panels, and distribution boards to the electrical isolators or power points (including cable termination) provided. Location of power supply isolators and power points shall be properly coordinated.

In addition to the interfacing requirements shown on the Drawings, interfacing provisions as described below shall also be provided and included in the Contract.

Electrical Installation

The Electrical Installation shall provide the following:

Circuit breakers, MCC, PCC and power points for all mechanical equipment and systems. The Electrical installation shall include direct power cable connections to the mechanical system's main motor control centers and further to equipment.

Earthing terminal in the Fire control Centre and all other plant rooms for supplementary equipotential bonding of mechanical equipment and systems.

Examination of Site

Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.

The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work, based on examination of the site or other information. Failure to examine the drawings or other information does not relieve the EPC Contractor of responsibility for satisfactory completion of the work.

Excavation and Backfill

Where ever required provide trenches details, duly approved by the consultant with all relevant section etc. as per IS codes, minimum before 1 month of laying the pipes, etc. Coordinate with during the excavation, and ensure that the excavation and backfilling is being properly done as per requirement.

Where ever it is asked by the Owner/ Consultant for providing trenches in EPC Contractor's scope. It is deemed that the cost of the pipe is inclusive of trench digging and backfilling. The following points need to be taken care of while making the trenches.

The trench shall be of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length. Except where rock is encountered, do not excavate below the depths indicated. Where rock excavations are required, excavate rock to a minimum over depth of four inches below the trench depths indicated on the drawings or required. Backfill over depths in the rock excavation and unauthorized over depths with loose, granular, moist earth, thoroughly machine tamped to a compaction level of at least 95% to standard proctor density or 75% relative density or as specified by the Engineer. Wherever unstable soil that is incapable of properly supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.

Excavate trenches for utilities that will provide the following minimum depths of cover from existing grade or from indicated finished grade as required by local authorities. Trenches should not be placed within 3 meters of foundation or soil surfaces which must be resist horizontal forces.

Do not backfill until all required tests have been performed and installation observed by the Engineer. Comply with the requirements of other sections of the specifications. Backfill shall consist of non-expansive soil with limited porosity. Deposit in 15 cm layers and thoroughly and carefully tamp until the work has a cover of not less than 30 cm. Backfill and tamp remainder of trench at 30 cm intervals until complete. Uniformly grade the finished surface.

Cutting and Patching

All kinds of cutting and repairing of brick Walls or Partitions, etc. for the proper routing of pipe, cutting and repairing of RCC wall, or ceiling shall be in the scope of the EPC contractor.

Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finish plaster, woodwork, metalwork, etc., using skilled trade people of the trades required at no additional cost to the Contract.

Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Contract.

Sealing of Penetrations

Airtight Seals

All penetrations through the building fabric subject to suction or pressurization shall be sealed airtight.

Holes in Roof

Roof penetrations for passage of conduits or circular PVC and PVC Cables shall be sealed watertight using a flexible polypropylene conical sleeve manufacturer to seal the cable to the roof structure, regardless of the roof profile.

All sharp metal edges, which may come in contact with the cable, shall be suitably bushed.

Fire Rated Penetrations

Where services penetrate any fire rated barrier, the EPC Contractor shall seal the penetration with the use of an appropriate material to ensure the integrity of the fire barrier.

The EPC Contractor shall seal the cable enclosures through fire rated barriers to ensure the integrity and rating of the fire barrier.

Acoustic Penetrations

Where services penetrate acoustic barriers, sealant shall be supplied and installed to maintain the acoustic separation at least equal to the barrier penetration.

Mounting Heights

Verify exact locations and mounting heights with the Engineer before installation.

Supports

Support work in accordance with the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.

Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets and equipment room.

Provide supporting frames or racks for equipment which is installed in a free-standing position.

Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workman like arrangement of all equipment mounted on them.

Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on ducts, pipe, electric conduits, raceways, or cables for support.

Equipment shall not rest on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splinters, runners, bars and the like in the plane of the ceiling). Provide independent support of equipment. Do not attach to supports provided for ductwork, piping or work of other trades.

Provide required supports and hangers for equipment so that loading will not exceed allowable loading of structure. Equipment and supports shall not come in contact with work of other trades.

Fastenings

Fasten equipment to building in accordance with the best industry practice.

Where weight applied to the attachment points is 45kg or less, conform to the following as a minimum:

Wood	:Wood screws
Concrete and solid masonry	:Dash Fastener of appropriate ratings-
HILTI/FISHER Solid metal	:Machine screws in tapped holes or with welded studs

Where weight applied to the building attachment point exceeds 45 kg, but is 135 kg or less, conform to the following as a minimum:

At concrete slabs provide 60cm x 60cm x 13cm steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top slabs screed line, where no fill is to be applied.

At steel decking or sub-floor for all fastenings, provide through bolts and threaded rods. The tops of bolts and rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the

decking or sub-floor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.

Where weight applied to building attachment points exceeds 135 kg, coordinate with and obtain the approval of Consultant and conform to the following as a minimum:

Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall suitably weld or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.

For items which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements. Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars.

Identification

Identify equipment with permanently attached black phenolic nameplates with 13 mm high white engraved lettering. Identification shall include equipment name or load served as appropriate. Nameplates shall be attached with cadmium plated screws; peel and stick tape or glue on type nameplates is unacceptable.

Services runs shall be properly identified as per the requirements in the Contract. See individual section for additional identification requirements.

Prohibited Labels and Identifications

In all public areas, tenant areas, and similar locations within the project, the inclusion or installation of any equipment or assembly which bears on any surface any name, trade mark, or other insignia which is intended to identify the manufacturer, the vendor or other source(s) from which such object has been obtained is prohibited.

Required test lab certification labels shall neither be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.

Equipment Pads and Anchor Bolts

Provide all details with proper sections for the equipment pads and anchor. The equipment pads casting and making provision for anchor fastening shall be as per the final UNALTERED drawing duly approved by the Consultant, shall be in the scope of EPC contractor.

All equipment pads for all vibrating Equipment's, shall have cork vibration pads sandwiched between the finish surface and the bottom surface of required thickness suggested by the EPC contractor to ensure that the minimum vibration can travel below.

Provide galvanized anchor bolts for all equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs. Provide bolts of the size and number recommended by the manufacturer of the equipment and locate by means of suitable templates. Equipment installed on vibration isolators shall be secured to the isolator. Secure the isolator to the floor, pad, or support as recommended by the vibration isolation manufacturer.

Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and securely attach to the partition studs. As an attached to 15 cm square, galvanized metal back plates which are attached to the gypsum board with an approved nonflammable adhesive. Toggle bolts installed in gypsum board partitions are not acceptable.

Miscellaneous:

A site order book will be maintained at site, which will be in the custody of the Owner, or his representative and all instructions given to the EPC contractor will be recorded in the siteorder book and the same has to be signed by the EPC contractor to comply with the instructions given therein.

After completion of the work the whole installation shall be tested by the EPC contractor. The tests shall comply the following I.E.E. Regulations and shall be submitted along with the final bill:

The result of the insulation test shall comply with the I.E.E. Regulations 1101 to 1108A and 1008B as may be applicable.

Test shall be carried out to ascertain that all the non-linked SP switches have been connected to the phase conductor.

The continuity test of the earthing system shall comply with I.E.E. Regulations 1108 to 1109 to the latest addition. If the result of the above tests does not comply with the I.E.E. Regulations, the EPC contractor shall be bound to rectify the faults so that the required results are obtained.

The EPC contractor shall be responsible to provide all the necessary test certificates oftesting instruments, such as megger insulation tester, earth tester multi-meter, AVO meter etc. for carrying out the above tests.

The work will not be considered as complete and taken over by the Owner till all the components of the work after being completed at site in all respects have been inspected/ tested by the Consultant/Owner to his entire satisfaction and a completion certificate issuedby the Owner/Consultant to this effect.

Shop drawing for electrical work e.g. equipment, cable earthing and conduit layout for all systems shall be prepared by the contractor and got approved before starting of the work.

At the completion of the work and before issuance of certificate of virtual completion, the EPC contractor shall submit 6 sets of drawing and soft copy of each drawing to Owner of each layout drawings drawn at approved.

EPCContractor's Superintendence:

The contractor shall provide all necessary superintendence during the execution of the works and as long as there is necessity. The contractor or his competent and authorized agent or representative approved of in writing by the owner (which approval may at any time be withdrawn) is to be constantly on the works and shall give his whole time to the superintendence of the same. Such authorized agent or representative shall receive on behalf of the contractor, directions and instructions from the Engineer-in-charge or his representative.

The contractor shall provide detailed organization of the execution team deployed for the works with names and CV's, of all key staff before the commencement of work and get it approved of in writing by the Owner/ Consultant. Contact telephone or pager numbers for emergency and/or twenty-four (24) hour call shall also be included.

If in any case of withdrawal of any worker/ technician/ Engineer from the execution team, the replacement of the same shall be done with equivalent qualification, and shall be approved in writing by the Owner/ Consultant.

PRODUCT, TESTING & COMMISIONING

Design Criteria

Electrical Details for Incoming Supply:

Supply Voltage: Multiple 33 kV

Fault Level (Sym.) at supply point (Designated): 350 MVA Neutral:Grounded

Voltage Regulations: +10%

Frequency Regulations: +3%

Combined Regulations: + 10%

33 KV HT Power Distribution System:

Voltage: 33 KV

Frequency: 50Hz

Neutral: Grounded

Short Circuit Fault with stand capacity: as per calculations

LT Power Distribution System:

Voltage: 415V

Frequency: 50Hz

Neutral: Grounded

Short Circuit Fault with stand capacity: 10 kA to 50 kA for 1 Sec, as per calculations

Controlsupply for Electrical System:

The various supply voltage to be used in the control panels for the main equipment shall be as under:

Springchargemotor	230V,Ac or24VDC(UniversalMotor)
Closing/TripCoil	24V,DC
Alarm/ Indication/ Relays	24V,DC
Heaters	230V,AC

Painting of Panels:

Powder coating of approved shade as per Specification. (Refer clause of painting)

Painting of Cable Trays and Structural steel:

Powder coating of approved shade as per Specification. (Refer clause of painting)

Cable Details:

LT Control Cables: Copper conductor armoured PVC insulated 1.1 KV grade.

LT Power Cables: Aluminium conductor armoured XLPE insulated.

Grounding Conductors: Copper/G.I. as per specifications

Drawings

The Tender drawings are enclosed along with this specification. These drawings are meant to give general idea to the EPC contractor regarding the nature of work covered by these specifications.

Any information/data shown/not shown in these drawings shall not relieve the EPC contractor of his responsibility to carry out the work as per the specifications. Additional information required by the bidder for successfully completing the work shall be obtained by him.

Shop Drawings

The EPC contractor shall prepare detailed coordinated electrical shop drawing indicating Panel layout, with other relevant services. The shop drawings shall indicate all setting out details and physical dimensions of all components with wiring and cable details including system operating write up in the system i.e. Control and Relay Panel and fixing details for the above-mentioned work. All work shall be carried out on the approval of these drawings. However, approval of these drawings do not relieve the contractor of his responsibility for providing maintenance free and full proof system including any missing component/accessories to meet with the intent of the specifications. Contractor will submit 2 (two) prints for preliminary approval and finally 6 (six) prints for distribution.

Manufacturer's Instructions

Where manufacturers have furnished specific instructions, relating to the material/Equipment's, to be used on this job, covering points not specifically mentioned in this document, manufacturer's instructions should be followed.

Completion Documents and Drawings

Three copies of operation manuals/catalogues of all standard equipment are to be furnished by the contractor immediately after commissioning of plant.

Three copies of write up on preventive maintenance, trouble shooting and operating instructions of the system along with as-built drawings are to be supplied by the Contractor at the time of commissioning.

On completion of the work in all respects, the Contractor shall supply five portfolios (300x450 mm), each containing complete set of drawings on approved scale, clearly indicating complete layouts, location; wiring and sequencing of automatic controls, location of all concealed 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 Panel rooms, one set of these consolidated control diagrams.

Materials and Equipment

All the materials and Equipment's, shall be of the approved make and design. Unless otherwise called from consultant, only the best quality materials and equipment shall be used.

Space Heaters:

Suitable number of adequately rated heaters thermostatically controlled with On-Off switch and fuse shall be provided to prevent condensation in any panel compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

Fungistatic Varnish:

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

Ventilation Opening:

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

Degree of Protection:

The enclosures of the control cabinet, junction boxes and marshalling boxes, panels etc. to be installed shall provide degree of protection as detailed here under.

Installed Outdoor IP-66

Installed indoor in air-conditioned area IP-31

Installed in covered area IP-42

Installed indoor in non-air conditioned area where possibility of entry of water

Is limited IP-41

For LT Switchgear

(AC and DC distribution boards) IP-42

The degree of protection shall be in accordance with IS: 13947 (Part-I) IEC-947 (Part-I). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

Rating plates, Nameplates and Labels:

LT panel and auxiliary items installed in the building is to permanently attach to it in a conspicuous position. A rating plate of non-corrosive material with engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of loading conditions of equipment in question has been designed to operate and such diagram plates as may require by the owner. The rating plate of each equipment shall be in accordance with IEC requirement.

All such nameplates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively, two separate plates on with Hindi and another with English inscriptions may be provided.

Quality Assurance Programmer:

To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at the Owner's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points necessary. Such programmer shall be outlined by the Contractor and shall be finally accepted by the Owner after discussions before the award of Contract. A quality assurance programmer of the contractor shall generally cover the following:

His organization structure for the management and implementation of the proposed quality assurance programmer.

Documentation control system.

Qualification data for bidder's key personnel.

The procedure for purchases of materials, parts components and selection of services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.

System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.

Control of non-conforming items and system for corrective actions.

Inspection and test procedure both for manufacture and field activities.

Control of calibration and testing of measuring instruments and field activities.

System for indication and appraisal of inspection status.

System for authorizing release of manufactured product to the Owner.

System for maintenance of records.

System for handling storage and delivery.

The Owner or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor / his vendor's quality management and control activities.

Quality Assurance Documents

The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after dispatch of the equipment.

All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.

Welder and welding operator qualification certificates.

Welder's identification list, listing welders and welding operator's qualification procedure and welding identification symbols.

Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.

Stress relief time temperature charts/oil impregnation time temperature charts.

Factory test results for testing required as per applicable codes/mutually agreed quality plan/standards referred in the technical specification.

The quality plan with verification of various customer inspection points (CIP) as mutually and methods used to verify the inspection and testing points in the quality plan were performed satisfactory.

Inspection, Testing and Inspection Certificates

The Owner and the Consultant or duly authorized representative shall have at all reasonable times free access to the EPC Contractor's premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection, if part of the works is being manufactured or assembled at other premises or works, the EPC Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the EPC Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Owner and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Bidder shall submit the type tests reports for approval. The EPC Contractor shall intimate the Owner/Consultant the detailed programmer about the tests at least three (3) weeks in advance in case of domestic supplies. If for any item type test were pending payment would be made on successful completion of type/routine test(s) actually carried out as per Consultant/Owner instructions.

The EPC Contractor shall give the Consultant/Owner thirty (30) days written notice of any material being ready for testing. Such tests shall be to the EPC Contractor's account. The Consultant /Owner unless witnessing of the tests is virtually waived will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the presence of Owner/Consultant and he shall forth with forward to the Consultant duly certified copies of tests in triplicate.

The Consultant/Owner within fifteen (15) days from the date of inspection as defined shall inform in writing to the Contractor of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and make the necessary modifications accordingly.

When the factory tests have been completed at the Contractor's or Sub-contractor's works, the Consultant/Owner shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Consultant/Owner, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Consultant/Owner. Failure of the issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificate shall not bind the Owner to accept the equipment should, it, on further tests after erection, is found not to comply with the Specification. The equipment shall be dispatched to site only after approval of test reports and issuance of material inspection clearance certificate by the Owner.

For tests whether at the premises or at the works of the Contractor or of any Sub-

Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labor, materials, electricity, fuel, water, stores, apparatus and instruments as may be required by Owner/Consultant or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.

The inspection by Owner/Consultant and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programmer forming a part of the Contract. The Consultant/Owner will have the right of having at his own expenses any other tests(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests to satisfy that the material complies with the specifications.

The Owner/Consultant reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment's for these tests shall be provided by the Contractor.

Tests

Charging (Pre-commissioning tests):

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Owner/Consultant and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The pre-commissioning tests to be performed as per relevant I.S. / vendor/ bidder submittal and as included in the Contractor's quality assurance programmer

Commissioning Tests:

The available instrumentation and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, immeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable. The Contractor will apply proper corrections in calculation, to take into account conditions which do not correspond to the specified conditions.

All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

Pre-commissioning test shall be carried out as per relevant IS and/or as specified in the relevant clause.

The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning of the equipment. However necessary fee shall be reimburse by Owner on production of requisite documents.

Packaging

All the equipment's shall be suitably protected, coated, covered or boxed and crated to

prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Owner takes no responsibility of the availability of any special packaging/transporting arrangement.

Protection

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

Finishing of Metal Surfaces

General:

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanized. All steel conductors used for earthing/grounding (above ground level) shall be galvanized according to IS: 2629.

Painting:

All sheet steel work shall be degreased, pickled, and phosphate in accordance with the IS-6005 "Code of practice for Phosphate iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swab shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After Phosphate process thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "flashing dried" while the second coat shall be stove

Powdercoating/electrostatic painting of approved shade shall be applied.

The exterior color of the paint shall be as per IS-5 or as approved by consultant. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the Equipment's, if required.

In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids for Owner's review and approval.

Handling, Storage and Installation

In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Owner or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level plumb, square and properly aligned and oriented.

Contractor shall follow the site procedure for transporting of materials, unloading, and safe storage. The equipment's after collection from store shall be erected, tested and commissioned as per contract specification, manufacturer guidelines and Engineer-in-charge instruction.

In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Owner/Consultant. Contractor shall be held responsible for any damage to the equipment consequent for not following manufacturer's drawings/instructions correctly.

Where assemblies are supplied in more than the one section, Contractor shall make all necessary connections between sections. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

The Contractor shall submit to the Owner every week, a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Owner in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Owner, as well as protection of the same against theft, element of nature, corrosion, damages etc.

The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment, which require indoor storage.

The words 'erection' and 'installation' used in the specification are synonymous.

Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

The minimum phase to earth, phase to phase and section clearance along with othertechnical parameters for the various voltage levels shall be maintained as per relevant IS.

Protective Guards

Suitable guards shall be provided for protection of personnel on all exposed rotating and / or moving machine parts. All such guards with necessary spares and accessories shall

be designed for easy installation and removal for maintenance purpose.

The Contractor shall also conform to the general regulations governing personnel on the site and must keep to the working space allocated for their use.

The contractor shall be responsible for any kind of mishap, etc. happened with personnel. The Owner shall not take the responsibility for any of such kind.

Tools and Tackles

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dismantling and maintenance of the Equipment's,

END OF SECTION

CONDUIT SYSTEM, CABLE TRAY, CABLE LADDER AND TRUNKING INSTALLATION

GENERAL

Work Description

This section describes the supply and installation of wiring facilities systems include conduits, cable trays, cable ladder and Trunking system, c/w associated fittings and accessories.

All cables running above the suspended false ceiling, columns, or on surface shall be supported by proper clamps, on cable tray. No free hanging of cable is allowed.

The cable routes shown in the drawings shall be used as a guide only. The cable routes may be physically examined and coordinated with other services before undertaking the installation work in hand.

Uncoordinated and inaccessible routes after other services are installed, shall be relocated at the expense of the Contractor.

All conduits, trunking, cable trays and cable ladders shall be earthed in accordance to IS: 4043.

Standards

The complete wiring facilities system shall be manufactured, supplied, installed and tested in accordance with the latest revision of the Indian standards and the appropriate BS / IEC include:

Steel Conduit and Fitting Accessories	IS:9537(Part-II)/BS4568&BS731/CPWD
PVC Conduit and Fitting Accessories	IS-9537/1983(Part-III) /BS6099 & BS4607 /CPWD
CableTray	BS729/CPWD
CableLadder	BS729/CPWD
CableTrunking	BS4678/CPWD

The complete wiring facility system shall conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in the approved specification and drawings.

Submissions

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

Routing of installation

Sample of proprietary factory-made accessories, elbows, risers, reducers, tees, crosses, etc.

PRODUCTS

Steel Conduit and Accessories (For Non Residential & Hostel Blocks)

Steel Conduit:

All conduits shall be of heavy gauge solid drawn ERW welded manufactured out of 16 (1.6mm) gauge MS Sheet up to 32mm dia and 14 (2 mm) gauge for sizes above 32mm.

Both inner and outer surfaces shall be smooth without burrs, dents and kinks.

Conduits shall be black stove enameled inside and outside. The cross-section of conduit shall be uniform throughout.

The welding shall be uniform such that welded joints do not yield when subjected to flattening test. Welded joint shall not break when threaded or bent at an angle.

Conduit shall conform to specifications of IS:9537(Part-II) and the capacity of conduits shall be in accordance with the standards

The minimum size of the conduit shall be 25mm diameter.

Care shall be taken to ensure that all conduits are adequately protected while stored at site prior to erection and no damaged conduit is used.

Fittings

Samples of conduit fittings shall be submitted for approval prior to use on work.

Fittings shall be those intended for use with screwed conduits and shall comply with IS 9537. However, bends, elbows and tees shall not be installed.

Boxes and cover plates installed outdoors shall have fixing lugs exterior to the box so that fixing screws do not enter the box interior.

Adaptors used with flexible conduits shall conform to IS:9537.

Circular Boxes

Circular boxes shall be of malleable cast iron, galvanized and of standard pattern with spout(s). When used for connecting lengths of conduits, circular boxes shall be provided with cover plates of similar make that are complete with brass fixing screws.

Rectangular Boxes

Rectangular boxes (adaptable boxes) shall be of mild steel not less than 2.4 mm gauge and galvanized. When used as junction boxes, lids of the same gauge with brass fixing screws shall be used.

Boxes for Accessories

Boxes for accessories shall be suitable for surface mounting or recessed mounting according to the requirements. Surface mounted boxes and accessories shall be metal clad pattern. Recessed boxes and accessories shall be complete with insulated molded type cover plates conforming to IS: 5133 Part 1-1969.

Covers

All covers for boxes, etc. shall be made of galvanized steel of 1 to 1.2mm thickness.

PVC Conduit and Accessories (For Residential Blocks Only)**PVC Conduit**

All conduits shall be high impact rigid 2mm thickness FRLS PVC heavy duty type and shall comply with I.E.E. regulations for non-metallic conduit as per IS-9537/1983 (Part-III).

All sections of conduit and relevant boxes shall be properly cleaned and glued by using epoxy resin glue and the proper connecting pieces.

Inspection type conduit fittings such as inspection boxes, drawn boxes, fan boxes and outlet boxes shall be of M.S. or otherwise mentioned.

Conduit shall be terminated with adopter/PVC glands as required.

PVC Conduit Accessories

Accessories used for conduit wiring shall be of an approved type conforming to IS:3837-1966.

All accessories used shall be of standard white or black color, identical to conduit used.

Plain conduits should be jointed by slip type of couplers with manufacturer's standard sealing cement.

All conduit entries to outlet boxes, trunking and switchgear are to be made with adaptors female thread and male bushes screwed.

PVC-switch and socket boxes with round knockouts are to be used. The colors of these boxes and the conduits shall be the same.

Standard PVC circular junction boxes are to be used with conduits for intersection, Tee-junction, angle-junction and terminal. For the drawing-in of cables, standard circular through boxes shall be used.

Samples of accessories shall be submitted for approval prior to installation.

All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

Conduit Installation**Layout**

The conduit layout and conduit routes shall be submitted for approval. Allowance for adjustments due to site conditions shall be made at no extra cost.

Conduit routes shall be chosen for easy, straight runs with minimum bends and crossings. Generally, they shall follow the structure of building, running at right angles or in parallel to floors and ceilings. Conduits shall be kept within 300 mm of floors and ceilings when running parallel to them.

Outlet boxes for housing accessories shall be used as draw boxes. The total number of draw boxes shall be kept to a minimum and shall be provided so that conduit runs do not exceed 12 m or have more than two right angle bends.

All conduits shall be kept clear of gas and water pipes. In particular, conduits shall be at least 150 mm away from gas pipes. Where proximity to these pipes is unavoidable,

they shall be effectively segregated e.g. using rubber or other insulating material to prevent appreciable voltage differences at possible points of contact. Segregation from extra low voltage circuits and telecommunication circuits shall also apply unless these are wired to the same voltage requirements as lighting and power circuits.

Conduits from different distribution boards shall not be connected to the same junction box. Each run of conduit shall be assembled complete with draw-in-wires.

Joints and Terminations

Electrical and mechanical continuity shall be maintained throughout all conduit joints and terminations. Conduit threads shall be thoroughly cleaned and tightly screwed. The conduit system shall be watertight after installation.

Conduits shall be connected using couplers or via boxes. With a coupler, the ends of the conduit shall butt close together and the running coupler is screwed tightly on and tightened by a locknut.

Conduits terminating into boxes provided with spouts shall be threaded so that there are no exposed threads. For boxes with no spouts, the termination shall be made using a brass bush and a coupler. The conduit is pushed through the knockout or drilled entry and the bush is screwed tightly onto its end. The coupler is screwed to butt firmly against the exterior wall of the box.

Where conduits are not jointed or terminated in boxes, they shall be terminated in a screwed brass bush.

In all joints and terminations, conduit threads shall not be exposed. Where this cannot be avoided as in a running coupler, the exposed threads shall be coated with red lead paint to seal against the ingress of water.

Bends

Conduits shall only be bent cold with an approved type of bending block or bending machine, without altering the dimensions of their sections.

All conduit bends shall be such as to permit compliance to the requirements for bends in cables to as stated in the BS 7671.

Bends shall be made with as large a radius as the position of the conduit within the building permits. Where the bend is more than 90 degrees, circular or rectangular junction boxes are to be used for connecting conduits.

Cabling

The conduit system must be installed free of obstructions and sharp corners before any cables are drawn in. Conduits shall be thoroughly swabbed to remove moisture and dirt immediately prior to the drawing in of cables.

Cables shall be drawn without crossing each other and shall not be pulled against the walls of the draw boxes. Slack cables shall have left in all draw boxes.

Cables shall be continuous throughout conduit lengths and no joints are permitted. There shall be no kink in cables, neither any cut, abrasion or chink in the cable insulation.

The same conduit shall carry the lead and return conductors bunched together. However, the same conduit shall not house cables from different distribution boards.

Cables for power and lighting circuits and extra low voltage systems shall not be drawn into the same conduit. Lighting and power circuits shall run in separate conduits except,

where an adopter box is employed as final distribution point, a number of final circuits are grouped together in larger conduits between the distribution board and the adopter box provided that all final circuits in one conduit are of the same phase. In the case of three phase circuits, all three phases including neutral, if any, shall be drawn into the same conduit.

Conduits shall not constitute the earth continuity path for the electrical circuit. A separate circuit protective conductor shall be installed within the conduit. The whole conduit system shall be effectively earthed.

Flexible conduits shall have a separate earthing conductor installed within the tubing and connected at conduit ends. Flexible conduits in general shall not be used for more than 3m length.

Maximum number of PVC insulated 650/1100V grade/copper conductor cable conforming to IS:694-1990

Nominal	25mm		32mm		38mm		61mm		64mm	
Cross-Sectional area of Conductor in Sq.mm										
	S	B	S	B	S	B	S	B	S	B
1.0	4	5	6	7	8	9	10	11	12	13
1.5	10	8	18	12	-	-	-	-	-	-
2.5	8	6	12	10	-	-	-	-	-	-
4.0	6	5	10	8	-	-	-	-	-	-
6.0	5	4	8	7	-	-	-	-	-	-
10	4	3	6	5	8	6	-	-	-	-
16	2	2	3	3	5	5	10	7	12	8
25	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	4	3	5	4

Notes:

The above table shows the maximum capacity of drawing in of cables in conduits

The columns Head 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight run by an angle of more than 15 degrees. The columns heads 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.

Conduit sizes are the nominal external diameters.

Access and Drainage

The conduit system shall be rewirable, that is, draw boxes must be accessible for the purpose. Where boxes are concealed, their covers shall be flushed with the finished surface.

The need for accessibility notwithstanding, the conduit system shall be protected against the ingress of water and impurities. When installed, conduits shall be kept dry and free of debris with approved pipe plugs or caps. Such plugging is especially essential prior to pouring concrete for concealed installation. As for boxes, they shall be covered by steel plates prior to concreting.

When installed outdoor, and in situations liable to condensation of moisture, conduits shall be arranged to be self-draining, so that water may drain to low points which are fitted with a drain plug. Conduits laid under concrete floors shall have watertight floor-traps of approved detail for access of these drainage points.

Conduits run on surfaces other than structural steel members shall be secured using galvanized space bar saddles and brass fixing screws. Spacing of saddles shall not exceed 1.2 m for conduit sizes up to and including 25 mm and 1.8 m for sizes 32 mm and above.

Conduits run on structural steel shall be secured using girder clips or an approved clamp. These conduits and those run in the vicinity of structural steel shall be bonded to the steelwork using an efficient and permanent metallic connection. The conduits shall not in any way be under mechanical stress.

All conduit boxes except loop-in patterns shall be fixed direct to the building structure in addition to the support provided by the conduits.

Conduits terminating into surface boxes shall be secured by a minimum of 3 saddles at not less than 32 mm, 150 mm and 300 mm respectively from the box.

Conduits shall be painted with an approved paint to blend with visual environment. A zinc rich undercoat shall be provided before painting the final coat.

Cable Tray

Cable tray shall be perforated type and construction with minimum 2.0 mm hot dipped galvanized mild steel for outdoor damp condition, and electro-galvanized mild steel for indoor installation. All cable trays shall be installed in a straight run parallel to walls where possible.

Cable trays shall be supported by electro-galvanized 'U' channel with galvanized threaded rod for indoor suspended tray and hot-dipped galvanized for area subject to weather.

All hangers shall be installed at 1-meter interval and shall be applied primer and painted to match with the surrounding building finish approved by the Engineer-in-charge.

The cable trays those are exposed to the weather, a hot-dip galvanized cover of 1.5mm gauge steel, flush fixing type with gasket, shall be installed on top of the tray.

Depending on the size of cable trays spare space of 25% shall be maintained for future expansion.

Copper earth link bar shall be fixed at every joint of the cable tray run.

Cable Ladder

All cable ladders and accessories installed indoors shall be heavy-duty electro-galvanized mild steel type. All cable ladders installed outdoors shall be heavy-duty hot dipped galvanized hot rolled mild steel. Thickness of the mild steel shall not be less than 2 mm.

Cable ladder shall have a 150 mm high longitudinal side member for ladders width of 800mm or above and 120 mm high longitudinal side member for ladder width less than 800 mm.

The rugs shall be at least 50 mm wide, with slots of 25 mm x 10 mm at 25 mm intervals covering the length of the rugs. The rugs shall be space at 300 mm apart along straight lengths of the ladder.

All nuts, bolts and washers for clips and brackets shall be zinc plated. Each cable ladder shall be in standard manufacturer's length and supplied complete with coupling sets consisting of fishplates, spine bolts, and nuts and locking washers.

The complete cable ladder installation shall be provided with all necessary proprietary factory-made elbows, risers, reducers, tees, crosses, drop-outs, etc. and any site fabricated items will not be permitted.

Separate flexible earth continuity connectors of at least 16mm² copper jumpers shall be installed between the ladder sections.

All cables ladders shall be supported from the ceiling concrete slab, steel structures or sidewalls using a frame system, with overhead hangers, support channels, hanger rods or angle brackets, beam clams and ceiling brackets.

Fixings and supports shall be installed at regular intervals not exceeding 1000 mm and 150 mm from all bends, tees, inter-sections and risers.

When cable ladder is refined to install across structure expansion joints, the ladder shall be in two sections between supports installed on either side of the expansion joint.

The ladder sections shall than be jointed with expansion joint fishplates, bolts, nuts and washers install in elongated holes permitting a lengthwise movement of 25mm from the initial fastening position.

For cable ladder that are exposed to the weather, hot-dip galvanized cover of 1.5mm gauge steel, flush fixing type with gasket, shall be installed on top of the ladder.

Copper earth link bar shall be fixed at every joint of the cable ladder run.

Cable Trunking

Cable trunking shall be manufactured from 1.6 mm minimum electro-galvanized mild sheet steel to BS4678 finished in oven-baked electro statically coated epoxy powder coating with color.

All trunking shall have removable lids extending over their entire lengths. Lids shall be fixed at interval not exceeding 1 meter by means of brass steel screws which and protected against corrosion by a finish of zinc coating or equivalent to zinc coating.

Factory-made bends, joints, elbow, riser, tee, reducer and accessories with same material shall be provided throughout the installation for trunking.

Trunking space factor shall be in compliance with latest IS standards.

Copper earth link bar shall be fixed at every joint of the cable trunking

Note: All items mentioned in this section shall be manufactured to comply with the specifications of National Electrical Code (NEC) and National Electrical Manufacturer's Association (NEMA).

END OF SECTION

WIRES AND CABLES

GENERAL

Work Description

The design, manufacturing, testing and supply of single core FRLS PVC insulated 1.1 KV grade stranded twisted wires shall comply with following standards with update amendments under the specifications.

IS-3961: Current rating for cables.

IS-5831: PVC insulation and sheath of electric cables.

IS-694: PVC insulated cables for working voltage up to and including 1100 volts.

IEC-54(I): PVC insulated cable.

Copper / Aluminum stranded twisted conductor PVC insulated wires shall be used in conduit as per item of work. Aluminum wires for power cables and copper wires for control cables shall be used.

The wires shall be color coded - (red, yellow, blue) for Phases, black for Neutral and green for Earth.

Progressive automatic in line indelible, legible and sequential marking of grade, voltage, capacity and length in meters shall be embossed at every meter on the outer's sheath of cable.

The design, manufacture, testing and supply of the cable under these specifications shall comply with following standards latest edition of:

IS:8130: Conductors for insulated electric cables and flexible cords.

IS:5831: HRPVC/HRPVC insulation and LSZH sheath of electric cables.

IS:3975: Mild steel wires, strips and tapes for armoring cables.

IS:3961: Current rating of cables.

The routing and minimum rated current carrying capacity of the LV power cables shall be indicated on the Drawing. The Contractor shall consider the manufacturer data and engineering for cable sizing and to ensure that it meets the conditions of grouping, ambient temperature etc.

All LT cables for normal power/control circuits within buildings shall be XLPE insulated and PVC sheathed Aluminum conductor and control cables shall be PVC insulated and PVC sheathed copper conductor respectively.

All LT cables, for emergency power circuits serving emergency light, Building Management System (BMS), Fire Protection System, Security Systems, emergency communication systems, and sump pump system and fire lifts etc. with back-up from UPS systems or incoming and outgoing from the Emergency Main Switchboard, shall be fire resistant as required.

Cables in service duct, open trench, direct-laid underground in soil shall be by means of armoured cables. Non-armoured cables shall only be laid in conduits, trunkings or tray/ladder for mechanical protection.

All L.T Cables to be used to feed smoke extraction , basement ventilation, Staircase pressurization & lift well pressurization will be of Standard Annealed Bare Copper Conductor /950 Degree Mica Tape Wrapped XLPE Insulation/Core Laid up together / FRLS inner Sheathed / GI Wire Strip Armoured / FRLS Outersheathed Fire Survival cables.

Standards

All cables shall be manufactured and constructed in accordance of the following standards with the latest revision:

1.	IS:694	HRPVC/XLPE insulated (heavyduty) electriccables for working voltage up to and including 1100 volts.
2.	IS:424-1475(F-3)	Powercable-flam abilitytest.
3.	IS:7098(1)	Specification for cross-linked polyethylene insulated LSZHPVC sheathed cable for working voltage up to 1.1 KV.
4.	IS:1554	Specification for PVC insulated (heavy duty) electric cables for working voltages up to and including 1100 volts.
5.	ASTM-D:2863	Standardmethodformeasuringtheminimum oxygen concentration to support candle-like combustion of plastics (Oxygen Index).
6.	ASTM-D:2843	Standard test method for measuring the density of smokefrom the burning or decomposition.
7.	IEEE:383	StandardfortypeoftestsClass-IE,Electriccables,field splices and connections for power generation station.
8.	ASTME: 662 / IEC: 754(x)	Standard test method for specific optical density of smoke generated by solid materials
9.	IS:10418	Cabledrums.
10.	IS-10810	Testingmethodofcable.
11.	IS-6121	Cableglands.
12.	IS-9537	Rigidsteelconduit.

The manufacturing of the cable shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in the approved Specification and Drawings of EPC contractor. Only more stringent specification shall be followed.

Submission

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant

for its review and approval.

As a minimum requirement, the submission shall include the following:

Equipment submission with manufacturer's data

Sample submission

Shop Drawings of the cable route showing the co-ordinated routing of cables, arrangement on cable trays, methods of fixing of cable trays and cables, etc. All conduits including concealed conduit routing drawings shall also be included

Cable test reports and IS Certification

Cable schedule indicate the following data include:

Cable code and type and installation method

Cable feed from and serve to

Cable route length and voltage drop

Cable capacity and

Upstream protection breaker rating

The cable schedule shall be prepared in accordance to the cable manufacturer's data.

PRODUCT

LTCables

The cables shall be suitable for laying in racks, ducts, trenches conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.

They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating condition.

The aluminum/copper wires used for manufacturing the cables shall be true circular / sector in shape before stranding and shall be of uniformly good quality, free from defects. The conductor used in manufacture of the cable shall be of H2 grade.

The cable should withstand 2.5 kA for 1 Sec. with insulation armour insulated at one end. Bidder shall furnish calculation in support of capability to withstand the earth fault currents. The current carrying capacity of armour and screen (as applicable) shall not be less than the earth fault current values and duration.

The fillers and inner sheath shall be of non-hygroscopic fire-retardant materials and shall be suitable for the operating temperature of the cable. Filler and inner sheath shall not stick to insulation and outer sheath.

Progressive automatic in line indelible, legible and sequential marking (grade, voltage, capacity, length-in-meters) shall be embossed at every meter on the outer's sheath of all cables and at every 5 meter 'LSZH marking in case of 'LSZH cables.

IS: 3975 methods (b) for strip / wire armouring shall only be acceptable. For single core cable aluminium wire armouring shall be used.

Allowable tolerance on the overall diameter of the cables shall be +2mm.

The normal current rating of all HRPVC/XLPE insulated cables shall be as per IS:3961.

A distinct inner sheath shall be provided by pressure extrusion process for all multi

cores armoured and unarmoured cables as per IS: 5831.

Outer sheath shall be provided by extrusion process as per IS:5831.

The breaking load of armour joint shall not be less than 95% of that armour wire. Zinc rich paint shall be applied on armoured joint surface.

In plant repairs to the cables shall not be accepted.

All the cables shall be supplied in non-returnable drums as per IS:10418.

Fire Survival Cables

Multi core Al / Cu Conductor XLPE/ Cross linkable Low Smoke Halogen Free insulated with Fire rated Glass Mica Tape, LSZH inner and outer Sheathed, Armoured with GI Strip/ Wire Fire Survival Cable.

Basic design shall be as per BS7846-2009, & IEC60502

Fire resistance of the cable shall be as per BS:8491-2008 & 8434-2:2003

Inspection

All cables shall be inspected on receipt of the same at site and checked for any damage during transit.

Joints in Cables

Cable drum length and sizes of cable lengths required may be checked carefully before cutting the cables from drum. The contractor shall take care that the cables received at site are distributed to various locations in single length as far as possible to ensure maximum utilization. Where the joints are unavoidable, the same is to be done with approval from the Owner/Consultant. The joints shall be done by qualified jointer strictly in accordance with manufacturer's instruction / drawings in presence of Engineer-in-charge.

Joint Boxes for Cables

The cable joint boxes shall be of appropriate size suitable for type of cable of particular voltage rating.

Cable Joints

All cable joints materials shall be of standard make and suitable to requirement. On jointing of cables in the joint box the cable compound shall be filled in accordance with manufacturer's instructions and in approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resins. Straight through joints shall not be permitted unless the length of run is in excess of cable drum.

End terminations of cables more than 1.1 KV grade shall be done with epoxy mould boxed and epoxy resin. Cable glands shall be 1.1 KV grade double compression type and made to tin plated heavy-duty brass casting and machine finished. Glands shall be of robust construction capable of clamping cable and cable armour, firmly without injury of cable.

All washers and hardware shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene of tested quality.

Cable lugs shall be tinned copper/ aluminium solder less crimping type conforming to IS: 8309 suitable for aluminium or copper conductor.

Crimping of terminals shall be done by using Corrosion inhibitory compound, with crimping tool.

Fire resistant paint has to be applied 1 Meter on either side of cable joint.

The contractor shall liaise fully with all other contractors to achieve an efficient and properly coordinated installation where equipment has to be re-positioned due to lack of site liaison; no extra cost shall be incurred by the client.

XLPE HT Cables(Upto 11KV)

The cross-linked polyethylene (XLPE) cable shall be aluminium conductor PVC outer sheath steel strip armoured over inner sheath construction. XLPE cable shall conform to testing in accordance with IS: 7098 (Part-I) 1977 and (Part-II) 1973. The screening shall be done on individual cover. The armouring applied over the common covering shall be flat steel wires. Each and every length of cable shall be subjected to routine test.

The termination and jointing techniques for XLPE cables shall be by using heat shrinkable or push on cable jointing kits.

While laying underground cables in ducts care should be taken so that any underground structures such as water pipes, sewerage lines etc. are not damaged. Any telephone or other cable coming in the way shall be properly protected as per instructions of the Engineer-in-charge. The HT cable shall be laid at least 1200mm for cable up to 33 KV (E) below the ground level in a trench 450mm wide.

After laying and jointing work is completed High Pot test shall be performed in presence of Engineer-in-charge and test results submitted for approval in order to ensure that they have not been damaged during or after the laying of cables. In case, the test results are unsatisfactory, the cost of all repairs and replacement and all extra work of removal and relaying will be made good by the contractor without any extra cost.

Note: All other procedure will be followed as per L.T. cables.

EXECUTION

Erection of Cables

Notwithstanding the cable routes indicated on the Drawings the Contractor shall be entirely responsible for the supply of correct lengths of the cables to be installed and for all allowances for connecting and terminating the cables to the switchgears and transformers respectively

The Contractor shall submit proposed cable routes including details of supports for the cables for approval before installation. The cable shall not be run in places other than corridor, passageway, electrical riser or other designated areas subject to the Engineer's approval. The cost of support shall be deemed to have included in the Contract.

Cable Pulling

Winching of cables through ducts / pipes shall only be carried out with the approval of

the Engineer-in-charge in which event a pulley eye shall be attached to the conductors. Cable shall be run in neat and orderly manner to allow space for future cabling and maintenance. Under any circumstances the cable shall not run diagonally across a room, cable basement, corridor, etc.

A cable sheath stocking may be employed on cables where no undue stress in the sheath is likely to occur.

Care shall be taken to ensure that the draw strain is applied to the armouring and protected during drawing against damage.

Cable Laying

The cable drum shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming links. At all changes in directions in horizontal & vertical places, the cable shall be bent with a radius of bend not less than 8 times the diameter of cable.

The cable of 1.1 KV grade shall be laid not less than 750mm below ground level in a 375 mm wide trench (throughout). Where more than one cable is to be laid in the same trench, the width of the trench shall be increased such that the inter axial spacing between the cables except where otherwise specified is at least 150mm minimum or as per site requirements or as approved by the Engineer-in-charge. Where single core cables are used in multiphase systems, the cables shall be installed in trefoil where possible.

In case the cables are laid in vertical formation due to unavoidable circumstance the depth per tier shall be increased by 200 mm (minimum). Cable shall be laid in reasonably straight line, where a change in direction takes place, a suitable curvature shall be i.e. either 20 times the diameter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever is less. Minimum 3-meter-long loop shall be provided at both sides of every straight through joint & 3 meters at each end of cable or as directed at site.

Greater care shall be exercised in handling the cable in order to avoid forming 'Kinks'. The cable drum shall in-verbally convey on wheels and the cable unrolled in right direction as indicated on the drum by the manufacturer. The cables shall be pulled over rollers in the trench steadily and uniformly without jerks and strains.

Cables laid in trenches in single tier formation, 10 CMS all-around sand cushioning is provided below and above the cable before a protective cover is laid. For every additional vertical tier. The 30 cm of sand cushion is provided over the initial tier. The cable shall be protected by 2nd class brick of size not less than 230 x 115 x 75mm, stone tiles / RCC curved channel be placed on top of the sand breadth wise for the full length of the cable and where more than one cable is to be laid in the same trench the brick shall cover all cables and project at least 8 CMS over the outer sides of the end cables.

Filling of trenches shall be done after sand cushioning and tiles or bricks lying and inspection is carried out by the Engineer-in-charge (Refer drawing). Back fill for trenches shall be filled in layer not exceeding 150 mm. Each layer shall be properly rammed & consolidated before laying the next layer.

PVC pipe shall be provided on all road crossing. The size of the pipe shall be above the size of the cable. Minimum 100 mm dia. Pipes are to be provided. The pipe shall be laid in ground with special arrangement and shall be cement jointed and concreting of 1:5:10 shall be provided as per relevant IS with latest amendment. Nothing extra shall be paid on this account. Cable route markers at interval of 30 meters and at the point of direction change shall be provided to indicate cable path. Aluminum strip cable tag of 20mm wide with engraved tag no. shall be provided at both ends of cable.

Where the cables are laid in ducts (pucca trenches) inside the building, they will be laid on MS rack / cable trays grouted on trenches walls. Cables passing through floors shall be protected from mechanical damage by steel channel to a height of one meter above the floor. Sleeve shall be provided in the wall for crossing of cables.

Where the cables are laid in open (in building) along walls, ceiling or above false-ceiling, cable rack (ladder type) or cable tray shall be provided. The size of the cable tray or rack shall depend on the number of cables to pass over that rack. Cable tray/rack shall be properly supported through wall/ceiling according to the site conditions. Cable laid on tray & riser shall be neatly dressed & clamped at an interval of 1000 mm & 750mm for horizontal & vertical cable run respectively either side at each bend of cable. All power cables shall be clamped individually & control cables shall be clamped in groups of three or four cables. Clamps for multi core cables shall be fabricated of 25x3 GI flats. Single core power cable shall be laid in trefoil formation & clamped with trefoil clamps made of PVC/fiber glass.

Cable openings in wall/floor shall be sealed by the contractor suitably by Hessian tape & Bitumen compound or by any other proven material to prevent ingress of water.

After the cables are laid, shall be tested as per IS and the results submitted to Architects/Engineer and in case the results found unsatisfactory, all the repairing/replacing of cables will be done by the contractor free of charge.

Internal Wiring

All the wiring installation shall be as per IS: 732 with latest amendment. PVC insulated copper conductor cables as specified in bills of quantity shall be used for sub-circuit runs from the distribution boards to the points and pulled into conduits. They shall be twisted copper conductors with thermoplastic insulations of 1100 volts' grade. Colour Code for wiring shall be followed.

Looping system of wiring shall be used, wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors with prior permission of the Consultant. No reduction of strands is permitted at terminations. No wire smaller than 1.5 sq.mm shall be used. Wherever wiring is run through trunkings or raceways, the wires emerging from individual distributions shall be bunched together with cable straps at required regular intervals. Identification ferrules indicating the circuit and DB number shall be used for sub main sub-circuit wiring. The ferrules shall be provided at both end of each sub main and sub-circuit.

Where single phase circuits are supplied from a three phase and a neutral distribution board, no conduit shall contain the wiring fed from more than one phase. In any one room in the premises where all or part of the electrical load consists of lights, fans and/or other single phase current consuming devices, all shall be connected to the same

phase of the supply. Circuits fed from distinct sources of supply or from different distribution boards or through switches or MCBs shall not be bunched in one conduit. In large areas and other situations where the load is divided between two or three phase, no two single phase switches connected to different phase shall be mounted within two meters of each other.

All splicing shall be done by means of terminal blocks or connectors and no twisting connection between conductors shall be allowed.

Industrial sockets shall be of polycarbonate and deeply recessed contact tubes. Visible scraping type earth terminal shall be provided. Socket shall have self-adjustable spring-loaded protective cap. Socket shall have MCB/ELCB/RCCB as specified in the schedule of work.

FireSealSystem

All the floor/wall opening provided for cable crossing shall be sealed by fire seal system.

The fire proof sealing system shall fully comply with the requirements of relevant IS/BS: 476 Part-B. The fire proof seal system shall have minimum one-hour fire resistance rating.

The fire proof seal system shall be physically, chemically, thermally stable and shall be mechanically secured to the masonry concrete members. The system shall be completely gas and smoke tight, anti-rodent and anti-termite.

The material used in fire proof seal system shall be non-toxic and harmless to the working personnel.

Type of fire proof seal system shall be foaming type or flame mastic type compound or approved equivalent.

After laying and jointing work is completed, high voltage test should be applied to all cables to ensure that they have not been damaged during or after the laying operation and that there is not fault in the jointing.

Cables for use on low and medium voltage system (1.1 KV grade cables) should with stand for 15 minutes a pressure of 3000V, DC applied between conductors and also between each conductor and sheaths. In the absence of pressure testing facilities, it is sufficient to test for one minute with a 1000V insulation tester in case the test results are unsatisfactory the cost of repairs and replacements and extra work of removal & laying will be made good by the contractor.

Cable shall be installed so that separations shown in the table be low are observed.

1. HVCable(33KV)	-	HVCable(33KV)	50mm
2. ELV<230V/433V	-	ELV<cable230	50mm
3. HTcables(33KV)	-	ELV&LVcables230	300mm
4. LTcables433V	-	Telephone/Instrumer	350mm
5. Allcables	-	Allhotpipework	200mm

Factory Tests

Each type of cable specified shall be fully type tested according to IEC 502 and the appropriate British Standards. The types and sizes of cables required are shown on the Drawings.

Should the Engineer require it, the Contractor shall submit reports issued by a national or international testing authority on type test that have been successfully performed on the cable for his approval.

The type test shall include the following test:

Partial discharge test;

Bending test, plus partial discharge test;

Tan δ measurement as a function of the voltage and capacitance measurement;

Tan δ measurement as a function of the temperature;

Heating cycle test plus partial discharge test;

Impulse withstand test, followed by a power frequency voltage test;

Medium-voltage alternating current test;

Type test (non-electrical) as stipulated in IEC 502, Table VI.

Cable routine test shall be conducted at factory in accordance with IEC 502 for the following tests: Measurement of the electrical resistance of conductor's Partial discharge test, 4-hour HT test

Site Acceptance Test

The Contractor shall supply all necessary testing Equipment's, for site testing. When required, these testing Equipment's, shall be calibrated at the expense of the Contractor at a recognized national laboratory.

The Contractor shall engage an Authorized Medium Voltage Testing Engineer who is recognized by SEB to perform all site tests.

In addition to SEB's requirements and those recommended by the manufacturer, the following tests shall be carried out:

Continuity test

Earth test

Polarity test

Insulation resistance test

DC high voltage test. The test voltage shall be in accordance with SEB's requirements and Engineer's approval.

END OF SECTION

LT PANEL BOARDS

GENERAL

Scope

The section covers the detailed requirements of medium voltage switch panel for 433 volts, 3 phases, 50 HZ, 4 wire systems. These shall be branded and or / assembled / fabricated of factory of repute. All switchgears shall be fully rated at an ambient of 50 deg C.

Type Of Panel

The medium voltage switch board panel shall comprise of any of the following types of switchgears or combination thereof as specified:

Air circuit breakers drawout type or fixed type

MCCBs of suitable Ics ratings. MCCBs shall invariably be current limiting type. Features like Double Break, positive isolation functions shall be preferred. Single break mechanism shall also be accepted

This specification covers the 'General Requirement' for the design, manufacture, supply performance, inspection, testing and commissioning including supply of indoor type low voltage switch boards panels up to 1100V including necessary termination cabling and bus work required for satisfactory operation.

The Panel boards including distribution boards and control panels shall be built in accordance with IEC-61439(Part-I & II) "Factory Built Assemblies for Low Voltage" or BS-5486 "Factory- built Assemblies of Switchgear and Control Gear for Voltage up to and including 1000V AC and 1200V DC.

Specific requirements shall be in accordance with single line diagram / specification. The technical parameters of switched are equipment's, transformers etc. shall be referred.

Standards

All equipment material and components shall comply with the requirements of the latest editions of Indian Standards with updated amendments. Standards and Regulations applicable in the area where Equipment's, are to be installed should be followed.

The equipment offered complying with other standards shall be submitted with copies of standard followed and full details indicating merits of adopted standard over to specified standards.

The Panel boards shall be engineered and constructed in accordance with the latest revision of the following Indian and British standards:

1	IS13947	: A.C.CircuitBreakers
2	IS3427	: MetalenclosedSwitchgear&ControlGear
3	BS162	: Safety Clearances
4	IS2705	: Current Transformers
5	IS3156	: Voltage Transformers
6	IS3202	: CodeofPracticeforclimateproofingofelectrical equipment

7	IS375	: Marking&ArrangementforSwitchgearBusBars,main Connectionsandauxiliarywiring.
8	IS722	: A.C.ElectricMeters
9	IS1248	: Direct actingElectrical IndicatingInstruments
10	IS3231	: Electrical Relays for Power SystemProtection
11	IS2544	: EpoxyCastResinInsulators
12	IS5082	: Electrolytic Copper/ Aluminium
13	IS5792	: HighVoltageHRCfuses
14	BS88	: Cartridgefusesforvoltagesuptoandincluding1000VAC and1500VDC.

BS89 : Direct acting electrical indicating analogue electrical Measuring instruments and their accessories.

BS142 : Electrical protectiverelays

BS159 : Bus-bar and Bus-barconnection

BS1433 : Copper for electrical purposes. Rods and bars.

BS EN : Circuit-breakers for over current protection
60898 for household and similar installations.

BS 3938 : Current transformers

BS EN : Low-voltageswitchgearandcontrolgear,Part-2
60947-2 circuit- breakers.

BS 4794 : Control switches(switchingdevices,Part-1including contactor relays, for control and auxiliary circuits, for voltages up to and including 1000V AC and 1200V DC). General requirements.

BS5419 : Air-breakswitches,air-breakdisconnections,andfuse combination units for voltages up to and including 1000VAC and 1200V DC.

BS 5420 : Degrees ofprotectionofenclosuresofswitchgearPart-Iand control gear for voltages up to and including 1000V AC and 1200V DC.

BS 5424 : Controlgearforvoltagesuptoandincluding1000V ACand 1200VDC-Part-1Contactors.

BS 5486 : Low-voltageswitchgearandcontrolgearPart1 assemblies.

Part I: Requirement for type tested and partially type tested assemblies.

BS 5685 : ElectricityMeters-Part-I:Class-0.5,1and2singlephase Andpolyphase,single-rateandmulti-rat watt-hourmeters.

BS 5992 : Electricalrelays

BS 6004 : PVCinsulatedcables,(non-armoured),forelectricpower Andlighting.

BS 6231 : PVCinsulatedcablesforswitchgearandcontrol gear wiring.

IS 3043/ : Earthing

BS7430

Submission

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

Detailed co-ordination with other services shop drawings for various electrical layouts such as equipment layout and earthing layout including equipment installation and cable termination details etc. prior to start of work.

Such drawings shall show the proposed method of construction of the cubicles, equipment, bus bar layout, method of supporting equipment and Bus bar electrical control wiring diagrams, equipment weight, colors, and surface treatment.

The drawings shall also incorporate full list of proposed materials. The construction shall not commence until the drawings are approved for construction.

Factory and site testing procedures and report formats shall also be included.

Preparation of bill of materials for different Items as mentioned in Schedule of Quantities. Lighting / power panel schedule.

Interconnection drawing.

Protection co-ordination drawings/tables for complete power system.

Shop inspection and testing procedures. Field testing and commissioning procedures.

Preparation of as built drawings for the services rendered by the contractor.

Any other work or activity not listed above but necessary for completion of electrical system shall form part of the specification.

PRODUCTS

Panel Board

The switch boards shall be floor mounted free standing cubicle type totally enclosed and extensible type. The switch board shall be dust and vermin proof offering degree of protection not less than IP-42 and suitable for climatic conditions specified.

The design shall include all provisions for safety of operation and maintenance personnel. The general construction shall conform to IEC-61439(Part-I & II) for factory assembled switch board.

All factories-built assemblies subject to rain or wet conditions or located outside electrical switch room shall be of weatherproof construction conformation to IP 65 and able to withstand high impact strength of 60KN/m² (min.) temperature resistant, flame retardant and corrosion resistant.

The switchgear cubicles shall be rigid and robust in design and construction fabricated out of CRCA sheet steel not less than 2 mm thick. Where ever necessary, such sheet steel members shall be stiffened by angle iron frame work

General construction shall employ the principle of compartmentalization and

segregation for each circuit. Unless otherwise approved, incomer and bus section panels or sections shall be separate and independent and shall not be mixed with sections required for feeders. Each section of rear accessible type panel shall have hinged access door at the rear.

Overall height of the panel shall not exceed 2.4 Meters. Operating levers, handles etc. of highest unit shall not be higher than 1.7 Meters and 200mm from finish floor level.

Multi-tier mounting of feeders is permissible. The general arrangement for multi-tier construction shall be such that the horizontal tiers formed present a pleasing and aesthetic look. General arrangements shall be approved before fabrication.

Cable entries for various feeders shall be either from Top and Bottom of the panel. Through cable allies may be located in between two circuit sections either in the rear or in front of the panels.

All cable entries shall be through gland plates. There shall be separate gland plate for each cable entry so that there will not be dislocation of already wired circuits when the new feeders are added. Cable entry place therefore shall be sectionalized. The construction shall include necessary cable supporters for clamping the cable in the cable alley or rear cable chamber.

Cubicle panels with more than 1000Amps bus shall be made of tested structural modular sections.

The each panel/board shall have 20% spare outgoing feeders for maintenance and 20% spare space with complete wiring & bus-bars etc. for future use.

All panels shall be of same height, width and depth. Panels shall be bolted together to form continuous flush front switch board suitable for front of board operation.

All doors, panels, removable covers shall be provided with non-deteriorating (neoprene) gaskets all around the perimeter.

Floor mounted cubicles shall be provided with a 75mm high channel base frame. The total height of the cubicle shall not exceed 2400mm keeping in view the operating height of top switch should not exceed 1750mm from FFL including base channel.

Bus-Bars & Bus-Bar Chamber

Rating

Bus bars shall be made of wrought aluminium or aluminium alloy, or electric grade copper, conforming to relevant Indian standard, as specified.

Current density

The bus bars shall be of sufficient cross-section so that a current density of 0.8A/1.0 Sq.mm is not exceeded at nominal current rating for Aluminium Bus Bars 1.0A/1.0 Sq.mm for copper bus bars.

CrossSectionof Busbar

The cross section of the Neutral Bus bar shall be same as of the phase bus bar for the bus bars of capacities up to 200 A; for higher capacities, the neutral bus bar must not be less than half the cross section of that of the phase bus bar.

Insulation

Each bus bar shall be suitably insulated with PVC sleeves/tapes in approved manner

Bus Bar Supports

Bus bar Support insulators shall be Class F insulators made of non -hygroscopic, noncombustible, track resistant and high strength FRP / SMC / DMC material, and shall be of suitable size and spacing to with stand the dynamic stresses due to short circuit currents. The spacing between two insulators should not exceed 250mm.

Bus Bar Clearances

The minimum clearance to be maintained for enclosed indoor air insulated bus bar for medium voltage application shall be as follows:

Between	Min clearance
Phase to Earth	26mm
Phase to Phase	32mm

Note: For strip connection from bus bar to switchgear, the above clearances do not apply.

Busbar Joints shall be thoroughly cleaned and suitable oxidizing grease shall be applied before making the joint.

High tensile bolts, plain and spring washers shall be provided to ensure good contacts at the joints.

The overlap of the bus bar at the joints shall be not less than the area of cross section of bus bars.

Busbars & busbar connections shall be of uniform microsection shall be suitable for carrying rated current continuously and short circuit current for specified duration without overheating. Normal operating temperature for bus bars shall be 85 Deg C. Short circuit rating of the bus bars shall be 20 to 65KA for 1sec as per calculations.

Direct access to accidental contact with bus bars and primary connections shall be avoided by providing shrouds. All apertures and slots shall be protected by barriers to prevent accidental short circuiting of bus bars. To provide a tight seal between cubicles, bushings or insulating panels shall be provided for bus bars crossing from one cubicle into another.

All busbars shall be color coded as per IS:375.

Current Transformers(CT'S)

Accommodation shall be provided in the circuit breaker panel to mount one set of three number dual core ratio CT's for metering and protection purposes. Access to the CTs for cleaning, testing or changing shall be from front, back or top of the panel.

Current transformers ratings shall be dual core and dual ratio CTs of suitable burden (but not less than 15 VA) shall be preferred with 5 Amp secondary.

Secondary terminals of CT shall be brought out suitably to a terminal block which will be easily accessible for testing and terminal connections.

The protection CTs shall be of accuracy class 5P10 of IS2705-Part-III-1992.

The Metering CTs shall conform to the metering ratio and accuracy class 0.5 of IS 2705 - 1992.

Current transformers shall conform to latest edition to relevant standards. The Current transformers shall be epoxying resin cast with bar Primary or ring type.

The design and construction shall be sufficiently robust to withstand thermal and dynamic stresses due to the maximum short circuit current of the circuit.

CT core laminations shall be of high-grade silicon steel.

Rating plate details and terminal markings shall be according to the latest edition of relevant Indian Standard specification.

Current transformers (core) shall be used for metering and protection.

Potential Transformers (PT'S)

Potential Transformers shall conform to latest edition of relevant standards.

Potential transformers shall be dry, cast epoxy resin type. The PTs shall be of single-phase construction.

The PT'S shall be capable of operating continuously at 110% of the rated voltage without any damage. When star - star connection is required in non-effectively or ungrounded system, the PT'S shall be suitable for continuous operation with a persistent phase to ground fault.

Maximum temperature rises of the transformer at rated burden and with rated primary voltage and frequency shall not exceed 40 Deg's above an ambient of 45 deg C

Voltage transformer of burden not less than 100 VA and of the proper ratio and of proper ratio as specified shall be provided at the incoming panel. The accuracy class for the VT shall be class 0.5 as per IS 3156 Part-I to III for incomer and class 1 for outgoing panels.

The transformer shall be of cast epoxy resin construction. It shall be fixed/ withdrawable type. HRC fuses/MCBs shall be provided on both HV & LV side. It shall be possible to replace PT fuses easily without having to de-energies the main bus bars. Prospective interrupting current rating of the fuses shall be same as the system fault level.

Voltage transformer ratio, output and class shall be as specified in the drawing & BOQ. Name plate as per relevant standards shall be provided on the PT.

Protective Relays

Relays type and numbers shall be in accordance with the protective scheme specified or as per drawings and schedule of quantities. All relays shall be numerical type. Relays shall be enclosed in rectangular shaped cases suitable for flush mounting dust tight covers projecting from the front cover panel. The case shall be dust tight, damp proof and tropicals.

Relays shall be accessible for setting from the front. Access to setting devices shall be possible only after removal of front cover.

Protective relays shall be draw-out type. Where it is not possible to provide protective relays of the drawout pattern fixed type relays with facilities for plugging in a portable test plug shall be provided. Necessary test plugs shall be furnished along with the relays.

Relays shall be provided with positive action self-reset type with indicator. The indicators shall be visible from the front.

Relays conform to relevant standards in all respects.

Relays shall be provided with minimum two pairs of self or hand reset type contacts as specified. Auxiliary relays shall have the number of NO and NC contacts as specified in data sheet.

Incomer/Termination

Incomer termination shall be suitable for receiving bus trunking / underground cables. Cable shall invariably be through terminal blocks (Polyamide or Superior) or brought out solid terminals.

The housing material shall have unbreakable and fire-retardant characteristic. All the metal parts shall be made up of copper alloy including the screws. Mounting shall be DIN or G-Rail type. Screws shall be captive type. No protection cover is required and the block shall be touch proof.

Instrument/Indication Lamp

All Voltmeters and Ammeters shall be flush mounted of size minimum 96mm conforming to class 1.5 of IS: 1248 for accuracy. All voltmeters shall be protected with MCB.

Multi-function meter of CL 1.0 accuracy with RS 485 port shall be provided. On all the incomers of HT panels, ON/OFF indication LED lamps shall be provided and shall be suitable for operation on AC supply. Phase indicating lamps shall be associated with necessary ON/OFF toggle switch.

LED type indicating lamps shall be provided everywhere except where low voltage filament type with series resistor called for.

Lamp covers shall be provided with interchangeable colored lenses of Perspex or equivalent unbreakable material. The lenses shall not discolor in course of time due to heat of the lamp. Bulbs and lenses shall be interchangeable and replaceable from the front.

Following colors shall be used for the function indicated:

Red - Circuit

Breaker 'ON' Green-
CircuitBreaker'

OFF'

White-

Continuoustripsupp

lysupervision Amber-		Auto trip
Blue	-	Springcharged
R,Y,B-		Potentialindication

Push Buttons

All push buttons shall be push to actuate the contact type.

Start & Stop push buttons shall be colored green and red respectively. Reset push buttons shall be yellow in color and test push buttons shall be blue in color. All other push buttons shall be black in color.

Emergency stop push buttons shall be lockable in the operated position, i.e. push to operate and key to release type. Push buttons for emergency stop shall be recessed/shrouded type to avoid accidental operation.

Control & Selector Switches

Control and Selector switches shall be of rotary type, having enclosed contactsaccessible only after removal of cover.

All control and selector switches for circuit breakers and instruments shall be mounted on the front of the panel. Control switches for space heater/s and control supplies shall be mounted inside the panel.

Circuit Breaker control switches shall be provided with pistol grip handles. Selector switches shall be provided with round, knurled handles. All handles shall be black incolor. Properly designated escutcheon plates clearly marked to show the operating positions shall be provided on all switches.

Circuit breaker control switches shall normally have three position close - Normal - Trip with spring return to normal position. Switch operating mechanism shall prevent theswitch from being operated twice successively in the same direction. Circuit breaker control switch shall have one NO-NC contact along with other contacts as required.

All other instruments and selector switches shall have stay put contacts.

Contacts of all control and selector switches shall be rated for 10Amps at 240V, AC or 20 Amps at 220 VDC (inductivebreak).Switch for space heater supply and control voltage supply shall normally be two poles rated for 25A, AC.

Control Terminal Block

Box - clamp type, 650V grade line up terminals of minimum 2.5 sqmm size shall be provided. Connection to terminals shall be from front.

Not more than one wire on each side shall be connected on any terminal. Where duplication of terminals block/s is necessary, suitable solid bonding links shall be incorporated.

Terminal blocks at different voltage shall be segregated into groups and distinctly labeled.

Current transformer secondary leads shall be brought to terminal blocks having facility for short circuiting and grounding the secondary.

Terminals shall be numbered for identification and grouped according to function. Engraved back on white PVC labels shall be provided on the terminal blocks describing the function of the circuit.

Separate terminals shall be provided for internal and external wiring.

Control terminal blocks shall be so located that control cables are fully segregated from power cables. Suitable insulated or earthed metal race ways shall be provided for control wiring. Separate unrolled removable gland plates shall be provided for the control cables at the bottom of each panel.

Minimum 20% of total number spare terminals shall be provided for future use.

Small Wiring

All wiring for Controls, Indication, protection, alarm and indicating circuits of all equipment shall be of suitable FRLS/HFFR (Halogen free fire retardant) copper conductor cable.

All wiring shall be suitably protected within switch board. Runs of wire shall be neatly bunched, suitably supported and clamped.

Means shall be provided for easy identification of the wires. Identification ferrules shall be used at both ends of the wires. Ferrules shall fit tight on the wires, without falling off when wire is removed. Ferrules shall be of white color with black lettering. Each wire shall be identified by letter to denote its function followed by a number to denote its identity at both ends.

Where wires are drawn through steel conduits, the work shall conform to CPWD General Specification for Electrical works Part-I-internal)-.2005 and IS: 732 as the case may be.

"All control wiring meant for external connections are to be brought out of terminal board.

All wiring shall be color coded as follows:

Instrument Transformer AC circuit	-
Red, Yellow & Blue wire associated by phases AC Phase Wire	-White
AC Neutral	-Black
DC Circuits	-Grey
Earth connections	-Green

All unused auxiliary contacts of the circuit breaker and relays shall be wired up to terminal block

Safety/Protection & Interlocks/Features

Following interlocks and features shall be incorporated for equipment protection and personnel safety under mal-operation. No deviations on these interlocks and safety features are allowed. These interlocks and safety features shall be fail-safe positive and full-proof.

It shall not be possible to plug-in or isolate a closed-circuit breaker. An attempt to do so

shall trip the breaker. (In case of breakers with vertical isolation, this will apply to raising and lowering). There shall be a positive locking facility to prevent closing of circuit unless it is in Service or Test position.

Closing and opening operations shall be possible only in discrete, well-defined Test and Service positions and not in any position midway. An extension adapter cable with plugs and sockets shall preferably be provided so that the closing and opening operation of the circuit breaker can be done in fully withdrawn position outside the cable.

Slow operation of circuit breakers shall be possible only in the circuit breaker in Test or Isolated position.

Isolating switches if provided shall be interlocked with respective circuit breakers to prevent them making or breaking the current.

1No. bus earthing truck shall be supplied with each panel to earth the outgoing cable of the ACB breaker.

Automatic safety shutters for all openings which will lead to access to the live parts of the switchgear upon withdrawal or any operation the switchgear components/parts shall be provided, preferably with a padlocking facility.

Spring of motor operated spring charged mechanism shall not discharge until they are fully charged and charging means are fully disconnected.

Where interlocking key is employed tripping of closed-circuit breakers shall not occur if any attempt is made to remove the trapped key from the mechanism.

Any other interlock considered to be provided which manufacturer may deem to be required for safety and specifically specified separately required for the system shall be included.

All terminals, connections which may be live and exposed for accidental contact shall be adequately shrouded.

Components within cubicles shall be properly labeled to facilitate testing.

Earthing

2 Nos 20 x 3 mm copper strip for LT panel up to 400 Amp and 20 x 5 mm copper strip for LT panel of higher capacity shall be provided all around the panel connected to 2 Nos earth bus copper strips connected to incoming conductors.

All non-current carrying metal parts frames and equipment mounted in the switch board shall be bonded to earth bus.

Earthing of moving carriage of draw out equipment shall be achieved by scraping earthing device. The earthing device shall maintain positive earth continuity in all Service Test and Isolated positions.

It shall be possible to connect each circuit or set of three phase bus bars to earth either through earthing trucks or through the circuit breakers.

One earthing trolley suitable for earthing of cables & bus bars for all circuit breakers of the same type / rating shall be provided

Name Plates and Labels

One Name plate giving designation of the MV switchboard shall be affixed prominently on top of the switch board. Details of designation will be specified.

Labels with following details shall be affixed on each feeder panel:

Feeder Number.

Equipment reference Number & Description

Rating (HP/kW/kVA/Amp.)

All components whether mounted inside or on the door shall be permanently and clearly labeled with reference number / letter or their function. Rating of fuse shall be part of fuse designation. Paper labels, stickers or labels fixed with adhesives are not acceptable. All labels shall be properly fixed by screws with provision to prevent distortion due to expansion.

All labels shall be non-corroding, preferably laminated plastic or rear engraved Perspex with white letters on black background.

Labels for feeder panel designation fixed on front side shall be fitted with chrome plated, self-tapping, and counter sunk head screws. These labels shall be of identical size to permit interchange.

Space Heaters

Adequately rated anti-condensation space heaters shall be provided in each cubicle.

Space heater/s shall be strip type, rated with operation voltage of 240 V, 50 Hz AC supply.

Each space heater shall be complete with a 2P MCB, 10KA and a control thermostat.

The space heater shall be rated for maintaining the panel inside temperature 10 Deg. C above outside ambient temperature.

Cubicle Lighting

Each cubicle shall be provided with interior lighting by means of CFL light fixture. An ON/OFF switch/door switch shall be provided. The lighting fixture shall be suitable for operation from 240V single phase, 50 Hz. A.C. supplies.

Auxiliary Supply

Auxiliary supply for control, indication, space heater etc. shall be made available at one point on the switch board. Vendor shall provide suitable auxiliary supply in the switch board.

Fuses

Fuses shall be HRC cartridge link type (Diaz-zed Fuses are not acceptable) and shall be provided with operation indicator which shall be visible without removal of fuses from service.

Fuses shall be pressure fitted type and shall preferably have ribs on the contact blades to ensure good line contact.

It shall be possible to handle fuses during off load conditions with full voltage available on the terminals. Wherever required fuse pullers shall be providing. The fuse bases shall be so located in the modules to permit insertion of fuse pullers and removal of fuse links without any problems.

Mounting of fuse fitting shall ensure adequate dissipation of heat generated and shall facilitate inspection and easy replacement of fuse.

Contactors

The contactor shall be air break type, equipped with three main contacts and minimum 2NO + 2NC auxiliary contacts. The main contacts of a particular contactor shall have AC 3 ratings for unidirectional motors & AC 4 for reversible motors.

The auxiliary contacts shall be rated for minimum 5 Amps at 240V AC and 1.3 Amps at 110V DC (Inductive load).

Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240V, (+) 10% & (-) 15% 1-0, AC supply. The drop off voltage of contractor shall be 15% to 65% of the rated coil voltage.

Single Phasing Preventer (SPP)

Unless specified otherwise SPP's shall be provided in all motor starter modules with contactor rating of 200 Amps and above. The SPP shall be of the current operated type and shall operate on the principle of sensing negative sequence component of current.

In case of single phasing, the SPP shall operate after a time delay of 2 to 3 Secs. The relay shall be of the hand reset type and visual indication of the relay operation shall be available.

The SPP shall be suitable for protection of the non-reversible and reversible motors. The relay operation shall be independent of the loading and RPM of the motor prior to the occurrence of single phasing.

HYBRID FILTERS

SCOPE OF WORK

Design, fabrication, assembling, wiring, supply, installation, testing and commissioning of HPFC (hybrid power factor correction) panel having IGBTs, microprocessors, capacitors, reactors and other associated accessories, as explained below.

The HPFC panel shall be fabricated out of 14-gauge CRCA sheet steel in cubicle compartment, free-standing, floor-mounted, dust and vermin proof with reinforcement of suitable size, angle iron, channel, 'T' sections and/or flats wherever necessary. Pre-treatment of panel shall be carried out

before epoxy powder coating with at least nine tank process. The HPFC panel shall adhere to IP 42 protection standard.

Cable gland plates shall be provided on top / bottom/ both of the HPFC panel. Lifting hooks shall also be provided at least on all four corners of the panel.

The HPFC panel shall be suitable for 415V, 3 phase, 4 wire, 50Hz supply system. The Hybrid panel shall have a tolerance of 10% for the voltage and 2% for the frequency. Two numbers of earthing terminals shall be provided on either side of the panel of the hybrid filter panel.

Unless otherwise stated below, the active filter panel shall comply with the following standards (and their latest amendments):

IS13340-1993, IS13341-1992, IEC60831-1+2

ACB:IS3947/IEC60947

MCCB: ISI3947(part2), IEC60947-2

Contactors: IS/IEC60947-4-1

ACcapacitor:IS13340-1993

DetunedReactors:IEC60289,IS-5553

DCcapacitor:IEC60068-1,60384-4,60068-2-6

GateDriverCard:IEC60068-1

SMPS:UL10212,UL60950,TUVEN60950approved

Sensor:EN50178

SwitchgearControlGearAssembly:IS:8623Part1to3

The HPFC panel shall implement the following:

Power Factor Correction(for both leading and lagging current)

Harmonics Compensation upto 51st order

Load Current Balancing in the three phases

The **APFC panel** shall comprise 800 KVAR. The HPFC with Active bypass filter shall be dedicated to a single transformer.

The Panel shall be provided with one(1)no, incoming of 1600 MDO-ACB with protection.

The APFC System Shall Comprise:

Metering and Indication

R, Y, B indication lights for incomer MCCB

6A,SP, 10kA,C-curveMCBsforeachofthethreeindicationlight.

A digital multifunction meter showing voltage, current, frequency, PF, KVA and other related parameters.

1000 KVAR HPFC shall comprise capacitor banks

On and Off indication

Start and Stop push buttons

Auto/Manual selector switch for auto mode (through the HPFC Panel's DSP microprocessor) or manual mode of operation of the capacitor banks.

One unit of 75/5A, 5VA, Class 1 CT.
One unit of analog ammeter with a 75/5A dial.

APFC Relay

The power factor controller shall/be able to:

Microprocessor based and shall be able to sense the reactive current requirement of the network and shall switch ON / OFF the required stages of a capacitor bank.

Insensitive to wirings such as reversed CT connection, PT on a wrong phase etc.

Detect any stage size by automatic recognition and the switching sequence should be user defined. Detect the capacitor bank size if in case the present capacitor is replaced by a new capacitor of different rating

Is equipped with LCD display which shows at any time power factor, internal capacitor bank temperature and monitors the line frequency.

Suitable for 1A or 5 A current input and operating in temperatures up to +50 degrees C. The capacitor Bank and controller shall ensure that after the loss by fault of any one stage, it shall continue to operate automatically and shall follow rotational switching.

Recognize the connection of CT and Voltage and be able to automatically adjust itself to the phase angle difference. Regulator shall have capability to automatically search and set the C/K setting, it shall be also possible to program the C/K setting manually.

Have a minimum time delay of 120 seconds for switching on a capacitor into circuit, from its last disconnection from the circuit.

The ingress protection of the regulator shall be minimum IP 40.

The regulator must be panel mounted, shall be easily programmable and shall conform to safety guidelines as per IEC 61010-1:2001

The regulator must be suitable for 1 A or 5 A current input and shall be sensitive to a minimum current input of 40mA

The threshold value for the operating temperature and system harmonics shall be programmable and the regulator shall be able to switch off the connected capacitor stages if the actual values exceed these thresholds

Be equipped with RS485 communication port.

Dual Cos Phi – The Controller should have programmable dual cos phi to differentiate the need in compensation (Cos Phi) when the operating condition changes. Like Peak Hour (2:30-3:30PM when the target PF could be increased to 0.98) or Power factor correction needs with a utility supply changes when the input power is from an inhouse Generator.

The Power factor controller/regulator should allow the following readings.

Automatic initialization and stage rating detection

Anystepsequencedetection(Userdefinablestepsequence)

Measurementofcapacitanceperstage

Capbankoverloadcurrentratio

THDVoltage

4Quadrantoperation

Active,reactiveandapparentpower

RecordoftheMaxtempinternalofthe capacity orbanksincereset

SystemVoltage(V AC)

Frequency

ApparentPower(kVA)

Apparentcurrent(A)

Temperature(D<C)

RealtimeCosphi

kVARvaluetotargetCosphi

The controller shall initiate alarms and warnings in the following events.

Temperaturelimitisexceeded

Insufficientcapacitoroutput

Overloadcurrentratio limit Isexceeded

Undervoltage,Overvoltage

THDUlimitisexceeded

Lowpowerfactor/undercompensation.

Overcompensation

Overcurrent

Capacitorstepdefective

NOTES: The automatic power factor controller shall be manufactured in full compliance with and tested to the requirements of IEC 61326-1. IEC 61326-1 Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1:General requirements.

Capacitors

Power Factor correction capacitor shall conform in all respects to IS140 / IS141, IEC 60831-1+2. Approval ofInsurance Association of India should be obtained, if called for. The capacitors shall be 3phase, 415V rated,suitable for 525 V. at 50 Hz. Frequency, heavy duty and shall be available in single

phase and three phase units of 5, 10, 15, 20, 25 & 50 KVAR sizes. The capacitors shall be suitable for indoor use up to ambient temperature of 50°C. A 3-phase pressure switch disconnector for protection against internal faults, over pressure, etc. should be available. The pressure switch disconnector must isolate all the three phases simultaneously in the event of fault. To ensure full functionality of the pressure switch disconnector, its elastic elements must not be hindered, i.e.

Connecting lines must be flexible leads.

There must be sufficient space for expansion above the connections

Capacitor shall have following features:

Leakproof

Rustproof

Totally insulated

Self-healing

Self-protected for switching surges,

Total operating loss less than 0.5 W per kVAR

Suitable for modular construction

Vacuum impregnated with Non-PCB Polyurethane resin / non-PCB insulating oil / non-PCB inert gas

Explosion proof, scratch proof and no welded joints.

Discharge resistors

And it shall work continuously for 2.5 times the rated current

Overvoltage as per IS 140.

Peak inrush current $300 \times I_n$.

Required KVAR as mentioned in the SLD shall be as per system voltage 415V and actual selection shall be done considering 14% detuned reactor.

Reactors

Space provision for detuned reactors of suitable rating to avoid resonance to be considered.

Standards: The reactor shall conform to IS 5553.

Objective:

The objective of connecting a reactor in series with the capacitor is to avoid resonance between the inductive impedance of the supply transformer plus the line cabling and capacitors installed for power factor

Improvement in networks polluted with harmonics.

In order to avoid resonance to the 5th harmonic and above reactor should have a reactance of 14% i.e. a resonance frequency of 139 Hz for 50 Hz network.

Construction:

The reactors should be built with a core made of oriented grain iron sheet with spiltair gaps so as to give excellent anti saturation characteristics and very low losses. The coils can be made either with insulated copper bars or with aluminum sheet insulated with NOMEX. The input/output connections should be made through tinned copper bars. The coil windings should be provided with ventilation space for allowing adequate heat evacuation even hot ambience. The reactor should be vacuum impregnated with a varnish having high

Technicalcharacteristicsof the Reactor

Insulationlevel:4.0KV

ToleranceofL:3%

Linearity(5%OFL)to:1.66x2RMS=1.8In

Maximumambienttemperature:45DegC.

Internalinsulation:ClassF(155deg C)

MaximumLoad–continuous:1.1.In.

Transient(1min):2In.

Constructivestandards:AsperrelevantIS/IECStd.

LossesTemperatureProtection:Below8watts/KVAR/Microswitch (NC)

CONTACTORS (STAGE SWITCHING)

Depending on the requirements either electromagnetic contactors or electronically controlled thyristors contactor shall be used for switching PFC capacitorsasindicatedin SLD. For very fast and transient free switching, thyristors shall be employed that have a switching time of only a few milliseconds.

Electromagnetic contactor:

The contactors shall be of type three poles, specially designed for switching capacitors and shall be able to make against large transient current peaks at a high frequency of several kHz that can occur on capacitor switching. The contactors shall isolate all the three supply phases to the capacitor on switch off. The contactors shall have an electrical lifetime of min. 200,000 operations under capacitive switching conditions. Contactors along with damping resistors (AC6b) shall be used where there is a possibility of high inrush peak current to reduce it. The capacitor contactors shall be weld resistant up to a possible peak inrush current of $200 * IR$.

In case capacitor banks are supplied with Harmonic Blocking Reactors, contactors for capacitor switching shall be without damping resistors (AC3), because the peak current limitation is provided by Reactor impedance.

The contactors shall conform to IEC 947-4-1/ IEC 947-5-1. They should have a current rating of not less than 1.3 times the rated three phase capacitor unit current. They shall be tested as per IEC 269.

Active filter panel:

Active filter unit shall provide rated 450A(rms value)of required current in a step-less mode to meet the current requirement for power factor correction, harmonic compensation, neutral compensation and load balancing.

The active filter unit's hall comprise:

Twothreephase,wireunitof225A(rmsvalue)

Activefiltershallbe2leveltopology

The active filter shall be rated at 415V, 50Hz, three phase power supply. The active filter shall be capable of providing full rating of 450A in each of the three phases (Red, Yellow, Blue) of the active filter.

Healthy and Trip Indication light for the active filter

On/Off selector switch for the active filter

Suitable number and rating (with sufficient margin for overload) of DC capacitor to meet the ripple current requirement in all the three legs of the active filter of 450A

Inductor chokes of suitable rating (with sufficient margin for overload) for the active filter of 450A. The Inductor chokes shall be installed for all the three legs of the active filter.

Resistor, cables, bus-bars and other associated hardware of suitable rating (with sufficient margin) and quantity to carry expected load of 450A continuously.

Advanced DSP microprocessor controller which shall monitor the voltage and current in the three phases (Red, Yellow and Blue) and Neutral conductor to compute the exact power requirement in the three phases, and thus, implement the following features - step-less compensation of leading and lagging power factor, harmonics compensation and load balancing.

Necessary control and firing cards with proper wiring and lugs of required rating shall be provided.

The APFC Panel shall have the following features, in addition to those already mentioned above:

Target PF level shall be programmable at the time of installation and commissioning.

Priority selection between the four features of the hybrid filter shall also be programmable at the time of installation and commissioning.

Fast response time of at least 100 micro-seconds for Active filter.

Heavy duty exhaust fans and suitably placed ventilation louvers for proper heat dissipation

Bus-bars or cables shall be suitably color coded and mounted using appropriate insulator supports. Suitable clearances shall be provided for the bus-bars and other live parts of the system as per international standards.

Inspection terminal strip, number ferruling, and other labeling shall be suitably provided.

Stickers marked with "DANGER" shall be provided wherever required

Detailed drawings and manuals shall be provided wherever required

Following protections shall be provided:

Over voltage (AC) protection

Over voltage (DC) protection

Over current protection

Over temperature protection

Protection circuits for the IGBT stack and its components

All components and wiring used in the system shall adhere to the relevant ISI and IEC standard.

Any number of detuned capacitor banks can be switched off even in the auto mode; however, the active filter needs to be in ON condition during the auto mode. An OFF condition of the active filter will not allow any PF/harmonics/Load balancing compensation

In the auto mode, upon switching on the hybrid filter, the active filter shall be switched on first.

Entire set of detuned capacitor bank shall not be switched on at the same time; they shall

be switched on in a staggered manner at regular intervals- to be decided during commissioning- using the timer circuits.

User is strictly advised to not interface with the timing setting of the timer circuits. xiv. In the Manual mode of operation, any combination of the active filter and detuned capacitor banks can be kept in the ON/OFF condition.

Advanced DSP microprocessor controller which is installed in the active filters shall monitor the voltage and current in the four phase (Red, Yellow, Blue and Neutral) to compute the exact current requirement for power factor correction, harmonic compensation, neutral compensation and load balancing in the four phase.

PF correction requirement shall be shared between detuned capacitor banks and active filter.

The active filter microprocessor shall switch off some or all of the detuned capacitor banks when the reactive current requirement is too less so as to save energy.

Harmonics compensation shall be implemented by active filter; only the spare capacity (i.e. capacity after PF compensation to the desired level) of the active shall be available for harmonics compensation.

EXECUTION

Testing and Commissioning

All panel boards shall be inspected & tested in the presence of Engineer-in-charge / Consultant's representative. Engineer-in-charge after inspection shall issue inspection certificate for materials as per specification and commissioning the panels.

Generally, such tests in the factory and repeated at site are as follows:

All routine tests specified in relevant Indian / British Standards shall be carried out on all circuit breakers.

Test for protective relay operation by secondary injection method.

Operation of all meters.

Secondary wiring continuity test

Insulation test with 1000 Volts megger before and after voltage test.

HV test on secondary wiring and components on which such test is permissible (2KV for one minute)

Simulating external circuits for remote operation of breaker, indicating lights and other operations, if any.

Measurement of power required for closing/trip coil of the breaker.

Pick up and drop out voltages for shunt trip and closing coils.

CT Polarity test.

Power frequency voltage withstand test.

Earth continuity test;

Check of clearance and creepage distances;

Tests to prove correct operation of controls, interlocks, tripping and closing circuits, indications, etc.

Interfacing test with BMS control function

All other tests required by the Engineer-in-charge to verify compliance with the Specification.

All principal test records and test certificates shall be supplied in triplicate for all the tests conducted in accordance with the Specification to the Engineer-in-charge for approval before dispatch from the factory.

All materials, instruments and, labour, etc. required for conducting the tests shall be provided by the contactor at no extra cost.

Drawings and Information

The Vendor shall furnish following drawings/documents in accordance with enclosed requirements:

General Arrangement drawing of the Switchboard, showing front view, plan, foundation plan, floor cut-outs/trenches for external cables and elevations, transport sections and weights.

Sectional drawings of the circuit breaker panel, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.

Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.

Terminal plans showing terminal numbers, ferrules markings, device terminal numbers and function details etc.

Relay wiring diagrams.

Equipment List.

Vendor shall furnish required number of copies of above drawings for purchaser's review. Fabrication of switch boards shall start only after purchaser's clearance for the same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.

The information furnished shall include the following:

Technical literature giving complete information of the equipment.

Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.

A comprehensive spare parts catalogue.

Tools

One complete set of all special or non-standard tools required for installation, operation and maintenance of the switch board shall be provided. The manufacturer shall provide a list of such tools individually priced with his quotation.

Spares

The manufacturer/ tenderer shall be responsible for commissioning of the equipment supplied by them. During commissioning if any of the components fails the same shall be replaced with new spare part with in the quoted price. Contractor shall ensure availability of commissioning spares and tools at site. The details for all such spare parts and tools shall be submitted in the tender. On commissioning of the system unutilized spares and tools shall be retained by engineer-in-charge and nothing extra shall be paid on this account. The delay in commissioning of system for want of spares shall be termed as delay in completion of contract and shall be dealt as per related terms of contract. The contractor shall also furnish minimum recommended spare parts required for 5 years with their prices. Availability of spares shall be guaranteed for rated life of the equipment.

Transportation

Panel boards are not allowed to be delivered to site until the electrical room or switch room is in clean and acceptable condition with lockable doors.

Panel boards, transported to site shall be fully covered with weatherproof covers and transportation eye bolts shall be provided for handling at site.

Panel boards, which are poorly packed and result in signs of corrosion, will be rejected. All necessary measures to cover and protect the panel boards at site shall be provided. Such measures shall include a complete PVC blanket over the whole panel boards.

Rejection of Panel Boards

Deviation from specification must be stated in writing at the quotation stage.

In absence of such statement, it will be assumed that the requirements of the specifications are met without expectation.

If any of the above tests fail to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site, the Engineer may reject the item or defective component thereof, whichever is considered necessary, and after adjustment or modification as directed by the Engineer, The Contractor shall submit that item for further inspection and/or test. In the event of the defective item being of such nature that the requirements of this specification cannot be fulfilled by adjustment or modification, such item is to be replaced by the Contractor at his own expense, to the entire satisfaction of the Engineer. Delivery of panel boards on site without significant cable connection (Say 80%) shall not entitle progress payment certified for material delivery on site.

ENDOFSECTION

MULTI FUNCTION METER

General Provisions:

All setup parameters required by the Multifunction Meter shall be stored in non-volatile memory and retained in the event of a control power interruption.

The Multifunction Meter may be applied in three-phase, three- or four-wire systems as well as single phase

The Multifunction Meter shall be capable of being applied without modification at nominal frequencies of 45 to 65 Hz.

Measured Values:

The Multifunction Meter shall provide the following, true RMS metered quantity:

Real-Time Readings

Current(Per-Phase)

Voltage(L-L,L-N)

RealPower(Total)

Reactive Power
(Total)

Apparent Power (Total)

PowerFactor(Total)

Frequency

Energy Readings

**Signed Accumulated Energy(Real kWh\SignedReactivekVARh*,Apparent kVAh)
(Absolute)**

Demand Readings

DemandCurrent Calculations (Per-Phase):

(i)Present(ii)Peak

DemandReal PowerCalculations (Total):

(i)Present(ii)Peak

DemandReactive PowerCalculations (Total):

(i)Present(ii)Peak

DemandApparentPowerCalculations(Total):

(i)Present(ii)Peak

KWhandkVARhassignednetconsumptionvalues.

Demand

All power demand calculations shall use any one of the following calculation methods, selectable by the user:

Block interval, with optional sub-intervals. The window length shall be set by the user from 1- 60 minutes in 1-minute intervals. The user shall be able to set the sub-interval length from 1- 60 minutes in 1-minute intervals. The following Block methods are available:

Sliding Block that calculates demand every 15 seconds with intervals less than 15 minutes and every 60 seconds with an interval between 15 and 60 minutes.

Fixed Block that calculates demand at the end of the interval.

Sampling

The current and voltage signals shall be digitally sampled at a rate high enough to provide true RMS accuracy to the 15th harmonic.

"The Multifunction Meter shall provide continuous sampling at a minimum of up to 32 samples/cycle, simultaneously on all voltage and current channels in the meter.

Current Inputs

The Multifunction Meter shall accept current inputs from standard instrument current transformers with 5-amp secondary output and shall have a metering range of 0-6 amps with the following withstand currents: 10 amps continuous, 50 amps 10 sec per hour, 120 amps 1 sec per hour.

Current transformer primaries through 327 kA shall be supported.

VoltageInputs

The Multifunction Meter shall allow connection to circuits up to 480 volts AC without the use of potential transformers. The Multifunction Meter shall also accept voltage inputs from standard instrument potential transformers. The Multifunction Meter shall support PT primaries through 1.6 MV.

The nominal full-scale input of the Multi-function Meter shall be 277 Volts ACL-N, 480 Volts AC L-L. The meter shall accept a metering over-range of 20%. The input impedance shall be greater than 2 Mohm (L-L) or 1 Mohm (L-N).

Accuracy

The Multifunction Meter shall comply with ANSI C12.16 and IEC-62053-21, Class 1

Functions performance class according to IEC 61557-12 (with CT ratio=1:1 and PT ratio=1:1) are, Class 0.2 for Voltage L-L from 30 Vac-480 Vac. Class 0.2 for Phase Current from $25\% I_n < I < I_{max}$ Class 1.0 for Total Active Power from $1\% I_n < I < I_{max}$ and 0.5 Ind to 0.8 Cap. Class 1.0 for Total Active Energy from 0 - 9999999.9 kWh. Class- for Power Factor Vector from 0.5 Ind to 0.8 Cap. And Class 0.02 for Frequency from 45 Hz - 65 Hz. (PM700)

No annual calibration shall be required to maintain this accuracy when the Multifunction Meter operates under specifications.

Input/Output

The Multifunction Meter shall be capable of operating a solid-state output to provide output pulses for a user definable increment of reported energy. Minimum relay life shall be in excess of one billion operations. The standard pulse output shall operate up to 240-volt AC, 300-volt DC, 96mA max, and provide 2.41 k Volt rms isolation.

All meters of main LT panel of all electrical substations shall communicate on Modbus

RTU for necessary integration wherever required.

Control power

The Multifunction Meter shall operate properly over a wide range of control power including 110-415VAC, +/-10% or 125-250VDC, +/-20%.

Communications

The Multifunction Meter shall communicate via RS-485 Modbus protocol with a 2-wire connection at speeds up to 19.2 k Baud.

It shall be possible to field upgrade the firmware in the Multifunction Meter to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly or changing of integrated circuit chips shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

Display

The Multifunction Meter display shall be back lit LCD for easy viewing, display shall also be antiglare and scratch resistant

The Display shall be capable of allowing the user to view four values on one screen at the same time. A summary screen shall also be available to allow the user to view a snapshot of the system.

The display shall include two different modes of visualization, IEEE and IEC for all quantities. The Display shall show 3 phase bargraphs

The Multifunction Meter display shall provide local access to the following metered quantities:

Current,perphaserm

Voltage,phase-to-phase,phase-to-neutral

Realpower,3-phasetotal

Reactive power, 3-phasetotal

Apparentpower,3-phasetotal

Signed Power factor, 3-phasetotal

Frequency

Demandcurrent,perphase

Demandrealpower,threephasetotal

Demandapparentpower,threephasetotal

SignedAccumulatedEnergy,(kWh,kVAh,andkVARh)

ResetofthefollowingelectricalparametersshallalsobeallowedfromtheMultifunctionMeter display:

Peakdemandcurrent

Peakdemandpower(kW,kVAr,kVA)

Energy(MWh)andreactiveenergy(MVARh)

Setup for system requirements shall be allowed from the Multifunction Meter display.

Setupprovisions shall include:

CTrating

PTrating(SinglePhase,2-Wire)

Systemtype[three-phase,3-wire] [three-phase,4-wire] [2wire]

Watt-hours per pulse (PM200P Only)

Communication parameters such as address and baud rate

Upgrades

It shall be possible to field upgrade the firmware in the Multifunction Meter to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly, changing of integrated circuit chips or kits shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

Installation

To ensure safety of goods and people, the installation category of the Multifunction Meters shall be III. The communication circuit shall be of SELV type (security extra low voltage) and shall provide a class II insulation level between distribution system connection and communication port. The meter shall withstand a Uimp of 6kV. (Uimp: impulse withstands voltage).

The Multifunction Meter shall be rated for an operating temperature range of 0°C to +60°C. Depth of the Multifunction Meter behind panel with communication port shall be equal or less than 50mm.

Standard

The multifunction meter shall comply with the following standards.

IEC62053-22-ActiveEnergyClass1

IEC61557-12

IEC61010-1-Safety

END OF SECTION

33kV HT Panel Specification

Electrical System

1. Medium Voltage Switchgear HT Panel

Scope

This specification covers design, manufacture, shop testing, delivery at site, erection, testing and commissioning of type tested Indoor Air insulated 35KV up to 2500A, 26.3kA / 40kA (3sec), 3 Phase, metal clad, horizontal draw out type Switchboard with vacuum circuit breaker and all accessories, protective devices mounted and wired up.

Codes and Standards

The design, material, construction, manufacture, inspection, testing and performance of the Switch Board offered shall comply with all currently/latest applicable standards, regulations and safety codes in the locality where the equipments will be installed. Other National Standards are acceptable if they are established to be equivalent to or superior in performance specifications to the listed standards.

IEC: 62271 - 1 High-voltage switchgear and control gear - Common specifications.

IEC: 62271 - 100 High-voltage switchgear and control gear - Alternating current circuit-breakers.

IEC: 62271 - 200 High-voltage switchgear and control gear - AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV.*

IEC: 62271 - 102 High-voltage alternating current disconnectors and earthing switches

IEC: 62271 - 103 Switches for rated voltages above 1 kV up to and including 52 kV

IEC: 62271 - 106 High-voltage alternating current contactors

IEC: 60044 - 1 Current Transformers

IEC: 60044 - 2 Voltage Transformers

General

Design Basis

The switchboards shall be modular and extensible at site. They shall comprise functional units as defined by IEC 62271-200. The factory-made functional units shall be bolted together at the place of use. The equipment shall be suitable for operation in tropical climate considering design ambient temperature of 40°C. Temperature rise shall be as per IEC 62271-200.

Degree of protection shall be IP 4X. The functional unit outer enclosure shall have a degree of protection of IP3X {option:} [IP4X]. The partitions between compartments of the same cubicle shall have IP2XC. The cubicle shall be of LSC 2B (Loss of Service Continuity) and PM (Partition Class) classes as defined by IEC standard 62271-200. And it shall comprise three high voltage compartments and one LV cabinet:

All the HV compartments shall be tested for Internal Arc of 26.3kA for 1 sec. Power frequency withstand voltage shall be 28KV rms. Impulse withstand voltage shall be 75KV peak.

The cubicles shall not require forced ventilation when the rated current is equal to or less than 2500A and service condition are normal.

Constructional Features

Switchboard shall be factory assembled, totally enclosed, metal clad, dead front cubicles. It shall be completely wired with all electrical accessories as specified in the tender.

Switchboard shall be dust, moisture and vermin-proof. All louvres shall have screens and filters. Vent openings shall be so arranged that hot gases or other material cannot be discharged through them in a manner that can injure the operating personnel. Pressurized gas shall get discharged only from the top of the respective HV compartments. Panel structure shall be of Aluzinc for extended panel life in saline, polluted atmosphere.

Sheet steel shall preferably be galvanized to avoid rusting. Sheet steel thickness shall be as per manufacturer's type tested design. Cubicles shall be fitted with removable gland plates of non-magnetic material with built in adjustable cable holding clamps. It is preferable to have fabricated cubicle with rivetted design.

Switchboard shall have separate vertical section (panel) for each circuit breaker.

Separate compartments shall be provided for circuit breaker, low voltage instruments, bus bars and cables. Current transformers shall be mounted in the cable compartment. Line potential transformers shall be mounted at the rear side of the respective breaker panel. Bus potential transformer shall be housed in a separate trolley, placed in a separate panel. Assembly of all current carrying parts shall be such that they shall be easily accessible for inspection and maintenance. Separate explosion vent shall be provided for each of the HV compartments; circuit breaker, bus bar and cable. The breaker shall be of Floor rolled mounted on trolley or with cassette arrangement.

Seal off bushing shall be provided between the breaker and bus bar compartment and also between the breaker and the cable compartment. The shutters for withdrawable parts shall be able to be locked out individually by a padlock.

The panel shall be designed for accommodating 5 runs of 1C X 630 sq.mm. cable or 2 runs of 3C X 400 sq.mm. cable. Head room clearance for cable termination shall be suitable for 11kV termination requirement. Power cable entry shall be from the rear bottom of the panel. Control cable entry shall be from the front bottom of the panel, along the either side of circuit breaker. Split gland plate with adjustable cable holding clamp shall be provided. Motorized option for rack in / rack out with door closed shall be preferred and if bidders can quote this option with extra price if design is available.

Switchgear shall be having following interlocks:

Movement of CB from test to service position shall be possible only when all the following conditions are met with.

The breaker is in OFF position.

The auxiliary plug and socket is engaged and locked.

CB compartment door is closed.

Rear covers are closed.

Earth switch is OFF.

Movement of CB from Service to Test position is possible only when the CB is OFF.

Front door of breaker compartment cannot be opened unless breaker is tripped and brought to test position.

Auxiliary plug and socket cannot be opened unless the CB is brought to test position.

Earth switch in the outgoing side (rear side) can be made ON only when circuit breaker is switched OFF and brought to test position.

Rear cable cover cannot be opened unless breaker is OFF and brought to test position & the earth switch is ON.

Metallic shutters shall be provided to prevent accidental contact with main stationary contact or other live parts when the circuit breaker is drawn out. When the circuit breaker is inserted back in the cubicle, it shall allow the circuit breaker to continue its travel until it fully engages the main stationary contacts. Suitable guides, slides and stops for proper positioning of the truck or trolley with the circuit breaker shall be provided to ensure easy removal, replacement and positioning of the circuit breaker. All circuit breakers of same rating shall be interchangeable with one another. Provision shall be made to prevent entry of circuit breaker of different rating even though the cubicle width remaining same. It is preferable to have cubicle width not exceeding 800mm.

Based on requirement each circuit breaker cubicle shall be provided with cable earthing switch at the rear side with due interlocks as stated earlier. Earth switch shall be tested for full fault make current, as well as short time rating. Provision shall be made for the operation of earth switch both from front as well as rear.

Instruments and relays shall be mounted on the hinged type front door of the metering compartment.

Sheet steel used for fabrication shall be ld rolled carbon annealed only and fabrication shall be done through CNC turret punch press and CNC bending machine. Painting is through epoxy based electrostatic powder spray or sheet steel shall be of aluzinc material without painting.

Breaker compartment door shall get locked at various points with one lever operation. It shall not necessitate bolting at various points for safety and reliability at all times. Doors and covers shall have several hinge points for proper locking to avoid opening of the same in the event of internal arc.

Busbars

The main busbars shall be of electrolytic copper/Al, with flat design for uniform field gradient.

The busbars shall be located in a separate metal clad chamber and shall be air insulated. Bus bars shall be extendible on either side.

The busbars shall be rated for 2500A (800A / 1250A / 2000A) continuous current, at 40°C ambient temperature. Temperature rise shall be as per IEC 62271-200.

The busbars shall be adequately supported on insulators or integral epoxy spouts to withstand dynamic stress due to the short circuit current specified.

The bus bars shall be sleeved for full voltage. Sleeve shall be heat shrinkable BTPM type of Reychem / equivalent make. No PVC sleeving in bus bar for 11 KV is acceptable.

Circuit Breaker

The breaking medium of circuit breaker, contactor shall be vacuum. The breaking medium of switch (switch-fuse combination function) shall be in Air. switchboard shall comprise indoor, metal clad, fully draw-out, Vacuum Circuit Breaker. The circuit breaker shall be trolley or cassette mounted and shall be operated by motor wound spring charged mechanism. It is mandatory for the switching devices that equip the functional units to be made by the switchboard supplier, or by a manufacturing plant that belongs to the same company.

Functional units shall be available with following withdrawable devices:

Withdrawable circuit breaker,

Withdrawable contactor with fuses,

Withdrawable earth connecting truck,

Each circuit breaker shall be provided with the following accessories:

ON-OFF indicator for indicating circuit breaker position.

Trip push button.

Shunt trip coil, operating between 70%-110% of rated control voltage.

Close coil, operating between 85%-110% of rated control voltage.

Spring charging motor, operating between 90%-110% of rated control voltage.

Dual tripping coils if required shall be provided in all the breakers.

Racking in and racking out operations shall be carried out only with the door closed and, for a circuit breaker or a contactor, when the circuit breaker or contactor operating auxiliaries are connected. It shall only be possible to open the door when the withdrawable part is in the "racked out or test" position.

The circuit breaker shall be designed so as to have class E2 (circuit breaker with extended electrical endurance) of electrical endurance, and class M2 (circuit breaker with extended mechanical endurance, mechanically type tested for 10 000 cycles) of mechanical endurance, as defined by IEC 62271-100.

Operation of switching devices

Handles shall be used for all operations (racking in/racking out withdrawable devices, open/close earthing switch, racking in/racking out fuses of VTs (if applicable)). { option: } It shall be possible to have motorized earthing switch to close/open Earthing switch remotely.

If there is extraction tool, there shall be mechanical interlock for the withdrawable devices extraction operation, in order to make it impossible to extract a device unless the extraction tool is solidly locked to the functional unit, and impossible to unlock the extraction tool unless withdrawable device is locked to the tool or in the functional unit.

The various operations of circuit breaker and earthing switch must be done in front of the switchboard. When the racking operations are completed, they shall be confirmed by means of a dedicated indicator.

Operations of circuit breakers and earthing switches shall be described solely in the form of explicit symbols and colour codes. Instruction using texts will not be accepted. There shall be indicators to show the positions of switching devices, of withdrawable parts and of earthing switches.

Wiring

Wiring for all control circuits shall be carried out with 1100 volts grade PVC insulated stranded copper conductor of size not smaller than 1.5 sq mm. CT circuits shall be with 2.5 sq mm. size conductor.

Control supply for closing and tripping shall be 110 Volts D.C. through external battery source. 230 Volts single phase A.C. supply shall also be available for the operation of spring charging motor and cubicle space heater. Wattage of closing and tripping coils shall be within 250 watts. Aux supply shall be suitably distributed along with switchgear in loop in loop out fashion.

All Switchgear panels shall be supplied completely wired internally up to the terminal block ready to receive external cabling.

All the secondary wiring in the panel shall have high quality PVC insulation and the same shall have conductor size of not less than 1.5 mm² of copper.

Colors of the secondary/auxiliary wiring should confirm to IS 375/1963 and latest amendment thereof if any. All wiring shall be neatly routed, and group of wiring shall be securely fixed by clips so that wiring can be checked without necessity of removing the clamps. Wiring between fixed and moving portion of the panel shall be run in flexible tubes and the same shall be so mounted to avoid any damage to them due to mechanical movements. Ferrules with number shall be provided on both end of the wiring.

All wires directly connected to trip the circuit breaker shall be distinguished by the addition of a red colored unlettered ferrule.

Earthing circuit

The earth conductors of all cubicles shall be connected to one another as well as connected to the main earth conductor. The main earth conductor shall be installed in the cable compartment.

There shall be a continuous copper earth bus of size 50x6 sq. mm running at the bottom of the panel. Earth bus shall be robust and shall carry full short circuit current for 1 second. Doors covers and all non-current carrying metallic parts shall be earthed through flexible copper wires. This also includes instrument casing and cable armor which are also connected to the earth bus.

Separate earthing truck shall be provided for bus earthing and cable earthing. The earthing truck shall be so designed that it is impossible to earth on live condition. It shall be provided with capacitive voltage divider and complete with audio visual annunciation.

In addition to scrapping earth in auxiliary plug and socket proper arrangement should be made so that during engagement of the breaker in service condition earthing contacts are made first before isolating power contacts are engaged.

Low Voltage Compartment

Low voltage compartment shall be mounted at the front on the top of breaker compartment and shall also have hinged type of door.

All wiring shall be routed through PVC ducts and shall be terminated on to stud type terminal with plastic cover.

For current transformer, terminals shall be disconnecting link type only. The wire shall be of 1.1KV grade and suitable for 2 KV rms for 1-minute power frequency high voltage.

Cable Compartment

It shall be at the rear side with rear bolted box type back covers.

The gland plate of cable chamber shall be of minimum 3mm thickness MS sheet in two halves section with built in adjustable cable holding clamp. In case of single core cable it shall be supplied with non magnetic gland plate. Cable box shall accommodate 2-3Core 400 sq. mm.

Sufficient headroom shall be provided for cable termination. The distance between gland plate and terminal shall be minimum 600mm.

Control cable entry shall be from front and there should be a possibility of terminating to LV chamber from both right hand and left hand side. Power cable entry shall be from rear bottom. Provision shall be available for entry of power cable or bus duct from rear bottom or rear top.

Current and Potential Transformer

Current transformers shall be double core window/bar primary for higher rating or wound primary for lower rating. Maximum VA burden shall be of 15 VA and shall be rated for full short circuit current for 1 or 3 second. Differential /REF CTs can be in one mould. Incase of numerical relays 10VA burden shall be sufficient. CT shall be of a minimum accuracy of class 0.5/5P10 and CT Secondary rating shall be 1A unless otherwise specified.

Potential transformer shall be 3phase 3 limb type with 50VA per phase of class 0.5/3P accuracy and shall be mounted on incomer breaker truck. For bus connected P.T the same shall be mounted in a separate withdrawable truck in a separate vertical panel.

Pre-Treatment and Painting

Switchgear front and rear covers shall be painted for aesthetic purposes and Paint shade shall be RAL 7032. Or based on customer requirement.

Type Tests

The design of cubicle shall be proven through all the routine and type tests in accordance with IEC 62271-200.

Relays

Numeric Protection Relays

1. General description

The Protection and Control device shall be of numerical type and designed to meet a high degree of dependability and security.

The local human machine interface (HMI) shall be based on a user-friendly and menu-structured program. The device shall include a 64x128 LCD matrix display which supports mimic (e.g. single line diagram can be drawn) and freely assignable analogue values.

The device shall include navigation push buttons, freely programmable function push buttons with user configurable legend texts. The keypad buttons have to provide tactile feedback to safely operate the device HMI.

The device shall have control buttons for direct or select-execute CB control. Also the device has to have at least 12 LEDs with user configurable legend texts. At least 8 LEDs shall be freely programmable.

Access to protection setting mode shall be protected by a password that can be personalized by the user. There shall be at least three separate user levels with dedicated password protection at least two out of three of the highest levels.

CT 1/5A nominal current shall be available for phase and residual current input. Also option for 0,2A/1A nominal current for residual current shall be available. The current values shall be scalable. Rated voltage input shall be 100V and configurable for VT secondary's between 50-120 V.

One common relay's management software (based on standard Windows operating systems) shall provide all necessary tools and functions to operate the devices. Via the management software relay parameters, configurations and recorded data can be exchanged between PC and the device. Supporting the comtrade format, the management software also incorporates tools for analyzing relay events, waveforms and trends from data recorded but the device.

The device shall be provided with at least 16 digital inputs and 8 digital outputs (trip relays). The DI threshold should be 70% of the control voltage.

A minimum of four setting groups must be provided in the device. These shall be activated locally, remotely or via a dedicated input.

At least 1 alarm relay and 1 self-diagnostic output must be available

The operating temperature range shall be from -40°C to $+65^{\circ}\text{C}$ (or -40°F to $+149^{\circ}\text{F}$). Storage and transport temperature range shall be from -40°C to $+70^{\circ}\text{C}$ (or -40°F to $+158^{\circ}\text{F}$).

The 5A current inputs shall be capable of thermal withstanding: 20 A continuously, 100A for 10s and 500A for 1s and 1A current inputs shall be capable of thermal withstanding:

4 A continuously, 20A for 10s and 100A for 1s.

The devices shall meet the applicable IEEE/ IEC design standards. It shall have type test reports for Disturbance tests, electrical safety tests, mechanical tests and environmental tests which are within 5 years from the date of issue of the certificate.

The device shall have KEMA IEC61850 edition 2 certificates which are within 5 years from the date of issue of the certificate.

The device shall support webserver/web HMI through which we can monitor and control the relays over a ethernet Lan network.

The device shall support virtual simulation through which protection functions and logic testing can be achieved without any separate software.

At least 8 programmable Protection stages should be present along with the inbuilt protection Functions available in the relay.

All the relays shall be conformally coated complying to the IEC 60068-2-60 standard.

2. Protection functions

The device shall contain following necessary protections;

Incomer

Phase overcurrent (50/51), Directional phase overcurrent (67), SOTF(50 HS), Thermal overload (49), Earth fault (50N/51N), Directional earth fault (67N), Directional power (32), Phase undercurrent (37), Undervoltage (27), Overvoltage (59), Zero sequence voltage protection (59N), Over and Under Frequency (81), Under frequency (81U), Rate of change of frequency (81R), Magnetizing inrush (68F2), 5th harmonic detection (68H5), Circuit breaker failure (50BF), Cold load pick-up, Synchro check (25), CB wear, CTS (60), VTS (60FL), TCS, Lockout (86), Broken conductor (46BC), Auto recloser (79), Fault locator (21FL)

Buscoupler

Phase overcurrent (50/51), Directional phase overcurrent (67), SOTF(50 HS), Thermal overload (49), Earth fault (50N/51N), Directional earth fault (67N), Directional power (32), Phase undercurrent (37), Undervoltage (27), Overvoltage (59), Zero sequence voltage protection (59N), Over and Under Frequency (81), Under frequency (81U), Rate of change of frequency (81R), Circuit breaker failure (50BF), Synchro check (25), CB wear, CTS (60), VTS (60FL), TCS, Lockout (86), Broken conductor (46BC), Auto recloser (79).

Outgoing Feeder/transformer

Phase overcurrent (50/51), SOTF(50 HS), Thermal overload (49), Earth fault (50N/51N), Phase undercurrent (37), Magnetizing inrush (68F2), 5th harmonic detection (68H5), Circuit breaker failure (50BF), Cold load pick-up & 2nd harmonic detection(68H2), CB wear, CTS (60), VTS (60FL), TCS, Lockout (86), Broken conductor (46BC), Auto recloser (79).

Outgoing Motor

Phase overcurrent (50/51), Thermal overload (49), Earth fault (50N/51N), Phase undercurrent (37), Start up supervision(48), Motor restart inhibit(66), Locked rotor (51LR), Magnetizing inrush (68F2), 5th harmonic

detection (68H5), Circuit breaker failure (50BF), Cold load pick-up & 2nd harmonic detection (68H2), CB wear, CTS (60), TCS, Lockout (86), Negative phase sequence overcurrent (46), Auto recloser (79).

Overcurrent protection shall have a wide range of time overcurrent protection curve settings, providing a choice of curve types:

Standard delay characteristics curve family: IEC, IEEE, IEEE2 and RI

Standard delay formulae with free parameters selecting a curve family (IEC, IEEE, IEEE2) and defining one's own parameters for the selected formula

Fully programmable inverse delay characteristics

Pick-up setting of three over current stages have to be able to control remotely.

Changing setting groups has to be able to do via: manually, digital inputs, virtual inputs, virtual outputs or LED indicator signals.

The device shall have force start and trip condition for testing. Any protection function has to be able to block by internal and external signals using block matrix.

Functional Description:*

Overcurrent protection:

The relay shall have independent time delayed Non-Directional and Directional O/C stages, with selectable DT/IDMT characteristics. In addition to the standard IDMT curves, the relay shall also have the facility to build at least three user programmable characteristics. It shall also be possible to view the graph of IDMT curves on the Local panel display.

Non-Directional

The relay shall have three separately adjustable over current stages: I>, I>> and I>>>. The first stage I> shall be configured for definite time (DT) or inverse time characteristic (IDMT) with a setting range of 0.05 In to 5 In. The stages I>> and I>>> shall have definite time operation with the setting ranges of 0.1 In to 20 In and 0.1 In to 40 In respectively.

Directional

The relay shall have four separately adjustable stages available: Idir>, Idir>>, Idir>>> and Idir>>>>. The first two stages shall be able to configure for both DT and IDMT standard and programmable curves with the setting ranges of 0.1 In to 4In. The third and fourth stages shall have DT characteristics with the setting ranges of 0.1 In to 20 In. The directional characteristics angle setting ranges from -180 degrees to +179 degrees.

Earth fault protection:

The relay shall have independent time delayed Non-Directional and Directional E/F stages, with selectable DT/IDMT characteristics. The relay shall have the facility to choose the residual current which is either derived from the three phase current inputs or measured directly from dedicated neutral CT's. In addition to

the standard IDMT curves, the relay shall also have the facility to build at least three user programmable characteristics. It shall also be possible to view the graph of IDMT curves on the Local panel display.

Non-Directional

The relay shall have five separately adjustable earth fault stages: $I_{o>}$, $I_{o>>}$, $I_{o>>>}$, $I_{o>>>>}$ and $I_{o>>>>>}$. The first stage $I_{o>}$ shall be configured for definite time (DT) or inverse time operation characteristic (IDMT) with a setting range of 0.005pu to 20 pu. The 2nd, 3rd, 4th and 5th stages shall have definite time operation with the setting ranges of 0.01 pu to 20 pu.

Directional

The relay shall have three separately adjustable stages available: $I_{o\ dir>}$, $I_{o\ dir>>}$ and $I_{o\ dir>>>}$. All stages shall be able to configure for both DT and IDMT standard and programmable curves with the setting ranges of 0.005 pu to 20 pu for the first stage, and 0.01 pu to 20 pu for 2nd and 3rd stage. The directional characteristics angle setting shall range from -180 degrees to +179 degrees.

Over Voltage/Under Voltage

The relay shall have 3 under/over voltage stages each. Also the relay shall have residual over voltage protection which can be either measured from the broken delta connection or can be derived from the three phase to neutral voltages.

Measurements

The device shall offer complete set of measurement functions. The measurement functions cover phase, line and residual currents, current imbalance, system frequency and harmonics from phase currents. Condition monitoring has to monitor continuously trip circuits, breaker wear and current transformers. Phasor diagram view of currents should be available.

Diagnostics

Event buffer size can be modified from 50-2000 events

The device shall provide storage up to events 2000 based on the resolution.

The devices shall further provide disturbance records:

Triggering shall be settable on any selected measured signal (currents, voltages, status information of DI and DO)

The sample rate of the recording has to settable from 32/cycle up to 1per minute

Each record shall be able to contain 12 channels

Memory shall be at least capable of recording 24 faults.

The device shall provide 8 fault records per protection with the details of the fault, fault current, date & time.

Control

The device shall support customer defined programmable logic for Boolean signals. User configurable logic has to support also something that is not provided by the relay as default.

The device has to allow controlling of min. six objects (circuit breakers, disconnectors and grounding switches). Controlling has to be done by “select-execute” or “direct control” principle. Controlling has to be possible by: through local HMI, remote communication, via digital input or via function key.

Communication

The device shall have USB communication port in the front for the setting software use and at the back the communication ports shall be either 2xRJ-45 Ethernet port or 2xLC Ethernet ports.

The device shall support following communication protocols: Native IEC 61850.

The IEC 61850 communication has to support peer to peer communication (GOOSE). The IEC 61850 interface must be able to configure through setting software. Also the same setting software has to be able to generate ICD files.

Thermal Monitoring (Wireless)

Thermal monitoring shall be fitted on HV field cable/busbar connections, The monitoring shall be done by a battery less sensor that communicates wirelessly using Zigbee Green Power protocol.

ARC flash protection system with ACTIVE Arc flash protection:

Purpose of Active ARC flash protection is to protect the Indoor switchgear & Human resources in case of any internal ARC fault and also minimize the damage, maintenance cost and downtime of the system. The system should focus on minimizing the operation time to control the fault energy released in case of fault. The system should be designed to trip the respective feeder quickly in case of ARC flash fault to isolate the fault based on the location of the ARC fault.

The protection system should have a possibility to have AND logic for LIGHT and Over Current to prevent Mal Operation due to any external light. The ARC protection system should be based on Numerical based devices which are capable of working on ARC presence and over current logic. The protection system should operate quickly to limit the damage due to ARC flash fault inside panel by reducing the tripping time which should be less than 10 ms in case of a real ARC fault. It should also have an additional High speed tripping contact of 2ms to ensure more faster tripping.

The ARC detection should be done by the Arc sensors (Optical detection~8000Lux intensity) installed at suitable locations to cover full switchgear and make sure that no ARC goes undetected. The Arc system should include three sensors per compartment for MV feeders, one in each compartment Bus Bar, breaker and cable.

Arc protection relays should have dedicated communication channels to achieve different operations mentioned in the schemes. The data (to achieve tripping) shall not be passed through substation communication networks (like scada network, GOOSE network) as it will bring substantial delay in operation time of tripping in the event of arc (especially for the fault occurring in breaker compartment and busbar compartment).

The Arc flash protection system should be based on Master Slave philosophy for flexible and scalable scheme which can be upgraded in future without major change in the existing scheme and additional

modules should be able to increase the scalability of the system. The system should have selective operation based on ARC location and zone, system should be able to have ARC zones for flexible and selective operation.

OEM-manufactured panels to be quoted only. Partner-made panels are not accepted.

11kV HT Panel Make List: **ABB/Schneider/Siemens**

ENDOFSECTION

TTA Panel Specification upto 4000A

Electrical System

1. Main Low Voltage Switchboard Enclosure

This section covers the detailed requirements of Main Low Voltage Switchboard for 415 volts, 3 phase, 50 Hz, 4 wire system.

STANDARDS AND CODES

The equipment proposed in this offer to be designed, manufactured, and tested according to the relevant IEC recommendations:

IEC 61439-1/2 Low voltage switchgear & controlgear assemblies – Part 2 Power switchgear and controlgear assemblies

IEC60529 Degrees of protection provided by enclosures

IEC60947-2 Low voltage switchgear & controlgear – part 2 Circuit breakers

IEC60947-3 Low voltage switchgear & controlgear – Part 3 Switches, disconnectors, switch-disconnectors & fuse combination units

IEC60 947-4-1 Contactors and motor starters

IEC60044-1 Current transformers

IEC60186 Voltage transformers

IEEE693 Environmental testing/ Seismic Withstand Level

IEC61140 Protection against electric shock – Common aspects for installation and equipment – Basic safety publication

IEC61641 TR Internal Arc Test report

General

LV Switchboards shall be certified by 3rd party Certification body as per IEC 61439-1 & 2. Test reports without certificate shall not be considered admissible proof of compliance. The Certifying Authority shall be qualified under ISO/IEC 17065 as per IEC 61439-1. IEC 61439 Certificate to be made available for all ratings of LV Switchboards as mentioned in Schedule of Quantities or Single Line Diagram for this project.

The Panels should be cubicle type indoor mounting, fully compartmentalised with hinged lockable detachable front & back openable, dust and vermin proof, floor mounting sheet steel clad switchboard fabricated out of 2 mm thick CRCA powder coated sheet steel suitable for use at 415 volts 3 phase 4 wire 50 cycle system and to withstand a symmetrical fault level of 50 KA at 415 volts. Panels shall be fabricated in easily transportable sections, length, height, depth etc. to match with site condition. All incomer breaker and Bus Couplers shall be interlocked electrically as shown in SLD and specifications. To ensure installation

consistency during switchboard life cycle, installation system, switchgears, motor starter components and metering devices must be supplied by the same Manufacturer (OEM).

IEC 61439-1&2 compliance certificate to be submitted for all ratings of LV Switchboards as mentioned in Schedule of Quantities or Single Line Diagram for this project along with the tender.

The LV switchboards and the associated equipment including switchgear, control gear, Busbar supports, Busbar orientation, Busbar links etc shall be identical in construction to the assembly which has undergone certification as per IEC61439-1 & 2.

Certified design of switchboards shall be proven design from OEM (Original Equipment/ Switchgear Manufacturer). OEM name should be mentioned on top of each column of switchboard. Also, OEM Partnership Certificate shall be furnished by Panel builder.

To ensure installation consistency during switchboard life cycle, installation system, switchgears, motor starter components and metering devices must be supplied by the same Manufacturer (OEM).

Switchboards shall have a short circuit level withstand as per Schedule of Quantities and drawings. The enclosures shall be designed to take care of normal stress as well as abnormal electro-mechanical stress due to short circuit conditions.

Switchboards shall have Rated Impulse withstand voltage (Uimp) of 12kV for withstanding against transient Overvoltages, for which the values of clearances are referred applicable for ACB, horizontal & vertical busbars.

All covers and doors provided shall offer adequate safety to operating persons and provide ingress protection of IP 42 unless otherwise stated. Ventilating openings and vent outlets, if provided, shall be arranged such that same ingress protection of IP 42 is retained.

Switchboards shall be tested for Internal arc as per IEC61641. The test should be performed for arc starting place - at Horizontal busbar, Vertical busbar and in outgoing cable compartments. Internal arc test to be performed on switchboards having Aluminium busbar. Reports with Cu busbar design shall not be accepted as proof of compliance.

As Aluminium busbar are recommended for switchboard - Internal arc test to be performed on switchboards having Aluminium busbar. Reports with Cu busbar design shall not be accepted as proof of compliance.

To ensure right performance on Seismic risk, Switchboards shall be validated design for Seismic withstand for Ground Acceleration level of 2g. Test shall be performed in accordance with standard IEEE 693 : 2018.

Switchboards must have mechanical impact IK10 tested.

In order to facilitate access within the switchboard for maintenance, its covering panels must be dismountable on all surfaces for all IP degrees

To ensure maximum protection of people around the electrical installation, front plates must be installed in front of all control and protection equipment in order to avoid direct access without a tool to the devices and consequently to the live parts.

For safety reasons and especially when the door is open during switchboard operation, all busbars must be covered by Metallic barriers over whole perimeter of the busbar zone. IP2X (touch proof) protection shall be available.

As specified in the BOM the switchboard shall be form 3b. For forms of separation to be achieved, only metallic covers shall be used. Hylem/ PVC sheets shall not be allowed.

To enhance Sustainability, LV Switchboards shall have Green Premium Certification, with eco production, with product design in accordance with RoHS & REACH directives and with End of Life Instructions. All TTA Panels shall be fitted with such arrangement which will guide early detection of cable over heating.

The switchboard shall be supplied with a smartphone/web-based maintenance tracking system. A unique identifier (like QR code) shall be employed for each switchboard to enable quick access to switchboard details including but not limited to switchboard drawings, wiring diagrams, list of spares, Switchboard BOM etc. A maintenance schedule shall be provided by the manufacturer for switchboard and major components inside. There should be a provision to enable alerts for upcoming maintenance activities for the switchboard and components. The alerts shall be automated and provided to the maintenance staff appointed by the End-user in the form of smartphone notifications.

Switchboard Configuration

The Switchboard shall be configured with Air Circuit Breakers, MCCB's, MCB's, Motor Starter components, Metering devices and other equipment as called for in the schedule of quantities.

The MCCBs shall be arranged in multi-tier formation whereas the Air Circuit Breakers shall be arranged in Single tier or Two-Tier formation to facilitate operation and maintenance.

The Switchboards shall be of adequate size with a provision of spare space to accommodate possible future additional switch gear.

Constructional Features

The Switchboards shall be metal clad totally enclosed; floor mounted free-standing type of modular extensible design suitable for indoor installations. Switchboards, panels and cubicles shall be fabricated with CRCA Sheet Steel of thickness, same as that of tested assembly according to IEC61439-1 & 2. Sheet thickness for Load bearing frame structures shall not be less than 2.0 mm and shall be folded and braced as necessary to provide a rigid support for all components. Also, the doors and covers shall be fabricated from CRCA sheet steel of thickness not less than 1.6 mm.

All panels and covers shall be properly fitted and square with the frame. The holes in the panel shall be correctly positioned.

Panel shall be supplied with a double door arrangement. Global Door/ Front Door shall be fitted with transparent Glass to allow maintenance staff to visually access device status, meter readings, indicating lamp status without opening the door. IP level & Mechanical impact performance of the panel shall not be compromised in any scenario and shall remain at IP42/54 and IK10 level respectively, in all conditions.

Global door shall be provided with Ergonomic handles with locking (key RONIS n° 405).

Switchboards construction shall employ the principle of compartmentalized and segregation for each circuit.

Incomer and bus section panels or sections shall be separate and independent and shall not accommodate any outgoing feeder. The incomer panel shall be suitable for receiving bus trunking or LV cable of size specified.

Switchboards shall be made up of requisite vertical sections, which when coupled together, shall form continuous switchboards.

Switchboard shall be readily extensible on both sides by addition of vertical sections after removal of the end covers.

The switchboards shall be designed for use in high ambient temperature upto 45 degree centigrade and humid tropical conditions suitable for pollution degree 3.

Ease of inspections, cleaning and repairs while maintaining continuity of operation shall be provided in the design.

Special care to be taken to ensure effective earthing of the frame and doors of the switchboards.

Each vertical section shall be provided with a rear or side cable chamber housing the cable end connections and power/control cable terminations. There should be generous availability of space for ease of installation and maintenance with adequate safety for working in one vertical section without coming into contact with any live parts. The design of the switchboard shall allow standard extension chambers if required to accommodate cables.

Some switchboards may be required to be installed against the wall, for such applications, documented designs shall be available.

The painting of the sheet metal shall be done by electrostatic spraying of epoxy resin powder to give smooth finish to the equipment. Color used shall be RAL 7047 for the enclosure and RAL 9022 for the functional unit.

Switchboard panels and cubicles shall be fabricated with CRCA Sheet Steel of thickness, same as that of tested assembly according to IEC61439-1 & 2.

All the devices must be installed onto dedicated mounting plate designed for one or several switchgears of the same type. The objective of this point is to group protection equipment of the same type, as well as distinguish inside the switchboard the function of each device or group of devices and avoid identification mistakes.

Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust and vermin proof to provide a degree of protection of IP 42/IP 54 as stipulated in schedule of quantities. The unused openings within the switchboards shall be closed using suitable grommets.

Switchboard Dimensional Limitations

The overall height of the switchboard shall be limited to 2000 mm for all the Busbar ratings and type of switchboards. Panel should have integral base frame of 75/100mm, The height of the operating handle push buttons etc shall be restricted between 300 mm and 1800 mm from finished floor level.

Other dimensional limits if any are specified separately.

Switchboard Compartmentalization

Switchboard design shall be completely compartmentalised with separate compartments for horizontal busbars, vertical busbars, Cable alleys and functional units consisting of ACBs, MCCBs, & MCB's.

Earthed metal or insulated shutters shall be provided between drawout and fixed portion of the switchgear such that no live parts are accessible with equipment drawn out. Degree of protection within compartments shall be at least IP 2X.

For all Circuit Breakers separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control MCB etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, busbars and connections.

Each switchgear cubicles shall be fitted with label in front and back identifying the circuit, switchgear type, rating and duty. All operating device shall be in front of switchgear only.

Separate cable compartments running the height of the switchboard in the case of front access boards shall be provided for incoming and outgoing cables.

Cable compartments shall be of adequate size for easy termination of all incoming and outgoing cables entering from bottom or top. The construction shall include necessary and adequate and proper support shall be provided in cable compartments to support and clamping the cable in the cable alley / cable chamber.

Switchboard Bus Bars

Busbars shall be made of high conductivity, and high strength Aluminum E91E or high strength Copper of ETP grade.

Busbars shall be of rectangular cross sections, with 10mm thickness, better suitable for full load current for phase bus bars and half/ full rated current for neutral bus bar or as stipulated in schedule of quantities. Busbar shall be suitable to withstand the stresses of fault level as specified in schedule of quantities.

The maximum temperature of the busbars shall not exceed 90 degree Centigrade.

The bus bar system may comprise of a system of main horizontal bus bars and auxiliary vertical bus bars run in bus bar Chamber on either side of Switchgear chamber, so that busbars could be accessed with front access itself.

Design of LV Switchboard shall be such that, Phase and Neutral busbars should be together in same compartment. Also, the Neutral busbar shall always be in front to ensure safety, even when covers are open.

For ratings upto 1600A, design of LV Switchboards shall be such that Main Horizontal Busbar can be assembled at Top or at Bottom of Switchboard, to achieve less footprint, depending on site conditions viz. Cable Entry from Top/ Cable Entry from bottom etc.

The bus bars carrying full current of Switchboard shall be supported on non-breakable, non-hygroscopic epoxy resin or glass fiber reinforced polymer insulated supports that are Thermoset in nature, so as to be able to withstand high operating temperature of 135 deg C and mechanical forces, arising from a severe fault level as stipulated in schedule of quantities.

To ensure ability to resist ignition & to self-extinguish when ignited, Insulated supports shall be supplied from OEM only & confirm to Glow Wire Test The Busbar Support and the spacing should be same as per the type tested assembly.

Clearances & Creepage distances between phases should be in line with IEC.

Continuous earth bus sized for prospective fault current to be provided with arrangement for connecting to site earth at two ends of Switchboard.

Switchboard Interconnection

All connection and tap offs shall be through adequately sized connectors appropriate for fault level at location. This shall include tap off to feeders and instrument/control transformers.

For unit ratings upto 160 Amps, PVC insulated copper conductor wires of adequate size to carry full load current shall be used. The terminations of such interconnections shall be crimped. Solid connections shall be used for all rating of 200 Amps & above.

All connections, tappings, clamping, shall be made in an approved manner to ensure minimum contact resistance. All connections shall be firmly bolted and clamp with even tension. Before assembly joint surfaces shall be filed or finished to remove burrs, dents and oxides and silvered to maintain good continuity at all joints.

All screws, bolts, washers shall be zinc plated. Only 8.8 grade nuts and bolts shall be used for Assembly of panels & also busbar connections.

Drawout Features for ACB

Air Circuit Breakers shall be provided in fully drawout cubicles, unless otherwise stated. These cubicles shall be such that drawout is possible without disconnection of the wires and cables. The power and control circuits shall have self-aligning and self-isolating contacts. Mechanical latches shall be integrated in ACB at service, test and isolated position to ensure that Breaker is firmly latched in respective position. It shall not be possible to move the breaker from the position unless latch is manually operated.

Instrument Accommodation/Meters

All voltmeter and ammeter and other instruments shall be flushed mounted type of size 96 sq. mm conforming to class 1.5 to IS 1248 for accuracy. All voltmeter shall be protected with MPCBs.

Instruments and indicating lamps shall not be mounted on the Circuit Breaker Compartment door for which a separate and adequate compartment shall be provided, and the instrumentation shall be accessible for testing and maintenance without danger of accidental contact with live parts of the Switchboard.

For MCCBs, instruments and indicating lamps can be provided on the internal compartment doors.

The current transformers for metering and for protection shall be mounted on the solid copper/aluminium busbars with proper supports.

On all the incomers of switch boards ON/OFF indicators lamps shall be provided suitable for operation on AC 230 volts supply. All lamps shall be protected by MCBs.

Wiring

All wiring for relays and meters shall be with PVC insulated copper conductor wires. The wiring shall be coded and labeled with approved ferrules for identification. The minimum size of copper conductor control wires shall be 1.5 sq. mm. Runs of wires shall be neatly bunched and suitably supported and clamped. Means shall be provided for easy identification of wires. Identification ferrules shall be used at both end of wires. All control wires meant for external connections are to be brought out on a terminal board. The cables and control wires shall be suitable for withstanding 105 deg C.

Space Heaters

Anti- condensation heaters shall be fitted in each cubicle together with an ON/OFF isolating switch suitable for electrical operation at 230 volts A.C 50 Hz single phase of sufficient capacity to raise the internal ambient temperature by 50 C. The electrical apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the switchboard is in operation. As a rule, the heaters shall be placed at the bottom of the cubicle.

Sheet Steel Treatment and Painting

Sheet steel used in the fabrication of switchboards shall undergo a rigorous cleaning and surface treatment seven tank process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognised phosphating process after which a coat of primer paint compactively with the final paint shall be applied over the treated surface. Final paint coat of oven baked powder coating, of minimum 50-micron thickness, of sheet approved by Engineer-in-Charge shall then be provided.

Testing at Works

Copies of Routine test carried out at the Panel Builder's Workshop shall be furnished along with the delivery of the switchboards. Engineer-in-Charge reserves the right to get the switchboard inspected by their representative at Panel Builder's works prior to dispatch to site to witness the followings.

Physical variation and dimensional check

Verification of bill of material

Functional check

HV test

IR test

Air Circuit Breaker

The ACB shall have following features

- ACBs shall be a sealed low voltage air circuit breaker operated as specified on the drawings with integrally mounted electronic trip units with option to add communication port.
- Circuit breakers shall have a maximum 5-cycle closing time. The closing time shall be less than or equal to 50 milliseconds for ratings <800A; 70 milliseconds for ratings <4000A; 80 milliseconds for ratings >4000A
- ACB shall be equipped with anti-pumping function: If opening and closing orders occur simultaneously, the circuit breaker shall remain in the open position. After fault tripping or intentional opening using the manual or electrical controls, the closing order must first be

discontinued, then reactivated to close the circuit breaker.

- ACB shall not derate up to 50°C, as per testing guidelines prescribed in IEC 60947-2.
- All ACBs up to 2500A shall be of same frame size to enable quick replacement in the event of emergency and to optimize spares inventory.
- All 4 Pole ACBs shall have 100% rated neutral pole.
- All EDO type ACBs shall indicate Ready-to-Close status of breaker (mechanically on front of ACB or electrical indication lamp of panel front door), after checking all the given conditions (UV release energized, Shunt release de-energized, spring charged, Breaker is not "ON", Breaker has not tripped on fault, Breaker is not mechanically interlocked with other breaker and ACB is not racked in completely in service position) ensuring safety for user and electrical distribution.
- All ACBs shall be fully tropicalized as standard & suitable for terminating copper or aluminum bus bars. ACBs up to 2500A shall be provided with top horizontal and bottom vertical terminal adapters on both sides for proper cable connections/bus duct connections. ACBs rated for 3200A and above, shall have both side vertical terminal adaptors for effective heat dissipation and better thermal performance.
- All ACB trip unit shall be possible to view the percentage loading of three phases at once on trip unit via LEDs or LCD display to help the user in identifying the current load balancing of the network.

ACB - Breaking Capacity

The ACB interrupting rating shall exceed the available fault current.

The ACB range will offer several level of Icu capacity up to 150kA @415V to fit to the application. (for 2MVA < Traffo <=3MVA) ACB shall have the breaking performance $I_{cs} = I_{cu} = I_{cw} 1\text{sec} = 65\text{kA}$ or (for <=2MVA Traffo) ACB shall have the breaking performance $I_{cs} = I_{cu} = I_{cw} 1\text{sec} = 50\text{kA}$.

ACB - Protection Type

Instantaneous settings on the trip units with LSI protection shall be adjustable from 1.5 to 15 x I_n . The Instantaneous setting shall also have an OFF setting when short-time pick-up is provided. Long time overcurrent protection threshold shall be adjustable from 0.4 to 1 x I_n . Long time overcurrent protection time delay shall be adjustable from 12.5 to 600s at 1.5 x I_r , 0.5 to 24s at 6 x I_r and 0.7 to 16.6 x I_r . Short time overcurrent protection threshold shall be adjustable from 1.5 to 10 x I_r and short time overcurrent protection time delay shall be adjustable from 10 to 40ms of I_2T .

Ground fault protection shall be adjustable.

ACBs shall have separately powered, individual fault trip indication LEDs (For overload, short circuit, earth fault and trip-unit failure) shall be available on the trip unit which shall function even in the absence of external power supply to the breaker.

All ACBs in main LT panel shall be provided with zone selective interlocking which helps in reducing the thermal and dynamic stress on installation during short circuit and ground faults. The releases shall be suitable to communicate between incomer breaker and outgoing breakers enabling zone selective interlocking.

ACB - Release Functions

ACB - Release with Metering, Protection & Communication functions.

ACB - Release with Metering, Protection & Communication functions

Trip unit shall allow communication of device status (open, close, tripped); indication of fault types (LT, ST, instantaneous, ground fault); faulty phases; interrupted current.

Trip units shall calculates and display: Current, Voltage & Trip History.

ACB - Connectivity

The ACB shall connect to a remote monitoring system via Modbus RS485.

All ACB MP based release should be able to withstand temperature upto 120 degree Celsius.

Stand alone Metering - Incomer

Power Quality Meter

The meter shall be compliant to IEC 61000-4-30 Class S. The meter shall be capable of measuring the following parameters: voltage, current, frequency, active, reactive, apparent power (total and per phase), power factor (total and per phase), current and voltage harmonic distortion to the 63rd, waveform capture, detection of voltage sags and swells. The meter shall detect the direction of disturbances. The meter shall be 0.1% for current and voltage accuracy and 0.2 Class for Active energy as per IEC 62053-22 (active energy). The meter shall record voltage and current waveforms at 256 samples per cycle. The meter shall support Modbus, ION, DNP3, IEC61850 with dual port ethernet for daisy chaining. The meter shall act as a Modbus Master connecting up to 31 downstream serial Modbus devices.

MCCBs

The MCCB shall have following features

- MCCBs shall comply with standards IS/IEC 60947-1 & 2.
- The breaking capacity performance certificates shall be available for category A to the above mentioned standards.
- MCCB shall have a rated operational voltage (U_e) of 415V, insulation voltage (U_i) of 690 V (AC 50/60 Hz) & impulse voltage (U_{imp}) of not less than 8kV.
- MCCB shall not have any line load bias. MCCB shall comply with the environmental directives like RoHS and WEEE.
- MCCBs shall be current limiting type and shall have an encapsulated double break roto design having two fixed contacts, one moving contacts and two arc chutes per pole. The design is required to minimize the effects of short circuit currents i.e. to limit the let through energy and improve the life of cables. It shall be possible to fit lead seals to prevent unauthorized access to the settings.
- MCCB's shall have push to trip function for checking the tripping mechanism healthiness. Also this checking shall be possible with or without rotary handle.
- MCCBs up to 200A shall be thermal magnetic type, above 200A shall be microprocessor-based type.
- MCCBs accessories (Shunt Coil, Auxilary Contacts, UV Coils,etc.,) shall be considered as per SLD.

MCCBs - Type

MCCBs shall be fixed type.

MCCBs - Protection Type

Adjustable thermal protection from 0.7 to 1.0 x the current rating. Fixed magnetic protection for current ratings up to 200 A. Adjustable (from 5 to 10 x the current rating) for current ratings greater than 200A.

Electronic Long-time protection will have a selectable I_r threshold settings from 36% to 100 % of the trip unit rating. Short time protection I_{sd} will have a threshold which shall be adjustable from 1.5 to 10 x the thermal setting I_r . The time delay shall be adjustable at 40ms. Instantaneous protection will have a threshold that shall be adjustable starting from 1.5 x I_n and up to a value between 12 and 15 x I_n , depending on the rating. It shall be possible to adjust ground fault protection down to 16A and deactivate ground fault protection.

On units above 630A selectable I_r threshold settings from 40% to 100% of the trip unit rating with adjustable t_r time delay. Short time protection I_{sd} threshold settings from 1.5x I_r to 10x I_r with adjustable t_{sd} time delay. Instantaneous protection I_i shall have an adjustable threshold settings from 2x I_n to 15x I_n with an OFF position. Ground Fault protection (GF) adjustable I_g threshold settings and t_g time delay.

All MCCBs with earth fault protection shall display the type of fault (overload, short circuit, earth fault, instantaneous tripping), the phase concerned and interrupted current value, on occurrence of fault and shall store last 5 trip record.

MCCBs - Control

It shall be possible to hand operate the device using a lockable rotary handle. The handle shall be

mountable to either the front of the device or extended to be mounted the front of the enclosure.

MCCBs - Embedded Metering

There shall be no embedded metering on the MCCB.

MCCBs - Connectivity

The outgoing MCCBs shall have no communication.

All microprocessor based MCCB release should be able to withstand temperature upto 120 degree Celsius.

Standalone Metering - Outgoing

Multi-function Meter

The power meter shall measure the following parameters: Energy, Active and Reactive power, Voltage, Current, Frequency, Power Factor and THD to the 31st harmonic (Over Communication). Power Meter (PM) needs to comply to Active energy accuracy of Class 0.5S as per IEC 62053-22. Relevant type test documents tested in third party lab to be produced. Power Quality Meter (PQM) needs to comply to Voltage, Current, Active Power, Power Factor, Frequency as per IEC 61557-12.5. Power Meter (PM) needs to be capable of storing 12am Snapshot (Time Configurable) for Voltage, Current, Power, Energy delivered and capable of retrieved during the 24 hours of the day. Power Meter (PM) needs to be capable of inbuilt 02 energy counters for KgCo2 and Energy Cost. 6. Power Meter (PM) needs to be inbuilt with Calibration Pulse LED configurable from 1 to 9999000 pulses/k_h (kWh, kVAh, or kVARh) unauthorized access and Heart beat LED for communication Status. 9. Power Meter (PM) needs to be capable of onboard data logging up to 2 parameters with option to select from Power (W,VA,VAR) Bi-directional energy (+/-Wh, +/- VAh, +/- VARh), Demand (W, VA,VAR) with configurable interval and duration (e.g. 2 parameters for 60 days at 15 minutes interval). Power Meter (PM) needs to needs to have RS 485 port Modbus RTU and disabling RS485 port through front panel keys against unauthorized access.

Thermal Monitoring Wireless Sensors (Temperature & Humidity)

Thermal monitoring wireless sensors shall be fitted at least on LV field cable connections and ACB connections (upstream and downstream) as well as bolted copper connections. The monitoring shall be done by a battery less sensor that communicates wirelessly using Zigbee Green Power protocol.

Smart Wireless Sensors (Cable Heating Detection)

Switchboards, non-forced air ventilated, shall be enabled with a DIN rail wireless sensor capable of monitoring the system and generate three-levels of alerts on overheating wire connections or overheating cables depending on the severity of the detected situation.

Each column of the electrical switchboard shall include one wireless sensor at the top, to help user to prevent electrical switchboards from being damaged, by analyzing gas and particles in the air and sending alerts before any smoke or insulator browning occurs.

Sensor shall be able to analyze gases and microparticles inside the switchboard, by concentrating air into the sensor (with the help of an aspiration fan), applying a smart algorithm to sort internal cable issues from overheating, and sending alerts via email or notification to a smart phone application, enabling the switchboard's digital management.

Temperature and humidity inside the switchboard should be measured by the wireless sensor and values to be communicated through the network. Wireless sensor for early detection of overheating wire connections or overheating cables, should fulfill ISO 14025 PEP ecopassport® program requirements.

Sensor device should not replace any fire protection device of the installation.

Total selectivity solutions

Panel builder and Switchgear Manufacturer must ensure total selectivity between Upstream and Downstream Breakers (ACB, MCCB, MPCB and MCBs) for entire electrical distribution network (i.e. right from Final Distribution Board and PCC, till the Main LV Panel). If required, Panel builder and switchgear manufacturer shall use higher incomer breaker ratings to achieve total selectivity w.r.t. downstream Breaker. Switchgear manufacturer shall submit Total Discrimination report along with techno-commercial offer.

Panel Builder shall use the adequate size of the Busbars, as per rated current of the breaker suggested by switchgear manufacturer based on discrimination study.

Panel shall be as per IEC61439-1&3

Panel shall be tested per IEC 61641 (50 KA for 0.3 sec minimum). The test should be performed for arc starting place - at Horizontal busbar, Vertical busbar and in outgoing cable compartments.

Panel must have QR code to download all drawings of Panel, breaker manuals, warranty card, maintenance history, etc.

Panel must have safety equipment to notify the facilities manager for overheating of cable due to a loose connection.

Make: Siemens, ABB, Schneider partners

End of Section

Distribution Board (DB) Specification

Electrical System

1. Final Distribution Boards

Enclosure Type

All final Distribution Boards (hereafter will be referred as DBs) shall be selected from the same range, based on installation requirement. Irrespective of the installation method (flush or surface mounted), they shall designed and manufactured as per Indian Standard IS 8623-1 and 3.

The Distribution Board shall be a combination of GI & CRCA Sheet Steel, with U-box or wraparound being made up of GI sheet only. It shall be powder coated with dust/dirt repellent white colour (Powder coating thickness shall be minimum 50 to 100 micron on all the plane surfaces) after seven tank process.

The DBs must be completely type tested as per IEC 61439 – 1&3 by any neutral testing authority (viz. NABL accredited or ERDA or CPRI).

The Ingress Protection for entire range of DBs must be certified by any neutral testing authority (viz. ERDA or CPRI) as per standard IS/IEC 60529 for the degree of:

IP30 for DBs with Single Door

IP43 for DBs with Double Door with EPDM (Ethylene Propylene Diene Monomer) Gasket

The Impact Protection for entire range of DBs must be certified by any neutral testing authority (viz. ERDA or CPRI) as per standard IEC 62262 for the degree of:

IK08 for DBs with Single Door

IK09 for DBs with Double Door

The manufacturer must submit the test report for IP and IK testing by neutral testing authority (viz. ERDA or CPRI) as per above mentioned standards. For internal connections DBs shall be supplied with suitably rated colour coded FRLS wire set with Pin type lugs on both the ends.

DBs shall be supplied with 63A rated Insulated fork type Busbars made of Copper with Tin plating to avoid copper oxidation.

DBs shall be provided with Side mounted shrouded & isolated 63A rated Brass Neutral Bars. Neutral Bar shall be fastened on the U-box.

The DIN rail shall be Zinc plated and must not have any injurious sharp corners. DIN rail shall be provided with MCB stopper arrangement in order to achieve the comfort in centre plate assembly. All the TPN DBs shall be provided with removable DIN rail chassis.

DBs shall be provided with rotary knob and shall have flexibility to change to field fittable Key lock.

DBs shall be provided with removable Gland plates on top and bottom with adequate numbers of knock-out holes of appropriate size and mounted on DB with minimal possible screws to save installation time.

Neutral Terminator shall be provided to terminate the Incoming Neutral in case of 3P MCCB incomer DBs.

DB shall be provided with door earthing.

Centre plate of double door DB shall be provided with user friendly knob for safe and ease of removal from U-box.

DB shall have adaptability to upgrade to IP43 from IP30 post installation, as well.

DB shall have all standard/common combi-head screws for Frame and Centre plate assembly.

In case of IP43 DBs, door shall be reversible to have flexibility to open from either side.

TPN DBs shall be ready to upgrade to Per Phase Isolation DB configuration, so as to give better continuity of supply and only respective phase isolation in case of fault in any phase.

The DBs shall have two nos. of external Earth Stud to ensure better Earth continuity and shall have embossed earthing symbol for easy identification.

DB shall be able to accommodate all types of Modular devices viz. Protection Devices (MCBs, RCDs, SPDs, Auxiliaries), Controlling Devices (Isolators, Changeover switches, Contactors, Impulse Relays, Push Buttons) and Indication Devices (Indicators, Meters etc.).

Cement spill protector shall be provided with the double door DBs, so as to avoid entry of dust & dirt at the time of the civil work. Also, full length plastering guide shall be provided to help ease and correct levelling of plaster along the DB sides.

DB shall be provided with 5 holes (1 keyhole for DB positioning and 4 nos capsule holes for DB fixing) for ease mounting on wall.

DB shall comply with RoHS and REACH standard and shall have high Strength-to-Weight ratio to avoid burden on building structure.

Protection Devices

MCB

Miniature circuit breakers shall be of approved design and make and must be tested and validated as per IS/IEC 60898, IEC/EN 60898 and IEC 60947-2 standards.

MCBs shall be suitable for operation at 230V/415V, 50Hz supply. The MCB ratings shall be available from 1--125A in 1P/2P/3P/4P versions. The rated short circuit capacity acc to IS/IEC 60898 shall be of 10,000A. MCBs shall be offered with B, C or D tripping characteristics as per the BOQ requirements. The MCBs shall be suitable for mounting on a 35mm DIN rail.

MCBs shall carry ISI and CE marking. The MCB manufacturer (through the bidder) has to submit the valid BIS license certificate at the time of offer submission.

MCBs shall ensure complete electrical Isolation of downstream circuit or equipment, when the MCB is switched OFF (to be marked on the MCB in symbolic form)

IP 20 Degree of Protection shall be ensured to prevent electrical shocks by accidental touch to any live parts, by providing finger touch proof terminals.

Energy Limitation Class-3 shall be to ensure minimum let through energy in the event of a fault, for safety & longevity of downstream circuit equipment. (to be mentioned on the MCB as per standards)

MCBs shall have bi-connect facility to terminate fork type busbar and wires, simultaneously. Terminal capacity shall be minimum 25 sq.mm. for ratings up to 25A, and 35 sq.mm. for ratings 32A & above to ensure perfect termination of wires and cables. Terminals of MCBs shall have captive screws.

Basic technical parameters, rating, operating voltage, energy limiting class 3 etc. shall be printed on front face of MCB for ease of identification.

The devices must be capable of heavy-duty operation and to that end, the manufacturer shall guarantee the following performance levels, defined by IEC / EN 60947-2 standards:

suitability for isolation

rated insulation voltage: 500 V

pollution degree: 3

rated impulse-withstand voltage: 6 kV

Discrimination for power continuity

Validated Cascading tables as per standard IEC 60947-2

Operating knob shall have provision to lock in ON / OFF condition without affecting any automatic tripping

Circuit-breakers shall be capable of operation under ambient temperature up to 50 °C, without derating of their overload tripping threshold with respect to their rated operating current. The same must be tested and validated as per IEC 60947-2 standard.

The material used to manufacture MCB shall be 100% recyclable and must comply to RoHS and REACH standards.

MCBs shall be suitable for field-fittable Protection auxiliaries (viz. Over-voltage release, Under-voltage release, Shunt trip) and Indication Auxiliaries (like Auxiliary Contact, Trip alarm contact).

The circuit breakers shall be communication ready to indicate the status of the device (On/Off/Trip), Number of On/Off cycles and Number of Tripping over universally open Modbus and Ethernet (TCP IP) protocol so as to have seamless connectivity with any Energy and Building Management System. In addition the circuit breaker should be able to communicate through GSM module the status of the device (On/Off/Trip) through mobile phone.

RCDs

RCDs shall be of approved design and make and must be tested and validated as per respective IS 12640 -1 & IEC 61008 standards for RCCBs IS 12640 -2 & IEC 61009 standards for RCBOs. shall carry CE marking. RCDs shall be suitable for operation at 230V/415V, 50Hz supply RCDs shall have IP 20 Degree of

Protection shall be ensured to prevent electrical shocks by accidental touch to any live parts, by providing finger touch proof terminals.

Basic technical parameters, rating, operating voltage, etc. shall be printed on front face of RCDs for ease of identification.

RCDs shall have clear indication of 'Tripping on fault' on front fascia.

RCDs must be voltage independent and purely current operated.

For electrically disturbed networks, Super Immunised type RCDs shall be provided, which shall be immune to electrical impurities (viz. Harmonics, pulsated DC components, transient over-voltages) and Corrosive atmosphere (viz. humid environments, chemical gases, dust etc)

Operating knob shall have provision to lock in ON / OFF condition without affecting any automatic tripping

The material used to manufacture RCDs shall be 100% recyclable and must comply to RoHS and REACH standards.

RCDs shall be suitable for field-fittable Protection auxiliaries (viz. Over-voltage release, Under-voltage release, Shunt trip) and Indication Auxiliaries (like Auxiliary Contact, Trip alarm contact).

The residual current circuit breakers shall be communication ready to indicate the status of the device (On/Off/Trip), Number of On/Off cycles and Number of Tripping over universally open Modbus protocol, so as to have seamless connectivity with any Energy and Building Management System.

Residual Current Circuit Breakers (RCCBs)

RCCBs must conform to IS12640 -1 and IEC/EN 61008 standards.

RCCBs shall be suitable for operation at 230V/415V, 50Hz supply. The RCCB ratings shall be available from 25A-125A in SPN and TPN versions with the sensitivity of 30mA (for personal protection) and 100/300mA (for Fire protection), as per the BOQ requirements.

RCCBs shall carry ISI marking. The RCCB manufacturer (through the bidder) has to submit the valid BIS license certificate at the time of offer submission.

RCCBs shall have bi-connect facility to terminate fork type busbar and wires, simultaneously. Terminal capacity shall be minimum 25 sq.mm. for ratings up to 32A, and 35 sq.mm. for ratings above 32A, to ensure perfect termination of wires and cables. Terminals of RCCBs shall have captive screws.

RCCB with Over Current Protection (RCBOs): 2 module version

RCBOs must confirm to IEC/EN 61009 standards

RCBOs shall be suitable for operation at 230V/415V, 50Hz supply. The RCBO ratings shall be available from 6A-40A in SPN version with the sensitivity of 30mA (for personal protection) and 300mA (for Fire protection), as per the BOQ requirements.


RCCB with Over Current Protection (RCBOs): RCD Add on module version.

RCD Add on module must confirm to IEC/EN 61009 standards.

RCD Add on module, when integrated with MCB shall provide protection against Over load, Short Circuit and Earth Leakages

RCD Add on module shall be adaptable to mount MCB as per desired rating of the loads and wires to ensure precise protection to the installation

RCD Add on module shall be suitable for operation at 230V/415V, 50Hz supply. The RCD Add on module ratings shall be available till 125A in SPN, TP and TPN version with the sensitivity of 30mA (for personal protection) and 100/300mA (for Fire protection), as per the BOQ requirements.

Surge Protection  circuits shall be fitted with type 2 surge protection.

End of Section

UNINTERRUPTIBLE POWER SUPPLY

GENERAL

Summary

Scope: Provide design and engineering, labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for a solidstate uninterruptible power supply (UPS) as required for the complete performance of the work, and as shown on the Drawings and as herein specified.

UPS System description

Transformer less, IGBT Rectifier & IGBT Inverter (Minimum 3 Level Inverter Topology) ____
Number of ____ kVA UPS system in standalone/parallel Configuration

Inverter Switching Frequency: ≥ 18 kHz. Inverter shall be PWM controlled using DSP logic. Analog control shall not be acceptable.

Each UPS shall be of modular architecture with sub power modules rating from 25 kW to 50 kW. Failure of any sub power module in individual UPS Frame shall not lead to entire Frame Capacity Down but only the failed sub power module capacity shall go down. i.e. In case of Failure of any one Sub Power module, rest of the available power module in the frame shall continue to operate in normal double conversion mode of operation with reduced capacity. This shall also be applicable to all UPS's operating in parallel configuration also.

The UPS shall consist of easy to repair rectifiers/inverters.

The UPS shall be provided with separate feeds for rectifier/inverter and the static bypass switch.

Modes of operation: The UPS shall operate as an on-line system in the following modes:

Normal mode: The UPS provides power to the connected load from mains. The UPS converts mains to conditioned power for the connected load while recharging the batteries(float or boost charge).

Battery mode: The UPS transfers to battery mode if the mains supply fails. The UPS provides power to the connected load from the connected batteries for a finite period. When the mains supply returns, the UPS transfers back to normal mode.

Frequency converter mode: In frequency converter mode, the UPS presents a stable output frequency (at 50 or 60 Hz) and the static bypass switch is not available.

Battery recharge: Upon restoration of the input source, the UPS shall simultaneously recharge the battery and regulate the power to the load.

Static bypass mode: The UPS supplies the load with power from the bypass source. If the conditions for normal or battery mode are not met, the load will be transferred from the inverter to the bypass source with no interruption in power to the load.

ECO mode: In ECO mode the UPS is configured to use static bypass mode as the preferred operation mode under predefined circumstances. The inverter is in standby in ECO mode and in case of interruption to the mains, the UPS transfers to battery mode and the load is supplied from the inverter.

Maintenance bypass mode: In maintenance bypass mode, the mains is sent via the (internal) maintenance bypass breaker (MBB) to the load. Battery backup is not available in maintenance bypass mode.

Auto-restart mode: When auto-restart is enabled, the UPS automatically restarts the inverter and bypass when the mains returns. By default, auto-restart is enabled.

The UPS shall be provided with RS485, USB, and dry contact signaling and Web/SNMP integration. This system must provide a means for logging and alarming of all monitored points.

The UPS shall be housed in a freestanding cabinet with casters and shall contain the following breakers/switches.

Unit input (UIB)
Static switch input (SSIB)
Unit output (UOB)
Maintenance bypass (MBB)

The UPS shall contain a bypass static switch:and a display. The UPS shall be of the double conversion on-line topology with power factor corrected inputs.

Each UPS shall be provided with phase sequence correction at Input i.e., In case of phase reversal at input, the UPS shall not transfer to battery and shall continue to operate in double conversion mode.

Each UPS Frame shall be sized for $kVA = kW \text{ load i.e. Unity Output power Factor.}$

The UPS battery shall be sized for ____ minutes at a power factor of 0.8/0.9 for >____ minutes with each UPS Frame.

The UPS shall be provided with an EPO.

Printed Circuit Boards in the UPS frame shall be 100% conformally coated.

UPS shall have built-in feature to test UPS at 100% Load without the need of any external Load Bank. Incase this feature is not available within the UPS, Vendor shall provide a External Load Bank equal to UPS Capacity which will be kept at the site till the Warranty period ends.

System input

Nominal Input voltage rating: 3×400 V (adjustable for 3×380V or 3×415V).

Input voltage window: 342 V to 477 V at full load.

Input frequency range: 40-70 Hz

Input power factor: > 0.99 for full linear loads

Total harmonic distortion: < 3% for full linear loads

System output

Nominal output voltage rating: 400V 3-phase.

Output voltage regulation (static): +/- 1%

Dynamic load response:20 ms.

Output frequency: 50Hz.

Output voltage harmonic distortion:

<3% at 100% linear load.

<5% at 100% non-linear load.

Overload capability

110% for 60 minutes.

125% for 10 minutes.

150% for 1 minute.

Output power factor: 1.0.

AC-AC Efficiency in normal operation from 25% load to 75 % Load shall be > 95%.

Audible noise at full load at 1 m from UPS shall be ≤65 dBA

Static bypass switch

The static switch shall consist of fully rated Silicon Controlled Rectifiers (SCRs). Part rated SCRs with a wraparound contactor are not acceptable.

The static bypass switch shall automatically transfer the load to bypass input supply without interruption after the logic senses one of the following conditions:

Inverter overload beyond rating.

Battery runtime expired and bypass available.

Inverter inoperable.
Control system inoperable.

Mechanical

UPS shall be housed in a freestanding cabinet with casters.
The cable entry shall be from the back/rear bottom of the UPS.
Ingress level of minimum IP20
Dust Filters and Rodent Mesh shall be provided with each UPS Frame.

Display, controls, and alarms

A display shall be located on the front of the system. The display interface shall consist of a touchscreen display, and status LEDs.

The following metered data, shall be available on the alphanumeric display:

Year, month, day, hour, minute, second of occurring events

Input voltage

Input current

Input frequency

Output voltage

Output current

Output frequency

Battery voltage

Battery current

Battery temperature

The display shall allow the user to display active alarms.

The following controls or programming functions shall be accomplished by use of the display unit.

Push button membrane switches shall facilitate these operations.

Silence audible Alarm

Set the display language

Display and set the date and time

Transfer load to and from static bypass

Test battery condition on demand

The LEDs for alarms shall be provided at UPS front panel

Battery Backup

The UPS shall use an open cell, a valve-regulated sealed lead-acid heavy duty industrial battery & shall also be capable to operate with li-ion battery solution.

Each Individual UPS shall be sized for ____ minutes at a power factor of 0.8/0.9 for >____ minutes with each UPS Frame with 12V valve-regulated sealed lead-acid battery, designed for auxiliary power service in a UPS application.

Battery voltage shall be battery temperature compensated.

Battery charge current limit: The selection shall be made from the display. The battery charge current limit should be software and hardware current limit.

Deep discharge protection shall be available.

The battery charging circuit shall remain active when the PFC operates normally.

Battery protection shall be provided by thermal-magnetic molded-case circuit breakers with UV Coil Protection in each battery Rack for an external battery.

Technical Compliance (To be filled by the UPS Vendor)

	Description		Required Parameters	Compliance, Yes/No along with the Values
1	UPS Capacity	:	kVA = kW	
2	UPS configuration		___ Number of ___ kW UPS in standalone/parallel Configuration	
3	Operating mode	:	Online Double Conversion, VFI	
4	Battery Sizing & Back up		___ Minutes backup at ___ kVA, 0.8/0.9 PF	
5	Type Of Battery	:	12V VRLA	
6	Ampere Hour & No of Battery	:	Required along with Battery Sizingsheet	
7	Construction	:	Modular Architecture: Each UPS shall be of modular architecture with sub power modules rating from 25 kW to 55 kW. Failure of any sub power module in individual UPS Frame shall not lead to entire Frame Capacity Down but only the failed sub power module capacity shall go down. i.e. In case of Failure of any one Sub Power module, rest of the available power module in the frame shall continue to operate in normal double conversion mode of operation with reduced capacity. This shall also be applicable to all UPS's operating in parallel configuration	
8	Technology	:	Transformer less, IGBT Rectifier & IGBT Inverter (Minimum 3 Level Inverter Topology)	
9	Inverter Switching Frequency		≥18 kHz	
10	Input Voltage Range at 100% Load		342 V - 477V	
11	Input Frequency Range	:	40 Hz - 70 Hz	
12	Input power factor	:	0.99	
13	Input THDI at 100 % Load		<3% for Linear Loads <5% for Non Linear Loads	
14	Output Voltage		380/400/415V AC	
15	Output voltage regulation (static)		± 1%	

16	Output THDU at 100% Load		<3% for Linear Loads <5% for Non Linear Loads	
17	Dynamic load response		20 milliseconds	
18	Duty condition	:	kVA = kW	
19	Elevation without derating		0 -1000 m	
20	Overload Capacity	:	110% for 1 hr 125% for 10 min, 150% for 1 min	
21	Crest factor		3:1	
22	Noise level		<65 dBA	
23	Output Power Factor	:	1.0 (Unity), Incase, Vendor does not comply, the next higher UPS rating shall be proposed	
24	Static Switch		Bypass path and Output path Static Switch for transferring the load to the input source during clearing overloads that exceeds the capability of power electronics. Special Hybrid bypass transfer switch shall be provided (Make before brake technology).	
25	Overall efficiency @25% - 75% Loading Condition	:	>95%	
26	UPS Load Bank Testing		UPS shall have built-in feature to test UPS at 100% Load without the need of any external Load Bank. Incase this feature is not available within the UPS, Vendor shall provide a External Load Bank equal to UPS Capacity which will be kept at the site till the Warranty period ends along with Cabling & Breakers.	
27	Phase Sequence Protection required (Inbuilt or Ex-ternal)		Required	
28	Phase Sequence Correction/Corrector required (Inbuilt or Ex-ternal)		Required	
29	Breakers/Switches within UPS frame		Input, Output, Bypass, Maintenance Bypass Breakers/Switches required, rated for full frame capacity. If not provided in-built, then separate termination panel with 4 breakers to be considered by UPS vendor.	
30	Event Log	:	Minimum 100time stamped events logged	
31	Inverter Short circuit handling capability		220% for 100 msec	

32	The unit should be able to work without the batteries connected to it.		Required	
33	Conformal coating of PCBAs	:	Required	
34	Cable Entry for UPS		Rear Bottom	
35	Dust filter & Rodent Mesh with each UPS		Required	
36	Each UPS Weight & Dimension		To be provided by the UPS Vendor	
37	Each 12V Battery Rack Weight & Dimensions		To be provided by the UPS Vendor	

END OF SECTION

EARTHING SYSTEM

GENERAL

Work Description

This section covers design, and setting of the complete earthing network for individual earthing systems, circuit protective conductors and bonding conductors and, supply, installation, testing, commissioning of earthing system.

A complete earthing network comprising cables, copper tapes, electrodes and earth bonding of all relevant necessary non-current carrying metal parts of Equipment's, / apparatus shall be connected as required.

The system shall have a common earthing system as described in the specification and as shown on the drawings. Individual earthing systems as per drawing shall be provided for following:

HT Electrical Earthing

LT Electrical Earthing

DG Generator Earthing

ELV Earthing

Data Communication Earthing

Main HT / LT / Generator Electrical Earthing shall have two earth connections to the earthing system.

Sufficient numbers of electrodes interconnected by Cooper / GI (as per requirement) to form earthing mat so that the overall earth resistance is less than 1ohm for each individual earthing mat.

The Contractor shall test the resistivity of soil at site and determine the exact number of earth electrodes to achieve the required earth resistance value with approval of Engineer-in-charge. Earth plate, earth mat detail to achieve the earth resistance value shall be included in the Contract for complete earthing installation.

The Contractor shall have approval of materials from engineer-in-charge before use on work. Execution of earthing shall be carried out only in the presence of the Engineer or the representative.

Standards

Complete earthing system shall be designed and executed in accordance with the latest revision of the following standards and the appropriate BS/IEC:

IS:3043 Earthing

BS6651 Lightning Protection System

IEC61024-1-2 Lightning Protection System

The detail of the Earthing System shall also conform to the requirements of all relevant local codes as applicable together with the additional requirements referred to in the Specification and Drawings, whichever is the more stringent and acceptable to the Engineer-in charge.

Submission

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

"As minimum requirement the submission shall include the following:

Shop Drawings and Sample Submission

Builder's work requirement

Testing procedures and report format for testing of the earth electrodes and/or earth strips
Soil resisting test report with calculation report for the details of the earthing system detail including quantity and layout of earth electrodes and/or earth strips to achieve the required earth resistance. The report shall be endorsed by the Contractor's Installation Engineer who supervise and endorse the installation upon completion
Proposed details of earthing system including quantity and layout of the earth electrodes and/or earth strips according to the calculation result.

PRODUCT

General

The resistance between earthing system and the general mass of earth shall not be greater than 1 ohm.

The earth loop resistance to any point in the electrical system shall not be in excess of 0.5 ohms in order to ensure satisfactory operation of protective devices.

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

At each electrical system ground or system neutral ground.

At one point each grounding system used to ground electrical equipment enclosures.

At one point each grounding system used to ground wiring system enclosures such as metal conduits and cable sheaths or armoured.

All earthing conductors shall be of high conductivity copper/ G.I. and able to protect against mechanical damage as per requirement. The cross-sectional area of earth conductor shall not be smaller than half that of the largest current carrying conductor. However, the contractor shall use the sizes specified in the bill of quantities of the Tender. Common earth mats of resistivity of less than one (1) ohm shall be constructed below the lowest floor structure prior to any groundwork construction. The earth mat shall comprise the complete earth electrodes, earth strips/grids, earth inspection chambers, earth leads, main earth terminals, earth test link boxes at ground level, etc. Each individual earthing system shall have earth leads connecting its main earth terminal directly to an earth electrode underground as specified.

All earthing products/accessories shall be in accordance to IS standards.

The mating surface of all tapes at joints etc. shall be cleaned before clamping and riveted with proper connector or exothermic welded. All connections to electrical apparatus shall be made by bolted connection in a visible and accessible position

Pipe Earth Electrode

G.I. pipe shall be of medium class 100 mm Dia and 3 min length.

G.I. Pipe electrode shall be cut tapered at bottom and provided with holes of 12mm dia drilled not less than 7.5cm from each other up to 2m of length from bottom.

The electrode shall be buried in the ground vertically with its top being 20cm minimum below ground level.

Clamping of the earth leads to the earth rod shall be made by earth clamp. The clamps shall be capable of providing high pressure contact between the earth rod and the earth leads to achieve low contact resistance.

When two or more electrodes are driven to form a group, the heads of the electrodes in the group shall be bonded to each other by means of a 25 mm x 3mm GI / Copper strip, laid at a depth of at least 600 mm in soil.

Recommended water seal insert sleeve approved by Engineer-in-charge shall be provided with all earth electrode penetrations through basement waterproofing membranes and the installation shall be done under strict supervision.

Plate Earth Electrode

The plate earth electrode shall consist of copper plate or G.I. plate as per item of work. The plate electrode shall be buried in ground with its faces vertical and top not less than 4.5m below Ground level. The plate shall be filled with charcoal dust and common salt filling, extending 15cm around it's on all sides.

A watering pipe of 50mm Dia of medium class G.I pipe shall be provided.

The top of the pipe shall be provided with a funnel and a G.I. mesh screen for watering the earth. In the case of pipe electrode, a removable plug shall be provided.

The earthing lead from electrode onwards shall be suitably protected from mechanical injury by suitable dia medium class G.I. pipe in case of wire and size according to strip size.

The overlapping of strips at joints shall be done in approved manner

GI strips shall be riveted with rivets/bolted and welded.

Copper strips shall be riveted with rivets/ bolted brass nuts, bolts and washers and brazed.

The protection pipe within ground shall be buried at least 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 the case of plate earth electrode, the earthing lead shall be securely bolted to the plate with two bolts, nuts, check nuts and washers.

In case of pipe electrode, it shall be connected by means of a through bolt, nuts and washers and cable socket.

Main earthing conductor is taken from the earth electrode with which the connection is to be made.

No earth pit shall be fixed within 1.5 M of a wall of foundation. The location of the earth electrode will be such where the soil has reasonable chance of remaining moist. Effort shall be made to locate them in grass lawns or near flower beds or water taps.

Earth Inspection Chamber

Earth electrode shall be fitted with a heavy-duty precast concrete inspection chamber/pit complete with heavy-duty cover as specified on drawings.

For earth electrodes located outside or on the apron of the building, earth inspection chambers shall extend to a depth of not less than 300 mm below finished ground level and kept free of soil.

Earth electrodes located inside building, earth electrodes shall be buried not less than 100 mm below the floor slab structure. Each earth electrode shall be clearly marked **'Safety Electrical'**

Earth Connection-Do Not Remove'

The chamber and cover shall be heavy duty detail to consider the traffic load at the location of installation. The cover shall be recessed cover to receive the Architectural floor finish at the location of installation.

Earth Strip

Earth strips/grids shall be of bare GI/Copper strips of 25mm x 3mm as specified.

Earth strips shall be riveted or joint with proper connector to earth electrodes underground below the floor slab structure, and shall be buried not less than 300 mm below the floor slab structure.

In order to minimize the mutual inductance between strips, earth strips shall be positioned at a distance not less than 6 m apart unless otherwise specified.

EARTH BONDING

Circuit Protective Conductor

Circuit protective conductor (CPC) is a system of conductors joining together all exposed conductive parts and connecting them to the main earth terminal.

The purpose of circuit protective conductor is to provide a path for earth fault circuit so that the protective device will operate to remove dangerous potential differences during a fault condition. The circuit protective conductors shall take the form of separate cable with as heat in green/yellow color or copper tape of minimum size 25mm x 3mm.

All exposed non-current carrying metal parts of light fittings, switchgears, motors, enclosures, etc. shall be effectively earthed by circuit protective conductors for earth continuity protection. For equipment where an earth terminal is provided, the earth continuity wire shall be firmly clamped. Where no earth terminal is provided, the exposed metal part shall be cleaned of paint and surface rust before welding the earth continuity lead.

The minimum size of the principal protective conductors shall be in accordance with to the current edition of IS: 3043/ BS7671 and BS7430.

The external earth terminal on the outside of the end panel of any switchboard shall be connected to the main earth bar provided in two independent points.

Circuit protective conductors shall be provided in electrical and mechanical rooms and along the routes for the bonding of all exposed conductive parts and extraneous conductive parts. A suitably sized earth terminal shall be provided at each zone of the building for this purpose. All exposed conductive parts shall be effectively connected in an approved manner to the principal protective conductors. The circuit protective conductors shall be single core copper cables or high conductivity annealed copper tapes specified. Unless otherwise specified, the minimum cross-sectional area of the circuit protective conductors shall be selected in accordance with IS: 3043/ BS7671.

END OF SECTION

LIGHTNING PROTECTION SYSTEM

General

Work Description

This section comprises the engineering, supply and installation, testing necessary for the Lightning Protection System for all buildings and of open areas (storage, leisure, office areas etc.) It includes the protection against the electrical consequences due to the lightning current flow through the lightning protection system.

Notes:

This standard does not cover the protection of electrical equipment's or system against voltage surges of atmospheric origin which are transmitted by networks entering the structure.

Other standards describe lightning protection systems using simple rod lightning conductor, stretched wires and meshed conductors.

The Lightning Protection System shall be installed generally in accordance with IS / IEC 62305-3 & IS 3043 and additional requirements of this specification. The system shall consist of air terminations, down conductors, joints and bonds, testing joints, earth terminations and earth electrodes. The general arrangement shall be as indicated on the drawings.

The lightning protection system shall comprise: -

Air terminal (as per rolling sphere or mesh or protective angle method or any combination thereof.)

Down Conductors

Joints and Bonds

Test Links

Maintenance free earthing system based on chemical earth compound

Lightning protection system employing steel structural and reinforcement system as part of the down conductors shall be adopted as per Drawing specified. All requirements in the specification included cast-in re-bar down conductors shall be applied unless otherwise specified.

Standards

Complete supply and installation of the lightning protection system shall be followed for engineering, construction and installation in accordance of the following standards and with the latest revision with update amendments:

IS / IEC 62305-3 & IS lightning

arrestor air terminals 3043

IS/IEC 62561 Lightning and Earthing Material

The detail of the lightning protection system shall also conform to the requirements of all relevant local codes, as applicable, to gather

with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.

In the adoption of standards and requirements, the Contractor shall take the following precedence:

Engineer's decision

Local codes of practice

Drawings

Specification

International standards and requirements

Submission

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

A prior survey may be conducted to determine the protection level to be considered, the ESE lightning conductor location(s), the down-conductor path(s), the earth termination system location(s) and type(s). All technical submissions shall be approved by the Engineer prior to the respective stages of construction.

Architectural constraints may be taken into account in the lightning protection system design and the design shall be based in a manner so that there is no reduction in the lightning protection system effectiveness.

As a minimum requirement, the submission shall include the following:

Equipment submission with manufacturer's data;

Sample submission;

Shop drawings showing the co-ordinator's details of fair terminations, down conductors bonding to re-bar and foundation earth terminations, methods of fixing etc.

Builder's works requirement.

Proposal on testing procedures and report format for testing of the Lightning Protection System.

Detail of the Contractor's installation Professional Engineer who supervises and endorses the installation for occupation permit application.

PRODUCT

AIR TERMINAL

General

Lightning Protection Systems shall be in accordance with IS/IEC 62305-3 & IS 3043

Zone of Protection

The zone of protection of a lightning conductor defines the space within which Air

Terminal provides protection against a direct lightning strike with probability of protection as per LPL.

LPL(LightningProtectionLevel)

LPL is a number associated with a set of lightning current parameters relevant to the probability that the associated minimum & maximum values do not exceed the normally occurring lightning. LPL can be determined by Risk analysis as explained in IS / IEC 62305-2.

LPLlevelsandprobabilityofprotection:

Lightning protectionClasses	Lightningcurrentpeak value MINIMUM	Lightning current peak value MAXIMUM	Interception probability

LPL1:	3kA	200kA	98%
LPL 2:	5kA	150kA	95%
LPL 3:	10kA	100kA	88%
LPL 4:	16kA	100kA	81%

Components of External LPS

Air terminal (as per rolling sphere or mesh or protective angle method or any combination thereof.)

Down conductor

Earthing

Air termination system:

No drilling is allowed in the terrace for fixing the air terminal, if the roof is made of concrete. Parapet wall is exception to this.

Values of Rolling sphere radius, Mesh size and protection angle as per Class of LPL/LPS.

Class of LPL/LPS	Rolling sphere radius (m)	Mesh size (m)	Protection angle
1	20	5*5	Refer figure 1
2	30	10*10	Refer figure 1
3	45	15*15	Refer figure 1
4	60	20*20	Refer figure 1

Material and Dimensions

Material of air terminal, down conductor, earth termination etc. shall be as below:

Material	May be destroyed by galvanic coupling with
Copper (Solid)	Aluminum
Hot galvanized steel (Solid)	Copper
Stainless steel (Solid)	
Aluminum (Solid)	Copper

Dissimilar metals (e.g. Copper with Aluminum) must be connected only by using bimetal connectors.

Minimum thickness of metal in air termination system for LPL/LPS

Material	Thickness(a)inmm	Thickness(b)in mm
Galvanizedsteel	4	0.5
Stainlesssteel	4	0.5
Copper	5	0.5
Aluminum	7	0.65

**Material,Configurationand
area ofair terminal&down conductors**

Minimum cross-sectional

Material	Type	Minimum cross s Sectionarea	Remarks
Copper	Solid tape	50sqmm	2mmminthickness
Copper	Solid round	50sqmm	8mm dia
Aluminum	Solid tape	70sqmm	3mmmin thickness
Aluminum	Solidround	50sqmm	8mmDia
Gl	Solid tape	50sqmm	2.5mmminthickness
Stainlesssteel	Solidtape	50sqmm	2mmmin thickness

Airterminalholder:

Concrete Roof structure: Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by adhesive of good quality taking care of varying weather conditions. Air conductor holder is an insulator & should be of minimum 50 mm height so that even small amount of water logging on terrace is below the level of conductor holder.

Metal Roof structure: Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by metal conductor holder of good quality which is tested for lightning current as per IEC standard. Vendor need to give proof. As metal roof structures are normally tapered at an angle, there is no min. height criteria for metal conductor holder.

Recommendeddistance between air terminal holders:

Arrangement	Recomm ended distance	Recommended distance For ROUND
Horizontal conductor on horizontal surface	500 mm	1000mm
Horizontalconductoronvertical surface	500 mm	1000mm

Vertical conductor from Ground to 20m height	1000mm	1000mm
Vertical conductor above 20m height	500 mm	1000mm

If antenna, air cooler or any other electrical equipment is present above terrace level, the same have to be protected by using vertical air terminal after calculating the safety or separation distance. The vertical air terminal has to have suitable supports to hold it. Wind speed need to be taken into account. Vertical air terminal must be connected to horizontal air terminal by using suitable connectors.

the crossings of the horizontal air terminals, suitable Cross connector has to be used for secure connection which is tested for lightning current as per IEC standard. Vendor has to provide proof.

Safety or Separation distance:

It is must to calculate safety or separation distance in order to avoid flashover to the electrical equipment when the lightning current is passing through the vertical air terminal.

Safety/ Separation distance (S) in m = $(k_i * k_c * L) / k_m$

Coefficient k_i depends on class of LPL/LPS $k_i = 0.08$ for

LPL1,

$k_i = 0.06$ for LPL 2

$k_i = 0.04$ for LPL3 and 4

Coefficient k_c depends on no of down conductors:

$k_c = 0.66$ for 2 down conductors

$k_c = 0.44$ for 3 or more down conductors Value of

coefficient $k_m = 1$

Value of L is the total distance between the equipment to be protected (fore.g. Antenna) to the equip-potential bonding bar situated just above the ground.

Expansion piece

In order to take care, the expansion of the metal in summer and contraction of the metal in winter, expansion piece with suitable connectors have to be used at every 20m distance of horizontal air terminal.

Joints and Bonds

The lightning protective system shall have few joints as far as possible & air terminal & down conductor have to be straight. Where it is not possible, it should NOT be bent at 90 degrees (right angles) & should have a curved path of 45-degree bend.

Downconductorsystem

In order to reduce the probability of damage to electronic/electrical equipment, the down conductors shall be arranged in equip distance in such a way that from the point of strike to earth, several parallel current paths should exist & length of the current path should be minimum. Down conductors can be installed separately or more wisely it can be part of natural components of the building. Examples are steel reinforcement in RCC columns, metal facades, profile rails, metal doors & windows.

Down conductors should be installed at each exposed corner of the structure as minimums.

Value of distance between down conductors as per Class of LPL/LPS

Class of LPL/LPS	Typical distance (m)
1	10
2	10
3	15
4	20

Test joints:

At the connection of the earth terminal, a test joint should be fitted on each down conductor at a height of 1 m from the ground, except in the case of natural down conductors combined with foundation earth electrode. The purpose of test joint is to measure the earth resistance value. The remaining portion of down conductor (i.e., after the test joint should be mounted inside a plastic pipe of minimum 3 mm thickness.)

Earth Terminations

Earth mat is most preferable. Where earth mat is not possible, ring earthing is the next best method. Ring earthing must be 1 meter away from the building and 0.5m below the ground level. The resistance of earthing system shall not exceed 10 ohms as per IEC 62305. Lower earth resistance is more preferable

For earth termination system, 2 basic types of earth electrode arrangements are applicable. Type A & Type B arrangement.

Type Arrangement: Comprises of horizontal or vertical earth electrode installed outside the structure to be protected connected to each down conductor.

In type Arrangement, the total number of earth electrodes shall not be less than two.

Type Arrangement is suitable in places where electronic equipment are not located.

Type B arrangement: This type of arrangement comprises either a ring conductor external to the structure to be protected, in contact with the soil for at least 80% of its total length or a foundation earth electrode. Such earth electrodes can also be meshed. For structures with extensive electronic systems or with high risk of fire, type B earthing is most preferable method. Corrosion proofing band has to be used wherever down

conductor is connected to earth termination system. Bitumen has to be applied at the point of inter-connection. In potentially corrosive areas, Stainless steel must be used.

References:

IS/IEC62305-PROTECTIONAGAINSTLIGHTNING:

Part1:GeneralPrinciples

Part2:RiskManagement

Part3:Protectionofstructures

Part4:ProtectionofElectrical&Electronicequipmentwithinstrucure

IS3043:1987:Codeofpractice for Earthing.

TESTING & COMMISSIONING

The contractor shall conduct his own inspection and test reports certified by their engineer shall be submitted to the Engineer-in-charge for his approval and submit a request for joint inspection.

Joint inspection shall be carried out by the engineer-in charge or his authorized representative. Test results shall be checked and compared with the reports submitted. All equipment, transportation, manpower and other necessary costs for the joint inspection shall be borne by contractor.

The system shall be tested once in every month intervals for earth resistivity, resistance to earth of the electrodes and electrical continuity of the system. The record of readings / results of these tests shall be maintained by contractor during defect liability period by the contractor and after that by Engineer-in charge.

The contractor shall supply one set of portable Air terminal test meter suitable for operation on batteries for maintenance and check of system. The meter should be suitable:

To test the individual charge sensor

To test the individual triggering terminal

To identify the faulty air terminal

To give alarm in case test meter is defective.

The Contractor shall submit a detailed layout drawing showing the positions of testing carry out on site.

END OF SECTION

WIRING DEVICES

GENERAL

Work Description

The drawings for the lighting and power points indicate approximate position of all lighting fittings, switches, power outlet points, isolating switch points etc. The actual position of all fittings, switches, the wiring details and cable routes shall be coordinated with other trades at site and submitted for the approval of the Engineer-in-charge. All time and cost required for adjusting the layout or complete installation to suit site requirement is included.

To determine the exact positioning of lighting and power points due consideration shall be given, for selection of the most accessible routes for wiring, convenience of switching and operational requirement of the installation.

No extra cost will be paid should the final positions be relocated within the same room.

For the purpose of specification and related drawing, each lighting & power point circuit shall be coded with a prefix to indicate the corresponding distribution board number.

The electrical equipment/system may develop sudden changes due to low frequency or direct electric current components such as fluorescent lamps, contactors, etc. shall be fitted with radio and television interference suppression components suitable to meet the levels specified in BS: 800 "Limits of Radio Interference".

This section includes the specification of the following:

Distribution boards
Miniaturecircuitbreakers
Earth leakagecircuitbreakers
6ASwitchSocketOutlet
16ASwitchSocketOutlets
Shaver Outlets
IsolatingSwitches
Conduit Boxes
Contactors
DimmersSwitch
TimeSwitch
Cooler Control Units
WaterHeaterSwitches
BellPushSwitches

Standards

The complete wiring installation shall be engineered according to manufacturer data and constructed in accordance with the latest revision of the IS and the appropriate BS/IEC

In the adoption of standards and requirements, the Contractor shall take the following precedence:

Engineer's decision
Local codes of practice
Drawings
Specification
International standards and requirements
Submission

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

The submission shall include the following as a minimum requirement,

Equipment catalogues submission with manufacturer's data. Sample submission include all wiring accessories. Shop drawings of the lighting and power positions, circuit numbers, cable routings, switching arrangement, mounting height, etc. The positions and mounting heights shall be coordinated with other services. Fixing details of all wiring accessories shall also be included.
Drawings showing the installation details
Labeling system
Builder's works requirement.

PRODUCT

Lighting Point Installation

The various types of light fittings to be supplied and installed are described in the Schedule of Lighting Fittings on Drawing

Surface mounted light fitting shall terminate at junction box having entries appropriate to the run of conduit. This shall be complete with porcelain / PVC connector suitable for the size and number of connections and wiring points to be connected with the specified fitting. Wiring to the light fittings within the false ceiling space shall be by means of heat resistant (butyl or silicon rubber insulated to BS 6500) cables i.e. between the junction box and the lamp holder/terminal blocks, in flexible conduits.

At every light fitting an approved type earth terminal shall be provided for connection of the circuit protective conductor of the final circuit.

Ferrous metal work shall be of minimum of 1mm thickness and treated against corrosion by galvanizing after welding or lead primer or other approved process. Metal work shall be painted with one priming coat, one under-coat and two final coats with stove-enameled matt white paint unless otherwise specified.

Cables used for internal wiring of the lighting fittings shall be with appropriate type and size, number with conductor of size not less than 1.5 sq mm single core. The insulation of the cables shall withstand the maximum temperature throughout the life of the fitting. It will be subject to normal use without deterioration which could affect the safety of the fitting.

Cables within the lighting fittings shall be neatly bundled by nylon self-locking cable ties.

Wiring shall be properly routed and secured away from control gear etc. wherever possible.

All cable terminations within the light fittings shall be suitably shrouded.

All light fittings shall be supported with appropriate fixing accessories such as clips, supporting brackets, suspension sets, nuts, washers, screws etc. for their proper installation on different types of ceiling panels. Suspension sets shall be of adjustable type suitable to carry the weight of the lighting fittings unless otherwise stated or indicated on drawings. The suspension sets shall be generally of 900 mm length. Exact lengths required shall be provided to suit the site requirement.

All lamps in operational condition with proper control gear shall be provided together with the light fittings as required and specified.

Switches

Lighting switches unless otherwise specified, shall be single pole, quick make and break, silent action type and totally enclosed for flush or surface mounting modular type as required.

Lighting switches shall be suitable for indoor or outdoor service according to location housed in standardized purpose manufactured galvanized steel boxes completed with conduit knockouts made up into single or multi-gang units employing a grid switch system of fully interchangeable components at standardized fixing centers of matching switches of different types and ratings but of identical dimensions, push buttons, neon indicator lamps, blanking units, grids, steel boxes and plates all capable of integration into standard composite assemblies in any combination as required.

Grids shall be adjustable for variation in depth of plaster and for squaring errors and of the same type for surface or flush mounting.

Switches in mechanical plant rooms and electrical sub-stations and switch rooms shall be of the metal clad type approved by the Engineer-in-charge mounted in flush or surface conduit boxes as specified.

Switches located on brick or concrete walls shall be mounted in horizontal arrangement in plaster depth steel boxes or in galvanized steel boxes using box suspension straps and cover plates. Countersunk screws shall be provided for fixing to the conduit boxes.

Switches for external use shall be of weatherproof construction with IP-65 rating unless otherwise specified.

Samples of all switches, conduit boxes and plaster depth boxes shall be submitted to the Engineer for approval prior to installation.

Switches shall be rated for 6Amps (minimum light switch rating 6Amps), 16Amps or 20Amps (as determined by circuit load). Inductive lighting circuit shall be assessed at twice the steady state connected load current. One- or two-ways switch as indicated on the drawings be fixed generally at a height of 1200mm from floor level in rooms. The switch shall possibly be located inside the room on the handle side of the door as close as practicable.

Earth continuity terminal shall be provided and connected to the circuit protective conductor at every lighting switch position.

Single pole switches shall be connected to break the phase wire of the supply. The neutral wire shall not be routed through switch boxes.

Switches which are mounted in the same location shall be of multi-gang type, of the maximum number of gangs available.

All switches used shall be of approved or prescribed items as required by local authorities. Circuit from different phase and circuit from emergency power should have separate switch plate.

Isolation Switch

Isolating switches shall be of the current ratings and number of poles (generally double pole for single phase and 4-pole three phases) as indicated on the Drawings.

Isolating switches shall be of the totally enclosed pattern, metal-clad or polycarbonate with positive quick-make and quick-break action.

Switches shall be capable of passing and interrupting their full rated current safely and without damage.

Ferrous materials shall be galvanized, switch handles shall be interlocked to prevent opening the cover with the switch "ON".

6 AMPS Switch Socket Outlets (With Antibacterial Properties)

Switch socket outlets shall be as per BS:1363 single pole 6 Amp 3 round pin shuttered outlets, one or two gang for indoor service except otherwise specified and suitable for surface or flush mounting according to location.

Switches shall be of the quick-make and break type silent action totally enclosed with solid silver alloy contacts. Switched socket outlets for indoor use shall be housed in suitable galvanized steel boxes as per BS: 4662 with conduit knockouts. Types and finishes of socket plates shall match those for the lighting switches.

Generally, switch socket outlets shall be positioned 300mm above floor level except in plant rooms, kitchen, etc. where they shall be positioned 1400mm above floor level or 150mm above counters or benches as per requirement.

Switch socket outlet in all mechanical plant rooms, electrical switch rooms shall be of the metal clad type, with recessed or protected switch dolly, mounted in flush or surface conduit boxes as specified.

All switch socket outlets used shall be of an approved quality.

16 AMP Switch Socket Outlets (With Antibacterial Properties)

16 Amp switch socket outlets shall be 3 pin round type to BS: 546 shuttered, of finished similar to 6 Amp switch socket outlets and flush mounted in galvanized steel conduit boxes to BS: 4662 requirements.

Weather proof Isolator (Industrial Type)

Weatherproof enclosure shall be of the high impact, water resistant to IP-65. The isolator provided shall complete with lockable device. Isolators shall be 2-pole, 4-pole as specified.

Floor Box-Access Outlet.

All plates shall be made from stainless steel or equal approved, heavy duty trap cover. All plates are to be mounted flush with surface and are to be aligned correctly. Access Outlet should carry service plates for providing services i.e. Power, Data & Telecom. The system must comply the relevant specification & IEC 61084 standards. The system should have Positive Double Earthing connections.

Lighting Dimmers Switch (With Antibacterial Properties)

Lighting dimmer switch shall be solid state, variable load and thyristor-controlled type suitable for controlling fluorescent or incandescent lighting circuits operating at $230\text{ V} \pm 6\%$, 50 Hz single phase AC supply.

Dimmer switch shall be manufactured to eliminate TV and radio frequency interference in compliance with IS.

The ratings of the dimmer units shall be suitable for lighting circuit specified on Drawing.

TimeSwitches

Time switches shall be self-contained unit suitable for mains operation. All units shall have self-started synchronous motor with single-pole fuse in the motor circuit, 3-way terminal block and thirty-six (36) hours spring reserve complete with an automatic solar dial.

The solar dial shall be capable of switching ON The lighting at sunset and OFF at sunrise throughout the year by control of a secondary calendar dial with month and day settings. The automatic switching time shall be adjustable.

Timeswitches shall be case in dust-tight metal casing having hinged front cover with clear Perspex window. The casing shall be effectively earthed.

An annual by pass switch shall be incorporated with the time switch to facilitate maintenance of the latter.

Miniature Circuit Breaker

The MCB shall be suitable for manual closing, opening and automatic tripping under overload and short circuit. The MCB shall also be trip free type.

Single pole/three pole versions shall be furnished as required.

The MCB shall be rated for 10KA fault level.

The MCB shall be suitable for housing in the lighting boards and is suitable for

connection at the outgoing side by tinned cable lugs and for bus-bars connection on the incoming side.

The terminal of the MCB and their open and close conditions shall be clearly/indelibly marked.

The MCB shall generally conform IEC/IS:60898

Earth Leakage Circuit Breaker

ELCB shall be 4 pole 415 volts 50Hz, 30-300mA sensitivity. These shall be of approved make

. The rating of the ELCB shall be as required. These shall be suitable for manual closing and opening and for automatic tripping under earth fault circuit of 30-300 mA as specified in item of work.

The enclosure of the ELCB shall be moulded from high quality insulating material. The material shall be fire retardant, anti-tracking, non-hygroscopic, impact resistant and shall withstand high temperature.

All parts of switching mechanism shall be non-greasing, self-lubricating material so as to provide consistent and trouble-free operation.

Operation of ELCB shall be independent of mounting position and trip freetype.

Lighting/Small Power Distribution Boards

Distribution boards shall be of standard make with MCBs as per approved make given. Distribution boards shall be of steel sheet construction double door all welded enclosure of IP42 protection and powder coated painted.

Ample clearance between the conductors of opposite pole and sheet steel body shall be maintained in order to obviate any chance of short circuit. Removable conduits entry plates shall be provided at top and bottom to facilitate drilling holes at site to suit individual requirements.

Additional / separate adopter box of suitable size shall be provided to accommodate wires, cables and No. of conduits etc. at no extra cost.

The MCB shall be mounted on high grade rigid insulating support and connected by electrolytic copper bus bars.

Each incoming MCB isolator shall be provided with solder-less cable sockets for crimping.

Phase separation barriers made out of arc resistant materials shall be provided between the phases. Bus bars shall be colour coded for phase identification.

Distribution boards shall be recessed in wall or mounted on surface of wall with necessary mounting arrangement.

The mounting height shall not exceed 1200mm from finished floor level. Distribution board shall be provided with proper circuit identification name plate and danger sticker/plate as per requirement.

All the distribution boards shall be provided with engraved name plates with 'lighting', 'power' or 'UPS' with DB Nos., as the case may be.

Each DB shall be provided with circuit list giving details of each circuit. All the outgoing circuit wiring shall be provided with identification ferrules giving the circuit number & phase.

Each distribution board shall have separate neutral and earth connection bar mounted within the DB each having the same number of terminals as the total number of outgoing individual circuits from the distribution board. Conduit & cable armouring shall be bonded together & connected to the distribution board earth bar.

Where oversized cables are specified due to voltage drop problems, it shall be contractors' responsibility to ensure that satisfactory terminal arrangements are provided without an extra cost.

Telephone Outlets

Telephone outlets where called for shall be single or twin flush mounted type suitable to receive the plug-in telephone cable led to the approval of the Telecom. The finish of the telephone outlet plates at various areas shall be as specified for lighting switches.

Water Cooler Drinking Fountain Switches

Flush-mounted double pole AC switch of 20Amps rating shall be provided for water cooler and marked "water cooler".

Associate disconnectors shall be provided next to the water cooler.

The switches and the connector shall be IP-65 waterproof rating.

Bell Push Switches

Bell push switches shall be flush-mounted having single-pole AC switch of 6Amps rating and marked with bell symbol.

Shaver Outlets

Shaver outlets shall comprise a 20VA continuously rated double wound isolating transformer to provide an earth-free AC supply at mains frequency, complete with self resetting thermal overload device fitted in the primary circuit an insulated voltage selector switch to provide either 115 or 230volt output, one ON-OFF switch and one universal socket outlet suitable for British, American, Continental and Australian razor plugs, all contained in recessed sheet steel box with insulated moulded front plate suitable for flush mounting and suitably inscribed to give clear indication of the voltages available at the outlet and the service of the outlet.

Cooler Control Units

Cooler Control Units shall be flush mounted double pole AC switch of rating 30 Amps complete with pilot indicating lamps and with self-adhesive plastic identification label mounted on a removable chassis contained within steel box finished aluminum stove

enamel provided with conduit knockouts and earthing terminals. The cover plates shall be of the same finish as those specified for the lighting switches.

Associated connector units shall be provided adjacent to the cooler units.

Wiring between the cooler control units and associated connector units shall be provided in concealed conduits.

Water Heater Switches

Water heater switches shall be flush mounted having double pole AC switch rated at 20amps fitted with pilot lamp and marked "water heater". The cover plates shall be of the same finish as those specified for the other switches. Associated connector units shall be provided next to the water heater units.

Power Supply for Lighting at Wet Condition

Residual Current Circuit Breakers shall be provided individually for each circuit serving lighting subject to wet condition.

END OF SECTION

LIFE SAFETY/FIRE DETECTION, DIGITAL VOICE EVACUATION SYSTEM

INTELLIGENT ADDRESSABLE FIRE ALARM SYSTEM

CHAPTER: A GENERAL

SCOPE OF WORK

These specifications shall cover the Design, Supply, Erection, Testing, and Commissioning of Intelligent Addressable Fire Alarm Systems

The work is to be carried out as illustrated in the drawings attached. These drawings are open to as per suitable design submitted by the tenderer.

A.2.2 The tender drawings indicate only the general scheme of requirement and the extent of work covered in this contract. The equipment and their associated works such as Cabling, etc. may be arranged in the space allotted subject to the approval of Engineer-in-charge. It is the Contractor's responsibility to ensure that his work is coordinated with the work of other agencies/client.

SCHEDULE OF REQUIREMENTS

Intelligent Addressable Fire Alarm System requirements are shown in the tender drawings and described briefly in other chapter of these specifications.

Tenderers are advised that the location of detectors and other accessories etc. as given in these drawings and specifications are indicative and for tenderers guidance.

It is the intent of these specifications to define a state-of-art integrated Fire Alarm System, which is user friendly, modular, flexible and expandable. The system is to be designed, installed, customized, tested, commissioned and supported by a local office or agent of the manufacturer by Engineers skilled in providing functional and efficient solutions to the needs of the Engineer in charge.

The contractor shall have an in-place support facility in India equipped with Competent Support Staff, Spare Parts Inventory and all the necessary Test and Diagnostic Equipment to provide support within 24 hours of any

breakdowns.

A.3.5 All electronic equipment shall conform to the pertinent regulations governing radio frequency electromagnetic interference and should be so labelled.

A.3.6 All system components and sub-systems are to be fault tolerant and provide satisfactory operation without damage at $\pm 10\%$ of the rated voltage and at ± 3 Hz variation in line frequency.

CONTROL PANEL

The fire alarm control panel shall be microprocessor-based using multiple microprocessors throughout the system, providing rapid processing of smoke detector and other initiation device information to control system output functions.

There shall be a watchdog circuit, which shall verify the system processors and the software program. Problems with either the processors or the system program the panel shall activate a trouble signal and reset the panel.

The system modules shall communicate with an RS-485 network communications protocol. All module wiring shall be to terminal blocks, which will plug into the system card cage. The control panel shall be capable of expansion via up to 100 SLC's. Maximum system capacity shall be at least 2500 intelligent initiation devices per panel.

The system shall be capable of supporting unshielded wiring applications.

System Components:

The Device Loop Card loop shall be capable of 252 intelligent devices distributed between two SLC circuits. Any trouble on one circuit shall not affect the other circuit. This module controls the signaling from the initiation devices reporting alarms and troubles to the control panel. Card shall not limit the address selection for sensors and input/output devices. This module shall also provide the signaling to the field devices for the controlling the output of specific initiation devices. The on-board microprocessor provides the Device Loop Card loop with the ability to function even if the main microprocessor fails. LEDs on the board shall provide annunciation for the following: Power, Card Failure, Network Failure, Gnd. Fault, Alarm, Trouble, Short Zone 1, Short Zone 2, Class A Open Zone 1, and Class A Open Zone 2. The card shall support I/O modules with build-in isolation capability. The system display shall provide the specific device which has detected a loop short trouble, when a loop short is present anywhere on the data communication circuit. This card shall plug into the system card cage.

The Signal Line Circuits (SLC) shall be tested for opens, shorts and communications with all addressable devices installed before connection to the control panel. Systems without this capability shall have a test panel installed for initial testing to eliminate any possible damage, short term or long term, to the control panel. After initial testing replace the test panel and proceed with complete testing.

The Operator Interface shall provide the system information on hi- resolution ¼ VGA Color LCD, with Touch Screen and LED display. Event Color is user defined and specific for each event type i.e., MNS, Fire Alarm, Gas, Trouble, etc. Graphic user interface shall be menu driven with tabs showing the level and the total events for each tab. The tabs shall be: Alarm, Supervisory, Trouble and Security. At least five (5) events shall be shown simultaneously with two full lines of text message for each event. Each event shall have a 32-character custom message describing the event's location. In addition, the time stamp and category of the event (i.e., Smoke, Water flow, Manual, etc.) shall be displayed. When configured for

Canadian operation, nine (9) events shall be displayed simultaneously. The LED displays shall indicate Power, Audibles On or Silenced, and Partial System Disabled. Systems not having the above LEDs shall provide separate LEDs within the control panel enclosure with appropriate labels. Selection buttons shall be backlit to aid the operator in the selection process. There shall be controls for scrolling throughout the event list. A button shall provide zoom in and zoom out control for the amount of information desired for a specific entry. The operator interface shall be capable of monitoring the power supply loading and show available capacity for future expansion planning. The operator interface shall provide a "More Info" button which can display addition device information such as a graphical map of the event, its device type and system address. This More Info button shall also have the ability to display a detailed screen that provides the following:

200-character custom message associated with the group of the device and physical location in the building to alert personnel

NFPA symbols representing fire service equipment in the area

NFPA symbols representing hazards in the area

NFPA symbols representing people in the area

Number of devices in the associated group that are in alarm

Name and phone number of emergency contact

The operator interface shall also have the ability to display a bitmap of a floor plan showing a "You are Here" symbol to tell the responding person exactly where they are in the building in relation to the event. Systems without this type of display shall supply a UL listed Graphics package with their system. The LCD shall have a keyboard screen to allow the technician ability to enter test and numbers for passwords or text changes. The operator interface shall also have a Context Sensitive Help button. A globally configured operator interface shall have the ability to view events, acknowledge, silence and reset networked FACP systems. A globally configured operator interface shall also have the ability to arm and disarm input and output points on the FACP systems. A globally configured operator interface shall have the ability to be configured for control of the entire network, control of the local FACP System, or annunciation only. In a networked configuration, the Partial System Disable LED shall be indicative of all networked FACPs. A globally configured operator interface in a networked configuration shall have the ability to store 6 maps for every FACP panel. Capable of at least 10 globally configured operator interfaces shall be supported in a network. The operator interface International (International Version) shall provide Spanish, Portuguese or Canadian overlays. The operator interface shall have the ability to be configured display text in Spanish, Portuguese, Hebrew or French while having the ability to swap in English text at anytime by a simple button press at the panel.

The system card cage shall provide the mounting of all system cards, field wiring, and panel's inter-card wiring. All power limited field wiring shall connect to the top of the card cage. All non-power limited internal wiring shall be connected to the bottom of the card cage. The card cage shall hold the systems cards and have capability of connecting multiple card cages to meet system demands. All terminal blocks are removable.

The Switch Control Module shall be a supervised module with eight (8) switches and two LEDs per switch for controlling such items as speaker/strobe or telephone circuits. The switches shall also be used as generic inputs into the system. The Switch Control Module shall be mounted in the door for easy access. These modules shall be connected to the control area network and have a maximum distance of 1000ft (305m).

System response time from alarm to output shall be an average of three (3) seconds.

To expedite system troubleshooting, the system cards shall have ground fault detection and diagnostic LEDs by card.

All system cards and modules shall have Flash memory for downloading the latest module firmware.

Passwords:

Maintenance/Control Password - There shall be a 5-character password that a user must enter into the control panel in order to perform such maintenance- and control-related functions at the panel as:

Arming and disarming devices.

Activating, deactivating or modifying detector ASD and sensitivity settings.

Activating and deactivating the History Log function, and deleting obsolete entries.

Changing the system time and date.

Function Key Password - There shall be a 5-character password that a user must enter into the control panel in order to access the panel's Function Keys: touch screen buttons which perform custom-programmed system functions.

Reports Password - There shall be a 5-character password that a user must enter into the control panel in order to access the panel's reporting functions.

Walktest Password - There shall be a 5-character password that a user must enter into the control panel in order to access the panel's walk testing functions.

Acknowledge Silence Reset Password - There shall be a 5-character password that a system user must enter into the control panel in order to acknowledge events, turn silenceable audibles and visuals on and off, and perform panel resets.

Degrade Mode Alarm Activation:

Each data gathering panel shall support the ability to have its corresponding Zone initiating circuits and output devices on a device loop card's loop activate when the device loop card or conventional detection card is in Degrade Mode (has lost communication with the operator interface's control panel). For example, if the device loop includes detectors with relay bases and lamps, the relays and lamps will activate upon any system alarm when the device loop card is in Degrade Mode.

Smoke Control: The fire alarm system panel shall have the ability to be configured as a smoke control station that complies with UL/UUKL (UL 864) and NFPA 90A and ULC/ORD-C100 requirements. The system shall have the capability to monitor and override smoke control systems and equipment provided at designated locations within the same building.

Software Modifications: The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made. Systems that require the use of external programmers or change of EPROMs are not acceptable.

Logic: The fire alarm system shall support generic functions that deal with binary states (True/False, high/low), and produce desired outputs from one or more binary inputs (for example, alarm outputs from spot detectors, VESDA detectors, monitor modules or manual station inputs). AND, OR, NOT, Any N, D Latch, RS Latch, Time Base Control, Start Timer, Restart Timer are generic functions. Generic functions can be used as inputs to other function. The system shall support 2500 logic functions.

History: The system shall store 5000 events in history while in straight mode and 4500 in circular mode. In straight mode, trouble warnings will occur at 4000 and 4500 events. In circular mode, the control panels shall maintain a 2000 event Alarm History buffer, which consists of the 2000 most recent alarm events from the 4500-event history file.

Reports:

The system shall have the ability to provide configuration, status, queue and history reports.

Configuration reports shall provide the following information:

Custom Messages

Database information

Entity type
Device usage
Device category
Firmware revision

Status reports shall provide the following information:

Disarmed cards and devices
ASD settings
Sensitivity in %/foot
Alarm threshold in %/foot
Temperature in degrees F
LOW TEMP DETECTOR Condition
Walktest

Queue reports shall provide the following information:

Alarm events with custom message and event time
Supervisory events with custom message and event time
Security events with custom message and event time
Trouble events with custom message and event time

History reports shall provide Address, History Type, Description, Time & Date and Custom Message. The following event types shall be reported:

Alarm events
Supervisory events
Security events
Status changes
Alarm verification
Output activation from logic
System Reset
Event Acknowledgements
Block Acknowledgements
Audible Silence System Flag Changes
Sensitivity Changes
Arm / Disarm Commands
Arm / Disarm By Logic
Manual Output Overrides
Output Overrides By Logic
Time Changes
Menu Logins
ASD Changes
Walktest
Device Input to Logic Activations/Deactivations

POWER SUPPLY

The system Power Supply/Charger shall be a 12-amp supply with battery charger. The power supply shall be filtered and regulated. The power supply shall have a minimum of 1 power limited output rated at 4 amps, and a minimum of 1 output rated at 12 amps. The system power supply can be expanded up to 48 amps. The auxiliary power supply module shall share common batteries with the primary power supply. The system power supply shall have 4 relays, 1 for common alarm, one for common trouble and two programmable relays. The power supply shall be rated for 120/240VAC 50/60Hz.

The battery charger shall be able to charge the system batteries up to 100 AH batteries. Battery charging shall be microprocessor controlled and programmed with an optional Thermistor for monitoring battery temperature to control charging rate shall be available.

The power supply shall have a plug for an AC adapter cable, which allows a technician to plug in a laptop computer for up or downloading program information or test equipment.

Transfer from AC to battery power shall be instantaneous when AC voltage drops less than 90% or brown out conditions it is not sufficient for normal operation.

REMOTE POWER SUPPLY FOR NON-VOICE NOTIFICATION APPLIANCES

The power supply unit shall be an addressable NAC distributed controller to provide power to visual strobe circuits or supply auxiliary power to such items as Door holder circuits. The power supply unit shall communicate on the SLC loop to the Fire Alarm Control Panel. It shall provide status monitoring, device level fault indications and individual NAC control using a single address on the SLC. The power supply unit shall provide a constant 24VDC nominal output voltage to each NAC-independent of voltage fluctuations on the primary or secondary power source.

Shall be a self-contained unit with 24VDC power supply and batteries housed in its own locked enclosure. Enclosure shall be made of 16 GA cold rolled steel, lockable and having the same key as the other control enclosures. Shall have 2 sizes (1 unit and a 2 unit) and colors (red and black).

Power supply unit shall be UL 864 listed and available in 6A and 9A models and 120 or 240VAC.

The power supply unit shall be able to support up to 18AH batteries in a single unit and 35AH in a 2-unit enclosure. Shall be able to support up to 100AH batteries in a separate enclosure.

The power supply unit shall have four independent 3 amp rated NAC circuits, expandable to a total of eight (8) Class B or four (4) Class A circuits or a mixture of each.

Ability to add one of two types of expansion cards which take one additional address on the SLC:

An expansion card that shall provide additional NAC circuits and can be configured with two (2) Class B or one (1) Class A releasing circuits with on board service disconnect switches.

An expansion card that shall provide for four (4) Class A or B conventional detection zone input circuit or shorting device (non-alarm) input circuits

The power supply unit shall be a class X isolating device residing on the SLC loop.

Each NAC output can be configured as an Aux Power output or a non-alarm closure input circuit.

Complete status monitoring to the individual circuit level at the main FACP and on-board LED status and diagnostic indicators.

The power supply unit shall be fully configurable through the manufacturer's system configuration tool.

The power supply unit output circuits shall be configurable individually as Steady On, Temp 3, Temp 4, March Time 30, 60 or 120PPM.

All NAC circuits shall have synchronized strobe outputs. Any combination of power supplies and expansion cards, up to a total of 32, shall be able to synchronize on the same loop.

The power supply shall have a dedicated Bell Follower circuit that can be used to achieve synchronization across multiple SLC loops.

Shall be able to accept a range of End of the Line (EOL) resistor values (2.2K to 24K Ω) without having to program or configure unit.

SYSTEM ENCLOSURE

Enclosure needed to hold all the cards and modules as specified with at least spare capacity for extra cards. The enclosure outer door shall be either black or red. Provide the color as to the local AHJ requirements. The outer doors shall be capable of being a left hand open or a right hand open. The inner door shall have a left-hand opening. System enclosure doors shall provide where required ventilation for the modules or cards in the enclosure.

Provide system enclosure for all amplifiers. Where required by the manufacturer, provide means for venting heat from the enclosure either by having enclosure sides and top vented or the doors vented.

FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

There shall be a dedicated, two-way, supervised, telephone voice communication links between fire-alarm control unit, the fire command center, and remote firefighters' telephone stations. The supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:

Selective-talk type for use by firefighters and fire wardens.

Controls to disconnect phones from talk circuits if too many phones are in use simultaneously. An indicator lamp shall flash if a phone is disconnected from the talk circuits.

Addressable firefighters' phone modules to monitor and control a loop of firefighter phones. Modules shall be capable of differentiating between normal, off-hook, and trouble conditions.

Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is taken off the hook, it shall cause an audible signal to sound and a high-intensity lamp to flash at the fire-alarm control unit, fire command center.

Selector panel controls to provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.

Display: Digital graphic to indicate location of caller.

Remote Telephone Cabinet: Flush or surface mounted cabinet as indicated, factory-standard red finish, with handset.

Install a one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Warden Phone" or "Fire Emergency Phone."

With "break-glass" type door access lock.

Remote Telephone Jack Stations: Single-gang, stainless-steel-plate mounted plug, engraved "Fire Warden Phone" or "Fire Emergency Phone."

Handsets: Push-to-talk-type sets with noise-canceling microphone stored in a cabinet adjacent to fire-alarm control unit in the fire command center.

FIREFIGHTERS' SMOKE-CONTROL SYSTEM REQUIREMENTS SHALL INCLUDE

Initiation of Smoke-Management Sequence of Operation:

Fire-alarm system shall provide all interfaces and control points required to properly activate smoke-management systems.

First fire-alarm system initiating device to go into alarm condition shall activate the smoke-control functions.

Subsequent devices going into alarm condition shall have no effect on the smoke-control mode.

Addressable Relay Modules:

Provide address-setting means on the module. Store an internal identifying code for control panel use to identify the module type.

Allow the control panel to switch the relay contacts on command.

Have a minimum of two normally open and two normally closed contacts available for field wiring.

Shall be listed for controlling HVAC fan motor controllers.

INTELLIGENT INITIATING DEVICES

General

All initiation devices shall be insensitive to initiating loop polarity. Specifically, the devices shall be insensitive to plus/minus voltage connections. Except when built in isolation is used polarity sensitivity is required for the devices configured in isolation mode.

Smoke Detectors – Advanced with ASA (advanced signal analysis) - Multi-Criteria Addressable Series

The detectors shall be guaranteed in writing not to false alarm when configured by the factory trained certified technician. The detectors must provide up to 26 different environmental algorithms that allow the detector to provide superior false alarm immunity without the need for additional alarm verification delays.

The detectors shall have a tri-color LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm.

Detectors shall utilize state of the art forward/backward light scattering technology, with improved detection for smoldering and flaming fire signatures. The detectors shall replace the need for ionization detectors due to improved response characteristics to flaming fires.

Detectors shall provide pre-alarm signal at 0.2% obs/ft. and a full alarm at 1.0% obs/ft. to meet the performance requirements of NFPA 76 - National Fire Protection Association Standard 76, Fire Protection of Telecommunications Facilities as a Very Early Warning Fire Detector (VEWFD).

The forward/backward light scattering technology shall provide improved immunity to spurious activation (deceptive phenomena). The detectors shall have a “No False Alarm Guarantee”.

The detectors shall be RoHS-compliant: it shall meet standards for Reduction of Hazardous Substances (RoHS) by reduction in lead content and other restricted substances.

The multi-criteria fire detectors shall be an intelligent digital photoelectric detector with a programmable heat detector. Detectors shall be listed for use as open area protective coverage, in-duct installation and sampling assembly installation and shall be insensitive to air velocity changes. The detectors' communications shall allow the detectors to provide alarm input to the system and alarm output from the system within four (4) seconds. So as to minimize the effort required by the installing and maintenance technician to appropriately configure the detector to ensure optimal system design, the detectors shall be programmable as application specific. Application settings shall be selected in software for up to 26 environmental fire profiles unique to the devices installed location.

The detectors shall be designed to eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report.

The detectors shall be capable of being field programmed for simultaneous and /or independent functionality, depending on the application. For example, the detectors shall be capable of utilizing the optical, heat, and/or CO sensors together for enhanced fire detection (multi-criteria) and simultaneously provide independent outputs for CO gas life-safety, smoke, and heat detection. Any combination of the sensors is possible.

The detectors shall be UL listed for operation in a 95% relative humidity (RH) environment.

The detectors shall be designed to eliminate calibration errors associated with field cleaning of the chamber.

The detectors shall support the use of a relay, or LED remote indicator. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling.

The detectors shall support the use of an ambient temperature warning signal at the panel. This temperature shall be user-configurable for the set temperature of the warning and the event type generated by the warning. This event can be used to trigger system logic.

For the detectors where required, there shall be available a locking kit and detector guard to prevent unauthorized detector removal.

UL Listed as “direct in-duct” mounting.

UL 268 7th edition listed or greater.

Detector shall have built-in standard isolation.

Available models:

Multi-Criteria incorporating 2 Optical sensors and 2 Thermal sensors with an operating temperature range of 32°F to 120°F (0°C to 49°C). Nineteen selectable profiles. Polarity insensitive installation wiring. Three color LED.

Smoke Detectors – Standard Addressable Detectors:

The smoke detectors must provide at least 2 environmental parameter sets to assist in device sensitivity configuration.

UL 268 7th edition listed or greater.

Shall have built-in isolation.

The detectors shall have a tri-color LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm.

The detector shall be RoHS-compliant: it shall meet standards for Reduction of Hazardous Substances (RoHS) by reduction in lead content and other restricted substances.

The detectors shall be UL listed for operation in a 95% relative humidity (RH) environment.

The detectors shall be designed to eliminate calibration errors associated with field cleaning of the chamber.

The detectors shall support the use of a relay, or LED remote indicator without requiring an additional software address. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling.

For the detectors where required, there shall be available a locking kit and detector guard to prevent unauthorized detector removal.

Available models:

Multi-Criteria incorporating 1 Optical sensor and 1 Thermal sensor with an operating temperature range of 32°F to 100°F (0°C to 38°C). Available in four parameter sets. Polarity insensitive installation wiring (polarity sensitive is required for use of the built-in isolation feature. Detector includes a three (3) color status LED.

Photoelectric Smoke detector with an operating temperature range of 32°F to 120°F(0°C to 49°C). Available in three parameter sets. Polarity insensitive installation wiring (polarity sensitive is required for use of the built-in isolation feature). Detector includes a three (3) color status LED.

Heat Detectors – Addressable

Thermal Detectors shall be rated at 135°F(57°C) and 15°F (8.3°C) per minute rate of rise. Detectors shall be constructed to compensate for the thermal lag inherent in conventional type detectors due to the thermal mass, and alarm at the set point of 135°F(57°C). The choice of alarm reporting as a fixed temperature detector or a combination of fixed and rate of rise shall be made in system software and be changeable at any time without the necessity of hardware replacement.

The detectors furnished shall have a listed spacing for coverage up to 2,500 square feet and shall be installed according to the requirements of NFPA 72 for open area coverage.

Detectors shall have built-in isolation.

Advanced heat detector shall have the following temperature settings:

Fixed temperature at 135°F(57°C), 145°F(63°C), 155°F(68°C), 165°F(74°C), 174°F(79°C)

Rate of Rise at 15°F/min (8.3°C) at 135°F (57°C)

Rate of Rise at 15°F/min (8.3°C) at 174°F (79°C)

Low temperature warning at 40°F (4.4°C)

Duct Smoke Detectors – Addressable

For duct detector applications, the smoke detector shall be an intelligent digital photoelectric detector. The detectors shall be listed to comply with an air velocity range from 0 to 4000ft/min(0 to 20m/s) and be listed for open air mounting, direct in-duct mounting, or listed sampling assembly.

The detector communications shall allow the detector to provide alarm input to the system and alarm output from the system within four (4) seconds. The detector shall be mounted in a duct detector housing listed for that purpose. The duct detector shall support the use of a remote test switch, relay or LED remote indicator. The duct detector shall be supplied with the appropriate sampling tubes to fit the installation.

Where duct detectors are exposed to the weather a weatherproof enclosure shall be available. A NEMA-3R and NEMA-4X option shall be available. The duct housing cover shall include a test port for functional testing of the detector without cover removal. The duct housing shall include a cover removal switch capable of indicating cover removal status to the fire alarm control panel.

An intelligent duct detector shall be available. Where required there shall be available a duct housing with an on-board relay. Also, where required, there shall be a standalone housing available with its own power supply and test/reset switch that does not require connection to a fire alarm control panel.

Duct smoke detector housing shall allow use in duct systems with air velocity ranging from 100 to 4,000 feet per minute, within temperature ranges of 32°Fto 120°F(0°C to 49°C), and with relative humidity ranging from 0 to 95%.

Duct Housings and Accessories:

Air Duct Housing for Conventional and Addressable Detectors

Air Duct Housing for Addressable P2 Detectors with Relay Application

Air Duct Housing for Conventional Detectors with Relay Application

Air Duct Housing for Conventional Detectors with Relay Application and Built-in Power Source

Weather-Proof housing to accommodate all versions of Air Duct Housings

Remote Test Lamp for Conventional Detectors

Detector Bases – Addressable

Detector bases shall be low profile twist lock type with screw clamp terminals and self-wiping contacts. Bases shall be installed on an industry standard, 4in square or octagonal electrical outlet box.

Multi-Criteria Fire Detector shall be listed as providing CO detection in duct application.

The large standard base shall be a 6in version.

The small standard base shall be a 4in version.

Manual Pull Stations – Addressable

Provide addressable manual stations where shown on the drawings, to be flush or surface mounted as required. Manual stations shall contain the intelligence for reporting address, identity, alarm and trouble to the fire alarm control panel. The manual station communications shall allow the station to provide alarm input to the system and alarm output from the system within less than four (4) seconds.

The manual station shall be equipped with terminal strip and pressure style screw terminals for the connection of field wiring. Surface mounted stations where indicated on the drawings shall be mounted using a manufacturer's prescribed matching red enamel outlet box.

A single action pull station shall be available. It shall provide built-in isolation capability. The operator display shall indicate which specific device has detected a wiring fault on the data communication line.

Where required, there shall also be available pull stations with break glass, capable of explosion proof installation, capable of weatherproof installation, reset key operation, and metal housings.

Addressable Interface Devices

Addressable Interface Devices shall be provided to monitor inputs (contacts) and control outputs (relays) to and from the fire alarm system and associated devices. These interface devices shall be able to monitor single or dual contacts. An address will be provided for each contact. Where remote supervised relay is required the interface shall be equipped with a SPDT relay rated for 4 amps resistive and 3.5 amps inductive.

Devices shall have built-in isolation. Shall be capable of a full class X loop compliance up to 252 devices in isolation mode.

Where needed, a Conventional Zone Module shall connect to the Signal Line Circuit, which will allow the use of conventional initiation devices. This module shall have the ability to support up to 15 conventional smoke detectors and an unlimited number of contact devices.

Devices include (but not limited to):

Single or Combination input/output control modules.

Remote test lamps

Remote test switches

Monitoring applications include (but not limited to):

Water-flow switches

Tamper switches

PIV switches

Damper position – All 3 states on one input

Conventional devices (e.g., Smoke detectors, beam detectors, flame detectors, etc.)

Duct Detectors

Control applications include (but not limited to):

Notification appliance circuits (NAC)

Telephone zones

Speaker zones.

Damper position

Solenoids for sprinklers

Where applicable, all interface devices shall have built in isolation.

Where applicable, all interface devices shall meet NFPA 72 Class X requirements for survivability.

DEVICE PROGRAMMING UNIT

Device Programming Unit: The programming tool shall program the intelligent devices with addresses. The unit shall test the device to respond to its address. Dipswitches and rotary switches shall not be acceptable. The programmer shall be available with carrying case.

ADVANCED FIRE ALARM NOTIFICATION APPLIANCES (LED based)

Horns, Strobes, and Horn/Strobes

Strobes and horn/strobes shall be listed for UL Standard 1971 (Emergency Devices for the Hearing Impaired) for Indoor Fire Protection Service.

Audibles devices shall be UL Listed under Standard 464 (Fire Protective Signaling).

All appliances shall meet the requirements of FCC Part 15 and ICES-003.

Visual appliances shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range and shall incorporate a Light Emitting Diode (LED) as the light source with a rugged Lexan® lens.

The appliance shall be a “low profile” device.

The appliances shall be of low current design.

The LED strobe flash duration shall be 20ms. Where Multi-Candela appliances are specified, the strobe intensity shall have 4 field selectable settings at 15, 30, 75, and 110 candela for wall mount applications.

The selector switch for selecting the candela shall be tamper resistant.

Audible appliances shall have a minimum of two (2) field selectable settings for dBA levels and shall have a choice of continuous or temporal (Code 3) audible outputs.

The strobes shall not drift out of synchronization at any time during operation. If the sync fails to operate, the strobe shall revert to a non-synchronized flash rate and still maintain (1) flash per second over its “Regulated Voltage Range”.

Finish shall be red or white.

Special lettering, ALERT, CO and No lettering, shall be available.

The appliance shall also be designed so that the audible signal may be silenced while maintaining strobe activation

INSTALLATION:

Installation shall be in accordance with the local and state codes, as shown on the drawings, and as recommended by the equipment manufacturer.

All fire detection and alarm system devices, control panels and remote enunciators shall be flush mounted or surface mounted as per instructions of the Engineer-in-charge.

Manual call boxes shall be suitable for surface mounting or semi-flush mounting and shall be installed at a height of not less than 1,000 mm, or more than 1200 mm above the finished floor level.

At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

DEMONSTRATION:

The Contractor shall completely check out, calibrate and test all connected hardware and software to ensure that the system performs in accordance with the approved specifications and sequences of operations submitted.

This demonstration shall consist of the following:

Display and demonstrate each type of data entry to show site specific customizing capability.

Demonstrate parameter changes.

Demonstrates can, update and alarm responsiveness.

MANUALS

The following manuals shall be provided at the time of Handing over: An Operator's Manual shall contain graphic explanations of keyboard use for all operator functions specified under Operator Training.

Computerized print outs of all data file layouts including all point processing programming details, flowcharts, etc.

On completion of works "**As Built**" drawings for completed installation shall be prepared by the Contractor and (5) Five copies of the same will be supplied to the Engineer-in-Charge. In addition, (5) Five sets of all Operation Manuals, Technical Literature for the various components of equipment, Controls and Accessories installed, Recommended Spares and Services Manuals will be supplied by the Contractor to the Engineer-in-charge.

TRAINING & HANDING-OVER

All training by the Contractor shall utilize manuals and as-built documentation and the on-line help utility.

Operator training shall include:

Sequence of Operation review

Sign ON -Sign OFF

Selection of all displays and reports

Commanding of points, keyboard

System initialization

Trouble shooting of sensors (determining bad sensors)

Password modification

Supervisor training shall include:

Password assignment/modification

Operator assignment/modification

Operator authority assignment/modification

Point disable/enable

Terminal and data segregation/modification

Guarantee

The guaranty shall cover the following: -

Quality, strength and performance of materials used.

Safe mechanical and electrical stress on all parts under all specified conditions of

Operation.

Satisfactory operation during the guarantee eperiod.

Performance figures and other particulars as specified by the tendered under

Labour to trouble shoot, repair, reprogram or replace system components shall be furnished by the contractor at no charge to the Engineer-in-charge during the guarantee period.

All corrective software modifications made during guarantee period shall be updated on all user documentation.

MISCELLANEOUS:

The onus of incorporating the **statutory requirements as per local rules** and obtaining necessary approval for the fire alarm systems shall rest fully with the Contractor.

The installation shall be carried out using new Equipment/ Materials complying with applicable standards in a workmanship like manner. Engineer-in-charge reserves the right to reject any part of installation having poor workmanship.

All minor Masonry, Carpentry and Civil works such as cutting / opening in Masonry Walls/ Internal Partitions, Chasing on Walls, etc. and making good the same to match existing surface shall be done by the Contractor, wherever asked for by the Engineer-in-charge or his authorized representative. Nothing extra shall be paid on this account.

ENDOF SECTION

Fire Suppuration System

TECHNICAL SPECIFICATION

GAS BASED SUPPRESSION SYSTEM

SCOPE OF WORK

The bidder shall supply, install, test and put in operation FK 5112 based fire suppression system. The fire suppression system shall include and not be limited to gas release control panel, CCOE approved seamless cylinders, discharge valve (with solenoid or pneumatic actuator), discharge pipe, non-return valve and all other accessories required to provide a complete operation system meeting applicable requirements of NFPA 2001 standards and installed in compliance with all applicable requirements of the local codes and standards.

The work under this system shall consist of design, supply, installation, testing, training & handing over of all materials, equipment, hardware, software appliances and necessary labor to commission the said system, complete with all the required components strictly as per the enclosed tender specifications, design details. The scope also includes the supply, installation & commissioning of any material or equipment including civil works that are not specifically mentioned in the specifications and design details but are required for successful commissioning of the project.

The system design should be based on the specifications contained herein, NFPA 2001 and in accordance with the requirements specified in the design manual of the agent. The bidder shall confirm compliance to the above along with their bid.

The system shall be properly filled and supplied by an authorized OEM (Original Equipment Manufacturer).

Key Component of the system along with calculation software of the system shall be approved by VdS/LPCB/UL-FM.

Generally, the key components of the FK 5112 system shall Comply with NFPA 2001 standards and Have the approval from US EPA (Environmental Protection Agency) for use as a total flooding fire extinguishant for the protection of occupied space:

Must have zero ozone depletion potential (ODP)

Be efficient, effective and does not require excessive space and high pressure for storage;

Be commercially available

Contain the required key components such as valves and its accessories, actuators, flexible discharge and connection hoses, check valves, pressure switch, and nozzles

DESIGN AND ENGINEERING

The system shall be designed taking the minimum design concentration as per NFPA 2001(Latest Edition) guidelines & as applicable to class 'A' & C risks. The FK 5112 agent shall be stored in seamless steel cylinders and dry nitrogen shall be added to provide additional energy to give the required rapid discharge. At the normal operating pressure of 42 bar at 21Deg C, the agent is a liquid in the container.

The system design must consider the limitations caused by the void height. The vendor should clearly indicate the quantity of the gas in Kgs. to be used for the system. All voids within each hazard shall be discharged simultaneously. Each hazard shall have an independent system, unless otherwise specifically stated.

The system shall have a working pressure of 42 bars. A fill density between 0.40 Kg /Lit. To 0.85 Kg/Lit or as recommended by the manufacturer should be considered for the agent to be discharged within the specified time of 10 seconds.

The system engineering company should carry out the Piping Routing, Isometric design and validate the same with a hydraulic flow calculation generated by using the agent's design software. The appropriate fill density to be arrived based on the same. Software calculation for one room must be designed and corresponding result shall be generated in front of the customer.

The design & calculation shall be checked & certified by manufacturer/Consultant. You may note that the calculation is the only guarantee that the system will work, provided the system is installed exactly as per the design. The contractor has to take into consideration the routing available while designing the pipe network.

The Vendor shall enclose their design sheet along with the offer & the offer/BOQ should be in line with their design. The dimensions of rooms to be protected are given in the BOQ. The vendor shall also consider the following

The vendor shall consider simultaneous total flooding of all voids within the protected volume. The system shall be designed in accordance with the OEM's Design Manual.

In order to extinguish a fire using clean agent, the concentration of agent delivered to each void shall be above the minimum design concentration. The following shall be considered while designing the system. The minimum design concentration shall be 4.5%. Class A&C fire risks.

If the protected volume has a floor and / or ceiling void the spaces shall be included in the protected volume, employing a minimum design concentration not below that of the main room compartment.

The discharge nozzles shall be located within the protected volume in compliance to limitations and with regard to spacing, floor and ceiling coverage, etc.

The nozzles shall be positioned such that they would cover the entire area up to the extreme corners of the area under protection and the design concentration will be established in all parts of the protected volumes and it shall be ensured that the nozzles are NOT placed directly above the racks

The final numbers of discharge nozzles shall be according to the OEM's product manual.

The gas flow calculations shall be carried out on special software given by the OEM. The software should support usage of seamless cylinders which have a different design compared to the standard containers used worldwide.

The system acceptance report shall show the resulting concentration in each independent void to be above 4.5% and the average pressure at each nozzle to be not less than 6.4 Bar.

The agent discharge time shall not exceed 10 seconds.

The design concentration shall follow at minimum NFPA 2001 for under floor, room and ceiling space. Unless otherwise approved, room temperature for air-conditioned space shall be taken around 20 - 23 Deg C. For non-air conditioned space, the temperature shall be taken around ambient temperature. The system shall be designed with minimum design concentration of 4.5 % as applicable to Class A& C fire.

The system engineering company should carry out the piping Isometric design and validate the same with a hydraulic flow calculation generated by using the agent's design software. Appropriate fill density to be arrived at based on the same.

REFILLING AND MAINTENANCE

In case of any leakage or accidental discharge of the agent, it should be possible to refill the cylinders in India itself in the CCOE approved filling station. The contractor should indicate the source of refilling and time that will be taken for refilling and replacement.

DISCHARGE TIME

As gas has to be fully discharged within 10 seconds for effective quenching of fire as per the relevant standards, the contractor has to ensure that the design meets this requirement. Once the discharge takes place there should be warning signs restricting personal from entering the protected area until the gas has been cleared from the area.

MATERIALS AND EQUIPMENTS

All materials and equipment's shall be from approved manufacturers and shall be suitable for the performance of their respective functions. The cylinders should be complete with all accessories. The contractor shall indicate the dimensions of the cylinders required for each area while quoting.

CYLINDER

The cylinder shall be high pressure, seamless steel gas cylinder, flat type, concave bottom as per IS 7285 complete with neck ring. Welded and non-CCE approved cylinders will not be accepted.

Each cylinder shall be seamless steel type manufactured from billets and tested in accordance

with IS 7285

As per the regulations of the Chief Controller of Explosives (CCE) Nagpur, any system which has a working pressure above 19 bar (280 psi) will require the use of seamless cylinders that have been duly approved by the CCE, Nagpur.

The maximum fill density of FK 5112 in a cylinder shall not exceed 0.85 Kg/Lit. of internal volume. Appropriate fill density shall be chosen based on the cylinder location and piping. The hydraulic calculations should prove that the fill density is appropriate and total discharge will take place within 10 seconds.

The cylinders shall be super-pressurized with dry nitrogen to 42 bar at 20°C. The cylinder shall be capable of withstanding any temperature between -30° C and 70°C. Cylinder shall be mounted according to manufacturer recommendations. The cylinder shall withstand Hydrostatic test pressure up to 250 bars and maximum working pressure at 15°C shall be 150 bars

The cylinder/valve assembly shall have suitable metallic protection for the valve enabling transportation of the filled cylinders safely.

All cylinders shall be distinctly and permanently marked with the quantity of agent contained, the empty cylinder weight, the pressurization pressure and the zones they are protecting.

CYLINDER VALVE

Each cylinder shall be provided with a valve of suitable size. Each cylinder valve shall have a provision for fixing a supervisory pressure switch and a safety burst disc to protect the cylinder from over pressure. The cylinder valve shall necessarily have a disabling plug (locking pin) to prevent accidental discharge of the valve during transportation and installation. The Valve assembly shall be mounted directly on the cylinder.

The Pressure Gauge must have in-built low supervisory switch and low-pressure supervisory switch must not be connected externally on the valve. The Cylinder Valve must have a provision of mounting the Electrical Actuator and the Pressure gauge on either any two sides of the Valve, it should not be limited to only one side.

Each valve is to be fitted with a pressure gauge for monitoring loss of pressure.

The master cylinder valve is to be released electrically which is performed by means of a solenoid valve arrangement.

CYLINDER VALVE ACTUATORS

In a single cylinder system the cylinder shall have a solenoid operated actuator and a manual actuator incorporating a strike knob mounted on top of the solenoid operated actuator. Multi cylinder systems shall have the same fitted on to the master cylinder and pressure operated actuators fitted on each slave cylinder. All actuators shall be original OEM make and locally manufactured actuators shall not be used.

HOSES

Each cylinder valve shall be provided with a plug-in type flexible rubber discharge hose of minimum 40mm size and shall withstand a test pressure as at least 150 -200% of the cylinder stored pressure. Each hose shall be permanently marked with the test pressure and OEM's part number. Multi cylinder systems shall have an interconnect hose for each cylinder. The interconnect hose shall have a length not less than 700 mm and shall be labeled with the test pressure of 100 Bar and the OEM's part number. All hoses shall be original OEM make and locally manufactured hoses shall not be used.

MANIFOLD WITH CHECK VALVE

The manifold shall be fabricated from ASTM A106 Schedule 80 seamless pipe and shall have integral check valves provided for each cylinder.

OTHER ACCESSORIES

Electric Control Head, Pressure operated control head, Master Cylinder Adapter Kit, Flexible discharge hose, discharge Nozzles, and other required accessories shall be approved or listed for use with FK 5112. All the gaskets, O-ring, sealant and other components shall be constructed of materials compatible with the clean agent. The system should be engineered using hardware & accessories approved by the Engineering System Distributors of FK 5112 as mentioned in the list of approved makes. The Vendor shall submit the detailed data sheets & drawings of each accessories with the required part Nos. and also the common system data sheet containing these parts with part Nos.

PIPES & FITTINGS

All Pipes shall be of ASTM - A-106, Gr: B, schedule - 40 seamless Mild Steel Pipes and fittings shall be as per ASTM-A-105 standard. Distribution piping and fittings shall be installed in accordance with the manufacturer's requirements, NFPA 2001, and approved piping standards and guidelines. All distribution piping shall be installed by qualified individuals using accepted practices and quality procedures. All piping shall be adequately supported and anchored at all directional changes and nozzle locations.

All piping shall be reamed, blown clear and swabbed with suitable solvents to remove burrs, mill varnish and cutting oils before assembly.

All pipe threads shall be sealed with Teflon tape pipe sealant applied to the male thread only.

DISCHARGE NOZZLE

Engineered discharge nozzles shall be provided within the manufacturer's guidelines to distribute the FK 5112 agent throughout the protected spaces. Nozzle shall control the flow of FK 5112 to ensure high velocity, proper mixing in the surrounding air and uniform distribution of the agent throughout the enclosure.

The number of nozzles and their positions must be chosen so that the design concentration is maintained everywhere in the enclosure. Nozzle shall be located where they can be adequately supported on walls, ceiling or structural members. Software generated calculation supporting the nozzle design shall be submitted by the successful bidder before signing of contract.

FIRE DETECTION & GAS RELEASE PANEL & OPERATION PROCESS

Fire detection shall be achieved using the microprocessor-based fire detection cum gas release panel specifically used for each protected area. The detectors shall be in cross zone and the trigger from the panel shall be for 2 stage action.

Some of the enhance features of the detection cum gas release panel shall be,

- Easy on-site configuration
- Upload / download of configuration data's
- Event logging facilitates identifying origin of events
- Display countdown timer before extinguishing release
- Extinguishing automatic activation with various alarm combinations
- 72h battery backup time
- Various system test modes
- Automatic calibration facility for actuators control lines (solenoid or pyrotechnical actuators)
- Manual Release button for manual activation of extinguishing
- Emergency hold button to temporary stop the extinguishing or abort button to cancel the initiated extinguishing release as long as the pre-warning time is running
- Remote transmission facility for transmitting alarms and faults

If in case the fire detection part is handled by a separate fire control panel, the panel shall have the capability to integrate with larger fire detection system. Also, the panel shall have the facility to connect repeater panel for remote status indication and remote control.

AUTO MODE OPERATION

The sequence of operation of the gas release system shall be as follows.

When the any one of the detectors connected to the building fire alarm panel goes into alarm, immediately the sounder cum strobe shall get activated.

The fire detection cum gas release panel shall ensure that the access control shall get deactivated.

The first stage activation in the gas release circuit shall happen only when any one of the detectors in the protected area goes into alarm.

When the first stage gets activated, the specific zone numbers and the detectors location shall be displayed, and the panel buzzer shall start operating. The stage 1 bells shall be identified by the fact that they pulsate at the rate defined by timer 1.

The panel shall also illuminate the "ALARM" lamp on the control panel face.

The sounder cum strobe shall remain on until the alarm is silenced in the panel. The panel shall return to normal only after the fire alarm condition is cleared and a reset is performed in the panel.

The second stage activation in the gas release panel shall happen when the second detector in the protected area goes into alarm in the second stage or vice versa.

The PAC units shall be deactivated. The panel shall also illuminate the "PRE-DISCHARGE" lamp on the control panel face

When the second stage is activated, the second zone number and the detectors location shall also be displayed on the panel and the sounder shall be activated which is identified by a continuous tone. The stage 2 bells indicate that area is to be evacuated.

The timer shall start to trigger the signal for gas release. The delay set time shall NOT exceed 60 seconds. It shall be possible to program the delay timing at site

During the delay time period, the Gas release can be aborted by activating the "Manual abort switch" mechanically. The countdown timer shall countdown till 10 second and stops. Once if the abort switch is released, the timer shall start count down from 10 seconds. Releasing and pressing again the manual abort switch shall reset the countdown time to 10 seconds. A buzzer shall be activated when the abort switch is operated.

After the expiry of the timer, the output from the actuator output terminal of the panel shall activate and operate the solenoid valve in the master cylinder. It is important to note that the actuator output on the panel shall be enabled only if the automatic gas release mode is selected

A Gas sign board with lamp (Located outside the protected area) shall also illuminate indicating that the gas discharge has taken place

The gas shall discharge into the protected area with in 10 seconds as stipulated in the NFPA 2001 guidelines (2004 edition). The gas shall permeate into all the voids in the desired quantity so that the fire shall be quenched.

As long as both the stages remain in alarm, the output to solenoid shall be active. If at least one of the two stage returns to normal as explained above, the delay timer shall stop. The gas release shall not happen if the delay is set to zero.

MANUAL MODE OPERATION

The manual release shall happen in three ways. Manual Release through the panel, Manual release station & Manual Release directly from the cylinder

The electric manual release (activated through the panel) shall be a dual action switch device which provides a means of manually discharging the suppression system from the panel

The manual release station shall also be a dual action device requiring two distinct operations to initiate a system actuation.

Manual actuation shall be capable of bypass the time delay or shall have the time delay depending upon the client requirements. It shall be possible to program both at site and abort functions and shall cause all release and shutdown devices to operate in the same manner as if the system had operated automatically.

Manual release station shall be located at each entry from the protected hazard and the abort station shall be located at the exit side

If the "Manual release lever on the master cylinder shall be activated by operating the lever, the gas shall get released immediately. Abort function cannot be performed after activating the manual release lever.

CONNECTION DETAILS

The Addressable detectors shall be connected in loops which are independently addressed from the fire alarm panel. Or Conventional detectors shall be used and the same shall be connected to the conventional fire detection cum gas release panel.

The manual abort station and manual release stations shall be connected to fire alarm cum gas release panel. In addition, the gas release panel shall have the manual mode switch as explained above

The discharge pressure switch shall be connected to the gas release panel thro addressable monitor modules.

The sounder cum strobes shall be connected gas release panel.

The solenoid actuator shall be connected to gas release panel in the Gas release terminal.

The fire trip input for the PAC units are looped and connected to through addressable control modules to the fire alarm cum gas release panel.

The Access controlled door release shall be connected to the fire alarm cum gas release panel thro addressable control modules.

The monitor module shall be connected from the Building fire alarm panel to the gas release panel for alarm communication fault status of the gas release panel.

CONVENTIONAL MULTI SENSOR DETECTOR

It shall be Multi Sensor type Smoke Detector with UL and FM Approval. It should have Green LED Indication for Normal Operation, RED for Fire condition and Yellow for Fault. Detector should have 3600 LED Indication.

MANUAL RELEASE UNITS / STATIONS

Manual release units - double action type shall be provided at each exit of the protected area and as indicated on the drawings. Manual release unit casings shall be colored YELLOW and shall be inscribed with the lettering "AGENT (NAME) MANUAL RELEASE POINT". Mounting heights for manual release units shall be agreed on site.

ABORT UNITS / STATIONS

Abort switches, where provided, shall be located within the protected area and shall be located near the means of egress for the area. The abort switch shall be of a type that requires constant manual pressure to cause abort, In all cases the normal and manual emergency control shall override the abort function. The abort switch shall be clearly recognizable for the purpose intended.

The abort units shall be momentary devices requiring constant pressure to maintain contact closure and shall be coloured RED and shall be inscribed with the lettering "AGENT (NAME) ABORT POINT". Mounting heights for abort units shall be agreed on site.

REMOTE LAMP UNIT

Remote lamp units shall be provided to give indication of an activated smoke detector within a ceiling or floor void.

DOCUMENTATION

The successful contractor should prepare & submit the piping Isometric drawing and support the same with a hydraulic flow calculation generated by using the agent's design software. The calculations shall validate the fill density assumed by the bidder.

The bidder shall submit copies of the datasheets of the hardware used in the system.

The bidder shall also submit calculations to evidence the qty of agent considered for the system. The System Company should provide, as part of handing over, the as-built drawing, operation manual and maintenance manual. The as-built drawing shall exactly match the Isometric drawing submitted with the flow calculation prior to commencement of work.

The successful vendor must submit, along with the supply invoice, a certificate of authenticity, for the agent.

The design & the installation shall be certified by principal system supplier.

TESTING PROCEDURES FOR GAS BASED FIRE SUPPRESSION SYSTEM

GENERAL

Prior to placing the completed system in service, the installation should be inspected and tested by qualified personnel to confirm that the system has been properly installed and will function as specified below.

Conformance to System design.

Suitability of piping, its correctness to project design, and its supports.

Operating Sequences.

Suitable Hazard Environmental controls and Safety precautions and.

Compliance with the norms of NFPA STD. 2001 (2008 Edition) and other applicable standard.

PIPING

Verify that pipe sizes and layout are as indicated on the project working drawings.

Verify the piping supports and ensure the pipes are secured and restrained from the movement.

After the installation after system piping is completed, and prior to the connection of the cylinders, accessories, nozzles etc., the discharge piping should be blown out and then

Pressure tested for leakage. Plug or Cap all pipe outlets and apply 40 psi (3 bar) pressure with air for 10 minutes. At the end of 10 minutes, the pressure loss shall not exceed 20% of the test pressure. Under no conditions should water be used in testing.

CYLINDERS

Inspect cylinders and ensure bracketing and cylinders are secure.

Check pressure gauge and ensure pressure is correct for temperature at cylinder location.

Check cylinder discharge bends and check valves for proper orientation, connection and tightness.

Ensure that the cylinder operating components and auxiliary control devices are installed in accordance with the project drawing.

All the required labeling as done on the cylinders

NOZZLES

Ensure each nozzle has an orifice drilled to suit the specific location and discharge flow requirements.

Verify that nozzle locations and orifice sizes are as indicated in the project drawing.

ELECTRICAL

All testing of the extinguishing system electrical circuits, Interlocks, Fire detectors and other electrical devices like solenoid actuators shall be carried out in accordance with the systems control panel.

The control panel should indicate normal supervisory condition.

Check the smoke detectors are in cross zone.

ROOM INTEGRITY TEST

NFPA2001 states that the design concentration of a clean agent post discharge shall be maintained for a sufficient period of time to ensure there is no reignition of fire once suppressed. NFPA 2001 and 12A require an enclosure integrity test as part of the acceptance procedure for all clean agent systems. This includes halocarbon and inert agents. This comprehensive test and calculation predict the leakage area corresponding to the retention time of agent in the enclosure on discharge. Most specification state it must be ten minutes.

Transformer

DISTRIBUTION TRANSFORMER (DRY TYPE)

Scope

Three-phase 11KV/0.433 KV, 2 no's 2500 KVA Transformers of Cast Resin Type, class F insulation system with natural (AN) cooling for indoor installation, destined for use in three-phase LV distribution systems.

Standards

These transformers will be in compliance with the following standards:

- IEC60076-11
- prEN50541-1

Specific Standards according to country requests

These transformers will be manufactured in accordance with:

a quality system in conformity with ISO 9001

an environmental management system in conformity with ISO 14001, both certified by an official independent organization.

Description

Magnetic core

This should be made from lamination of insulated silicon steel, and should be protected against corrosion with a coat of varnish. In order to reduce the power consumption due to transformer no-load losses, the magnetic core should be stacked using overlapping-interlocking technology.

In order to reduce the noise produced by the magnetic core, it should be equipped with noise-damping devices.

LV windings

The LV windings should be produced using copper foils in order to cancel out axial stress during short circuit; this foil should be insulated between each layer using a heat-reactivated class F pre-impregnated epoxy resin film.

The ends of the winding are to be protected and insulated using a class F insulating material.

The whole winding assembly will be polymerized throughout by being autoclaved for 2 hours at 130°C, to ensure:

High level of resistance to industrial environments

Excellent dielectric withstand

Very good resistance to radial stress in the instance of a bolted short circuit.

HV windings

They should be separated from the LV windings to give an air gap between the MV and LV circuits in order to avoid depositing of dust on the spacers placed in the radial electrical field and to make maintenance easier.

These will be made of copper wire or foil (according to the manufacturer's preference) with class F insulation.

The HV windings will be vacuum cast in a class F fireproof epoxy resin casting system composed of: an epoxy resin
an anhydride hardener with a flexibility additive
a flame-retardant filler.

The flame-retardant filler will be thoroughly mixed with the resin and hardener. It should be composed of trihydrate alumina powder (or aluminium hydroxide) or other flame-retardant products to be specified, either mixed with silica or not.

The casting system will be of class F. The interior and exterior of the windings will be reinforced with a combination of glass fibre to provide thermal shock withstand.

MV winding support spacers

These will provide sufficient support in transport, operation and during bolted short circuit conditions as well as in the case of an earthquake.

These spacers should be circular in shape for easy cleaning. They should give an extended tracking line to give better dielectric withstand under humid or high dust conditions.

These spacers should include an Elastomer cushion that will allow it to absorb expansion according to load conditions. This Elastomer cushion should be incorporated in the spacer to prevent it being deteriorated by air or UV.

HV connections

The HV connections will be made from above on the top of the connection bars. Each bar will be drilled with a 13mm hole ready for connection of cable lugs on terminal plates.

The HV connection bars will be in rigid copper bars protected by heat shrinkable tubing. HV connections in cables are not allowed, in order to avoid all risk of contact, due to cables flapping. The HV connections will be in copper.

LV connections

The LV connections will be made from above onto bars located at the top of the coils on the opposite side to the HV connections.

Connection of the LV neutral will be directly made to the LV terminals between the LV phase bars. The LV connection bars will be in copper.

The output from each LV winding will comprise copper connection terminal, enabling all connections to be made without using a contact interface (grease, bi-metallic strip: out of scope of supplying) able to connect to the Bus Duct.

HV tapping

The tapping which acts on the highest voltage adapting the transformer to the real supply voltage value, will be with ON Load Tap Changer (OLTC Type) as per manufacturer's standard/ 1.25% Step Up & Step-Down settings with remote panel.

Accessories and standard equipment

These transformers will be equipped with:

4 flat bi-directional rollers

lifting lugs

haulage holes on the undercarriage

1 earthing terminal

1 rating plate

1 "Danger Electricity" warning label (T10 warning)

1 routine test certificate

1 instruction manual for installation, commissioning and maintenance in English.

Thermal protection

These transformers will be equipped with a thermal protection device which will comprise:

3 thermal detection systems (1 by phase), installed in the active part of the transformer. These sensors will be placed in a tube to enable them to be replaced if ever necessary.

An electronic converter with two independent monitoring circuits equipped with a changeover switch, one for "Alarm 1" the other for "Alarm 2". The position of the relays will be indicated by different coloured indicator lights. A third indicator light will indicate the presence of voltage.

These three indicator lights will be on the front of the converter. The electronic converter should be installed away from the transformer.

A plug-interterminal block for connection of the sensors to the electronic converter.

These sensors will be supplied assembled and wired to the terminal block fixed on the upper part of the transformer. The converter will be supplied loose with the transformer, packaged complete with its wiring diagram.

Metal enclosure

On request, these transformers will be equipped with a metal enclosure for indoor installation comprising an integral IP31 (except the base which may be IP21) metal enclosure, that can be dismantled on request, with:

On requests specified in the annex, these transformers can be supplied mounted equipped with protective metal enclosure:

either for indoor installation, with degree of protection IP31 (except the bottom which may be IP 21),

Electrical tests Routine tests

These tests shall be carried out on the transformers after the manufacturing, enabling an official test certificate to be produced for each one:

measurement of windings resistance

measurement of the transformation ratio and vector group

measurement of impedance voltage and load loss

measurement of no-load loss and no-load current

applied voltage dielectric test

induced voltage dielectric test

measurement of partial discharges. For this measurement, the acceptance criterion will be: partial discharges less than or equal to 10 pC at 1.30 Un, or

partial discharges less than or equal to 5 pC at 1.30 Un (Special test)

(All these tests are defined in the IEC 60076-11 and IEC 60076-1 to 60076-3 standards).

Type tests or special tests

The manufacturers should furnish following type test certificates:

temperature rise test carried out in accordance with the simulated loading method as defined by the IEC 60076-11 standard

lightning impulse test in accordance with IEC 60076-3

short circuit test in accordance with IEC 60076-5

noise level measurements in accordance with IEC 60076-10.

(All these tests are defined by the IEC 60076-11 and IEC 60076-1 to 60076-5 standards).

Climatic and Environmental classifications

These transformers will be of environmental class E2 and of climatic class C2 as defined in IEC 60076. E2 and C2 classes will be indicated on the rating plate.

The manufacturer must produce a test report from an official laboratory for a transformer of the same design as those produced.

The tests must have been performed in accordance with IEC 60076-11 for C2 climatic class and IEC 60076-16 for E2 environmental class.

Fire behaviour classification

These transformers will be of class F1 as defined in IEC 60076-11. F1 class will be indicated on the rating plate.

The manufacturer must produce a test report from an official laboratory on a transformer of the same design as those produced and on the same transformer which have initially passed the hereabove Climatic and Environmental tests. This test must have been performed in accordance with IEC 60076-11.

3.11 Transformer Losses:

Transformer Losses should be as per ECBC PLUS.

END OF SECTION

PLCSYSTEM

CONTROL PHILOSOPHY

AUTOMATIC STARTING & STOPPING OF ENGINES

The system should come in operation after sensing of grid failure and or the voltage drops below preset value. The 'PLC' shall issue the command to 'Master' D.G. In case the D.G. set do not start in the 1st cranking; two more cranking attempts shall be made with proper intervals. Even then if engine fails to start, indication must appear on MMI/Monitor 'SET FAILS TO START' & alarm shall be generated. The PLC shall give the command to the next D.G. in selected sequence.

D.G. set has started and put on load. The system shall start monitoring voltage, Frequency and load, if the load exceeds a settable limit. The next D.G. shall be started to prevent D.G. over loading. The process shall continue till all the D.G.s have been started.

At any point of time, the engines are under loaded and the load is capable of being catered by less than the numbers of running D.G.'s. Stop command shall be given to the D.G. running for shortest duration at that moment.

On restoration of mains and sensing the healthiness of the same, the load shall be transferred to mains. The D.G.'s shall be given stop command after a settable time delay ensuring adequate cooling down of the engine.

AUTO SYNCHRONISATION

Synchronization facility shall be available for 'Auto & manual mode. In auto synchronizing mode, the synchronization will be achieved by 'PLC' (PLC will control voltage, frequency and phase angle and issue command to breaker), However if due to any reason auto synchronization fails repeatedly, the 'PLC' system should initiate start command to next DG for operation and as well as synchronise the system automatically. **In manual mode the system shall be manually operated backed by relays only.** In auto mode facility the closing of breaker shall be automatic, whereas in manual mode breaker will be closed by panel switch through synchronizing relay.

In any case if the auto synchronization is failed to achieve in a settable time an alarm shall be generated and displayed that the 'DG FAILED TO SYNCHRONISE' and the same shall be aborted.

AUTOMATIC LOAD SHARING

'PLC' shall monitor continuously the Active & Reactive Power Generated by the various sets and shall issue command to achieve proper load sharing.

BACKUP PROTECTION

The system shall have built in protection as listed below and shall continuously monitor the parameters and on sensing of any electrical fault P.L.C shall trigger 'Trip command Through Trip relay of the corresponding breaker similarly in case of semi auto mode and in case of manual mode it shall be through master trip relay.

Overvoltage/Undervoltage

Overfrequency/underfrequency

Overcurrent

Reverse power active

Active Power reactive

Synchronizing check (MMI)

Earth fault relay unbalance

Differential protection through relay interface with PLC/PC

Engine Protection as listed under DG sub-head shall also be interfaced with PC/PLC for generating trip command/alarm and generating report etc.

PROGRAMMABLE LOGIC CONTROLLER (PLC)

The entire operation of the captive power generation system and Grid supply shall be controlled automatically through PLC. These PLCs shall be a state-of-the-art equipment's using latest technology and shall be of most rugged and reliable design. Since system will be operating in the harsh and unfriendly environment of D.G. Room, they should be suitable to operate trouble free under the conditions. The selected equipments should be able to withstand high temperature, humidity and voltage fluctuations, thus making it suitable for the operating conditions described above.

Automatic PLC system basically shall consist of but not limited to:

Main processor unit

EEPROM for CPU

Power supply for unit (1 KVA UPS with maintenance free batteries for 15-minute capacity)

Mounting chassis 16/slot mounting rack

Power monitor module

Digital input module

Digital output module

Computer to PLC communication card with cable (MMI)

Operator interface graphics software package (window based)

Analog/P module 16/8 channels

Outgoing ckt (kwh) meter with pulse counter interface with PLC for generating report

20% spare incoming/outgoing shall be provided for future use.

Interfaced connectivity for engine safeties and parameters with cabling etc.

System diagnostic card control for DG auxiliary (Pump, fans, oil, fuel cooler etc.)

Monitoring of HT voltage Transformers alarm and trip mimic of 11 KV & LV system

Monitoring of electrical parameters including and outgoing Circuit Breaker of high and low voltage ckt and PC complete with CPU, coloured monitor, keyboard, inkjet printer, required software shall be installed and commissioned.

SEQUENCE OF OPERATION FOR AUTO START-STOP, AUTO SYNCHRONISING AND AUTO LOAD SHARING AND LOAD MANAGEMENT OF DG SETS

ON GRID Supply failure or on sensing of grid supply voltage (voltage drop than pre-set value), the master DG shall start automatically and closes its breaker/neutral contactor, bus breaker also closes to feed the loads.

On attainment of maximum permissible load on master DG set (i). The 2nd DG set shall start automatically.

Voltage & frequency of 2nd No. DG shall be monitored and compared with Bus Parameters and will be adjusted by giving commands to the incoming DG sets (2nd) if required.

Autosynchronizing system shall verify the phase angle and also compensate closing time of incoming breaker by initiating closing command to breaker ahead of the actual on predictable synchronizing ensuring thereby a zero (0) degree phase difference, as well as the system shall monitor the slip frequency, beat (hunting) voltage of the machine or system.

First DG neutral contactor shall remain in circuit even if the 1st DG set is shut-off. The neutral contactor of the other working set shall get closed first before tripping of the shutting off DG Set.

The process shall continue for incoming DG's such as 3rd, 4th so on.

The starting sequence of the DG sets can be altered through MMI/PLC

ON restoration of grid supply and sensing of healthiness of the same. The DG's & bus breaker shall be 'out' and grid breaker shall be 'in' to feed the power.

Active power on DG's is balanced automatically through Governor Control with the help of Active Load Balancing System.

Reactive load balancing system to achieve KVAR and regulation within preset bank value through the motorized potential meters.

In the event set fails to synchronise, the alarm generated through Annunciator shall invite the attention of the Operator for 'Manual' intervention. If the sets do not synchronise, the bus breakers shall be switched off and both the sets shall start feeding their respective loads.

In the event of a D.G. standing idle more than 8 hours lube oil priming pump shall be started for 3-5 minutes.

DG auxiliary feeders shall be controlled through 'PLC' for starting/stopping of respective DG auxiliary system.

The system shall have total manual over-side w/o (without) by-passing the safeties and protections.

The system shall facilitate program changeability/selling's/timedelayetc.through MMI on PC.

Stand-alone Mode (No synchronizing)

In this case the system shall work independently with electrical inter-linking to prevent parallel operation of two supply sources.

FUNCTION/FEATURE OF PLC SYSTEM

In general terms the following will be the functions of PLC. During final freezing of the controls, logic & Dos, additions and deletions can be made through PLC (MMI)

The system shall directly accept CT & PT signals without the need of any transmitters for electrical parameter monitoring and control system or the same shall be met through energy monitoring/management relays with RS 232/485 communication port.

Depending upon the load requirement starting and stopping of DG sets automatically with by-pass arrangement in PLC.

Automatic selection of next DG as master after stopping/tripping of master DG & to close or open of neutral contactor respectively.

Automatic synchronizing of DG sets in auto mode.

In the event of PLC failure, the system shall run on manual mode with relay protection back up.

Key for selection of number of DG sets to start and synchronize at no load for kick (starting) load requirements.

Active & reactive power sharing of each DG sets.

Monitoring of electrical parameter per D.G., voltage, frequency, reactive load, active load, energy produced etc.

Status and control of outgoing breakers

Backup protection electrical by time delayed tripping of D.G. Sets

Alarm and trip for reverse power, reverse KVAR, under voltage, over voltage, under frequency, over frequency, over current, low lube oil pressure, high cooling water temperature and pressure, over speed and other safeties as called for in DG tender.

Data acquisition system will be incorporated with the system for the purpose of recording and display of all important and critical parameters of the engine, alternator and system as such in totality operation and maintenance of the system will also be through operator interface with graphic screen.

PLC system should be capable to take care of all the protection (relay features) in Auto mode. Relay base protection features of manual mode shall also be compatible with PC.

'B' checks alarm after each DG complete 500 hours or as recommended by DG supplier of running for proper maintenance.

Tripping of less priority loads in the building in case of under frequency of bus both in isolation as well as synchronised mode.

PLC input/output cards should be dedicated to individual DGs without intermingling of signals from different DGs.

PLC system shall have provision to test the DG in auto mode without closing the Breaker to do the routine electrical/mechanical testing of Set without interruption of power generation.

Monitoring of 6 points alternator winding, 2 points bearing temp drive and non-drive, ends for alarm & trip respectively. Provision for monitoring of 2 points exhaust gas temperature and smoke quality.

Also, the system supplier shall include of the cost of 1 spare card for each system to facilitate in case of maintenance.

The system supplier will supply 6 sets of as built drawings along with trouble shooting with suggested measurer operational and maintenance guidelines through consultants.

MANUALMODE

In this case complete system operation will have to be done manually. Hence starting of the DG sets, stopping of the DG sets, Synchronization procedure, breaker closing, tripping etc. will be done through respective switches, push buttons provided on respective feeders.

In this mode load sensing units will be ineffective hence starting or stopping of D.G. sets will be done manually only.

Note:

Any hardware/software required to make the system operational in PLC/manual mode shall be included with any extra cost to project (employer).

NEUTRALCLOSINGSYSTEMFORPARALLELRUNNINGOFD.G. SET

A suitably rating L.V. contactor shall be provided for each D.G. set for neutral isolation controlled through PLC (auto/manual) from remote. Neutral contactor of the D.G. set started first will be closed and then command for that ACB closing can be effective. Only one neutral contactor (of the first started D.G. set) will be closed during parallel operation. In the event of tripping of neutral contactor for master D.G. set the next selected D.G.'s N/C (Neutral Contactor) should close before the neutral contactor of the master D.G. trip. While switching 'off' the D.G. sets which has started first is selected then neutral contactor of either of remaining set will be switched on and then tripping signal to the first started D.G. set will be actuated. After voltage and frequency reached the set band, PLC shall issue close command to neutral contactor 1st and then to ACB of selected set. This will prevent fault level current from flowing into the system. At any moment of time only neutral is the system to avoid any circulation current in other alternator.

The operational mimic shall also be provided on for complete function of mains & D.G.'s etc. on the boxed.

END OF SECTION

BUSBARTRUNKINGSYSTEM

Suggested specifications

A.

- Rang** - Aluminium (Having contacts of Copper): 800A-6300A
e: - Copper (Silver plated throughout the length): 630A-6300A

B. Manufactured Units

1. General

a) The busbar trunking system (800A and above), both feeder and plug-in, shall be sandwich construction.

All busbar trunking products and fittings (straight length, elbow, tees, flanged ends, cable tap box and circuit breaker, etc.) shall be in accordance with IEC 61439 Part 6 (2012) or UL 857 and from the same manufacturer as the busbar trunking system. The degree of protection of the busbar trunking system should be IP 54/65 in accordance to IEC 60529.

b) Rated operation voltage of the busbar trunking is 1000V. 3-Phase, 4 or 5 Wire with 50% capacity continual integral/ internal earth busbar. The neutral conductor should have the same cross-sectional area as the phase conductor. The earth busbar must be one continuous piece without bolting on housing

c) The ampere ratings, approximate footage, fitting, plug-in units etc. are shown on the plan. The electrical contractor shall be responsible for routing the busbar trunking to coordinate with the other trades. Final field measurements shall be made by the contractor prior to release to the busbar trunking for fabrication by the manufacturer.

2. Certificate

a) The busbar, of full range and each rating, should pass full type tests specified in IEC 61439 Part 6 (2012). The certificate shall be issued by an international independent testing authority (e.g. ASTA, KEMA, UL)

b) A product safety mark (e.g. KEMA-

KEUR, ASTA DIAMOND, UL) should be on the product offering a

visible assurance to all of full product safety testing, factory inspection and ongoing surveillance under independent authority to ensure the ongoing safety of product.

c) The busbar trunking systems should pass seismic tests with actual physical product and being certified

complying with UBC seismic Zone 4 condition by an international recognized earthquake research body, e.g. Asian Pacific Network of Centers for Earthquake Engineering Research (ANCER).

3. Short Circuit Ratings and Tests

a) The whole busbar trunking system shall be capable of withstanding the short circuit of the electrical

installation without damaging the electrical, mechanical and thermal stress under fault condition at a service voltage of 1000V 50Hz. The minimum rated insulation voltage shall be 1000V.

b) The minimum certified short circuit ratings of the busbar trunkings shall be as follows:

Rating	KA/1sec.	KA Peak	Rating	KA/1sec.	KA Peak
800A	40	84	2500A	75	165
1000A	50	105	3200A	90	198
1250A	50	105	4000A	100	220
1600A	60	132	5000A	120	264
2000A	60	132	6000A	120	264

C. Basic Construction

1. Housing

- a) The busbar trunking housings shall be constructed of electrogalvanized steel and aluminum to reduce hysteresis and eddy current losses and shall be provided with a suitable protective finish of ANSI 49 grey epoxy paint.
- b) The busbar trunking housings shall be totally enclosed non-ventilated for protection against mechanical damage and dust accumulation. And it shall pass at least 500 hours salt spray test to ensure the anticorrosion ability.
- c) The totally enclosed housing shall be manufactured by the busbar trunking manufacturer. Modifications of busbar trunking to make it totally enclosed by other than the busbar trunking manufacturer voids the manufacturer's warranty. Busbar trunkings so modified is unacceptable without the written consent of the manufacturer.

2. Busbars

- a) Busbars shall be of hard drawn silver-plated high conductivity copper of 99.9% purity or aluminum with copper cladding utilized Molecular Fusion technology.
- b) There shall be no bolts passing through the busbar of the busway.
- c) Each busbar shall be insulated with Class B (130°C DuPont Polyester). Epoxy insulation is not allowed.
- d) The temperature rise at any point of the busbar trunking enclosure shall not exceed 55 degree Centigrade rise above ambient temperature when operation at rated current.

3. Joint

- a) The busbar trunking joints shall be of the one-bolt type which utilizes a high strength steel bolt(s) and Belleville washer to maintain proper pressure over a large contact surface area.
- b) The bolt shall be torqued indicating and date earth potential.
- c) The bolt shall be two-headed design to indicate when proper torque has been applied and require only a standard long handle wrench to be properly activated.
- d) Access shall be required to only one side of the busbar trunking for tightening joint bolts.
- e) It shall be possible to remove any joint connection assembly to allow electrical isolation or physical removal of a busbar trunking length without disturbing adjacent busbar trunking lengths.

4. Plug-in Opening

- a) The connecting jaw of the plug-in unit shall plug directly onto the busbar and have full contact with busbar itself. Welded tab at plug-in busbar is not allowed.
- b) All contact on joint and plug-in openings should be silver plated copper.
- c) On plug-in busbar trunking there shall be three dead front, hinged cover type plug-in openings on each side.
- d) All openings shall be usable simultaneously.
- e) Busbar trunking shall be installed so that plugs are side mounted to permit practical use of all plug-in

openings.

f) It shall be possible to inspect the plug-in opening and busbars prior to the installation of the plug-in units.

D. Support of busbar Trunking

1. Hanger spacings shall be noted on layout drawings and shall not exceed manufacturer's recommendations.

2. Indoor feeder and plug-in busbar trunking shall be approved for hanger spacing of up to 3 meters for horizontally mounted runs and 4.88 meters for vertically mounted runs. Outdoor feeder busbar trunking shall be approved for spacing of up to 1.5 meters for horizontally or vertically mounted runs.

E. Voltage drop

1. The voltage drop (input voltage minus output voltage) specified shall be based on the busway operating at full rated current and at stabilized operating temperature in 30 °C ambient.

2. The three-phase, line-to-line voltage drop shall not exceed 3.4 volts per hundred feet at 40% power factor concentrated load which may exist during motor starting.

3. The line-to-line voltage drop shall not exceed 4.1 volts per hundred feet at the load power factor which produces maximum voltage drop in the busway.

F. Plug-in Units

1. The plug-in jaw shall be spring design composed of different metal to ensure the firm and tight contact with the busbar

2. Plug-in Units should be type tested in accordance with IEC 61439-6 (Annex D: Part 1-5 and 9-13)

3. The earthing contact of the plug-in unit shall always be made before that of the live conductors and the last to break during removal. And it must connect to the earth bar of busway to ensure the safety.

4. Covers of all plug-in units must have interlocks to prevent the cover from being opened when the switch is in the ON position.

5. Plug-in units (circuit breaker type or fuses switch type) shall be operated with visible blade quick-make and quick-break mechanism

6. Presence of transparent shield shall be inside to avoid direct contact of human

7. The plug-in unit shall be equipped with internal barrier to prevent accidental contact of live parts and conductors with live parts on the line side of the protective device during time of wire pulling.

END OF SECTION

16.0 EXTERNAL LIGHTING

a. GENERAL

16.1 WorkDescription

The scope of work includes design, erection, testing and commissioning of external lighting, façade and landscape lighting. The all fittings, the wiring details and cable routes shall be coordinated with other trades at site and submitted for the approval of the Engineer-in-charge. All time and cost required for adjusting the layout or complete installation to suit site requirement is included.

To determine the exact positioning of External lighting points due consideration shall be given, for selection of the most accessible routes for wiring, convenience of switching and operational requirement of the installation.

Noextracostwillbepaidshouldthefinalpositionsberelocated.

For the purpose of specification and related drawing, each lighting circuit shall be coded with a prefix to indicate the corresponding distribution board number.

Theelectrical equipment/systemmaydevelopsuddenchangesduetolowfrequency/ordirectelectric current components such as fluorescent lamps, contactors, etc. shall be fitted with radio and television interference suppression components suitable to meet the levels specified in BS 800"Limits of Radio Interference".

16.2 Standards

The complete wiring installation shall be engineered according to manufacturer data and constructed in accordance with the latest revision of the IS and the appropriate BS/IEC

Intheadoptionofstandardsandrequirements,theContractorshalltakethefollowingprecedence:

- Engineer'sdecision
- Localcodesofpractice
- Drawings
- Specification
- Internationalstandardsandrequirements

16.3 Submission

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

Thesubmissionshallincludethefollowingasaminimumrequirement,

- Equipmentcataloguessubmissionwithmanufacturer'sdata
- Samplesubmission include allwiringaccessories
- Shop Drawings of the lighting, circuit numbers, cable routings, switching arrangement, mounting height, etc. The positions and mounting heights shall be coordinated with other services. Fixing details of all wiring accessories shall also be included.
- Drawingsshowingtheinstallationdetails
- Labelingsystem
- Builder'sworksrequirement.

Supply, Installation, Test & Commissioning of 60W LED Decorative double triangle Post Top type luminaire with System efficacy of 130 lm/W (7800lumens). Luminaire shall be made up of Aluminum Extrusion/die cast housing duly Powder coated with gray pure polyester powder with polycarbonate Diffuser, capable of producing Symmetric optics. LM 80-08 compliant LEDs of EMC/ceramic package from reputed makes such as Nichia/Cree/ Bridgelux/ Lumiled/ Osram/Seoul should be provided. LEDs used in the product shall comply with EN 62471 for Photo-biological safety and certificate for the same from manufacturer shall be provided. Luminaire shall be with IP66 and IK10 protection. The LED shall be compliant with LM80-08 standard with L70 life of 50000 Hrs tested at maximum current (Complete LM 80 test report for LED should be submitted for 10000 hrs of testing). The LEDs used should be with CCT of 57000 K, CRI of Minimum 70 and SDCM <5. LEDs must be driven at max 70% of the rated current. MCPCB with Aluminium core and copper thickness of 35 micron to be used for LED mounting. LED Driver shall be silicone potted, Integrated type, Isolated, Constant Current with range 140-290V AC. Driver Efficiency > 85% & 5 KV internal surge protection, Power factor greater than 0.95 and total harmonic distortion (THD) of less than 10% should be integral to the luminaire. Manufacturer shall have inhouse lab approved by NABL or ministry of science of govt of India. LM79 and LM80 reports need to be submitted from a NABL/UL accredited lab to verify above parameters. Compliance to Indian Standards of IS10322 Part 5 / Sect 5:1967; 16105 : 2012; IS 16106 : 2012; IS 15885 (Part2/Sec13) : 2012; IS 16108 : 2012 should be there.

Supply, Installation, Test & Commissioning of 11W LED Decorative patterned Bollard with System efficacy of 100 lm/W (880 lumens). Luminaire shall be made up of dark grey, pure polyester powder coated extruded Aluminium housing with High efficiency Transmission PC diffuser, having dimension of length 151mm± 2mm, Width 151 mm with height of 800mm±2mm. All external hardware must be of SS304 grade. LM 80-08 compliant LEDs of EMC/ceramic package from reputed makes such as Nichia/Cree/ Bridgelux/ Lumiled/ Osram/Seoul should be provided. LEDs used in the product shall comply with EN 62471 for Photo-biological safety and certificate for the same from manufacturer shall be provided. Luminaire shall be with IP65 and IK10 protection. The LED shall be compliant with LM80-08 standard with L70 life of 50000 Hrs tested at maximum current (Complete LM 80 test report for LED should be submitted for 10000 hrs of testing). The LEDs used should be with CCT of 4000 K, CRI of Minimum 80 and SDCM <5. LEDs must be driven at max 70% of the rated current. MCPCB with Aluminium core and copper thickness of 35 microns to be used for LED mounting. IP66 rated LED Driver shall be silicone potted, Integrated type, Isolated, Constant Current with range 140-280V AC. Driver Efficiency > 80% & 2.5 KV internal surge protection, Power factor greater than 0.95 and total harmonic distortion (THD) of less than 10% should be integral to the luminaire. Manufacturer shall have inhouse lab approved by NABL or ministry of science of govt of India. LM79 and LM80 reports need to be submitted from a NABL/UL accredited lab to verify above parameters. Compliance to Indian Standards of IS10322 Part 5 / Sect 5:1967; 16105 : 2012; IS 16106 : 2012; IS 15885 (Part2/Sec13) : 2012; IS 16108 : 2012 should be there. similar to

Supply of 100W SMD LED Streetlight fixture with System efficacy of 100 lm/W (13000 lumens). Luminaire shall be made up of pure polyester powder coated die cast Aluminium housing with high purity IP66 of single module of same make. The housing should be made non-corrosive pressure die-cast aluminum, to withstand extreme environments. T. All external hardware must be of SS304 grade. The name of the brand should be embossed/engraved & should not be mentioned using sticker/screen printing. Luminaire shall be designed with street optic LENS for uniform light distribution. LM 80-08 compliant LEDs of EMC/ceramic package from reputed makes such as Nichia/Cree/ Bridgelux/ Lumiled/ Osram/Seoul should be provided. LEDs used in the product shall comply with EN 62471 for Photo-biological safety and certificate for the same from manufacturer shall be provided. Luminaire shall be with IP66 and IK10 protection. The LED shall be compliant with LM80-08 standard with L70 life of 100000 Hrs tested at maximum current (Complete LM 80 test report for LED should be submitted for 17000 hrs of testing). The LEDs used should be with CCT of 5700 K, CRI of Minimum 70 and SDCM of < 5. LEDs must be driven at max 70% of the rated current. , Integrated type, Isolated, Constant Current with range 120-300V AC. Driver Efficiency > 85% & 5 KV internal surge protection

along with external SPD of 10 KV mounted on the streetlight , Power factor greater than 0.95 and total harmonic distortion (THD) of less than 10% should be integral to the luminaire. Driver must be of die cast / extruded Aluminium casing. Manufacturer shall have inhouse lab approved by NABL or ministry of science of govt of India. LM 79 and LM80 reports need to be submitted from a NABL/UL accredited lab to verify above parameters. Compliance to Indian Standards of IS10322 Part 5 / Sect 3:2013; 16105 : 2012; IS 16106 : 2012; IS 15885 (Part2/Sec13) : 2012; IS 16108 : 2012.

Supply, Installation, Testing & Commissioning of 495mm Length X 200 mm Width X 330mm Height Rectangular Flood light with Non-integral driver & completely made in India luminaire. Luminaire must use Single LED of RGBW ChIP and not discrete individual LEDs of each colour for colour effect. The luminaire's shall be made of Extruded aluminum housing powder coated in grey. The complete luminaire has IP66 & IK08 protection and it comprises of high purity integrated poly carbonate Lens. The LEDs shall have minimum CRI ≥ 80 (White LED) & shall have SDCM ≤ 5 . The luminaire shall have wattage 192W and shall deliver 8640 lumens. Beam angle of the Luminaire shall be 60 deg. Fixture shall operating temperature range of 0°C to 45°C. Input Voltage Range of 24V DC, Integrated DMX Decoder, No need to additional external decoder. The luminaire shall have declared life of 50,000 burning hours at L70. The luminaire shall be compatible with DMX controller. The luminaire shall automatically addressable using hand-held addressing device. The luminaire shall be capable of 8-bit control of RED, Green, Blue & White (W=4000K) to produce 16.7million colours. Luminaire and Driver must be made in India with same brand. Luminaire manufacturer must have In-house NABL accredited lab to conduct LM79. The successful bidder must submit the NABL accreditation certificate for Luminaire manufacturer along with technical bid. LM80 , RoHS compliance issued by LED luminaire manufacturer, BIS certificate for LED Luminaire. Brand name shall be embossed / engraved on each an every light fixtures. Luminaire and Driver should be Made in India. Luminaire, Driver and controller should be with same make.

Supply, Installation, Testing & Commissioning of 500 mm length X 80mm Width X 115mm Height RGBW Linear Wall Washer with Non-integral driver & completely made in India luminaire. Luminaire must use Single LED of RGBW ChIP and not discrete individual LEDs of each colour for colour effect. The luminaire's shall be made of Extruded aluminum housing powder coated in grey. The complete luminaire has IP66 & IK07 protection and it comprises of high purity integrated poly carbonate Lens. The LEDs shall have minimum CRI ≥ 80 (White LED) & shall have SDCM ≤ 5 . The luminaire shall have wattage 12W and shall deliver 480 lumens. Beam angle of the Luminaire shall be Asym deg. Fixture shall operating temperature range of 0°C to 45°C. Input Voltage Range of 24V DC, Integrated DMX Decoder, No need to additional external decoder. The luminaire shall have declared life of 50,000 burning hours at L70. The luminaire shall be compatible with DMX controller. The luminaire shall automatically addressable using hand-held addressing device. The luminaire shall be capable of 8-bit control of RED, Green, Blue & White (W=4000K) to produce 16.7million colours. Luminaire and Driver must be made in India with same brand. Luminaire manufacturer must have In-house NABL accredited lab to conduct LM79. The successful bidder must submit the NABL accreditation certificate for Luminaire manufacturer along with technical bid. LM80 , RoHS compliance issued by LED luminaire manufacturer, BIS certificate for LED Luminaire. Brand name shall be embossed / engraved on each an every light fixtures. Luminaire and Driver should be Made in India. Luminaire, Driver and controller should be with same make.

Supply, Installation, Testing & Commissioning of 1000 mm length X 80mm Width X 115mm Height RGBW Linear Wall Washer with Non-integral driver & completely made in India luminaire. Luminaire must use Double LED Array of RGBW ChIP Double Array and not discrete individual LEDs of each colour for colour effect. The luminaire's shall be made of Extruded aluminum housing powder coated in grey. The complete luminaire has IP66 & IK07 protection and it comprises of high purity integrated poly carbonate Lens. The LEDs shall have minimum CRI ≥ 80 (White LED) & shall have SDCM ≤ 5 . The luminaire shall have wattage 96W and shall deliver 3840 lumens. Beam angle of the Luminaire shall be

Asym deg .Fixture shall operating temperature range of 0°C to 45°C. Input Voltage Range of 24V DC, Integrated DMX Decoder, No need to additional external decoder. The luminaire shall have declared life of 50,000 burning hours at L70. The luminaire shall be compatible with DMX controller. The luminaire shall automatically addressable using hand-held addressing device. The luminaire shall be capable of 8-bit control of RED, Green, Blue & White (W=4000K) to produce 16.7million colours. Luminaire and Driver must be made in India with same brand. Luminaire manufacturer must have In-house NABL accredited lab to conduct LM79. The successful bidder must submit the NABL accreditation certificate for Luminaire manufacturer along with technical bid. LM80 , RoHS compliance issued by LED luminaire manufacturer, BIS certificate for LED Luminaire. Brand name shall be embossed / engraded on each an every light fixtures. Luminaire and Driver should be Made in India. Luminare, Driver and controller should be with same make.

Supply, Installation, Testing & Commissioning of 196mm Dia X 158mm Height RGBW Circular Flood light with Non-integral driver & completely made in India luminaire. Luminaire must use Single LED of RGBW ChIP and not discrete individual LEDs of each colour for colour effect. The luminaire's shall be made of Extruded aluminum housing powder coated in grey. The complete luminaire has IP66 & IK08 protection and it comprises of high purity integrated poly carbonate Lens. The LEDs shall have minimum CRI ≥80 (White LED) & shall have SDCM ≤5. The luminaire shall have wattage 60W and shall deliver 3300 lumens. Beam angle of the Luminaire shall be 15 deg .Fixture shall operating temperature range of 0°C to 45°C. Input Voltage Range of 24V DC, Integrated DMX Decoder, No need to additional external decoder. The luminaire shall have declared life of 50,000 burning hours at L70. The luminaire shall be compatible with DMX controller. The luminaire shall automatically addressable using hand-held addressing device. The luminaire shall be capable of 8-bit control of RED, Green, Blue & White (W=4000K) to produce 16.7million colours. Luminaire and Driver must be made in India with same brand. Luminaire manufacturer must have In-house NABL accredited lab to conduct LM79. The successful bidder must submit the NABL accreditation certificate for Luminaire manufacturer along with technical bid. LM80 , RoHS compliance issued by LED luminaire manufacturer, BIS certificate for LED Luminaire. Brand name shall be embossed / engraded on each an every light fixtures. Luminaire and Driver should be Made in India. Luminare, Driver and controller should be with same make.

Supply, Installation, Testing & Commissioning of 16mm X 16mm of 5 meters length RGBW Neon Flexible strip LED light with Non- Integral driver embedded inside. The luminaire's shall be made of Silicon extrusion with high-efficiency, high grade appearance, soft bend flexibility & Option of Top bend , the same shall be so designed with completely made in India luminaire. The luminaire shall have silicon glue between optical cover & LED chamber to ensure proper IP67 protection. Required external decoder. The LEDs shall have minimum CRI ≥80 (White Light). The luminaire shall have system wattage of 14 Watt/ meter. Fixture shall operating temperature range of 0°C to 45°C. The fixture shall have an Non integral driver with input voltage for 220-240 VAC, 50/60Hz. The luminaire shall have declared life of 50,000 burning hours The luminaire shall be compatible with DMX512 controller. The luminaire shall automatically addressable using hand-held addressing device. The luminaire shall be capable of 6-bit control of RED, Green, Blue & White (W=4000K) to produce 16.7million colours. Luminaire manufacturer must have In-house NABL accredited lab to conduct LM79. The successful bidder must submit the NABL accreditation certificate for Luminaire manufacturer along with technical bid. Bidder shall submit the following reports along with technical bid LM79 report of the family of luminaire issued by NABL accredited lab, LM80 issued by LED manufacturer BIS certificate for LED Luminaire.. Brand name shall be embossed / printed on each an every light fixtures.

Supply of Isolated, constant Voltage type 240 W LED Driver enclosure in Extruded Aluminium metal enclosure . Driver shall be made in India compatible for RGBW luminaires with silicone potted and IP66 Protected of same make as luminaire. Output voltage of the driver 24Vdc. Driver efficiency should be greater than 85% at full load, THD < 10%, PF > 0.95 with Under and Over Voltage Cutoff Protection and 440V withstand for 8 hours minimum & should have large operating input voltage range of 140V to 300V AC (nominal rated voltage – 240V) with 5KV internal surge protection. LED driver shall have inbuilt output short circuit, over voltage protection, Thermal Shutdown protection.

Supply of Isolated, constant Voltage type 120 W LED Driver enclosure in Extruded Aluminium metal enclosure . Driver shall be made in India compatible for RGBW luminaires with silicone potted and IP66 Protected of same make as luminaire. Output voltage of the driver 24Vdc. Driver efficiency should be greater than 85% at full load, THD < 10%, PF > 0.95 with Under and Over Voltage Cutoff Protection and 440V withstand for 8 hours minimum & should have large operating input voltage range of 150V to 300V AC(nominal rated voltage – 240V) with 5KV internal surge protection. LED driver shall have inbuilt output short circuit, over voltage protection, Thermal Shutdown protection.

Supply of Isolated, constant Voltage type 150 W LED Driver enclosure in Extruded Aluminium metal enclosure . Driver shall be made in India compatible for RGBW luminaires with silicone potted and IP66 Protected of same make as luminaire. Output voltage of the driver 24Vdc. Driver efficiency should be greater than 85% at full load, THD < 10%, PF > 0.95 with Under and Over Voltage Cutoff Protection and 440V withstand for 8 hours minimum & should have large operating input voltage range of 150V to 300V AC(nominal rated voltage – 240V) with 5KV internal surge protection. LED driver shall have inbuilt output short circuit, over voltage protection, Thermal Shutdown protection.

Supply, installation, testing and Commissioning of 5Core 5C DMX cable/Patch cord Patch Endcap 1m

Supply, installation, testing and Commissioning of 5Core T Type 5C DMX cable

Supply, Installation, Testing and commissioning of DMX Decoder completely made in India product .Input Power DC 12V -24V input which Outputs 6A/Channels. 100-240V, 24VDC plug-in power adaptor .The number of devices controlled from 001-512 via DIPSwitch. Connection of DMX (3 pin, 3.5mm pitch screw terminal). Channel bondin capable up to 10A. 8 pin terminal connector current LED connection. Compact PCB or chassis mounted.All six output ports should have an independent output driver and ELV transformer to boost the DMX signal. 1: 6 Way DMX Splitter/Booster ,Optically isolated DMX Input/Outputs, Individual coil transformer for each output , Surface/Rack/Floor/Celling mountable with provide mounting accessories ,Refined and filtered data , Cable 3 core 0.75sq.mm .Five Year Warrantyof DMX Signal Splitter+Amplifier - One DMX512 signal Input to six DMX512 outputs, Designed to amplify, distribute and isolate DMX signals in short-runs and localised splitting scenarios. Protection of short circuit, Reverse Polarity, Over Temperature, Over Voltage and Over Current. Photo-electric isolation between Input and Output terminals as well as between output terminals among channels. Compensates for any intereference from external sources like AC lines, Electrical equipment operating close to DMX transmission lines.Compact DIN rail enclosure enables easy installation inside most enclosures.

Supply, Installation, Testing and commissioning of DMX Master Controller, with completely made in India product. A stand alone interface for installation in electrical DIN Cabinets with Din rails, which can control from 512 to 1024 and can go up to 2048 channels on 1, 2 or 4 DMX universes. A robust Stand Alone mode and a wide range of trigger possibilities (RS232, Contacts, Clock, NODE x4 ports, Master/slave), USB-C Networks Ethernet, Internet, WIFI compatible when connected to a router Multiple Zone 10 Zone, play 10 scene/sequence per time in Stand Alone ,Memory of Micro SD Card (max. 256 GB) and 8Mb Internal memory . Art-Net and sACN from SD card, including triggers (2x512). A master / Save Synchro (32 max wired / 128 max Ethernet) that Commands from the Contacts (speed, scene, dimmer, zone). Default start scene, Scene priority, Cross Fade time between scenes , Automatic Scene Recovery if the power is cut off and 16-bit and fine channel management. Triggers options of RS232 In/Out (16 characters max for RS232 triggers, commands or orders) and UDP / Ethernet triggers and commands (from SDK). Software Requirements with System Compatibility of Windows, Mac, iOS. Flexible, adaptable mounting options ,Should be provided with light show authoring software, Direct line voltage power supports 100—240VAC,Minimum five configurable effects, Using light show authoring software to select from standard five effects, adjust effect settings such as color, speed, and brightness. IP20. Addressing & Programming inclusive and with Five Year Warranty. Brand name shall be embossed on each and every lighting fixtures.

Supply, Installation, Testing and commissioning of DMX Splitter, Booster 343 mm Height X 123mm Width X 46 mm Depth with completely made in India product .Input Power DC 12-24V input, 100-

240V, 24VDC plug-in power adaptor included Power Consumption 4.5W max and of MS/ Aluminium Housing. Power Consumption of 4.5 Approx and Weight of 1.5Kg .The output terminals should be optically isolated from the input and share a common ground reference. All six output ports should have an independent output driver and ELV transformer to boost the DMX signal. 1: 6 Way DMX Splitter/Booster ,Optically isolated DMX Input/Outputs, Individual coil transformer for each output , Surface/Rack/Floor/Ceiling mountable with provide mounting accessories ,Refined and filtered data , Cable 3 core 0.75sq.mm .Five Year Warrantyof DMX Signal Splitter+Amplifier - One DMX512 signal Input to six DMX512 outputs, Designed to amplify, distribute and isolate DMX signals in short-runs and localised splitting scenarios. Photo-electric isolation between Input and Output terminals as well as between output terminals among channels. Compensates for any intereference from external sources like AC lines, Electrical equipment operating close to DMX transmission lines.Compact DIN rail enclosure enables easy installation inside most enclosures.

Supply, Installation, Testing and commissioning of 6 push button keypad/panel made of aluminium brushed CNC style modular with 6 individual push buttons that can trigger the Dry Port contacts.Output Voltage 12 V DC. A completely made in India product.

Supply, Installation, Testing and commissioning of Moving Head Gobo Projector having light source of 700 W with illumination level 14174 lux @15M With IP66 protection and operating temperature -30to +45°C and 20000 Hrs LED Source , with adjustableZoom range 4 to 36 °, light output aperature 138 mm with color temperature 6500K , having color wheel 1 (7 color +CMY+CTO) static GOBO wheel 1 (6 Interchanable GOBOs) , Rotating Gobo wheel 1 (& interchangeable Of Gobo)with prism 2 (8 face & 6 face) no of channle 38/41 ch , dimming 0-100 % linear with horizontal 540° Scan , vertical 270°Cscan and control with DMX 512 / RDM

Programming & Intergartion of all the Façade & Gobo as per Client Requirement will all the required accessories

b. PRODUCT

EXTERNALLIGHTING:

A. STEELTUBULARSWAGEDTYPEPOLE

Steeltubularswagedtypepestreetlightingpolesofthefollowingstandardshallbeusedonwork

1. The steel tubular swaged type welded poles in stepped from shall be with single/double curved bracket arm suitable for mounting luminaries as per bill of quantities.
2. The poles shall be manufactured from electric resistance welded tubes as per IS: 2713-1980 with latest amendment.
3. Thepoleshallbeerectedinplumb,buried1/6thofthepolesizeundergroundincement concrete foundation as per details given in the schedule of quantities and the drawing.
4. The excavation shall be made in hard and dense soil as per site. A MS plate of size450x450x10mm thick shall be welded at the bottom of the pole and 300x300x6mm thick MSplate for GI pipes poles.
5. The base plates of pole shall be grouted over a 150mmthick 1:2:4 cement concrete bed. Thepole shall have a brick / concrete collar as per drawing duly plastered around it at the ground level.
6. AMSjunctionbox of size250x200x115mmdepthfor looping incoming andoutgoing cables asper drawings. MS whether proof junction box shall be fabricated out of 16SWG sheet steel having hinged cover on the front with neoprene gasket and locking arrangement. The box shall incorporate glands and one 63A, 10way ELMAX connector for looping incoming and outgoing 2Nos. cables and 10/20A DP, MCB, 40mm GI pipe for incoming and outgoing cables shall be fixed to the pole so that PVCA aluminium cable shall be protected from

mechanical damages.

7. An earthing stud with copper lugs for connecting 8SWG GI wires for earthing shall be provided on the pole at the position outside the MS box. The incoming and outgoing cables shall be marked with ferrules as required.
8. The poles shall be given a coat of rust preventive bituminous paint on the inside and red oxide primer on the outside at the factory premises. After the erection of the pole, two coats of enamel/aluminium paint of approved colour shall be applied.
9. Touch up paint shall be given at the time of handing over the work. Marking of circuit and pole number shall also undergo same painting treatment as given above for the pole. GI pole shall be supplied in 3M length as per B.O.Q., no jointed /welded pole shall be accepted.

B. DECORATIVE STREET LIGHTING POLES:

Decorative street lighting pole of the following standard shall be used on work

Design & Construction:

Ornamental cast aluminum pole BCIP- 01 made out of cast aluminum as per requirements of IS: 202-1993 or equivalent. Casting of all pole sections should be accurately done from permanent moulds and cores of the design submitted to achieve uniformity in all design aspects in internal and external shape of the unit. All sections should be free from defects like blowholes, porosity, hard spots, cracks, hot tears, cold shuts, distortion, sand and slag inclusion and other harmful defects. All the casted sections used in the poles should be free from welding of any kind used to repair it. The casted sections should be machined from all the locations used to insert the pieces into one another using either threading or socket method. Accuracy of all machined parts should be maintained throughout a lot for random replacements of sections if and when required. All the threaded joints should be mechanically tightened and sealed using industrial tools to make the entire unit vandal resistant.

Aesthetic Appearance:

All the grooves and carvings of the pole units should be free from any kind of distortion for a pleasing aesthetic appearance.

Material:

Cast aluminum material used for casting pole unit should be of grade FG-220 type, as described in IS: 202 and should have minimum tensile strength of the order of 200 N/sq. mm.

Pretreatment:

Each and every casted piece should be subject to sand blasting at a pressure of 10-15 Kgf to remove all external dirt and sand remains etc.

Painting & Finishing:

Entire unit should be given an extensive three stage treatment with PU based two pack Zn-Ph primer and paint prescribed for CI surfaces to make it absolutely rust and corrosion proof, as well as giving it a pleasing appearance. PU based paint.

Thickness of the coating:

A minimum of 80 microns of coating thickness should be achieved on the final piece.

Installation:

Pole unit should be grouted using 4 nos. anchor bolts of size M-16x450mm confirming to 6.8 Gr. As per IS: 2062. Pole unit should be grouted in a Foundation made out of 1:3:6 cement concrete after excavating the earth with proper cable sleeves etc. laid in the foundation itself.

Manufacturer standard installation drawing shall be followed for installation of poles.

C. OCTAGONAL STREET LIGHTING POLES:

Octagonal G.I. street lighting poles of the following specification shall be used for work.

1. The Octagonal Poles shall be designed to withstand the maximum wind speed as per IS 875. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI 1982.
2. The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by Submerged Arc Welding (SAW) process.
3. All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing 4 foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside. The welding shall be done as per qualified MVAW process approved by third party inspection agency.
4. The octagonal pole shall have a door of approximate 500mm length at the elevation of 500mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.
5. The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.
6. The welding shall be carried out conforming to approved procedures duly qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal shafts.
7. The Octagonal Poles shall be in single section (upto 11mtr). There shall not be any circumferential weld joint
8. The poles shall be hot dip galvanized as per IS-2629/IS-2633/IS-4759 standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.
9. The Octagonal Poles shall be bolted on a pre-cast foundation with a set of four foundation bolts for greater rigidity.
10. Top Mounting; the galvanized mounting bracket shall be part of supply along with the Octagonal Poles for installation of the luminaries.
11. Installation of poles shall be carried out as per manufacturer's standards.

D. The Lux level for lighting shall be considered as per IS standards and on the following are requirements.

Public Parking	Public Parking
Internal Roads (10mtrs)	Internal Roads (10mtrs)
Main Approach Roads (12mtrs)	Main Approach Roads (12mtrs)
Piazza Lights	Piazza Lights
Security lights	Security lights

END OF SECTION

18.0 SOLAR PV SYSTEM

a GENERAL

18.1 Work Description

This specification covers the 'General Requirements' for the design, manufacture, supply performance, inspection, testing and commissioning of required rating of KWp as per Girah requirement of star-3.

It is proposed that power for lights, raw power etc. shall be supplied through solar PV. The load shall get two supplies. One from normal panel and other from solar PV. The total capacity of solar power has been considered at required rating of KWp as per Girah requirement of star-4. The solar panels shall be installed in the terrace area

18.2 System Description (Grid Connected System)

The Photovoltaic (PV) Grid connect system consists of mainly of 3 components: The Mono Crystalline Silicon PV array, Module Mounting Structure and the Power conditioning Unit (PCU). The C-Si module will generate the DC voltage and to increase the voltage to make it suitable for the PCU rating.

The Solar Photovoltaic (PV) modules convert solar radiation from the sun into electrical energy in the form of direct current (DC). The Solar Charge Controller (SCC) part of PCU then maximizes the use of this electrical energy to charge the battery bank and at the same time it prevents overcharging of the battery bank.

The PCU is nothing but converting the DC Power into AC power and feeding into the grid. It is designed with a high efficiency >98% with IGBT technology, it is delivering the max. Power generated through solar modules into the grid due to its inbuilt feature of MPPT operations. The PCU is having internal self-protection in case of any fault in the grid. Also, the PCU has inbuilt contactors/breakers with fuses for self-protections.

The PCU is having inbuilt microprocessor-based controls before starting it's monitored the grid voltage, frequency of the grid if it is within set value then it senses the array voltage and current then it's start feeding the power in the grid if all parameters are within range. In case of power gets fail the PCU will stop working automatically. During the morning the PCU starts on its own when the power generation starts from the solar module and stops automatically when the sunset and array is not generating any power.

Each PCU is having a remote and local data monitoring system with which one can monitor all the parameters ^{internal} and current energy generation & past generation for the given period. Outputs of PCU's are connected to Distribution

boards and grid supply will be brought to distribution boards for synchronization with the PCU.

The power generated from the PV Modules will be supplied to the load through solar inverter unit (part of PCU), which converts DC power to pure 440V/230V AC sine wave power. The inverter unit will power the dedicated load either from the solar array or battery bank in that order of preference. The inverter is designed for catering the power needs of the load.

18.3 Submission

All technical submissions shall be approved by the EPC contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

Such drawings shall show the proposed method of construction of the Solar PV systems

The drawings shall also incorporate a full list of proposed materials. The construction shall not commence until the drawings are approved for consultant.

Pre delivery inspection of materials at manufacturer's works, pre commissioning test at site and preparation of report in formats are included.

Submission of test certificate and testing procedure details prior to pre delivery inspection at works.

Providing procedure detail for pre commissioning of equipment's installed and testing at site.

Preparation of as built drawings for the services rendered by the contractor.

Any other work/activity which is not listed and is necessary for completeness of electrical system

c. PRODUCTS

18.4 Electrical Features of Crystalline silicon solar photovoltaic module

Module array consists of high efficiency Solar Modules utilizing crystalline high-power silicon Solar Photovoltaic cells.

- Solar module has laminated using lamination technology using established mono crystalline.
- 250Wp solar module consists of 72 crystalline silicon photovoltaic cells.
- Solar Modules has made with High Quality, High Transmission 3.2mm tempered Solar Glass.
- The efficiency of Solar Photovoltaic module is greater than 13%. It has made of high transmissivity glass front surface giving high encapsulation gain and

hot butyl rubber edge sealant for module protection and mechanical support.

- All materials used in manufacturing of module have a proven history of reliable and stable operation in external outdoor applications

Solar module has designed to operate and perform in relative humidity up to 100% with temperatures between -10 Deg C and +85 Deg C and withstand gust up to 200 km/h from back side of the panel.

- Sturdy New screw type anodized Aluminum framed design using double sided tape for framing.
- Solar Modules have IEC and UL approved, IP65 rated junction box assembly using USE cable and UL approved connectors. Three Schottky bypass diodes used for preventing any damage due to shading
- Degradation of power generated will not exceeding 20% of the min. Rated power over the 25-year period. Efficiency of solar PV system is 90% for above 12 years & 80% for above 25 years.
- The solar module has suitable encapsulation and sealing arrangements to protect the silicon cells from the environment. The arrangement and the material of encapsulation are compatible with the thermal expansion properties of the silicon cells and the module framing arrangement/material.
- Multilayered Back sheet giving weather-able barrier for modules and high performance in rugged environments around the world, high dielectric performance, superior partial discharge and electrical insulation properties.
- Solar modules have Tedlar/Polyester trilaminate back surface

18.5 SYSTEM CONFIGURATION

a) PV MODULES

A Photovoltaic module is a packaged interconnected assembly of Photovoltaic cells, which converts sunlight into Electrical Power. The Solar Modules are mono/multi crystalline type, made of High Transmissivity front glass giving high encapsulation gain and silicon rubber edge sealant for module protection, mechanical support and moisture proofing.

b) MOUNTING STRUCTURE

The Solar Module Mounting Structure (MMS) is designed for holding suitable number of modules. Modules will be mounted on Mild Steel, support structures suitable for site conditions, which are tilted according to the Site Locations to maximize annual energy output. Support Structure design and foundation or fixation mounting arrangements shall withstand minimum horizontal wind speed relevant to site conditions.

TECHNICAL SPECIFICATION OF PV MODULE MOUNTING STRUCTURE

Internal

Parameters	Specifications
Type	Roof Mounted
Configuration	Designed to suit site requirements

Material	Mild Steel
Tilt angle	Suitable to site
Fasteners	SS304
Design Wind Speed	120ph

c) PVCCU.CABLES

Sizes of cables between array interconnections, array to junction boxes, junction boxes to Inverter etc. shall be so selected to keep the voltage drop (power loss) of the entire power plant to the minimum. Cables are flexible and are used with annealed electrolytic grade copper conductors. They are suitable for outdoor and for 1000VDC application

TECHNICAL SPECIFICATION OF PVC CABLES

Parameters	Specifications
Type	PVC Insulated and sheathed
Material	Copper
Working voltage	Up to 1100V
Test voltage	650V/1.1Kv
Color	To suit Red, Black, Blue
Temperature	-15 Deg C to +70 Deg C

d) SOLARON-GRID INVERTER

The PCU consists of in-built charge controller and bi-directional inverter to supply continuous power to the dedicated load with support to the load coming either from the solar array, battery bank, Grid Power in order of preference. The Grid-Tie of required rating of KWp as per Grid requirement of star-4 is considered for this project. The sine wave inverter generates a sinusoidal AC voltage with an exceptionally precise voltage and stabilized frequency. The inverter is protected against overload and short circuit.

e) JUNCTION BOX

In the Junction boxes, individual module strings are bundled and safely routed to the inverter. It is a combination of an exact, well-organized string monitoring system and a safety concept adapted to the PV technology.

Internal

These junction boxes are weatherproof outdoors suitable and are IP65 rated, making it

ideal for long-term use in PV systems. In addition, the direct connection between the strings and the spring connector ensures a durable and safe installation.

f) **EARTHING PROTECTION**

Earthing: The array structure of the PV yard will be grounded properly using adequate number of earthing kits. All metal casing / shielding of the plant shall be thoroughly grounded to ensure safety of the power plant.

Lightning: The SPV Power Plants shall be provided with lightning & overvoltage protection. The main aim in this protection shall be to reduce the overvoltage to a tolerable value before it reaches the PV or other subsystem components. The source of overvoltage can be lightning, atmospheric disturbances etc. Metal

Oxide varistor shall be provided inside the Array Junction Boxes. In addition, suitable MOVs shall also be provided in the Inverter to protect the inverter from over voltage.

END OF SECTION

19.0 EnergyMeter

1. OBJECTIVE&SCOPE

This specification shall cover design, engineering, manufacture, assembly, inspection, testing at manufacturers works before dispatch, supply and delivery at destination anywhere in "state", Class 1.0 accuracy class static 3 phase-4 wire tri-vector energy meter. The meter shall be suitable for measurement of energy and power, demand requirement in an AC balanced/unbalanced system over a power factor range of zero lag to unity. These meters should have communication port to interface for remote meter reading.

2. SERVICECONDITION

The meters shall be suitable for satisfactory continuous operation under the following tropical conditions: -

Maximum ambient temperature	:	50°C
Maximum ambient temperature in shade	:	45°C
Relative Humidity	:	10 to 95%
Maximum wind pressure	:	150 Kg/m. sq.
Maximum altitude above mean sea level	:	1000 meters
Isoceraunic level	:	50 days/year
Seismic level (Horizontal acceleration)	:	0.3g
Moderately hot and humid tropical climate		

3. APPLICABLE STANDARDS

The whole current energy meters shall be of accuracy Class 1.0 and conform to relevant clauses of following standards or report: -

1.	IS 13779	AC Static Transformer Operated Watt-hour and VAR-Hour Meters, class 1.0.
2.	CBIP Technical report no. 111	Specification for common Meter Reading Instrument

Internal

3.	IS:9000	Basic Environmental Testing Procedures for Electronic & Electrical Items.
4.	ETD13(6211)	DLMS Indian Companion Standard – Category 'C' for consumer metering

Unless otherwise specified elsewhere in this specification the static meters shall conform to the latest version available of the standard as specified above.

4. GENERAL TECHNICAL REQUIREMENT

- 4.1 Application : 3 phase 4 wire
- 4.2 Rated Secondary Voltage : 240 volts (Phase to Neutral)
- 4.3 Current Rating : 05-30A, 10-60A, 20-100A
- 4.4 Rated Frequency : 50Hz.
- 4.5 Accuracy class : 1.0
- 4.6 Power Factor : Unity to Zero (all power factor lag or lead)
- 4.7 The meter shall start and continue to register on application of 0.2% of basic current at Unity P.F., as per relevant standards and shall work satisfactorily with the following supply system variation:
Voltage: $V_{ref} + 30\%$ to -30%
Frequency: $50\text{Hz} \pm 5\%$
- 4.8 Temperature:
The standard reference temperature for performance shall be 27°C . Temperature coefficient shall not exceed 0.03%.
- 4.9 The reactive accuracy class of the meters shall be same as the active accuracy class
- 4.10 The meters shall be able to continuously withstand phase to phase voltage of 500V

5. INFLUENCE QUANTITIES:

The meter should be designed and protected such that all external effects and influences shall not change its performance & shall work satisfactorily within guaranteed accuracy limits, as specified in IS 13779, under the presence of influence quantities.

6. CONSTRUCTION

The case, winding, voltage circuit, sealing arrangements, registers, terminal block, terminal cover & name plate etc., shall be in accordance with the relevant standards. The meters should be compact & reliable in design, easy to transport & immune to vibration & shock involved in the transportation & handling. The construction of the meter should ensure consistent performance under all conditions especially during storms/heavy rains/very hot weathers. The insulating materials used in the meter should be non-hygroscopic, non-ageing & have tested quality. The meter should be sealed in such a way that the internal parts of the meter become inaccessible.

The meter should employ latest technology such as Application Specific Integrated Circuit (ASIC) to ensure reliable performance. The mounting of the components on the PCB should be Surface Mounted Technology (SMT) type except some power supply related component. The electronic components used in the meters should be of high quality.

6.1 GENERAL MECHANICAL REQUIREMENTS

The construction of the meter shall be rigid & suitable to withstand shock & vibration involved in transportation & handling, as specified in IS 13779. Meter shall be designed and constructed in such a way as to avoid introducing any danger in normal use and under normal conditions, so as to ensure especially personal safety against electric shock, safety against effect of excessive temperature, protection against spread of fire, protection against penetration of solid objects, dust and water. The design of meters shall conform to IP51 class degree of protection against dust and moisture as per relevant standards.

6.2 TROPICAL TREATMENT

All parts, which are subject to corrosion under normal working conditions, shall be protected effectively. Any protective coating shall not be liable to damage by ordinary handling or damage due to exposure to air, under normal working conditions. Meters shall withstand solar radiation. The meters shall be suitably designed and treated for normal life & satisfactory operation under the hot and hazardous tropical climatic conditions as specified in clause no. 2. The meter shall work from -10°C to +55°C and RH 95% non-condensing type.

6.3 METER CASE

The housing of the meter shall be safe high-grade Engineering plastic or any other high quality insulating material and shall be very compact in design. All the insulation materials used in the construction of meter shall be non-hygroscopic, non-ageing & of tested quality, capable of withstanding resistant to heat & fire. The construction of the meter offered shall be such that it can be sealed independently and the cover cannot be removed with the use of a tool, without breaking the seal. The case of offered meters shall be so constructed that any non-permanent deformation shall not prevent the satisfactory operation of the meter. The meter shall have a transparent cover and opaque base with seamless ultrasonic welding.

6.4 TERMINALS-TERMINAL BLOCK

The base of the meter shall have a terminal block at the bottom made out of high-grade engineering plastic so as to facilitate bottom connection and having capability to carry maximum value of current.

The material of the terminal block shall be capable of passing the tests given in IS 13779.

The terminal holes in the insulating material shall be of sufficient size to accommodate the insulation of the conductors. The diameter of the terminal hole for current terminals shall not be less than 9 mm & shall be of adequate length in order to have proper grip of conductors / crimping pins with the help of two screws.

The terminal block shall satisfy all the conditions such as clearance & creepage distance between terminals & surrounding part of the meter as specified in relevant clause of IS 13779. The material of terminal and connection screws should be brass.

The manner of fixing the conductors to the terminals shall ensure adequate and durable contacts such that there shall have no risk of loosening or undue heating. Screw connections transmitting contact force and screw fixing which may be loosened and tightened several times during the life of the meter shall be such that the risk of corrosion resulting from contact with any other metal part is minimised. Electrical connections shall be so designed that contact pressure shall not be transmitted through insulating material.

6.5 TERMINAL BLOCK COVER

The terminal block cover for the energy meters shall be extended transparent type, which can be sealed independently of the meter cover. The ETBC shall have a clear space of 45 ± 5 mm, thus allowing sufficient clearance space for inserting cables. ETBC shall have a top side hinge arrangement for easy access to terminal for wire termination. The terminals, their fixing screws and the insulated compartment housing them shall be enclosed by extended terminal cover in such a way that no part of meter or accessories at terminal block shall be accessible from the front of the meter. There shall be provision of fixing of seals so that screws cannot be loosened without breaking the seals.

The terminals shall not be accessible without removing the seal(s) of terminal cover when energy meter is mounted on the meter board.

6.6 WINDOW

The energy meter cover shall be made of high-grade engineering plastic with a clear window. The window shall be of transparent material such that it cannot be removed undamaged without breaking the meter cover seals.

6.7 QUALITY

Overall the quality of the meter should be good and the service life of the meter shall be more than the guarantee period. The material, components used for manufacturing the meter shall be of premium quality. The LCD display shall not fade with time and the display annunciators should be visible. Functionality of the meter shall not be affected by the harsh environmental conditions. Quality meters shall be given preference and the performance of previous installed meters shall be analysed before awarding the tender. Aesthetically, the meter shall be of premium quality.

7. COMMUNICATION PORT

a) LOCAL COMMUNICATION PORT

The energy meter shall have a galvanically isolated IEC 1107 optical communication port located in front of the meter for data transfer to or from a hand-held Data Collection Device. The sealing provision should be available for optical port.

b) REMOTE COMMUNICATION PORT

Meter shall have an additional communication port (RS 232) in the form of RJ11 port to interface external modem for remote data collection. RS 232 (RJ11) port shall be located under the terminal cover.

Both the ports will support communication on DLMS and should be accessible through a DLMS compliant HHU.

8. DATA DOWNLOADING CAPABILITY

Meter shall support a minimum baud rate of 9600 on optical port as well as RS 232 remote communication port. It shall be possible to read selective data set from the meter from the meter, as specified in ETD 13(6211).

9. DISPLAY OF MEASURED VALUE:

The measured value(s) shall be displayed on seven segments, seven digit Liquid Crystal Display (LCD) display unit/register, having minimum character height of 10 mm.

The data should be stored in non-volatile memory. The non-volatile memory should retain data for a period of not less than 10 years under unpowered condition. Battery back-up memory will not be considered as NVM.

It should be possible to easily identify the single or multiple displayed parameters

through symbols/legend on the meter display itself or through display annunciators.

The register shall be able to record and display starting from zero, for a minimum of 1500 hours, the energy corresponding to rated maximum current at reference voltage and unity power factor. The register should not roll over in between this duration.

The principle unit for the measured values shall be kWh for active energy, kVAh for reactive energy & kVAh for apparent energy. Bidder shall mention the scale in which the meter displays the energy values.

Required display list will be given at the time of order. However it will be in line with companion standard such as:

- RealTime
- Date
- Line currents
- Phase to Neutral Voltages
- Phase wise Power Factor
- Frequency
- Active, Reactive and Apparent Power
- Cumulative tamper count
- Cumulative MD reset Count
- Cumulative active forwarded energy
- Cumulative reactive lag forwarded energy
- Cumulative reactive lead forwarded energy
- Cumulative apparent forwarded energy
- Universal active maximum demand with date and time
- Universal apparent maximum demand with date and time
- Present PT status
- Present CT status
- Other status
- Last occurred and restored tamper with date and time
- High resolution active forwarded energy (upto 4 decimal point)
- High resolution reactive lag forwarded energy (upto 4 decimal point)
- High resolution reactive lead forwarded energy (upto 4 decimal point)
- High resolution apparent forwarded energy (upto 4 decimal point)

Above listed displays shall be configurable in three different pages in push mode for easy access in mains on condition. First page should contain the instantaneous parameters, second page, for energy and demand values, and third page for tamper related displays.

The meters should have visual quadrant representation on the LCD for energy measurement. Relevant quadrant in which metering is taking place should be in on state for ease of understanding.

Parameter value with relevant OBIS code should also be simultaneously available along with the respective values on the display.

10.ELECTROMAGNETICCOMPATIBILITY

The static energy meters shall conform to requirements listed in relevant standards and shall also be protected against radiated interference from either magnetic or radio-frequency source.

10.1 IMMUNITYTOELECTROMAGNETICDISTURBANCE

The meter shall be designed in such a way that conducted or radiated electromagnetic disturbance as well as electrostatic discharge do not damage or substantially influence the meter and meter shall work satisfactorily under these conditions as per relevant standards

NOTE: the disturbances to be considered are: -

- (a) Harmonics
- (b) Voltagedipsandshortinterruptions
- (c) Conductedtransients
- (d) D.C.andA.C.magneticfields
- (e) Electromagneticfields
- (f) Electrostaticdischarges

10.2 RADIOINTERFERENCESUPPRESSIONS

The meter shall not generate noise, which could interfere with other equipment, and meter shall work satisfactorily as per relevant standards

10.3 INFLUENCEOFHIGHMAGNETICFIELD

The meters shall be provided appropriate magnetic shielding so that any external magnetic field (AC/DC electromagnet) as per IS 13779 applied on meter would not affect the proper functioning of the meter andmeter shall work satisfactorily as per relevant standards.

11.STARTINGCURRENT

The meter shall start and continue to register at the current 0.2% of Ib.

12.RUNNINGWITHNOLOAD

When the 115% of rated voltage is applied with no current flowing in the current circuit, the meters shall not register any energy and test output of the meter shall not be more than one pulse/count on "no load".

Internal

13.POWERCONSUMPTION

13.1 The active and apparent power consumption in each voltage circuit at reference voltage; temperature and frequency shall not exceed 1.0 W and 4 VA per phase respectively.

13.2 The apparent power consumption in each current circuit at basic current, reference frequency and reference temperature shall not exceed 1.0 VA per phase.

14. CALIBRATION & TEST OUTPUT

All the meters shall be tested, calibrated and sealed at works before despatch. Further, no modification of calibration shall be possible at site by any means.

However, it shall be possible to check the accuracy of energy measurement of the meter in the field by means of LED output on meter. Meter should have two calibration LEDs for accuracy measurement for different energies. Out of these, one should be kept fixed on kWh and other one shall be configurable for rest two (kVArh, kVAh). Resolution of the test output shall be sufficient to enable the starting current test in less than 10 minutes.

15. CONNECTION DIAGRAM

The connection diagram of the meter shall be clearly shown for 3 phase 4 wire system, on the terminal cover. The meter terminals shall also be marked and this marking should appear in the above diagram.

16. QUANTITIES TO BE MEASURED:

The meters shall be able to provide the following data in line with Category 'C' type as per ETD 13(6211).

- a) Instantaneous Parameters
- b) Block Profile/Load Survey data for 30 minute capture time block.
- c) Parameters for billing.
- d) Abstract quantities
 - Name Plate Details
 - Programmable parameters
- e) Event Conditions.

The meters shall be able to measure and provide the parameters listed in the guideline document. The OBIS code for each parameter shall be as identified in Indian companion standard.

17. ABNORMAL EVENTS:

The meter should have features to detect the occurrence and restoration of, at least, the following common abnormal events:

- a) **Missing Potential:** The meter shall be capable of detecting and recording occurrence and restoration with date and time the cases of Potential failure (one phase or two phases). All potential missing cases shall be considered as power failure.
- b) **Current imbalance:** The meter shall be capable of detecting and recording occurrence and restoration with date and time of Current unbalance (for more than a defined persistence time).
- c) **Current Reversal:** The meter shall be capable of detecting and recording occurrence and restoration with date and time if the current is flowing in reverse direction in one or more phases. The meter shall continue to record in forwarded direction even in case of CT reversal.
- d) **Power on/off:** The meter shall be capable to record power on/off events in the memory. All potential failure should record as power off event.
- e) **Magnetic Influence** - The Meter shall be capable of detecting and recording of presence of abnormal magnetic influence near the meter, if the magnetic influence affects the meter functionality. The meter should record at I_{max} on account of magnetic influence. Separate legend for magnet event shall be made available on LCD. This legend shall remain in on state till meter reading so that it will come in to notice of meter reader.
- f) **Voltage unbalance** – Meters shall detect voltage unbalance if there is unbalance in voltages.
- g) **Over Current** – When load condition at any phase i.e. Line current at any phase goes more than defined limit, this will be detected as Over current condition.
- h) **CT Open** – The meter should detect phase wise current circuit open when the circuit is opened from meter side.
- i) **CT Bypass** – The condition should be detected whenever the current terminal is bypassed in the meter
- j) **Neutral Disturbance** – The meter should detect neutral disturbance if any spurious signal is applied at the meter's neutral.
- k) **High and Low Voltage:** The meter should detect under and over voltage events respectively if voltage falls / Rise from defined limits.

- l) **Cover Open:** The meter shall be able to detect cover open occurrence event if cover is opened in main on or off condition. Separate legend for cover open event shall be made available on LCD. This legend shall remain in on state till meter reading so that it will come in to notice of meter reader
- m) In absence of one phase and neutral, meter should record the event with date and time and maintain the accuracy within $\pm 3\%$.

A separate register is additionally required for defraud energy registration.

The above shall be selectable and will be in line with ETD 13 (6211): Data Exchange for Electricity Meter Reading, Tariff and Load Control – Companion Specification

The meter shall keep records for the minimum last 300 events (occurrence + restoration) for above abnormal conditions. Each event shall be logged with date and time of occurrence/restoration with snapshot of voltage, current power factor and active energy (except cover open, power on-off). It shall be possible to retrieve the abnormal event data locally using a hand-held unit (HHU) through the meter's optical port & same can be viewed / analysed at base computer end in simple and easily understandable format.

18. ABNORMAL VOLTAGE/FREQUENCY DEVICE TEST:

The accuracy of the meter would not be affected with the application of abnormal voltage/ frequency generating device having spark discharge of approximately 35KV. The meter will be tested by feeding the output of this device to meter in any of the following manner for 10 minutes:

- i) On any of the phase or neutral terminals.
- ii) On any connecting wires of the meter.
- iii) Voltage discharge with 0-10mm spark gap.
- iv) Spark on meter body.
- v) At any place in load circuit.

The accuracy of the meter will be checked before and after the application of above device.

19. BILLING HISTORY & LOAD SURVEY: -

The meter shall have sufficient non-volatile memory for recording history of energy parameters for minimum last twelve billing cycles (Bill date shall be 00 hrs. of the 1st date of the calendar month by default- programmable)

Following parameters shall be made available for last 60 days with integration period of 30 min:

- Active forwarded energy
- Reactive lag energy
- Reactive lead energy
- Apparent forwarded energy
- Phase wise voltage
- Phase wise current
- Avg power factor

These load survey and history data can be retrieved with the help of Meter Reading Instrument on local interrogation or remotely using the remote communication interface.

20. Daily Energy Snapshot

The meter shall record the daily mid night energy snap for 60 days for active forwarded energy (kWh) and apparent forwarded energy.

21. MD REGISTRATION

The meter shall continuously monitor and calculate maximum demand for each interval of time, which may be programmable as a block of 30 minutes. At the end of every demand integration period the new calculated MD shall be compared with the previous MD and meter shall store whichever value is higher.

22. MD RESET

The meters shall have any of the following MD resetting options: -

- (a) Automatic reset at the end of a certain predefined period (say, end of the month)
- (b) Manual resetting arrangement (MD reset button) with sealing facility.
- (c) MD reset through authenticated transaction

23. SELF DIAGNOSTIC FEATURE

The meter shall be capable of performing complete self-diagnostic check to monitor the circuits for any malfunctioning to ensure integrity of data memory location at all time. The meter shall have indication for unsatisfactory/non-functioning/malfunctioning of the following:

- a) Time and date on meter display
- a) All display segments on meter display
- b) Self-diagnostic (RTC, NV Memory information) on display

24. OTHER SALIENT FEATURES OF METERS

- a) It should be possible to check the healthiness of phase voltages by phase indicator available on meter display.
- b) The meter shall have provision of reading in the absence of power through an internal battery. It shall be possible to access the display in power off condition. It shall also be possible to do meter data download through MRI under power off condition.
- c) The meters should work accurately irrespective of phase sequence of the supply.

25. TEST AND TEST CONDITIONS

- Acceptance test: All acceptance tests as per relevant standards shall be carried out in the presence of utility representatives.
- Routine Test: All the routine tests as per –IS 13779 shall be carried out and routine tests certificates shall be submitted for approval of purchaser.

GUARANTEED TECHNICAL PARTICULARS FOR 3 PHASE 4 WIRE WHOLE CURRENT TRIVECTOR ENERGY METER

S.No.	Item	Bidder's data
1.	Type	
2.	Application	
3.	Rated Voltage	
4.	Rated Current	
5.	Frequency	
6.	Minimum starting current in % of base current	
7.	Power loss in potential circuit	
8.	Power loss in current circuit	
9.	Change in error due to	
	i. Variation in frequency	
	ii. Variation in voltage	
10.	Accuracy Class	
11.	Total Weight of meter	

12.	Detailsofcase	
13.	Standardtowhichtheterconfirms	
14.	TypeofEnergyRegistrationMechanism.	
15.	MDResetMechanism	
16.	MDresetbuttonwithsealingprovision	
17.	TwoLEDsforaccuracymeasurement	
	Workingrange	
18.	Voltage	
19.	Current	
20.	Displaydetails	
	i. DisplayCycle(pagemodedisplay)	
	ii. Periodofdisplayofeachparameter	
	i. Displayscroll-lockfacility	
	ii. BacklitLCD	
	v. RelevantOBIScodesforparameter	
	iii. LegendforCoveropendetection	
	iv. LegendforMagnetevent	
21.	Poweroninabsenceofmains	
	i. Internal/ExternalBattery	
	ii. Displayaccess	
	i. Reading(Datadownload)	
22.	TotalEvents(300nos)	
23.	LoadSurvey	
24.	ParameterLogged	
25.	Logginginterval	
26.	No.ofdaysofLoadSurvey	
27.	DailyEnergySnap	
	i. Parameters	
	ii. No.ofDays	
28.	TimeofthedayZone	
29.	CapabilityforfraudPrevention&detection	
30.	SealingandLockingArrangement	

31.	Type of communication i. Local-Optical port IEC 1107 ii. RS232 port for remote comms	
32.	Event Logging Current Related events: <ul style="list-style-type: none"> • CT reversal (phase wise) • Current imbalance • Over Current • CT open (phase wise) • CT Bypass 	

	Voltage related events <ul style="list-style-type: none"> • PT missing (phase wise) • Voltage unbalance • High and low voltage Others: <ul style="list-style-type: none"> • Magnet • Neutral Disturbance • Low Power factor Non-Rollover events <ul style="list-style-type: none"> • Front Cover open Power on-off events	
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- TECHNICAL SPECIFICATION FOR STATIC 3 PHASE 4 WIRE CT OPERATED STATIC THREE VECTOR ENERGY METER

26. OBJECTIVE & SCOPE

This specification shall cover design, engineering, manufacture, assembly, inspection, testing at manufacturers works before dispatch, supply and delivery at destination anywhere in "state", Class 0.5s accuracy class static 3 phase-4 wire CT operated three-vector energy meter. The meter shall be suitable for measurement of energy and power, demand requirement in an AC balanced/unbalanced system over a power factor range of zero lag to unity. These meters should have communication port to interface for remote meter reading.

27. SERVICE CONDITION

The meter shall be suitable for satisfactory continuous operation under the following tropical conditions: -

- a) Maximum ambient temperature : 50°C
- b) Maximum ambient temperature in shade : 45°C
- c) Relative Humidity : 10 to 95%
- d) Maximum annual rainfall : 1450 mm'
- e) Maximum wind pressure : 150 Kg/m.sq.
- f) Maximum altitude above mean sea level : 1000 meters
- g) Isoceraunic level : 50 days/year
- h) Seismic level (Horizontal acceleration) : 0.3g
- i) Moderately hot and humid tropical climate

28. APPLICABLE STANDARDS

The CT operated energy meter shall be of accuracy Class 0.5 for active / reactive / apparent energy and conform to relevant clauses of following standards or report: -

IS 14697: 1999	Specification for A.C Static Transformer operated Watt Hour & VAR – Hour meters, class 0.5s
CBIP Technical Report No. 304	Specification for A.C. Static Electrical Energy Meters.
IS 15959 (Companion specification)	DLMS Indian Companion Standard – Category 'C' for consumer metering

Unless otherwise specified elsewhere in this specification the static meters shall conform to the latest version available of the standard as specified above.

29. GENERAL TECHNICAL REQUIREMENT

- 4.11 Application : 3 phase 3 wire
- 4.12 Rated Secondary Voltage : 240 volts (Phase to neutral)
- 4.13 Rated secondary Current (I_{Basic}) : 5 Amps
- 4.14 Rated Frequency : 50 Hz.
- 4.15 Accuracy class : 0.5s (the meters should meet the same class of accuracy for reactive energy also)

4.16 Power Factor : Unity to Zero (all power factor lag/or lead)

4.17 The meter shall start and continue to register on application of 0.1% of basic current at Unity P.F., as per relevant standards and shall work satisfactorily up to maximum continuous current of 2 times rated basic current with the following supply system variation:

Voltage: $V_{ref} \pm 30\%$ Frequency: $50\text{Hz} \pm 5\%$

4.18 Temperature: The standard reference temperature for performance shall be 27°C . The mean temperature co-efficient shall not exceed 0.03%.

4.19 The active accuracy class of the meter shall be same as the active accuracy class

4.20 The meter shall be able to continuously withstand phase to phase voltage of 500V

30. INFLUENCE QUANTITIES: The meter should be designed and protected such that all external effects and influences shall not change its performance & shall work satisfactorily within guaranteed accuracy limits, as specified in IS 14697: 1999 / CBIP technical report – 304, under the presence of influence quantities.

31. CONSTRUCTION

The case, winding, voltage circuit, sealing arrangements, registers, terminal block, terminal cover & name plate etc., shall be in accordance with the relevant standards. The meter should be compact & reliable in design, easy to transport & immune to vibration & shock involved in the transportation & handling. The construction of the meter should ensure consistent performance under all conditions especially during storms/heavy rains/very hot weathers. The insulating materials used in the meter should be non-hygroscopic, non-ageing & have tested quality. The meter should be sealed in such a way that the internal parts of the meter become inaccessible.

The meter should employ latest technology such as Application Specific Integrated Circuit (ASIC) to ensure reliable performance. The mounting of the components on the PCB should be Surface Mounted Technology (SMT) type except some power supply related component. The electronic components used in the meter should be of high quality.

6.8 GENERAL MECHANICAL REQUIREMENTS

The construction of the meter shall be rigid & suitable to withstand shock & vibration involved in transportation & handling, as specified in IS 14697. Meter shall be designed and constructed in such a way as to avoid introducing any danger in normal use and under normal conditions, so as to ensure especially personal safety against electric shock, safety against effect of excessive temperature, protection against spread of fire, protection against penetration of solid objects, dust and water. The design of meter shall conform to IP51 class degree of protection against dust and moisture as per relevant standards.

6.9 TROPICAL TREATMENT

Internal

All parts, which are subject to corrosion under normal working conditions, shall be protected

effectively. Any protective coating shall not be liable to damage by ordinary handling or damage due to exposure to air, under normal working conditions. Meters shall withstand solar radiation. The meters shall be suitably designed and treated for normal life & satisfactory operation under the hot and hazardous tropical climatic conditions as specified in clause no. 2. The meter shall work from -10°C to +55°C and RH 95% non-condensing type.

6.10 METERCASE

The housing of the meter shall be safe high-grade Engineering plastic or any other high quality insulating material and shall be very compact in design. All the insulation materials used in the construction of meter shall be non-hygroscopic, non-ageing & of tested quality, capable of withstanding resistant to heat & fire. The construction of the meter offered shall be such that it can be sealed independently and the cover cannot be removed with the use of a tool, without breaking the seal. The case of offered meters shall be so constructed that any non-permanent deformation shall not prevent the satisfactory operation of the meter. The meter shall have a transparent cover and opaque base with seamless ultrasonic welding.

6.11 TERMINALS-TERMINALBLOCK

The base of the meter shall have a terminal block at the bottom made out of high-grade engineering plastic so as to facilitate bottom connection and houses solid nickel-plated brass terminals having capability to carry maximum value of current.

The material of the terminal block shall be capable of passing the tests given in IS 14697:1999.

The terminal holes in the insulating material shall be of sufficient size to accommodate the insulation of the conductors. The diameter of the terminal hole for current terminals shall not be less than 5.0 mm & shall be of adequate length in order to have proper grip of conductors / crimping pins with the help of two screws.

The terminal block shall satisfy all the conditions such as clearance & creepage distance between terminals & surrounding part of the meter as specified in relevant clause of IS 14697: 1999.

The manner of fixing the conductor to the terminal shall ensure adequate and durable contacts such that there shall have no risk of loosening or undue heating. Screw connections transmitting contact force and screw fixing which may be loosened and tightened several times during the life of the meter shall be such that the risk of corrosion resulting from contact with any other metal part is minimised. Electrical connections shall be so designed that contact pressure shall not be transmitted through insulating material.

6.12 TERMINALBLOCKCOVER

The terminals block cover for the energy meters shall be extended transparent type, which can be sealed independently of the meter cover. The ETBC shall have a clear space of min 40_{internal}±5mm, thus allowing sufficient clearance space for inserting cables. ETBC shall have a top side hinge arrangement

for easy access of terminal for wire termination. The terminals, their fixing screws and the insulated compartment housing them shall be enclosed by extended terminal cover in such a way that no part of meter or accessories at terminal block shall be accessible from the front of the meter. There shall be provision of fixing of seals so that screws cannot be loosened without breaking the seals. The terminals shall not be accessible without removing the seal(s) of terminal cover when energy meter is mounted on the meter board.

6.13 WINDOW

The energy meter cover shall be made of high-grade engineering plastic with one window. The window shall be of transparent material ultrasonically welded with the meter cover such that it cannot be removed undamaged without breaking the meter cover seals.

6.14 QUALITY

Overall the quality of the meter should be good and the service life of the meter shall be more than the guarantee period. The material, components used for manufacturing the meter shall be of premium quality. The LCD display shall not fade with time and the display annunciators should be visible. Functionality of the meter shall not be affected by the harsh environmental conditions. Quality meters shall be given preference and the performance of previous installed meters shall be analysed before awarding the tender. Aesthetically, the meter shall be of premium quality.

32. COMMUNICATION PORT

a) LOCAL COMMUNICATION PORT

The energy meter shall have a galvanically isolated IEC 1107 optical communication port located in front of the meter for data transfer to or from a hand-held Data Collection Device. The sealing provision should be available for optical port.

b) REMOTE COMMUNICATION PORT

Meter shall have an additional communication port (RS 232) in the form of RJ11 port to interface external modem for remote data collection. RS 232 (RJ11) port shall be located under the terminal cover.

Both the ports will support communication on DLMS and should be accessible through a DLMS compliant HHU

33. DATA DOWNLOADING CAPABILITY

Meter shall support a minimum baud rate of 9600 on optical port as well as RS 232 remote communication port. It shall be possible to read selective data from the meter as specified in the companion standard.

Internal

34. DISPLAY OF MEASURED VALUE:

The measured value(s) shall be displayed on seven segments, seven-digit Liquid Crystal Display (LCD) display unit/register, having minimum character height of 10 mm.

The data should be stored in non-volatile memory. The non-volatile memory should retain data for a period of not less than 10 years under unpowered condition. Battery back-up memory will not be considered as NVM.

It should be possible to easily identify the single or multiple displayed parameters through symbols/legend on the meter display itself or through display annunciators.

Meter shall have Scroll Lock facility to display any one desired parameter continuously from display parameters.

The register shall be able to record and display starting from zero, for a minimum of 1500 hours, the energy corresponding to rated maximum current at reference voltage and unity power factor. The register should not roll over in between this duration.

The principle unit for the measured values shall be Wh/kWh/MWh for active energy, VARh/kVARh/MVARh for reactive energy & VAh/kVAh/MVAh for apparent energy based on secondary current. Bidder shall mention the scale in which the meter displays the energy values.

Required display list will be given at the time of order. However it will be in line with companion standard such as:

- Real Time
- Date
- Line currents
- Phase to Neutral Voltages
- Phase wise Power Factor
- Frequency
- Active, Reactive and Apparent Power
- Cumulative tamper count
- Cumulative MD reset Count
- Cumulative active forwarded energy
- Cumulative reactive lag forwarded energy
- Cumulative reactive lead forwarded energy
- Cumulative apparent forwarded energy
- Universal active maximum demand with date and time
- Universal apparent maximum demand with date and time
- Present PT status
- Present CT status
- Other status
- Last occurred and restored tamper with date and time
- High resolution active forwarded energy (upto 4 decimal point)
- High resolution reactive lag forwarded energy (upto 4 decimal point)
- High resolution reactive lead forwarded energy (upto 4 decimal point)
- High resolution apparent forwarded energy (upto 4 decimal point)

Above listed displays shall be configurable in three different pages in push mode for easy access in mains on condition. First page should contain the instantaneous parameters, second page, forenergy and demand values, and third page for tamper related displays.

The meter should have visual quadrant representation on the LCD for energy measurement. Relevant quadrant in which metering is taking place should be in on state for ease of understanding.

Parameter value with relevant OBIS code should also be simultaneously available along with the respective values on the display.

35. ELECTROMAGNETICCOMPATIBILITY

The static energy meters shall conform to requirements listed in relevant standards and shall also be protected against radiated interference from either magnetic or radio-frequency source.

9.1 IMMUNITY TO ELECTROMAGNETIC DISTURBANCE

The meter shall be designed in such a way that conducted or radiated electromagnetic disturbances as well as electrostatic discharge do not damage or substantially influence the meter and meter shall work satisfactorily under these conditions as per relevant standards

NOTE: the disturbances to be considered are: -

- (g) Harmonics
- (h) Voltage dips and short interruptions
- (i) Conducted transients
- (j) D.C. and A.C. magnetic fields
- (k) Electromagnetic fields
- (l) Electrostatic discharges

9.2 RADIO INTERFERENCE SUPPRESSIONS

The meter shall not generate noise, which could interfere with other equipment, and meter shall work satisfactorily as per relevant standards

9.3 INFLUENCE OF HIGH MAGNETIC FIELD

The meters shall be provided appropriate magnetic shielding so that any external magnetic field (AC/DC electromagnet) as per CBIP Technical Report no. 304 applied on meter would not affect the proper functioning of the meter and meter shall work satisfactorily as per relevant standards.

36. STARTING CURRENT

The meters shall start and continue to register at the current 0.1% of I_b.

37. RUNNING WITH NO LOAD

When the 115% of rated voltage is applied with no current flowing in the current circuit, the meters shall not register any energy and test output of the meter shall not be more than one pulse/count on "no load".

38. POWER CONSUMPTION

13.1 The active and apparent power consumption in each voltage circuit of the CT Operated meters at reference voltage; temperature and frequency shall not exceed 1.0 W and 4 VA per phase respectively.

13.2 The apparent power consumption in each current circuit for the CT Operated meters at basic current, reference frequency and reference temperature shall not exceed 1.0 VA per phase.

Internal

39. CALIBRATION & TEST OUTPUT

All the meters shall be tested, calibrated and sealed at works before despatch. Further, no modification of calibration shall be possible at site by any means.

However, it shall be possible to check the accuracy of energy measurement of the meter in the field by means of LED output on meter. Meter should have two calibration LEDs for accuracy measurement for different energies. Out of these, one should be kept fixed on kWh and other one shall be configurable for rest two (kVARh, kVAh). Resolution of the test output shall be sufficient to enable the starting current test in less than 10 minutes

40. CONNECTION DIAGRAM

The connection diagram of the meter shall be clearly shown for 3 phase 4 wire system, on the terminal cover. The meter terminals shall also be marked and this marking should appear in the above diagram.

41. QUANTITIES TO BE MEASURED:

The meters shall be able to provide the following data in line with Category 'C' type as per IS 15959 - Indian Companion Specification.

- f) Instantaneous Parameters
- g) Block Profile/Load Survey data
- h) Parameters for billing.
- i) Abstract quantities
 - Name Plate Details
 - Programmable parameters
- j) Event Conditions.
- k) Billing profile parameters.
- l) Time of day registers.

The meter shall be able to measure and provide the parameters listed in the guideline document. The OBIS code for each parameter shall be as identified as per DLMS/COSEM protocol in line with Indian companion standard.

42. ABNORMALITY EVENTS DETECTION:

The meters should have features to detect the occurrence and restoration of, at least, the following common abnormal events:

- n) **Missing Potential:** The meter shall be capable of detecting and recording occurrence and restoration with date and time the cases of Potential failure (one

phase or two phases). All potential missing cases shall be considered as power failure.

- o) **Current imbalance:** The meter shall be capable of detecting and recording occurrence and restoration with date and time of Current unbalance (for more than a defined persistence time).
- p) **Current Reversal:** The meter shall be capable of detecting and recording occurrence and restoration with date and time if the current is flowing in reverse direction in one or more phases. The meter shall continue to record in forwarded direction even in case of CT reversal.
- q) **Power on/off:** The meter shall be capable to record power on /off events in the meter memory. All potential failure should record as power off event.
- r) **Magnetic Influence** - The Meter shall be capable of detecting and recording of presence of abnormal magnetic influence near the meter, if the magnetic influence affects the meter functionality. The meter should record at I_{max} on account of magnetic influence. Separate legend for magnet event shall be made available on LCD. This legend shall remain in on state till meter reading so that it will come in to notice of meter reader.
- s) **Voltage unbalance** – Meters shall detect voltage unbalance if there is unbalance in voltages.
- t) **Over Current** – When load condition at any phase i.e. Line current at any phase goes more than defined limit, this will be detected as Over current condition.
- u) **Neutral Disturbance** – The meter should detect neutral disturbance if any spurious signal is applied at the meter's neutral.
- v) **High and Low Voltage:** The meter should detect under and over voltage events respectively if voltage falls / rise from defined limits.
- w) **Cover Open:** The meters shall be able to detect cover open occurrence event if cover is open in mains on or off condition. Separate legend for cover open event shall be made available on LCD. This legend shall remain in on state till meter reading so that it will come in to notice of meter reader

The above shall be selectable and will be in line with IS 15959: Data Exchange for Electricity Meter Reading, Tariff and Load Control – Companion Specification

The meter shall keep records for the minimum last 300 events (occurrence + restoration) for above abnormal conditions. Each event shall be logged with date and time of occurrence/restoration with snapshot of voltage, current power factor and active energy (except cover open, power on-off). It shall be possible to retrieve the abnormal event data locally using a hand-held unit (HHU) through the meter's optical port & same can be viewed / analysed at base computer end in simple and easily understandable format.

43. ABNORMAL VOLTAGE/FREQUENCY DEVICE TEST:

The accuracy of the meter would not be affected with the application of abnormal voltage/ frequency generating device having spark discharge of approximately 35KV. The meter will be tested by feeding the output of this device to meter in any of the following manner for 10 minutes:

- vi) On any of the phase or neutral terminals.
- vii) On any connecting wires of the meter.
- viii) Voltage discharge with 0-10 mm spark gap.
- ix) Spark on meter body.
- x) Spark on the optical and RS232 port.
- xi) At any place in load circuit.

The accuracy of the meter will be checked before and after the application of above device.

44. LOAD SURVEY:-

Meters should support parameters as mentioned in IS-15959 for Category "C".

Following parameters shall be made available for last 60 days with integration period of 15 min. Out of which the utility should be able to select any five parameters

- Real time clock, date and time.
- Current, I_r
- Current, I_y
- Current, I_b
- Voltage, V_{Rn}
- Voltage, V_{Yn}
- Voltage, V_{Bn}
- Active forwarded Energy
- Reactive lag forwarded energy
- Reactive lead forwarded energy
- Apparent Energy

These load survey can be retrieved with the help of Meter Reading Instrument on local interrogation or remotely using the remote communication interface.

45. TIME OF DAY REGISTERS

The meter shall have support of eight TOD registers and rate registers for demand and energy monitoring in peak and off-peak time zones. TOD rate and MD registers are required for active and apparent energy channels.

46. MD REGISTRATION

The meter shall continuously monitor and calculate maximum demand for each interval of time, which may be programmable as a block of 15 minutes or 30 minutes (30 minutes by default). At the end of every demand integration period the new calculated MD shall be compared with the previous MD and meter shall store whichever value is higher.

47. MD RESET

The meters shall have any of the following MD resetting options: -

- (d) Automatic reset at the end of a certain pre-defined period (say, end of the month)
- (e) Manual resetting arrangement (MD reset button) with sealing facility.

48. MD reset through authenticated transaction SELF DIAGNOSTIC FEATURE

The meter shall be capable of performing complete self-diagnostic check to monitor the circuits for any malfunctioning to ensure integrity of data memory location at all time. The meter shall have indication for unsatisfactory/non-functioning/malfunctioning of the following:

a) Time and date on meter display

- c) All display segments on meter display
- d) Self diagnostic (RTC, NVM information) on display

49. OTHER SALIENT FEATURES OF METERS

- It should be possible to check the healthiness of phase voltages by phase indicator available on meter display.
- The meters shall have provision of reading in the absence of power through an internal battery. It shall be possible to access the display in power off condition. It shall also be possible to do meter data download through MRI under power off condition.
- The meters should work accurately irrespective of phase sequence of the supply.

50. TEST AND TEST CONDITIONS

- Acceptance test: All acceptance tests as per relevant standards shall be carried out in the presence of utility representatives.
- Routine Test: All the routine tests as per – IS 14697 shall be carried out and routine tests certificates shall be submitted for approval of purchaser.

GUARANTEED TECHNICAL PARTICULARS FOR 3 PHASE 3 WIRE CT OPERATED TRIVECTOR ENERGY METER FOR CONSUMER METERING

S.No.	Item	Bidder's data
1.	Type	
2.	Application	
3.	Rated Voltage	
4.	Rated Current	
5.	Frequency	
6.	Minimum starting current in % of base current	

7.	Powerlossinpotentialcircuit	
8.	Powerlossincurrentcircuit	
9.	Changeinerrordueto	
	iii. Variationinfrequency	
	iv. Variationinvoltage	
10.	AccuracyClass	
11.	TotalWeightofmeter	
12.	Detailsof case	
13.	Standardtowhichthemetereconfirms	
14.	TypeofEnergyRegistrationMechanism.	
15.	MDResetMechanism	
16.	MDresetbuttonwithsealingprovision	
17.	TwoLEDsforaccuracymeasurement	
	Workingrange	
18.	Voltage	
19.	Current	
20.	Displaydetails	
	v. Display Cycle (page mode display)	
	vi. Period of display of each parameter	
	vii. Displayscroll- lockfacility	
	viii. BacklitLCD	
	xii. Relevant OBIS codes for parameter	
	ix. LegendforCoveropen detection	
	x. LegendforMagnetevent	
21.	Poweroninabsenceofmains	
	v. Internal/ExternalBattery	
	vi. Displayaccess	
	vii. Reading(Data downloading)	

22.	TotalEvents(300nos)	
23.	LoadSurvey	
24.	ParameterLogged	
25.	Logginginterval	
26.	No.ofdaysofLoadSurvey	
27.	TimeofthedayZone	
28.	Capability for fraud Prevention &detection	
29.	SealingandLockingArrangement	
30.	Typeofcommunication iii. Local-OpticalportIEC1107 iv. RS232portforremotecomms	
31.	<p>EventLogging</p> <p>CurrentRelatedevents:</p> <ul style="list-style-type: none"> • CTreversal(phasewise) • Currentimbalance • OverCurrent <p>Voltagerelatedevents</p> <ul style="list-style-type: none"> • PTmissing(phasewise) • Voltageunbalance • Highandlowvoltage <p>Others:</p> <ul style="list-style-type: none"> • Magnet • NeutralDisturbance • LowPowerfactor <p>Non-Rollover events</p> <ul style="list-style-type: none"> • FrontCoveropen <p>Poweron-offevents</p>	

20.0 LIFT SYSTEM

GENERAL

To provide complete electric operated Passengers Lifts including design, manufacture, installation at site, testing and commissioning of the same to the Engineer-in-charge's satisfaction. No consideration will be given to extra payment based upon difference in interpretation of the specification and drawings.

1 SCOPE

Safety to personnel and equipment during both operation and maintenance Reliability of service
Minimal fire risk

Ease of maintenance and convenience of operation

Automatic protection of all electrical equipment through selective relaying system Maximum interchangeability of equipment

Fail safe feature.

Suitability of applicable environmental factors

These specifications define the basic guidelines of the system as necessary for lifts. All data required in this regard shall be taken into consideration to develop a detailed engineering of the system. Site conditions as applicable are mentioned elsewhere. Compliance with these specifications and or approval of any of Contractor's documents shall in no case relieve the Contractors of his contractual obligations.

All works to be performed and supplies shall be affected as a part of contract requirement, specific approvals/review of Engineer-in-Charge. Major activities requiring approvals/review shall include but not be limited to the following: -

- General Arrangement drawings for the lifts including section through lift pit and lift shaft,
- Quality assurance procedures,
- Field testing and commissioning procedures

Engineering activities to be performed by Contractor shall include but not be limited to the following as relevant to the scope of work included in the project specification.

- a) Control and protection scheme.
- b) Making of shop drawings with bill of materials.
- c) Factory in section and testing procedures.
- d) Field testing and testing procedure.
- e) Preparation of as-built drawings
- f) Any other work/activity, which is not listed above, however is necessary for the completion of lift/system.

2. TESTS

Charging

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Owner/ Engineer-in-Charge and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The pre commissioning tests are to be performed as per relevant I.S. codes given and shall be included in the Contractor's quality assurance programme.

Commissioning Tests

The available instruments and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, un-measurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted with specified load capacity for the respective lifts. All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

Pre-commissioning test shall be carried out as per relevant IS Codes and / or as specified elsewhere in the tender.

The Contractor shall be responsible for obtaining clearances from the concerned authorities for commissioning of the equipment. However, necessary fee for these clearances, if any, shall be reimbursed by Owner on production of requisite documents in original.

3. PACKAGING

All the equipment's shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken into account by the Contractor. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, warfare and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Owner takes no responsibility of the availability of the wagons etc.

4. PROTECTION

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

5. CODES AND STANDARDS

The following Indian Standard Specifications and Codes of Practice, currently applicable and as per amended/updated as of date irrespective of dates given below, shall apply to the equipment's and the works covered by this contract. In addition, the relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended up to date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

Electric Traction Lifts – Guide line for outline dimension IS 14665 (Part-1)–2000 Electric Traction Lifts – Code of practice for installation IS 14665 (Part-2)–2000 ElectricTractionLifts–SafetyRules IS14665(Part-3)–2000

Electric Traction Lifts – Components IS14665(Part-4)–2000 Electric Traction Lifts – Inspection manual IS14665(Part-5)–2000 Glossary of terms relating to wire ropes IS 2363 – 1981

Steel wire suspension ropes for lifts and hoists IS2365–1977 Flexible Trailing Cables for lifts IS4289–1984 1100-volt grade XLPE insulated Armored cables IS 7098

1100-volt grade PVC insulated Armored cables IS1554–1988 1100-volt grade FRLS PVC insulated copper conductor wires IS 694RigidsteelconduitsIS9537–1981

Flexible steel conduits IS 3480 – 1966 Safety procedure and practices in electrical works IS 5216 – 1982 Electrical installation fire safety of buildings IS 1646 – 1997

ElectricTractionLiftsPart–4Components IS14665(Part-4/ Sec1&9):2001

ElectricTractionLiftsPart–5InspectionManualIS14665(Part-5):1999 Specifications for hoist way door-locks IS 7754-1975 Rules for design, installation, testing and Operationoflifts,escalatorsandmovingparts IS1735-1975

In addition, the relevant clauses of the following, as amended up to date shallapply. The Indian Electricity Rules 1956

TheIndianElectricityAct1910 State Lift Rules

Firesafetyregulationspertainingtolifts

The tenderers shall also take into account local and State regulations as in vogue for the design and installation of lifts.

Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable. BIS certified equipment shall be used as a part of the Contract.

6. ELECTRIC SUPPLY

The available system of electric supply is 415 volts +10% -10%, - 3 phase 4 wire AC 50 Hz system and 240 volts between phase and neutral. Any equipment/ component operating at other than the above-mentioned power supply shall be provided with necessary transformers/voltage stabilizers. The amount of power required for lifts shall be indicated in the tender. Power shall be provided at one point to be indicated by the tenderer. All subsequent electrical systems shall be deemed to be included in the scope of this contract.

7. SITE CONDITIONS

Liftshallbedesignedconsideringthefollowing:

AmbientTemperature - 45DegreeC.

RelativeHumidity - 100%

MeanSeaLevel - 300m

8. DRAWINGS

Before the commencement of work, the lift contractor on receipt of building drawings, shall prepare and submit all drawings necessary shop drawings showing the general arrangement of the lift equipment's for the approval of the Engineer-in-Charge and these drawings will become part of the contract. Contractor shall also check the exact dimensions of the lift shaft at site, before taking up the manufacturing the equipment at site.

9. PAINTING

All exposed metal work furnished under these specifications, except as otherwise specified shall be properly spray painted over an anti-corrosive primer coat.

10. CIVILWORKTOBEDONEBYLIFTCONTRACTOR:(INCLUDEDINCONTRACT)

- a) To providescaffoldinginthehoistwayrequiredforerectionoflift.
- b) To carry out minor civil work, such as modification and making good the pocket/cutout in wall/ceiling for car, counter weight, rail bracket, hall buttons, indicators and laying of sills in positions or any other workrequired for smooth operation commissioning of lifts.
- c) To provide and fix the steel items such as machine beams, bearing plate in the machine room, lift shaft for installation of machinery. Separators wherever required and buffer support channels and vertical iron ladder in lift.
- d) Providing of hoisting beam, lifting hook in the lift shaft for hoisting of equipment during erection and to facilitate maintenance in future including their fixing etc.
- e) Providing and fixing of necessary sill supporting projections, sheet steel facia plates on all landings as per requirements.

11. WORKNOTINCLUDED

Theemployershallprovidethefollowing:

- a) A hoist way properly framed and finished including pit of required depth with drain including water proofing, as per approved lift supplier drawing.The hoist way walls shall be neatly plastered to avoid dust accumulation.
- b) Properly lighted and ventilated machine room (in case of lifts with Machine

Rooms) and hoist way shall also have lights including power plugs point at landing as per requirement including access doors, ladder and guards as required. Walls & ceiling shall be properly finished to avoid accumulation of dust.

12. MAINTENANCE CONTRACT-2YEAR

Bidders are to quote their rates for annual maintenance contract for maintenance of all the lifts. The maintenance shall start after expiry of sales service guarantee period for all the lifts.

13. WARRANTY

The bidder shall provide for one year warranty after commissioning against all manufacturing defects and shall provide for free replacement of all materials having manufacturing defects.

14. PERMISSION TO INSTALL THE LIFTS AND LICENSE TO RUN THE LIFTS FROM RELEVANT AUTHORITIES

It shall be the responsibility of the successful tenderer for obtaining the necessary permission, if required, to install the lifts from the relevant local authorities and subsequently to have the installation inspected by the relevant local authorities and arrange to obtain the license to run the lifts. All relevant papers connected for obtaining the permission and final inspection will be signed by the Owner / Engineer-in-Charge. The requisite fee for this purpose shall be payable on the production of original receipts on this account.

15. ERECTION

The lift Contractor shall commence the erection of the lift equipment's immediately after receipt of the complete equipment's from their works and complete the work to the satisfaction of the Engineer-in-charge within the stipulated time. The lift installations shall be handed over in perfect working order on completion of the work.

16. TESTS

The following tests shall be carried out as per relevant IS requirement.

- a) Insulation and earth test for all electrical apparatus.
- b) Continuous operation of the lift full load conditions for one hour. This shall be as per I.S. specifications.

17. TESTING

Testing at manufacturers works of the various equipment's and components as required by I.S Codes/Standards & other applicable/European Standards shall be done by the successful tenderer before dispatching the materials to site. The tenderer shall furnish a certificate for the same.

If the authorized representative of Owners, wishes to participate/witness these tests the scheduled dates for the same will be informed well in advance before carrying out such tests.

Various tests required to be done as per I.S. Codes / European Standards at site of the installations shall be carried out in the presence of the Engineer-in-Charge.

18. HOIST MOTOR

- (a) Each elevator shall be provided with individual A.C. Motor. Motor shall be 415 Volt AC 3 phase, 50 cycles. The motor shall be designed for lift duty i.e., for repeated starts and shall be of high-capacity integral motor with class F insulation and equipped with thermal protection. It shall be AC reversible type for elevator service with high starting torque and low starting current. It shall be with minimum sound during operation and shall comply with latest relevant IS specifications for lifts.
- (b) Protection for motor - Provision shall be made for over load protection of motor. Protective relay shall be provided on the controller to protect the lift equipment's against low voltage and phase failure. The slow speed winding of this motor shall function automatically when the car is approaching a floor so as to provide a greater stopping accuracy.
- (c) Reverse phase relay - A reverse phase relay shall be provided on the individual controller to protect the lift equipment against phase reversal, low voltage and phase failure switches. Relays shall have suitable contact to withstand wear due to frequent make/break operation of the floor controller in the machine room and in the contact hoist way.

19. BRAKING SYSTEM

The brakes shall be used only to hold the counterweight and car in position. The brakes should not be used for stopping the lift. The electromechanical brakes mounted on the motor and gear shall work on rectified D.C. supply. The brakes shall be fitted with self-aligning shoes and operated on power release principle to ensure safety if the power supply fails. The brake should be capable of operation automatically by various safety devices, current failure and by normal stopping of car. It should be possible to release the brake manually, such releases requiring the permanent application of manual force so as to move the lift car in short stops. For this purpose, one set of brake release equipment shall be supplied. The tenderer shall specify the make of rectifiers for DC supply. Provisions made in IS - 10923:1984 shall be complied with. Stopping of the lifts shall not be achieved electrically but by electromechanical system.

20. CONTROL

The control shall be by microprocessor controlled electronically regulated A.C. Variable Voltage & Variable Frequency drive using pulse width modulation (PWM) with phase reverse relay.

21. CONTROLLERWITHDRIVESYSTEM

Controller with Simplex / duplex full collective control and selective, drive control with digital technology having Thyristor controlled acceleration and deceleration and digital tachometer on warm shaft.

22HOISTWAY

- a) Car Frame: A suitable car frame shall be provided with adequate bracing to support the platform and car enclosure. The buffer striking plate on the underside of the car-frame platform assembly must fully compress the buffer mounted spring in the pit before the plunger reaches its lower limit of travel.
- b) Platform, Heavy Loading Type: The car platform shall be arranged to accommodate one piece load weighing up to 25% of the rated capacity, such as wheeled food carts, passenger's baggage, etc. The platform shall be recessed 25mm for flooring Granite / Marble stone flooring as per approved samples pattern.
- c) CarGuideRails:Teesectionsteelrailswithbracketsandfasteners.(asapplicable).
- d) SpringBuffer:Helicalcoilsspringtype.(asapplicable).
- e) Wiring: Wiring for hoist way electrical devices included in scope of the elevator system, hall panel, pit emergency stops switch, and the travelling cable for the elevator car.

23. CARFRAMESAFETYGEARANDGOVERNOR

The car frame which supports the car platform and enclosure shall be made of structural steel and equipped with suitable guides and car safety device mounted under car platform.The safety gear shall be of instantaneous type.Car safety, to stop the car whenever excessive descending speed is attained,shallbeoperatedbyaspeedgovernorthroughacontinuoussteelrope.Suitabledeviceshall be provided to cut off power from the motor and apply the brake on application of safety.

24. THERMALOVERLOADPROTECTION

Auto thermal overload protection is to be provided to protect the driving motor against overloads. If the car is overloaded, it will not start. The overload indicator and the sounding buzzer shall signal the

overload condition.

25. PRIORITYCONTROL

Switching on the key contact and at the same time pressing the required floor buttons will allow a direct travel to the selected floor while the already registered car commands will be cancelled.

26. FULLLOADCONTROL

Full loaded cars should respond only to car commands. Floor calls remain registered and are served by the next available not fully loaded cars.

27. COUNTERWEIGHT

All counter weights shall be cast iron and shall travel between rigid guides of steel frame capable of withstanding buffer impacts. Suitable metallic counter weights guard of required length shall be provided at the bottom of the hoist way.

28. CARSAFETYANDGOVERNOR

The car safety is to be provided to stop the car whenever excessive descending speed is attained and runs more than 10 seconds in the same directions. The safety shall be operated by a centrifugal speed governor located at the top of the machine or hoist way and connected to the governor through a continuous steel rope. Suitable means shall be applied to cut off power from the motor and apply brake to stop the elevator immediately & after that the elevator shall restart automatically in normal speed.

29. SOUNDREDUCTION

The lift contractor shall provide necessary sound reduction materials, preferably anti-vibration pads of proper density to effectively isolate the machine from the machine beams or flooring.

30. TERMINALANDFINALLIMITS

Terminal switches shall be provided to slow down / stop the car at the terminal landings. These terminal switches shall act independently of the operating device or final limits switches. Ultimate or final limit switches shall also be provided to automatically cut off the power and apply brake in case the car travel beyond terminal landings.

TERMINALBUFFER

Suitable spring buffers shall be installed to stop the car and counter weight at the extreme limits of travels. Buffer must be suitable for installation in the space available.

31. GUIDES

Car and counter weight guides shall be of rigid steel guides shall be of machined "T" section only. The size

being in accordance with relevant European EN 81 standards, it shall be capable of withstanding the forces resulting from the application of car or counter weight safety devices.

32. ROPES

The hoist ropes shall be of traction steel of suitable size, construction and number to ensure the proper operation of elevator and shall give satisfactory wearing qualities. The Governor rope shall be of steel. The factor of safety should be as given in IS-4666. No car or counter weight rope shall be repaired or lengthened by splicing. Fixing arrangements shall conform to IS - 2365-1977 shall be complied with."

33. CAR PLATFORM

The car platform shall be framed construction and designed on the basis of rated load evenly distributed. The flooring shall be sound isolated platform having 6mm chequered plate with tough wearing floor cover and fire-resistant material and final finish with approved granite stone. Car's stoppage accuracy at floors shall be within ± 3 mm.

34. CAR ENCLOSURE OR BODY

The car body shall be approved finish stainless steel material. The car shall have suspended ceiling with arrangement for air through pressure fan mounted on the roof of car and in direct/ indirect lighting shall be with LED lamp fixtures evenly distributed in the cabin. Ceiling / wall interior material finishes to be submitted with offer.

35. CABIN FINISHES

- a) **For Passenger Lifts:** The car body shall be in approved finish stainless steel panels, the car floor will be of approved stone materials. The car shall have a suspended ceiling with arrangement for air through a pressure fan mounted on the roof of the car & indirect lighting shall be done with LED lamps fitting evenly distributed on the cabin finishes for the service lifts.
- b) **Other Cabin Features**
 - a. Telephone cabinet with phone and lead up to the control room or as directed by engineer in charge. Microphone with switch along with communication cable between cabin car and Centralized Security Room shall also be provided.
 - b. Full height infrared light-ray with photo-electric cells across the car entrance.
 - c. Door reversal feature in case of obstruction of doors.

- d. Handrail only on rear side.
- e. Braille signage on door and operation Panel.
- f. Voice announcement system in the car & at landings, to announce the position of the elevator car in the hoistway as the car passes through or stops at any floor issued by the elevator.

36. CAR DOOR

Stainless steel hairline finishes as per brief technical sheet. The door panels to be of center opening type with horizontal sliding doors & shall be of minimum 2 Hrs. Fire Rating.

37. LANDING DOOR

As per card door specifications

38. CAR AND LANDING DOOR OPERATORS

An electric door operator for opening and closing the car door and the landing door shall be provided. It shall consist of a machine on the elevator car for each stopping at a landing. The car door and the landing door shall be mechanically connected and shall move simultaneously while opening and closing. Every landing door shall be provided with a locking device which shall comply with the following requirements:

- a) It shall not be possible to open the landing door from the landing side until the lift car is within that particular relevant zone.

However, provision shall be made for opening the door by means of special key for use in case of an emergency.

- b) It shall not be possible for the car to be started or kept in motion unless all the landing doors and car door are closed and locked except when the car is coming to a stop at that landing within the levelling zone.
- c) The electrical and mechanical parts of all locking devices shall be of suitable design and construction.
- d) An electric contact for each car door shall be provided which shall prevent car movement away from the landing unless the door is in closed position.

The car doors and landing doors shall open automatically as the car is stopping at a landing. The closing of car door and landing door must occur before the car is set in motion. An electronic device shall be provided to stop and reverse the doors during their closing motion.

39. DOOR HANGERS AND TRACKS

The car and the landing door shall be provided with two-point suspension sheave type hangers complete with tracks. Sheaves and rollers shall be of steel with moulded nylon collar and shall include shielded ball bearing. Tracks shall be suitable steel section with smooth surface. The landing doors shall also consist of headers, sills, frames etc. as required.

41 CAR DOOR SAFETY SHOE

Full height car operating panel shall be installed on the car door panel. In the event of a person interrupting the beam, the closing operation of the doors (the car and landing doors) shall return to the open position. The closing operation of the doors shall also be reversible by pressing a button (Door Open button) in the lift car operating panel.

42. CAR AND CAR FRAME

- I. The passenger cars shall be isolated from frames to prevent vibration being transmitted from the ropes and guide shoes. Lateral and upward motion of the car shall be restrained by locking blocks but there should not be metal contact between the car and the frame. The top of the car shall be held firmly by rubber braced clamps welded to each side of the car's canopy. In addition, the side panels shall be coated with a layer of bituminous sound deadening compound. The car frames shall be of suitable steel section properly and securely braced and shall be sufficiently rigid to withstand the operation of the safety gear without permanent deformation of car frame.
- II. All passenger lifts shall be of metal construction with center opening sliding steel doors, side panels in stainless steel finish. The car enclosure will be provided with fan with grill for ventilation. The floor of the lift car shall be granite stone over suitable structural steel frame. (Sample is to be approved by Engineer-in-charge). Following shall also be provided in the passenger lifts: -
 - a) False ceilings – As per Para 36, Stainless Steel (Stainless steel finish and panels as per manufacturer) fitted with LED light fittings through two rows of translucent fixture & Pressure fan with grills. The fan shall be connected on electric mains independent of mains supplying power to lift machine. Ventilation opening shall be provided inside the enclosure as per standard practice of lift manufacturers. To permit switching off the power supply to the lift without switching off the fan and the light, a separate circuit with control in machine room shall be provided in machine room.
 - b) One number full car operating panel with buttons in stainless steel finish integral full height. Operating panel to be with Braille signage for PWD's.
 - c) Digital car position indicator in car and car position indicators at ground floor & landings of all upper floors.

- d) Car direction indicator showing up/down directional movement of car is to be fitted on the ground floor and on each landing (at all upper floors).
- e) Battery operated alarm bell and emergency light with recharge equipment (charger) including invertors and batteries. The lighting shall automatically come on in case of failure of normal lighting supply.
- f) Overload warning indicator in car.
- g) One specification plate showing rated load, passenger capacity and other installation details/ rating.
- h) DO's and DON'Ts notice for lift operation duly framed.
- i) Fireman's switch at main lobby.
- j) Call Registration indicator for the purpose of registering the requirement of car at a particular landing.
- k) Digital Floor position indicator.
- l) A three-pin plug socket with switch for a hand lamp shall be fitted on top of the lift car for use by person working thereon.
- m) Hands free intercom system.
- n) Voice synthesizer.
- o) Voice Announcements system in each & landings for People with Disabilities (PWD's).

43. CAR DIRECTION INDICATOR

Digital signal indicator in the car shall be provided by the appropriate arrow being illuminated to indicate the car travel direction.

44. EMERGENCY LIGHT IN CAR

A trickle charged battery operated emergency light lamp shall be provided in the car which shall operate automatically in case of power failure for minimum 90 minutes.

45. ALARM BELL

An emergency alarm bell shall be provided. The alarm bell shall be located at the ground floor landing and push for the same shall be at the car operating panel. The system shall be operated by batteries with trickle charger and the bell/sirens should work the moment the alarm button in the car is pressed.

46. COMMUNICATIONSYSTEM

Telephone system with cables shall be provided between cabin car and machine room for each lift. In addition to this, microphone with switch shall be provided in each lift cabin so that operator/passenger can talk to main security personnel sitting at centralized room in case of emergency.

47. CALLBUTTONINLANDINGS

An 'up' push button and a 'down' push button at each intermediate landing and a single push button at each terminal landing shall be provided to call the lift car in a particular landing for travelling in a desired direction. The push buttons shall have call registration lights and shall illuminate when a button is momentarily pressed to indicate that the call is registered and the direction of the call is registered. The button shall remain illuminated until the call is answered. The top covers of the push button boards at the landings shall be of stainless steel.

48. FLOORPOSITIONINDICATOR&DIRECTIONARROWS

Digital signal indications at all landings shall be provided by the appropriate numeral and direction arrows being indicated when the car is passing the corresponding floor. The indicator shall remain illuminated when the car is stopped at a floor. The top cover of the floor position and direction arrow indicator units shall be stainless steel.

49. ELECTRONICDOORDETECTOR

Oneachsideoftheliftentrancedoorandcardoorpanel's,infraredlightsensorunitshallbemounted in such a way to continuously monitor the light beam. (no. of beams shall be more than 100). When any beam is disturbed, an electronic circuit shall be interrupted and the doors operating mechanism shall return the door to open position. When the entrance is clear the lift door shall close automatically. Openingofthedoorsmayalso be accomplished by pressing the "DoorOpenButton" in the car operating panel.

50. EMERGENCYKEY

Emergencykeyorequivalent devices shall be provided as required by the elevator supplier.

51. DETAILEDINSTRUCTIONS

Inside the lift car suitable instruction for passengers on car operating panel will be displayed. Such instructions in lift car shall indicate capacity, Nos. of persons; 'No Smoking' and such other instructions as are suitable for proper and safe operation of the lifts.

52. FIREMAN SWITCH

Each lift will have fireman switch for access of fireman. The operation of this switch shall cancel all calls to this lift and lift will stop at the next nearest landing if travelling upward. The doors will not open at this landing and the lift will start travelling to ground floor. In case of its travel in the downward direction when the fireman's switch is operated, it will go straight to ground floor direct without stopping enroute. The emergency stop button inside the car will become inoperative during the journey. Once the car has reached the ground floor, it shall be safely under the command of fireman by car buttons, landing calls being isolated. The lift can be put in normal use by putting the fireman switch in its original position.

53. OPERATION

The operation shall be Simplex/Duplex, full collective-selective with or without attendant. It shall generally function in the manner described below: -

On every intermediate landing is a Up/Down button with 'Call Registered' lights. The extreme positions have one call button with a "Call Registered" lights. Inside the car is the complete set of buttons and a key operated change over switch to facilitate operation with or without attendant. However, in this case the car attends to all calls registered inside the car and also at the landings, in the ascending or the descending order. If it is landing, the last stop is the top-most registered call. After this, it automatically reverses the direction of travel and attends to all calls registered "Down" on this downward trip, irrespective of the sequence in which the calls are registered. The car will answer all calls in a sequenced order depending upon the direction in which it is travelling. If the key is turned to 'Attendant' operation, and also lift operation can select the direction of travel by pushing the right buttons in the car.

54. EMERGENCY STOP SWITCH

On top of the lift car an emergency stop switch shall be provided for use by maintenance personnel. Similar switches shall also be provided in the car. Operation of these switches shall render the car and landing buttons inoperative and cancel all registered calls.

55. EMERGENCY BATTERY DEVICE

The emergency battery unit shall consist of suitable capacity of SMF (Sealed Maintenance Free) batteries with battery charger having auto trickle boost rate of charge. The unit shall be of such a capacity that in case of power failure, the lift shall come to the nearest landing automatically. The Bidder will submit calculations for batteries and battery charger before procurement.

56. AUTOMATIC TERMINAL STOP (RESCUE DEVICE)

The elevator shall be equipped with an automatic stopping device arranged to bring the car to a stop at the terminal landings, independent of the regular operating device in the car. This safety device is required so that in case of controller failure or power failure, the lift should not get stuck in the shaft. With this device, the lift will come to the nearest landing and its doors will open and the person can come out of the lift. All power-operated doors shall have a full length infra-red light curtain safety to retract the door in the event of coming across any obstacle during closing of door.

57. ELECTRICAL WIRING

Power wiring between the controller and main board and controller to various landings shall be done in heavy gauge M.S. conduits conforming to Indian Electricity Rules and Specifications for electrical works. All cables shall be PVC insulated of appropriate size and voltage grading. Complete copper wiring for the entire lift installation will be used.

All multi-core trailing cables employed for the car shall satisfy the requirement of relevant IS and / or European Standard. There shall be separate trailing cables for the controls, for the lighting and fan and for signal circuits. The length of the cable shall be adequate to prevent any strain due to movement of the car. All cables shall be so tagged for easy identification. Trailing cables shall be so suspended, anchored and run that the strain on individual cable conductor shall be reduced to a minimum and the cables are free from contact with the car counter weight, shaft sides etc. No intermediate jointing shall be permissible in the trailing cable.

58. MACHINE

The machine shall be of gearless traction type for variable speed equipment for all passenger lifts and shall include electric motors, electromechanical brakes, chromium molybdenum steel shafts and a sheave all completely mounted on a single base or bed plate. The worm shaft will be provided with taper roller bearings to take the end thrust and self-aligning spherical roller bearing will be furnished for the sheave shaft to ensure alignment and long bearing life. The driving sheave will be grooved to ensure sufficient traction and minimum rope wear. Adequate means of lubrication will be provided for all bearings and the worm gear. The machines shall be equipped with an arrangement for manual winding of machine for testing purpose or for operation when the power supply fails.

59. DUAL OPERATION WITH ATTENDANT

Provisions shall be made for automatic operation as given below:

- (a) Without attendant
- (b) With attendant: For the use of attendant, the following additional equipment shall be added to car operating panel:
 - (i) Key operated switch for cutting in/out additional requirements for "WITH ATTENDANT" operations
 - (ii) Emergency buttons
 - (iii) Car Call indicators

60.AUTOMATICSELFLEVELLINGDEVICES

This device shall be operated in slow speed to bring the car door in level with landing door; the tenderer should specify the leveling errors that can be achieved by them.

61. LIGHTFIXTURES

Suitable composite LED light fittings as specified, recessed in the false ceiling and operated by a switch in the car operation panel shall be provided. A light point along with bulb shall be provided about 5 cm above ground level for the purpose of providing proper light in the pit. Properly earthed lighting arrangement shall be provided in the hoist way in the form of volts Bulk-head fitting at each floor level.

62. CAROPERATINGPANEL

The car operating panel shall be flush –mounted to full height in car enclosure and shall contain the following:

- (a) Bank of buttons to correspond to various floors/landings served.
- (b) Emergency switch for stopping the car independent of regular operating device.
- (c) Emergency alarm bell button connected to the alarm bell located at the main floor landing or adjacent to hoist way. The alarm should be operated through DC battery.
- (d) Light/Fan control switches.
- (e) A key operated switch to operate lift “Automatic without attendant” and “With attendant”.
- (f) All call buttons, signals, control switches and car operating panel shall be numbered/mounted on stainless steel finish panel to full height and flush mounted.
- (g) Overload warning indicator in car.
- (h) Battery operated emergency light.

63 TRAILINGCABLE

The trailing cable shall have flame retarding and moisture resistant outer cover. They shall be flexible and shall be suitably suspended to relieve strain in the individual conductors.

A. The works listed as under shall be arranged by Lift contractor and deemed to be included in the quoted rates.

- a) All cutting of walls, floors or partitions together with any repairs made necessary thereby, including grouting in position like bolts, cills, steel members, indicator, button boxes etc., after they are fitted in position.
- b) Scaffolding including temporary barricade required for lift works in elevator hoistway during the erection period and to remove the same thereafter.

- c) Facia Plates are to be provided and installed by the Lift contractor.
- d) All painting work of elevator material.

B. The Employer shall ensure the provisioning of the following: -

- (a) Provisioning of continuous cill bearing area for each hoist way entrance of such construction as to assure secure anchorage and support for each cill.
- (b) Painting work of hoist way except of Elevator materials.
- (c) Lighting/Power Point of hoist way and pit.
- (d) Hoisting hook in the ceiling of the hoist way.

C. Tenderer's lump sum price in Schedule 'A' shall be deemed to include for full and entire completion of all works in accordance with good engineering practice and recognized principles. If any additional

civil works required other than mentioned in above to suit the lift well as constructed at site shall also be got executed by the lift contractor under his own arrangement, and the cost of same shall be deemed to have been included by them. The details of construction that may not have been inadvertently specified but are apparently and obviously required for making the lifts functional shall be deemed to be included in the lump sum rate quoted by the contractor. Decision of Engineer-in-Charge in such matter shall be final and binding.

- D. The lift tenderer has to work in close liaison with the building contractors.
- E. Braille signages shall be provided in each Lift in each Block.

Escalators

Passenger Escalators of below listed passenger capacity

Type External, Value of Rise (mm) 5800- 6300. Step Width (mm) 1000, Capacity, 9000 persons /hour, Speed 0.5m/s, Angle of Inclination 35°, Operation System VVVF Drive, Handrail Black Synthetic Rubber. Handrail support Stainless Steel Hairline, Balustrade interior paneling, 10mm transparent tempered safety glass, Inter & outer decking Hairline Stainless Steel, Skirting Hairline Stainless Steel, Comb plate Aluminum alloy, Step Integrated Aluminum Alloy with black painting, Step Cleat Yellow Molding Resin at the flank & on the front wall, Step of horizontally moving distance Two steps, Floor plate Stainless Steel Plate with Antiskid Patterns, Power voltage 415V, 3 Phase, 50 Hz, Lighting voltage 240V, 1 Phase, 50 Hz all Complete.

END OF SECTION

Technical Specifications

Sr. No.		
1	Usable Platform	Standard
a.	Length	3755mm
b.	Width	2000~2500mm
c.	Height(Car which could be accommodated)	Upper-Minimum 1500mm for all stack
		Lower 1500~2000mm- Based Upon actual Clear Heights available at Site
d.	Equipment Weight	696Kgs (approx.)
2	Required Dimensions	Standard
a.	Length	5000/4500/4250 (Car length Vary)
b.	Width	2300~2800mm
c.	Clear Height for the system	3200~3700mm
3	Lifting arrangement	Standard
a.	Capacity of the motor	Electrical Motor for power pack 3KW only for Lifting
b.	Mode of transmission	Hydraulic Cylinder
c.	Speed of operation	Up Operation - 2.7mtr./min Down Operation - 2.5mtr./min (Depend on Vehicle Weight)
d.	Lifting Capacity	2000Kgs
4	Mode of Operation	Manual
5	Power supply	3ph., 415V, 50hz
6	Hydraulic Piping Location	Cable tray from Ground
7	Number of Equipment for single Power pack (in a row)	Maximum 7 - As per the Site Layout
8	Color of the Structures	Basalt Gray RAL (7040)-Plain/Structure
9	Type of Powder Coating on Structures	Epoxy Powder Coating/hot dip galvanizing
10	Galvanization Details	Pre-Galvanized Sheet of 120GSM (Corrugated Platform Profiles only)
11	Safety devices	<ul style="list-style-type: none"> Hydraulic valve with Solenoid Coils Electromagnet Operated Mechanical Stopper to prevent unintentional lowering of platform, Leaf Chain Synchronization of platform lifting and lowering Wheel Stopper

StructuralPart

1.	TypeofMSSteel	IS 2062
2.	ThicknessofCchannel	ISMC200
3.	PlatformProfile	Pre-Galvanized1.5mmthick,120GSM

HydraulicPart

1	Typeof Cylinder	SingleActingHydraulicCylinder
2	Strokelength	2100 /1800mm
3	PowerPack/Oilreservoir	Submergedtypewith60-litercapacity
4	Valves	ElectricallyoperatedsolenoidValves
5	Piping	12mmODseamlesshydraulicpiping

➤ **General description of Two Level Dependent Car parking system**

- 2 steel pillars with base that is mounted on the floor
- Two slides (mounted to the steel pillar with sliding Nylon bearing)
- 1 platform
- 1 Leaf Chain (for Synchronization of platform)
- 1 Hydraulic cylinder
- Hydraulic system with power pack & piping
- Operating panel for platform lifting and lowering.
- Bracketing for site fixings.
- Mechanical & Electrical safety systems.

➤ **Platforms consisting of:**

- Platform Side Members
- Platform Connection Strips
- Adjustable wheel stops
- Access strip
- Platform profiles made out of pre-galvanized
- Screws, nuts, washers, distance tubes, etc.

➤ **Hydraulic System consisting of:**

- Hydraulic cylinder
- Solenoid valve
- Hydraulic piping's
- Hydraulic power pack
- Fixing supports (wall stands)

➤ **Electrical system consist of:**

- Operating panel (Emergency Stop, Deadman control switch with key)
- Terminal box on valve Column
- 2 Electromagnets for mechanical locking
- Electrical wiring

22.0 CCTV System

1	Specification for IP Indoor Dome Dual Sensor Camera:		Compliance (Yes/No)
	Technical Specification		
	Image Sensor (CMOS)	2 TO 4MP	
	Optical Format	1/2.5" or better	
	Minimum Illumination	Colour (Day Mode) - 0.3Lux	
		B/W (Night Mode) - 0.15Lux	
	Wide Dynamic Range	True Sensor Based 70dB or higher	

	FullFieldofViewResolution	Total:5120HX1920V PerSensor:2560HX1920V	
	VideoCompression	H.264(MPEG-4,Part10)/MotionJPEG	
	FrameRate	Atfullresolution:7fps(5120X1920) Scaled down resolution: 10fps (2560 X maintainingfullfieldofvie w	
	Lenses	2X8.0mmMPlenswithremotefocuscapability F1.6, H- FoV=43°;2.1/2.8/4.0/6.0/8.0/12.0/16.0mm MPlenswithremotefocuscapability	
	BacklightCompensation	Required. Reference windows for auto exposure and white balance	
	PrivacyMasking	Required.Unlimited	
	Shutterspeed	Userprogrammable1ms-500ms	
	MotionDetection	RealTime.1024detectionzones	
	ImageRotation	CorridorView(90°,180°and270°imagerotation)	
	NetworkInterface	100Base-TEthernet	
	NetworkProtocols	RTSP,RTP/TCP,RTP/UDP,HTTP,DHCP,TFTP	
	Industry Standard compliance	ONVIFProfiles	
	Compliance and certifications	UL (CB), 47 CFR 15 Class A FCC, RoHS, REACH, WEEE, (CE)EN55022ClassA,EN55024,EN61000-3-2, EN61000-3-3,EN60950-1	
	Mechanicalrating	IP66(EN60529),IK-10	
	OperatingTemperature	-40°C(-40°F)to+50°C(122°F)upto90%non- Condensinghumidity	
	AlarmInput/Output	Generalpurposeupto-coupled,1input/1output	
	PowerOverEthernet	PoE802.3af,Class3	
	PowerConsumption	7.9WattsDCPowermax	
	FlickerControl	50/60Hzselectable	
	Casing	Tamper-resistant Dome housing, IK-10 Impact- resistant, IP66 weather proof standard	

2	SpecificationforIPIndoor/OutdoorFixed/VarifocalDomeCamera:		
	TechnicalSpecification		Compliance (Yes/No)
	ImageSensor(CMOS)	1080p(2.1MP)	
	OpticalFormat	1/3.2"	
	MinimumIllumination	Colour(DayMode)-0.2Lux B/W(NightMode)-0.02Lux,IRSensitive	
	WideDynamicRange	TrueSensorBasedupto100dB	
	FullFieldofViewResolution	Total:1920Hx1080V	
	VideoCompression	H.264(MPEG-4,Part10)/MotionJPEG	
	FrameRate	Atfullresolution:30fps(1920X1080)	

	Lenses	2.1/2.8/4.0/6.0/8.0/12.0/16.0mmMP lens	
	BacklightCompensation	Required.Customwhitebalance	
	PrivacyMasking	Required.Unlimited	
	Shutterspeed	Userprogrammable1ms-500ms	
	MotionDetection	RealTime.1024detectionzones	
	ImageRotation	CorridorView(90°,180°and270°imagerotation)	
	NetworkInterface	100Base-TEthernet	
	NetworkProtocols	RTSP,RTP/TCP,RTP/UDP,HTTP,DHCP,TFTP,QoS, IPv4, IPv6, 802.1x	
	Industry Standard compliance	ONVIFProfiles	
	Compliance and certifications	UL (CB), 47 CFR 15 Class A FCC, RoHS, REACH, WEEE, (CE) EN55022 Class A, EN55024, EN61000-3-2, EN61000-3-3, EN60950-1	
	Mechanicalrating	IP66(EN60529),IK-10	
	OperatingTemperature	-40°C(-40°F)to+50°C(122°F)upto90%non-Condensinghumidity	
	AlarmInput/Output	Generalpurposeopto-coupled,1input/1output	
	PowerOverEthernet	PoE802.3af,Class3	
	PowerConsumption	5.59WattsDCPowermax	
	FlickerControl	5Hz–255Hzadjustable	
	IRIlluminatorLED	Builtin3pcs850nmLEDs/50ft(15m)IRdistance (max) / 80° IR angle	
	Casing	Tamper-resistant Dome housing, IK-10 Impact-resistant, IP66 weather proof standard	

3	SpecificationforIPIndoor/Outdoor360°OmniDirectionalQuadsensorDome Camera:		
	TechnicalSpecification		Compliance (Yes/No)
	ImageSensor(CMOS)	4x3MPCMOS	
	OpticalFormat	1/3.2"	
	MinimumIllumination	Color(DayMode)-0.5Lux B/W(NightMode)-0.0Lux,IRsensitive	
	WideDynamicRange	TrueSensorBasedupto100dBatfullresolution	
	FullFieldofViewResolution	Total:8192Hx1536V PerSensor:2048Hx1536V	
	VideoCompression	H.264(MPEG-4,Part10)/MotionJPEG	
	FrameRate	Atfullresolution:5fps(8192X1536) Scaled down resolution: 16fps (4096 X	

	Lenses	2.1/2.8/4.0/6.0/8.0/12.0/16.0mmMPfixedlenses Internal	
	BacklightCompensation	Required.Automulti-matrixwhitebalance	

	PrivacyMasking	Required.Unlimited	
	Shutterspeed	Userprogrammable1ms-500ms	
	MotionDetection	RealTime.1024detectionzones	
	NetworkInterface	100Base-TEthernet	
	NetworkProtocols	RTSP,RTP/TCP,RTP/UDP,HTTP,DHCP,TFTP	
	Compliance and certifications	UL (CB), 47 CFR 15 Class A FCC, RoHS, REACH, WEEE, (CE) EN 55022:2010 Class A, EN 55024:2010, EN 61000-3-2:2006+A1:2009+A2:2009,EN61000-3-3:2008, EN60950 1:2006+A11:2009+A1:2010+A12:2011,(UL)IEC 60950-1(ed.2)andIEC60950-22(ed.1)	
	IndustryCompliance	ONVIFProfileSconformant	
	Mechanicalrating	IP66,IK-10	
	OperatingTemperature	-40°C(-40°F)to+50°C(122°F)upto90%non-Condensinghumidity	
	AlarmInput/Output	1input/1 output	
	PowerOverEthernet	PoE802.3af,Class3	
	AuxiliaryPower	12–48VDC,24VAC	
	PowerConsumption	14Wattsmax(Aux)	
	FlickerControl	50/60Hzselectable	
	Casing	Die-cast aluminium chassis with polycarbonate dome bubble, IK-10 Impact-resistant, IP66 weather proof standard.Easilyadjustable,2-axisw/360°panand90° tilt.	
	MountingOptions	Surface/Wall/Polemounting option shouldbe available	

	SpecificationVideoManagementSystem:		
			Compliance (Yes/No)
	GENERAL	The system shall be a highly scalable and modular enterprise level software solution.	
		The system shall have an open architecture, supporting seamless integration with third party applications.	
		The system shall have an object-oriented architecture /Design.	

		The system shall have the capability to integrate an unlimited number of video servers into one unified network – each server must be able to communicate with other servers, and video and events from any server must be viewable from other servers.	
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		ThesystemshallsupportPostgreSQLdatabase.	
		The system shall allow an unlimited number of sites and cameras to appear as a single Site to the end- user.	
		The system shall allow for an unlimited number of servers, workstations, cameras, and user accounts to be configured into one logical enterprise implementation with a single Graphical User Interface (GUI).	
		Thesystemshallhavethecapabilityofdirectly viewing and recording analogue and IP cameras.	
		The system shall have the capability to support simultaneous streams from the same IP camera (if camera supports multi-streams); each stream can be assignedforrecording,playbackandnetwork transmission.	
		The system shall allow for a distributed architecture of the system configuration database. Each Video Server and Administrator Workstation can store a local copy of the system configuration database toadd a level of built-in redundancy.	
		The system shall support a solution for native failover of the video servers. The system shall have the ability to be configured such that if one of the video servers fail, the failover server will automatically take over the recordingofthecamerasfromtheseverthat failed.	
	System Setup / Configuration	The system shall provide the following software installation types on a single computer: Video Server (VS), Operator Workstation (OW), and Administrator Workstation (AW).	
		AllsoftwareinstallationtypesShouldbeavailable From the sameinstallationpackage.	

		Video Server installation will include all functionality of the Operator Workstation and Administrator Workstation.	
		The system shall not require a dedicated configuration server. The system shall allow making changes to the configuration from any Video Server or Administrator Workstation on the security network.	
		The system shall provide a configuration wizard to help configure the system during the initial install process.	
		The system shall have an IP-Device Manager tool with an "IP auto-discovery" feature to search the network for connected IP devices and easily add them to the System configuration.	
		The system shall have the capability of individually configuring each object in the system (video capture devices, cameras, sensors, relays, desktops, monitors, etc....).	
		The system shall allow an option to make a backup of the entire system configuration to a single file (XML or SQL).	
	Built-In Feature	The system shall provide a tool to extract logs, Database data and other information necessary for support without shutting down the application.	
		The system shall support all IP camera/device vendors Quoted by the SI	
		The system shall support all major video compression formats: H.264, MJPEG, MPEG4, MxPEG, Delta Wavelet.	
		The system shall support Generic RTSP drivers to be able to get video from any IP device supporting the RTSP protocol.	
		The system shall support Generic HTTP drivers to be able to get video from any IP device supporting the HTTP protocol.	
		The system shall have an RTSP Server module that will provide the ability to send out live and archived video streams through the RTSP protocol to Requesting clients.	
	Video Recording	Internal	

		The system shall support video streams directly from analog cameras, IP cameras, and analog cameras connected to IP encoders.	
		The system shall have the capability to be configured to record continuously, on motion, on a schedule, or on event.	
		The system shall support all video resolutions, frame rates, and bitrates that the IP camera manufacturer supports.	
		Each camera's resolution, frame rate, and bitrate will be set independently from other cameras in the system, and changing these settings will not affect the Recording and display settings of the other cameras.	
		The system shall have the capability of recording video from analog and IP cameras on the same server.	
		The system shall have the capability to protect the recording of each camera with a password.	
		The system shall have the capability of recording at least 400 Mbps of video per server (depending on server specifications).	
		The system shall have the capability to record using another camera stream than the one being used for viewing (if a camera being used supports multiple streams).	
		The system shall have a button on the camera view to easily start/stop recording of a single camera.	
		The system shall support the FIFO (First-In-First-Out) recording mode, to continue recording over the previously recorded video.	
		The system shall have the option to configure the minimum days of video retention per camera.	
		The system shall have the option to configure the Maximum days of video retention per camera.	
		The system shall have the capability of pre- and post- motion recording.	
		The system shall have the capability to keep free Space on the hard drive.	
		The recordings should be for at least 60 days	

		The system shall have the capability to display a recorded video file as a virtual camera (format of video files must be Native / AVI).	
		The system shall have the capability of recording video at a lower frame than is received from the Camera (frame rate reduction).	
		The system shall allow for use of non-proprietary PC storage hardware that shall not limit the storage capacity and shall allow for future upgrades of recording capacity.	
	Video Playback / Archive Search	Video Should be available immediately for playback (as soon as current video sequence/file is finished recording).	
		The system shall have a one step process (single button click) to toggle between live and archive mode.	
		The system shall support a Timeline view for playing Back archive video.	
		The Timeline shall support playback of up to 32 simultaneous cameras without any performance degradation.	
		The Timeline shall be easily dragged with the mouse in either direction	
		The system shall provide a calendar to easily search for recorded video.	
		Dates of recordings shall be designated in the calendar.	
		The system shall have simple to use VCR type digital controls to control playback.	
		The system shall have an option to speed up and slow Down playback speeds up to x32.	
		The system shall support backward playback of video, where video frames will be played in reverse order.	
		The system shall have the capability Text (based on video start time, or full-time interval).	
		The system shall have the capability of multiple search methods by motion, event, or timespan.	
		The system shall have the capability of masking out non-essential areas of recorded video and only Searching within areas of interest ("Smart Search").	

		The system shall support digital PTZ on archived video.	
		The system shall support warping and PTZ control for archive video recorded from 3600 and 1800 cameras.	
		The system shall provide an option to search by camera name to easily find video for a camera (without having to manually search through a list of all cameras).	
		The system shall provide an Archive Player to play back native video in the case the VMS client software is not installed on the client PC.	

	Camera Motion Detection / Motion Zones		
		The system shall have the capability to support Multiple Motion Detection Zones from each camera.	
		Each Zone Should be uniquely addressable and be able to have specific reactions programmed based on alarm of a zone.	
		Each Zone can be created from a grid of 4,800 motion Detection blocks.	
		Each Zone shall have individual sensitivity settings for Contrast and Size of the moving object(s).	
		Each Zone shall have the option to be individually armed/disarmed.	
		For each Zone, video frame rate, quality of frames, and memory frames can be adjusted for motion detection.	
		The system shall have the capability to display/hide The Motion Zones in the camera live view.	
		The system shall display the Motion Zone in a different colour if motion was detected in that Zone.	
	User Interface (GUI)	Virtual Desktops can be created on Operator Workstations, Administrator Workstations, and Video Servers.	
		Virtual Desktops can contain:	
		Virtual Matrix	
		Event Viewer	
		Task Specific Dialog Forms	
		Graphical User Interfaces (GUIs) for VMS built-in analytics modules.	
		The system shall provide buttons to easily toggle Between different virtual Desktops.	
		The system shall provide a single button to minimize/hide any virtual Desktop being displayed and show the Windows Desktop.	
		The system shall have a very customizable User Interface where multiple UI components can be stitched together to create a single User Interface and User experience.	
		GUI objects on a single virtual Desktop can be configured to display across multiple physical monitors connected to a computer.	
	System Automation		
		The system shall have the capability to send notifications to a specified client system.	
		The system shall have the capability to send Notifications by Email, SMS, or phone call.	

		The system shall have the capability for audible notification of alarm.	
		The system shall have macro programming capability.	
		The system shall have a built-in script programming capability based on VB/JScript programming languages.	
		The system shall provide an option to create Times Zones for the purpose of scheduling system events/reactions.	
		The system shall have the capability to call external Applications from within its interface.	
		The system shall be able to notify the administrator if a camera fails, blinding occurs, or if a server connectivity issue occurs.	
	Logging / Health Monitoring	The system shall have an event logging capability with filtering options.	
		The system shall have the capability to store login information in log / txt files in a designated folder.	
		The system shall have an option to control the size of the log files.	
		The system shall have a Health Monitoring feature that will generate real-time alerts if certain problems arise in the system.	

	Control Room Equipment's: Server		
			Compliance (Yes/No)
	Memory	16.0GB or better expandable up to 32Gb	
	Network Interface	2 on-board Intel GbE NICs	
	Network Management Interface	110/100/1000 MbE NIC	
	USB Communication Ports	4 USB 2.0 ports	
Expansion bus			
	Remote Management	Standard IPMI 2.0-compliant service processor with iLOM	
	Supported Protocols	IPMI 2.0, SNMP v1, v2c, v3, Secure remote access using Web interface over SSL, or CLI over SSH	
	Storage	1TB of SATA III hard disk	
		Hardware RAID; RAID 0, 1	

	PowerSupply	Redundant,hot-swappablePSUandfanmodules	
	IncludedOS	Microsoft®WindowsServer®2012OS	

	ControlRoomEquipment's:StorageServer		
			Compliance (Yes/No)
	Processor	DualIntel®Xeon®E5OctaCore,2.66GHzorfaster Processor	
	Memory	16.0Gb orbetterexpandableupto32Gb	
	NetworkInterface	2on-boardIntelGbE NICs	

	Network Management Interface	110/100/1000MbENIC	
	Serial Communication Ports	RJ-45	
	USB Communication Ports	4USB2.0ports	
	Expansionbus	1PCIExpressslots	
	Remote Management	StandardIPMI2.0-compliantprocessorwith iLOM	
	Supported Protocols	IPMI 2.0, SNMP v1, v2c, v3, Secure remote access using Web interface over SSL, or CLI over SSH	
	RAID	HardwareRAID;RAID0,1,5	
	PowerSupply	Redundant,hot-swappablePSUandfanmodules	
	IncludedOS	Microsoft®WindowsServer®2012OS	

BOOMBARRIERS

Application	Outdoor
IPRating	IP-56
Housing	BarrierHousingUnit:PowderCoated
HousingDimension	Modular
HousingMaterialofConstruct ion	AllAluminiumHousingwithBaseframeinSS-304forhigh protection against corrosion.
Protection	AllHousingandinternalpartswillberust&corrosionfreeme tals or alloysof highstrengthwithsuitable Epoxy coating as applicable.
HousingDimension(WxDxH)	469x279x1100mm
BoomSpecification	Boomshouldberoundorellipticalwithledlights&rubberbum per

Intelligence	The barriers shall use a Hydraulic Drive in combination with microprocessor based control card communication standard interfaced Controller.
Loop Detector	Inbuilt Dual Loop Channel Detector
Compliance & Safety	<ul style="list-style-type: none"> • Compliance to CE.
	Adherence to Safety Requirements of the
	<ul style="list-style-type: none"> • EMC Directive 2004/108/EC,
	<ul style="list-style-type: none"> • Low Voltage Directive 2006/95/EC and
	<ul style="list-style-type: none"> • The basic requirements of the Machinery Directive 2006/42/EC
Power Supply	230 +/- 10% VAC, 50Hz.
Electric Motor	36vdc Brushless
Maximum Power Consumption	Not More than 240 watts
Reverse on Contact feature	Inbuilt in barrier, reverses when hits any obstacle
Opening & Closing Time	2.3 Mtrs in less than 1.5 sec & 8.3 mtrs in less than 6 secs.
Operating Temp	- 20 Degree Celsius to +55 Degree Celsius
Safety	Detection of Presence of Vehicle in Loop or in the path of Infrared Safety Sensors available. Loops or Sensors to be used to prevent barriers from closing on the vehicle.
Duty Cycle	100%
Integration	Shall function in integration with Smart cards, proximity reader based access control systems etc.
Requirement	MCBF-2 Million Cycles
Certificates Required	CE/UL Certification for the product

23.0 PassiveCablingwithComponents

1. 144CORES-OUTSIDEPLANTFIBER CABLE: -

StandardCompliance	Compliance (Yes/No)	Remarks
ShallbeSinglemode(OS2),SingleJacket,SingleArmor,Gel-free Fiber.		
QualificationStandards:ANSI/ICEAS-87-640,EN187105and TelcordiaGR-20 StandardsCompliance:ITU-TG.652.D,ITU-TG.657.A1(bend insensitive) and TIA-492CAAB (OS2)		
RegulatoryCompliance:RoHS2011/65/EUcompliant		
No.ofFibers:144 No.ofTubes: 12		
ConstructionMaterials a) OuterJacketMaterial:MDPE b) ArmorType:CorrugatedSteel c) Numberoffiberspertube:12 d) JacketColor:Black e) Jacket UV Resistance: UV Stabilized f) SubunitType:Gel-free g) No.ofRipcords:2 h) WaterSwellableTape:Yes		
Dimensions a) CableDiameter:18mm b) Cable Weight: 234 kg/km /157.0lb/kft		

Physical Specifications			
a)	Minimum Bend Radius, loaded: 25.7cm		
b)	Minimum Bend Radius, unloaded: 17.1 cm		
c)	Tensile Load, long term, Max: 800N		
d)	Tensile Load, short term, Max:		

2700N			
Environmental Specifications			
a)	Environmental Space: Aerial, lashed or Buried		
b)	Installation Temperature: - 30 degree Celsius to +70 degree Celsius		
c)	Operating Temperature: - 40 degree Celsius to +70 degree Celsius		
d)	Storage Temperature: - 40 degree Celsius to +75 degree Celsius		
Mechanical Test Specifications			
a)	Compression: 44N/mm (as per IEC 60794-1 E3)		
b)	Flex: 35 Cycles (as per IEC 60794-1 E6)		
c)	Impact: 6.62N-m (as per IEC 60794-1 E4)		
d)	Water Penetration Test Method: 24 h (as per IEC 60794-1 F5)		

Optical Specifications		
Attenuation, Maximum		
a) 0.22dB/km@1550 nm		
b) 0.27dB/km@1490 nm		
c) 0.31dB/km@1385 nm		
d) 0.34dB/km@1310 nm		
Index of Refraction		
a) 1.467@1310nm		
b) 1.468@1385nm		
c) 1.468@1550nm		
Cabled Cutoff Wavelength, maximum: 1260nm		

2. 12 CORES-OUTSIDE PLANT FIBER CABLE: -

Standard Compliance	Compliance (Yes/No)	Remarks
Shall be Single mode (OS2), Single Jacket, Single Armor, Gel-free Fiber.		

Qualification Standards: ANSI/ICEAS-87-640, EN187105 and Telcordia GR-20		
Standards Compliance: ITU-TG.652.D, ITU-TG.657.A1 (bend insensitive) and TIA-492CAAB (OS2)		
Regulatory Compliance: RoHS 2011/65/EU compliant		
No. of Fibers: 12		
No. of Tubes: 1		

ConstructionMaterials			
i)	JacketMaterial:MDPE		
j)	ArmorType:CorrugatedSteel		
k)	Numberoffiberspertube:12		
l)	FillerQuantity:4		
m)	JacketColor:Black		
n)	Jacket UV Resistance: UV Stabilized		
o)	SubunitType:Gel-free		
p)	No.ofRipcords:2		
q)	WaterSwellableTape:Yes		
Dimensions			
c)	CableDiameter:11.50mm		
(0.45in)			
d)	CableWeight:108kg/km		
PhysicalSpecifications			
e)	MinimumBendRadius,		
loaded:			
17.3cm			
f)	Minimum Bend Radius, unloaded: 11.5 cm		
g)	TensileLoad,longterm,Max:		
800N			
h)	TensileLoad,shortterm,Max:		
2700N			
EnvironmentalSpecifications			
e)	EnvironmentalSpace:Aerial,		
lashed or Buried			
f)	Installation Temperature: -		
30 degree Celsius to +70 degree Celsius			

g) Operating Temperature: - 40 degree Celsius to +70 degree Celsius		
h) Storage Temperature: - 40 degree Celsius to +75 degree Celsius		
Mechanical Test Specifications		
e) Compression: 44N/mm (as per IEC 60794-1 E3)		
f) Flex: 35 Cycles (as per IEC 60794-1 E6)		
g) Impact: 2.94N-m (as per IEC 60794-1 E4)		
h) Water Penetration Test Method: 24 h (as per IEC 60794-1 F5)		
Optical Specifications		
Attenuation, Maximum		
e) 0.22dB/km@1550 nm		
f) 0.27dB/km@1490 nm		
g) 0.31dB/km@1385 nm		
h) 0.34dB/km@1310 nm		
Index of Refraction		
d) 1.467@1310nm		
e) 1.468@1385nm		
f) 1.468@1550nm		
Cabled Cutoff Wavelength, maximum: 1260nm		

3. 06 CORES-OUTSIDE PLANT FIBER CABLE: -

Standard Compliance	Compliance (Yes/No)	Remarks
Shall be Single mode (OS2), Single Jacket, Single Armor, Gel-free, Zero Water Peak Fiber.		

QualificationStandards:ANSI/ICEAS-87-640,EN187105and TelcordiaGR-20		
StandardsCompliance:ITU-TG.652.D,ITU-TG.657.A1(bend insensitive) and TIA-492CAAB (OS2)		
RegulatoryCompliance:RoHS2011/65/EUcompliant		
No.ofFibers:6		

No.ofTubes:1		
ConstructionMaterials		
r) JacketMaterial:MDPE		
s) ArmorType:CorrugatedSteel		
t) Numberof fibers spertube:12		
u) FillerQuantity:4		
v) JacketColor:Black		
w) Jacket UV Resistance: UV Stabilized		
x) SubunitType:Gel-free		
y) No.ofRipcords:2		
z) WaterSwellableTape:Yes		
Dimensions		
e) CableDiameter:11.50mm (0.45in)		
f) CableWeight:108kg/km		
PhysicalSpecifications		
i) MinimumBendRadius, loaded: 17.3cm		
j) Minimum Bend Radius, unloaded: 11.5 cm		
k) TensileLoad,longterm,Max: 800N		
l) TensileLoad,shortterm,Max: 2700N		

Environmental Specifications		
i) Environmental Space: Aerial, lashed or Buried		
j) Installation Temperature: - 30 degree Celsius to +70 degree Celsius		
k) Operating Temperature: - 40 degree Celsius to +70 degree Celsius		
l) Storage Temperature: - 40 degree Celsius to +75 degree Celsius		
Mechanical Test Specifications		
i) Compression: 44N/mm (as per		

IEC 60794-1E3)		
j) Flex: 35 Cycles (as per IEC 60794-1E6)		
k) Impact: 2.94N-m (as per IEC 60794-1E4)		
l) Water Penetration Test Method: 24 h (as per IEC 60794-1 F5)		
Optical Specifications		
Attenuation, Maximum		
i) 0.22dB/km@1550 nm		
j) 0.27dB/km@1490 nm		
k) 0.31dB/km@1385 nm		
l) 0.34dB/km@1310 nm		
Index of Refraction		
g) 1.467@1310nm		
h) 1.468@1385nm		
i) 1.468@1550nm		
Cabled Cutoff Wavelength, maximum: 1260nm		

4. FiberJointEnclosure(IP68Rated)

StandardCompliance	Compliance (Yes/No)	Remarks
Shallbe abut typeenclosurewithadomeandbase(IP68Rated)		
The Cable entries should be through the cable ports located in the base.		
The dome and base should be sealed using a clamp with O-ring system. The cable entry ports should be sealed mechanically, Gel- Sealed and no need of added tools for cable Installation.		
Thisblockcanbeopenedandclosedrepeatedlywithouththeneedto remove or replace the gel.		
GeneralSpecifications a) IP68Rated b) No.ofSplicetrays:6nos. c) SpliceTrayCapacity:24Fibers d) No.ofcableentryports:4 round ports and 1 oval port.		
Theclosureshouldhavethecapabilitytoaccommodateloopcables (un cut loose tube cables)		
The cables should be secured to the closure using hose clamps and a cable attachment device.		
Theclosureshouldhaveabasketforstoringloosetubes.		

5. 144SlidingFiberShelf

StandardCompliance	Compliance (Yes/No)	Remarks
Shallaccommodate12couplerplatesor12pigtailcassettesfora total of 144 fiber terminations.		
Thewidthshallbe19inchesandheightof4U(7inches),witha maximum of 18-inch depth.		
Theshelf/LIUshallbesliding.		
The Fiber shelf must be Intelligent ready and must support field upgrade to intelligent fiber panels without removal of existing patch cords and without disruption of network services.		

Shall have splicing tray to splice minimum 144 fibers.		
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6. 48/24/12 Sliding Fiber Shelf

Standard Compliance	Compliance (Yes/No)	Remarks
Shall accommodate 4 coupler plates or 4 pigtail cassettes for a total of 48 fiber terminations.		
The width shall be 19 inches and height of 1U (1.75 inches), with a maximum of 18-inch depth.		
The shelf/LIU shall be sliding.		
The Fiber shelf must be intelligent ready and must support field upgrade to intelligent fiber panels without removal of existing patch cords and without disruption of network services.		
Shall have splicing tray to splice minimum 32 fibers.		

7. 12 Fiber Singlemode Fiber Pigtail Cassettes

Standard Compliance	Compliance (Yes/No)	Remarks
Shall be Singlemode OS2, zero water peak fiber.		

Standards Compliance: G.652.D, G.657.A1 and OS2 Regulatory Compliance: RoHS 2011/65/EU Safety Standard: UL		
Number of Fiber: 12 Interface, Front: LC Adapter Color: Blue		
Optical Performance a) Insertion Loss Change, mating: 0.30 dB b) Insertion Loss Change, temperature: 0.30 dB c) Insertion Loss, Typical: 0.30 dB d) Return Loss, Min: 55.0 dB		

PigtailEnvironmentalSpecifications Environmental Space: Plenum Operating Temperature: -10degreeCelsiusto+60degreeCelsius Cable Retention Strength, Max: 1.00 lb. @ 0-degree, 1.00 lb. @ 90degree FerruleGeometry:Pre-radiused Ferrule Material: Zirconia OpticalComponentsStandard:ANSI/TIA-568-C.3		
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8. LC–LCSinglemodeLSZHPatchCords

StandardCompliance	Compliance (Yes/No)	Remarks
Shall be Singlemode (OS2), zero water peak, LC to LC, Fiber patch cords.		
StandardsCompliance:G.652.D,G.657.A1andOS2 Regulatory Compliance:RoHS 2011/65/EU Jacket: Low Smoke Zero Halogen (LSZH) compliant to IEC 60332-3, IEC 60754-2, IEC 61034-2, IEEE 383, UL 1666, UL 1685 FlameTestListing:NECOFNR-LS(ETL)andc(ETL)		

CableQualificationStandards:ANSI/ICEAS-83-596andTelcordiaGR- 409 OpticalComponentsStandard:ANSI/TIA-568-C.3		
GeneralSpecifications Connector Color: Blue ConnectorInterface:LC Operating Temperature: -10degreeCelsiusto+60degreeCelsius		
ConnectorOpticalPerforman ce InsertionLoss,Typical:0.20dB ReturnLoss,minimum:55.0d B	Internal	

InsertionLossChange,mating:0.30dB InsertionLossChange,temperature:0.30dB		
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9. 6CORES-OUTSIDEPLANTOM4FIBERCABLE:-

StandardCompliance	Compliance (Yes/No)	Remarks
ShallbeMultimode(OM4),50/125IIIIISingleJacket,Indoor/Outdo or, Non-MetallicArmour,Gel- free,LSZHSheath,TightBufferCable.		
QualificationStandards:ANSI/ICEAS-104-696,EN187105and TelcordiaGR-409.		
RegulatoryCompliance:RoHS2011/65/EUcompliant AllOM4FiberstrandsshallbeBend-InsensitiveMultimodeFiber		
No.ofFibers:6		
ConstructionMaterials: a) Non-Armored b) JacketColor:Black c) JacketUVResistance:UVStabilized d) CoreDiameter:50IIIm e) CladdingDiameter:125IIIm f) TightBufferDiameter:900IIIM e)AramidYarnwithcentralstrengthmember		
Dimensions g) CableDiameter(lessthanor equal to): 6 mm (0.47 in) h)CableWeight(lessthanor Equalto):27kg/km		

Physical Specifications		
m) Minimum Bend Radius, loaded: 8.3cm		
n) Minimum Bend Radius, unloaded: 5.5 cm		
o) Tensile Load, long term, Max: 400N		
p) Tensile Load, short term, Max: 1335N		
Environmental Specifications		
m) Environmental Space: Low Smoke Zero Halogen (LSZH) & Riser		
n) Installation Temperature: -30 degree Celsius to +60 degree Celsius		
o) Operating Temperature: -40 degree Celsius to +70 degree Celsius		
p) Storage Temperature: -40 degree Celsius to +75 degree Celsius		
Mechanical Test Specifications		
m) Compression: 22N/mm (as per IEC 60794-1 E3)		
n) Flex: 100 Cycles (as per IEC 60794-1 E6)		
o) Impact: 5.88N-m (as per IEC 60794-1 E4)		
p) Water Penetration Test Method: 24 h (as per IEC 60794-1 F5)		
Optical Specifications		
Attenuation, Maximum		
m) 1.00dB/km@1300 nm		
n) 3.00dB/km@850nm		
Index of Refraction		
j) 1.479@1300nm		
k) 1.483@850nm		

DistanceSupported 1GbpsEthernetDistance:600m@1300nm		
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10 @850nm	1110m@850nm bpsEthernetDistance:550m	
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10. 48/24/12FixedFiberShelf

StandardCompliance	Compliance (Yes/No)	Remarks
Shallaccommodate48fiberterminations.		
The width shall be 19 inches and height of 1U (1.75 inches), with a maximum of 14inch depth.		
Thes half/LIUshallbeFixed.		
Shallhavesplicetraystospl iceminimum32fibers.		
TheCouplersshallaccommodateOM2,OM3,OM4fibertypes		
GeneralSpecifications a) Interface:LC b) BodyStyle:Duplex c) Color:Aqua d) Alignment Sleeve Material: PhosphorousBronze e) Transmission Standards: TIA/EIA 568 B.3 and TIA/EIA-604 FOCIS-3		
RegulatoryCompliance:RoHS2011/65/EU		

11. OM4MultimodeFiberPigtail

StandardCompliance	Compliance (Yes/No)	Remarks
ShallbeMultimodeOM4,BendInsensitivefiber.		

12. LC-LCMultimodeOM4LSZHPatchCords

StandardCompliance	Compliance (Yes/No)	Remarks
Shall be Multimode (OM4), Bend Insensitive, LC to LC, Fiber patch cords.		
Standards Compliance: IEC 60793-2-10, type A1a.3a IEC 60793-2- 10, type A1a.3b TIA-492AAAD (OM4) RegulatoryCompliance:RoHS2011/65/EU Flame Test Method: Low Smoke Zero Halogen (LSZH) compliant to IEC60332-3,IEC60754-2,IEC61034-2,IEEE383,UL1666,UL1685 FlameTestListing:NECOFNR-LS(ETL)andc(ETL) CableQualificationStandards:ANSI/ICEAS-83-596andTelcordiaGR- 409 OpticalComponentsStandard:ANSI/TIA-568-C.3		
GeneralSpecifications		
ConnectorColor:Beige ConnectorInterface:LC Operating Temperature: -10degreeCelsiusto+60degreeCelsius		
ConnectorOpticalPerforman ce InsertionLoss,Typical:0.17dB ReturnLoss,minimum:25.0d B InsertionLossChange,mating:0.30dB InsertionLossChange,temperature:0.30dB		

13. OutdoorStreetCabinet/FiberDistributionCabinet

S.No	MinimumSpecifications/Functionalities/Capabilities	Compliance (Yes/No)	Remarks
I	<p>StreetCabinet/FiberDistributionCabinettheStreetcabin et shallbeusedforFiberCabledistributionatfieldsideandisa plinth mountable outdoor unit. It should at least have the following features:</p> <ul style="list-style-type: none"> a) Should be loaded with adequate number of SCPC/SCAPC Adapters and pigtails so that all the Distribution fiber ports can be patched to the incoming and outgoing main cables. The numbers of Ports shall exceed 12 numbers at the maximum. b) Should have provision for loading up to 4nos of 24F splice trays, the product should be loaded with adequate number of splice trays for splicing the conventional fibers. c) The splice trays should be book type and should be fixed on to a tray tower d) The tray tower should be rotatable for ease of installation e) Plastic tray wedge should be provided for ease of working on lower trays f) The splice tray should have a maximum of 6 splice holder locations placed on the edge of the splice trays. Each location should have a provision to hold2 nos. fusion splice protectors g) The box should have the provision to terminate 6nosArmoureddropcableand1no.of96Fiberloop cable <p>Theadapterpanelshouldhavethefollowingfeatures</p> <ul style="list-style-type: none"> i. Thepanelshouldbeswingout type ii. The96F,MainFiberCable&Distribution fiberCableinputsandoutputsshouldbe patchedtothefrontoftheadapter 		

	<p>panel</p> <p>iii. The pigtail should be patched to the rear of the adapter panel</p> <p>iv. The adapter panel should be pre-loaded with adequate number adapters and pigtails</p> <p>v. There should be a provision for fixing 96F adapters</p> <p>vi. The adapters should be fixed using screws to the adapter panel</p> <p>vii. The blank adapter ports should be closed with plastic blanking plugs</p> <p>a) Baskets should be provided for looping the uncut loose tubes</p> <p>b) The Cabinet should have a locked System.</p> <p>c) The top should have a canopy to protect against weather</p> <p>d) The cabinet should have a document holder.</p> <p>e) The Cabinet should have a plinth for easy cable entry</p> <p>f) The cabinet should be supplied with all the required accessories for installation viz. Fusion splice protectors (40mm), cable ties, IPA, tissue paper, hose clamps, red adhesive tape, grounding accessories, route card, transport tube (non kinking type 3mm diameter), cable ties, foam tape.</p>		
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**14. Fiber Patchcords SCPC/SCAPC–
SCPC/SCAPCSM, Simplex for Cross Connectivity at Fiber Distribution Cabinet**

Sr No.	Minimum Specifications/Functionalities/Capabilities	Compliance (Yes/No)	Remarks
1	Type: SCAPC SCAPCS MITU-TG.652. D & G.657.A1 Simplex Patchcord, 1/2/3mtr.		
2	Cable Qualification Standards: ANSI/ICEA S-83-596 or Telcordia GR-409		
3	Cable Diameter: 1.7mm Simplex		
4	Tensile Load, short term, maximum: 33lb for 147N		
5	Compression: 10N/mm as per IEC 60794-1		
6	Tight Buffer Diameter: 900µm easy strip		
7	Insertion Loss: MAX 0.3 dB		
8	Return Loss: >65dB		
9	Temperature Range: -20 Deg.C +70 Deg.C ^{Internal}		

Technical Specifications for CAT6A Copper Cable with Components

1. Specification for CAT6A SZHU/UTP Cable

Standard Compliance	Compliance (Yes/No)	Remarks
Channel Performance		
The Category 6A/Class EA UTP SCS shall comply with the following standards a) ISO/IEC 11801:2010 b) EN 50173 Part 1 through Part 5:2010 and 2011 c) ANSI/TIA-568-C d) IEC 60603-7-4 e) IEEE 802.3 applications as outlined in section 2		
The Category 6A/Class EA UTP system should support the following IEEE Ethernet applications		
a) 802.3e - 1BASE5 b) 802.3i - 10BASE-T c) 802.3u - 100BASE-TX, 100BASE-T4 d) 802.3y - 100BASE-T2 e) 802.3z - 1000BASE-X f) 802.3ab - 1000BASE-T g) 802.af - Power Over Ethernet (15.4W) h) 802.3at - Power Over Ethernet Enhancements (25.5W) i) 802.3az - Energy Efficient Ethernet		
Additionally, the Category 6A/ Class EA UTP SCS shall be capable of supporting the following Fiber Channel Applications Standards, per Technical Committee 11 of INCITS:		
a) 1GFC-BASE-T b) 2GFC-BASE-T c) 4GFC-BASE-T		
It is critical that guaranteed worst-case values are provided to ensure the SCS can support 10 G transmission without risk. "Average value" or "Typical Value" is not acceptable as they do not account for lower performance channels. The proposed Category 6A UTP SCS, when configured as a worst-case 100 meter channel shall provide performance headroom over limits specified by Cat6A		
NEXT- Minimum 3db above the standards; Should support a minimum of 4 connector Channel with a minimum 3db guaranteed NEXT		
Insertion Loss - 3%		
Return Loss - 1.0db		

The Category 6A cable and Category 6A channel components shall be manufactured by a single manufacturer. The manufacturer shall warrant the Category 6A channel cable, components, and applications for a period of 20 – 25 years.		
The Category 6A system should support channels that are shorter than 15 meters for 2, 3, 4 connector channels without any minimum length requirements. Intertek (ETL) report for 4 connector channels has to be submitted for full 100 meter channel and 15 meter or lower channel.		
The Cable should meet ANSI/TIA 568C.2 Category 6A Specifications		
Cables should have TRACKING Number to check the Genuity/details of the test reports online.		
The cable should consist of Eight 23 AWG copper conductors. Copper Clad Aluminum or any other combinations are not allowed		
The Cables should be round in shape		
The nominal Jacket thickness should be 0.05 inches		
The nominal Outside diameters should not be more than 0.285 inches (7.24 mm)		
The cables should support the installation temperature: 0 to 60 °C It should support Operating temperature of -20 to 60 °C		
The cable shall be Low-Smoke, Zero Halogen (LSZH) compatibility and must comply with the following Fire Safety standards: 1) ISO/IEC 60332-3-22: Vertical Flame Spread 2) ISO/IEC 60754-2: Acidity 3) ISO/IEC 61034-2: Smoke Density		
The cable and cordage shall be "True UTP" components that do not include internal or external shields, screened components or drain wires. No Special Grounding requirements.		

The horizontal cable shall have a unique print string on the cable jacket. This unique identifier shall also be used for on-line reference to a full set of factory tests that were performed on a sample from the same mater reel. The test parameters shall include NEXT, PSNEXT, Return Loss, Attenuation, ELFEXT and PSELFEXT.The on-line reference must be available on the SCS vendor public website, such that it can be accessed at any time.		
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2. SpecificationforCategory6AU/UTPInformationOutlets

StandardCompliance	Complianc e (Yes/No)	Remarks
The8-pinmodular(RJ-45)jacksshallcomplywithIEC60603-7-4		
TheCategory6Aoutletsshallbbackwardcompatiblewith		

Category6and5Ecordsandcables.		
TheCategory6Aoutletsshallbeofauniversaldesignsupporting T568 A & B wiring.		
TheinformationoutletshallhaveaCurrentRatingof1.5Aat 20°C		
The information outlet must support 90degree cable termination. As some mounting hardware does not allow for cable entry directly from the rear, this capability is necessary		
3rd Party Verification test certificates shall be provided to show compliance to ISO/IEC 11801 Amendment 2 testing for Cat 6A components.		
Theinformationoutletwillhaveinsertionlifeof750cycles minimum.		

3. SpecificationforCAT6ALSZHU/UTPRJ45PatchCords

StandardCompliance	Complianc e (Yes/No)	Remarks
SCS must support patch cord lengths of 1 meter minimum and equipment cords of 2 meter minimum and The Patch cords shall be solid core construction		
Cordsshallbeequippedwith8-pinmodularplugsoneach end.		
All cords shall be round, and consist of copper conductors, tightlytwisted into individual pairs.		
Nominalcordagediametershallnotexceed7.24mm.		

Plugsshallbedesignedwithananti-snaglatchtofacilitateeasy removal during move, add and change processes.		
TheLSZHjacketmustcomplywiththefollowingFireSafety standards: ISO/IEC60332-3-22:VerticalFlameSpread ISO/IEC 60754-2: Acidity ISO/IEC61034-2:SmokeDensity		
The cordage shall be UTP components that do not include internal or external shields, screened components or drain wires.		
Thepatchcordswillhaveinsertionlifeof750cyclesminimum.		

4. SpecificationforCAT6AJackPanel

StandardCompliance	Compliance (Yes/No)	Remarks
24or48PortPatchPanel		
The ganged adapter style patch panel will utilise increments of six RJ-45 style jacks in a common moulded component.		
ThegangedadaptersshallhaveRJ45jackinthe frontand InsulationDisplacementConnector(IDC)attherearofthemodule.		
The panel must be capable of supporting an upgrade to an intelligent system without any interruption to service due to patch cord removal or terminal block re-termination.		
Termination managers must be provided with the panel.These terminationmanagersprovideproperpairpositioning,control,a nd strain relief features to the rear termination area of the panel.		
When configured in worst-case 100meter channels with full cross- connects and consolidation points with the other products proposed in this tender, the panel shall be capable of deliveringthe minimum guaranteed channel performance		
The patch panel type shall be a 1U (24 port) or 2U (48 port)panel capable of supporting 24 or 48 unshielded modular 8-pin connectors compliant with IEC 60603-7-4 while meeting the Channel Performance as specified in Amendment 1 to ISO/IEC 11801:2002		
The panel shall be equipped with a removable rear mounted cable management bar and front and rear labels		

The panel shall be UL and cUL listed		
Operating Temperature Range = 14°F to 140°F (-10°C to 60°C)		
Storage Temperature Range = -40°F to 158°F (-40°C to 70°C)		
Humidity = 95% (noncondensing)		
Nominal Solid Conductor Diameter = 0.025 to 0.020 in (0.64 to 0.51 mm) (22 to 24 AWG)		
Nominal Stranded Conductor Diameter: = 0.025 to 0.020 in (0.64 to 0.51 mm) (22 to 24 AWG)		
Insertion Life = 750 minimum insertion of an FCC 8-Position Telecommunications Plug		

5. 2&4 Port Shuttered Face Plate

Standard Compliance	Compliance (Yes/No)	Remarks
Shall be available in 2 port and 4 port square versions.		
General Specifications		
a) Color: White		
b) Width: 86.36 mm (3.4 in)		
c) Height: 86.36 mm (3.4 in)		
d) Depth: 13.72 mm (0.54 in)		
Material shall be high impact, flame retardant, UL-rated 94V-0, thermoplastic.		
Flammability Rating: UL 94V-0		
Safety Standard: UL listed		
Shall be compatible with CAT 5e / CAT 6 / CAT 6A information outlets.		
Shall have inbuilt shutter to prevent dust to accumulate on the information outlets which are not in use.		

6. Specification for Ceiling Connector module for Ceiling applications (Wi-Fi & CCTV)

Standard Compliance	Compliance (Yes/No)	Remarks
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The module shall consist of a connector kit and an 18" CAT 6 or CAT 6A stranded copper cable. The end of the copper cable shall have a factory terminated RJ 45 plug.		
TheCablejacketmaterialofthecables shall beLSZH.The material of the connector kit shall be High-impact, flame retardant, thermoplastic.		
Safetycompliance:ETLListed;UL1863andCAN/CSA-C22.2(ETLFile 3166536CRT-001)		
Thestoragetemperatures shall be14°Fto140°F(-10°Cto60°C). The operating temperature shall be -40°F to 158°F (-40°C to 70°C).		
ShallsupportsIEEE802.3af,802.3atandproposed802.3bt*PoE applications.		
Shallsupports20re-terminationcycles		

7. CAT6A,SHIELDED,OUTDOOR,BURIEDCABLE:-

S. No.	MinimumSpecifications/Functionalities/Capabilities	Make , OEM Model/ OEMPart No.	Meets Spec[Y/N]	Deviations, if any
	Cat 6A F/UTP Cable Outdoor, Black Jacket, Aluminum Tape Shield inner Jacket Cable, TIA- 568C.2, (305 Mtrs. /1000 feet per Box), RoHS Compliant			
1	MinimumSpecifications			
1.1	Shallbeof4twistedpairsofsolidconductors			
1.2	Shallsupportnetworklinespeedsupto10 gigabits per second as per ANSI/TIA-568-C.2.			
1.3	Shall be 4-pair overall Foiled twisted pair to restrict alien crosstalk & should have a crossfiller/ divider/ isolator pair separator, meeting Category 6A tested to 500 MHz or more as per ANSI/TIA-568C.2. <small>Internal</small>			

1.4	The cable should be in Black color and packaged as reel-in-box.			
2	ConstructionMaterials.			
2.1	a) JacketMaterial:PE b) ConductorMaterial:BareCopper c) DrainWireMaterial:TinnedCopper d) Insulation&SeparatorMaterial:Polyolefin e) Shield(Tape)Material:Aluminum f) DiameterOverJacket,nominal:8.4mm			
3	ElectricalCharacteristics.			
3.1	a) ANSI/TIACategory6A b) DcResistanceUnbalance,maximum:5% c) DcResistance,maximum:9.38ohms/100m d) MutualCapacitance:6.0nF/100m@1KHz e) OperatingFrequency,Maximum:500MHz f) OperatingVoltage,Maximum:80V g) Dielectric Strength, minimum: 1500 Vac / 2500 Vdc			
4	EnvironmentalSpecifications.			
4.1	a) EnvironmentalSpace:Buried b) Environmental Note: UV resistant for outdoor and/or direct burial installations c) Installation Temperature: -30°Cto+70°C(-22°Fto+158°F) d) Operating Temperature: -40°Cto+70°C(-40°Fto+158°F)			

Technical Specifications for Network Racks

Description	Compliance	Remarks
TECHNICAL SPECIFICATION FOR 42U RACK:		
Racks manufactured out of steel sheet punched, formed, welded and Powder coated		
Rack should be from ISO 9001:2008 & ISO 14001:2004 Certified Company with UL Listed product		
Rack should be embossed with manufacture brand name		
Standard for Rack configuration will be welded frame with side panel and vented top cover		
Rack should have Front Perforated Door and Dual Perforated door at Rear.		
Rack should have provision to mount rack on Floor		
<i>Rack should be 42U (1U=44.45 mm) in Height.</i>		
It should be available in 600 & 800 Width and 650/800/1000/1200 Depth		
Rack should conform to DIN 41494 or Equivalent EIA/ISO/EN/CEA Standard		
Rack should have Adjustable mounting depth,		
Rack 4 No Adjustable, 19" verticals with Punched 10mm Square Hole and Universal 12.7mm-15.875mm-15.875mm alternating hole pattern offers greater mounting flexibility, maximizes usable mounting space.		
Rack should have Numbered U positions,		
Rack should have 100% assured compatibility with all equipment's conforming to DIN 41494 (General industrial standard for equipment's)		
Powder coated finish with seven Tanks pretreatment process meeting IS		
Rack should have Proper Grounding & Bonding		
Server/IT Rack mount power distribution unit, 1Ph, 230V, 32A, 50/60Hz, Zero U standard with 12XC13 & 4XC19, Inlet Plug (Not Installed, Recommended IEC 309 32A 2P+E), 16AMCB X2 Circuits -PDU Rating 7.3KVA/Bottom feed-3Mt/ Black		
<i>Rack should have Fan module Mount Provision on top Cover</i>		
Rack should have provision for cable entry Exit from Both top & Bottom.		
Rack should have 1 Packet of mounting hardware, Pack of 20.		
Rack Should carry 1 year warranty		

Description	Compliance	Remarks
TECHNICAL SPECIFICATION FOR WALL MOUNT RACK:		
Racks manufactured out of steel sheet punched, formed, welded and Powder coated		
Rack should be from ISO 9001:2008 & ISO 14001:2004 Certified Company & UL Listed		
Standard for Rack configuration will be welded frame integrated with side panel and vented top cover		
Rack should have Front Toughened Glass Door with lock & Key		
Rack should have provision to mount rack on wall.		
Rack should be 9U/12U/15U (1U=44.45mm) in Height, 550MM Width, 400MM Depth and overall height 749MM.		
Rack should conform to DIN 41494 or Equivalent EIA/ISO/EN Standard		
Rack should have Adjustable mounting depth,		
Rack 2 No Adjustable, 19" verticals with Punched 9mm Square Hole and Universal 12.7mm-15.875mm-15.875mm alternating hole pattern offers greater mounting flexibility, maximizes usable mounting space.		
Rack should have 100% assured compatibility with all equipments conforming to DIN 41494 (General industrial standard for equipments)		
Powder coated finish with seven Tank pretreatment process meeting IS		
Rack should have Proper Grounding & Bonding		
Rack should have the provision for mounting 1 or 2 Fan on Top cover		
Rack should have 1 No Cantilever Shelf for mounting NON Rack mountable Equipments		
Rack should have 1 No Power Distribution Units with 6 No 5A Indian Round Pin with PDURating 1.8KVA		
Rack should have 1 No Horizontal Cable Organizer with Plastic Loops.		
Rack should have provision for cable entry Exit from Both top & Bottom.		
Rack should have 1 Packet of Mounting hardware, Pack of 20		

25.0 Main IP-PBX Exchange

1). Necessary Technical terms & conditions for Interested Vendors

1.1 The offered system shall be modular in design. The Architecture of the EPABX shall be capable of seamless migration to its maximum capacity by simply adding peripheral cards/Expansion Cabinets and without compromising on any function/ features of this system or any degradation of service. The system should be capable to expand up to at least 960 extensions, including Analog, Digital and IP.

1.2 The EPABX shall support IP distributed architecture for future scope. IP access points shall be centrally administrable from the host system. Peer to Peer connectivity shall be possible on IP end points. The system shall have universal ports for line/trunk cards, where in any peripheral card can be inserted in any slot of the peripheral shelf, thereby enhancing the flexibility of the configuration

1.3 The system should be having a Minimum equipped capacity of 5 PRI / 16 CO Lines/ 200 Digital/ 2000 Analog extensions

1.4 System is inclusive of all cables & accessories required from exchange to MDF/IDF though Proper cable managers/cable tray etc.

1.5 The bidder should be able to provide after sales service, spares etc. for at least Seven years from the date of commissioning. The firm shall submit the under taking by OEM on Non-Judicial stamp Paper / OEM's letter head for providing after sales support for providing service, spares etc. for at least Seven years from the date of commissioning.

1. General Terms

1.1 Any application software as required for completion of the project shall be within the scope of The bidder.

1.2 The supplier shall be responsible for all upgrades and updates of the firmware and application software during the warranty period and no separate amount should be claimed for this.

1.3 Supply, Installation and Commissioning of MDF/IDF with their all accessories required will be in

Internal

supplier's scope.

1.4 Cabling & Termination from EPABX upto MDF/IDF with their accessories required will be in supplier's scope. Internal Cable and UPS will be in the scope of the department.

1.5 Supplier will complete whole job in the presence of existing maintenance staff.

2. SYSTEM FEATURE AND FACILITIES: -

1. Central Processing Unit:

The Central Processing Unit of the EPABX shall be Next Generation Converged, Linux based Unified Communication Server, with in-built, Ethernet LAN Port Connectivity, WAN Port and Maintenance Port, MOH Connectivity, External Paging Connectivity, and USB Port for Up-gradation Purpose. No additional hardware or ports shall be utilized for these functions.

2. Storage Media: The system should be able to download and back up all Data on a PC or external Hard disk and recover the same on the standby unit. The Backup Data should be in a single file for accurate and faster recovery of system Features.

3. Trunks ISDN (Integrated Services Digital Network)- The offered exchange shall support ISDN & only the necessary ISDN BRI & PRI Cards (Basic Rate Interface & Primary Rate Interface) need to be added for functionality.

4. Operating System: The system should be ready to connect Analog Phones and Digital Phones. In addition, the system should support IP extensions, (Proprietary IP and SIP Phones of the same make as the EPABX/IP-PBX) using MGCP/SIP Protocol resp. The operating system of EPABX should be reliable or proprietary make and should be protected against loss / alteration of memory due to power failure / unauthorized command or due to any other faulty condition. The system should support Auto Restore of data in case of Power Failure; No Manual intervention should be required and all Features and facilities should be working on Power Restore.

5. Network: The EPABX system should support DHCP server, built-in Router / functionality with capability to create VPN Network within the system, with no additional 3rd Party Hardware or Application.

6. Voice Response System: The system shall be equipped with integrated (in-built) Voice

Response System (VRS) with a minimum of 4 channels for voice processing applications allowing the incoming call to be directly connected to the desired extension number

after the voice response from the VRS. OGM messages could be uploaded as wave file using PC, to be used to Voice Response from within the system, without using any 3rd Party Hardware. The system should support DISA restriction to designated subscriber through Programming. At least 16 Multi Levels of DISA / Voice prompts should be supported by the system. The multi-level should be Upgraded to 64 Level as required, within the same embedded Server, with no additional Hardware. The offered system shall have the following standard features i.e. Direct Inward Dialing (DID), Direct Inward Station Access (DISA), Direct Outward Dialing (DOSA), password protected. The system should support subscriber feature access by remote using Password.

7. **Voice Mail:** The system shall be equipped with an integrated (in-built) 4 Port Voice Mail System to be accessible to all ports of the EPABX. The recording time for voice Mail should be 200 Hours, Expandable to 1000 hours without using and 3rd. Party device. The User shall be able to access the system internally or remotely from any phone and shall be able to record standard /personal greetings within the mailbox. The system shall be able to inform the outside caller about the exact status of the desired extension (no answer /busy). The system should support Name dialing to reach the designated user. The system shall also support recording of name & personalized greeting within each mailbox. In the event of a Voice message, the system should support the following Notifications, an email should be sent to the designated user to inform the user of the message, If configured the entire message should be sent on the email in a wave file format. Message Indication on Digital Phones/ Voice Call to be made by the Voice Mail to advice of the pending Message. The Voice mail should be equipped for 2-way Manual Call Conversation recording by Attendant Console in case of an Emergency, by giving a command on the Attendant Console / Digital Phone or PC.
8. **Conversation Recording:** System should be equipped for 2-way call recording and should have option to select different extensions for recording based on number of Licenses available for simultaneous recordings. Supervisor should be able to select and record Analog/Digital/Proprietary IP phones without using any 3rd. party Hardware or Application
- 9 **Caller Line Identification CLI on Analog Extension and Trunks:** The offered system shall have the capability to offer CLI on Analog Extensions for all internal calls. The system shall also offer CLI on Analog Trunks. The system shall provide Name/Number on the display of the Analog Extension. (If the Analog Phones support this feature) It should also support CLI based Routing.

10 The legacy TDM circuits should not utilize any IP bandwidth when any TDM-TDM switching is being done in the system.

11 **Conference:** It shall be possible for Digital extension user to initiate a conference of maximum 8

parties each and for Analog Phones a 3 Party Conference with any combination of internal stations & outside circuits to talk to each other at the same time on the conference circuit, (Ad hoc Conference without using Conference Bridge) It should support 30 Conference capacity Slots for a Supervised meet-me conference facility, both by Analog and Digital Phone users. (SIP based Conference Bridge to be integrated with EPABX/IP-PBX)

The system should support Group Dial for Outbound Calls where up to 30 participants can be simultaneously dialed through an Analog or Digital Instrument, using ISDN PRI Lines. Upto 8 such groups should be supported by the system.

12 **VOIP-VoiceoverIP:**

The system shall support Voice over IP (VOIP) applications; the system should support SIP trunks, SIP and H.323 Protocol for Gateway functioning, SIP Extensions for remote extensions, the remote Extensions should be able to work without any VPN and use Built in functioning of the EPABX System.

13. **Music-On-Hold:**

The system shall support in-built music-on-hold. It shall also be able to upload wave file for customized Music on Hold.

13. **MessageWaitingIndicationforVoiceMail:**

The system shall have facility for lighting a Message Waiting Lam provided on Digital Phones
The Analog Extensions Telephone Instruments should get a Voice prompt Notification of the Waiting Message on the voice mail unit.

14. **Networking:**

The offered system shall be capable of networking with other exchanges using normal LAN cable, signaling interfaces like E&M, E1, ISDN, BRI/PRI and IP Trunking. The system Support in built Logical Partitioning, without any external hardware or Software on an external device or PC. Log for Logical Partitioning should be available for audit and control purposes

15. **DECT/IP DECT:**

The system should support DECT Handsets for Future Wireless communication.
The DECT Base unit and the DECT Phones should be of the same make as that of the EPABX Main Unit. The Base Stations should also support connectivity on LAN, i.e. IP DECT Base Station

Each DECT Base Station shall be capable of handling minimum of 2/4/8 DECT Phones calls Simultaneously. The DECT communication should support call handover without call disconnect.

16. Networking with Multiple Exchanges/Remote Sites

The system should support IP networking with other remote sites on VOIP connectivity. The remote sites should be of the same make as the make of the Central EPABX /IP-PBX (No 3rd Party Gateway is to be used). The Command and Control of the entire Network should be with the Central unit and the slave / remote site should work seamlessly without any feature loss. The system solution should support minimum 12 such remote site connectivity. The system should support the following Protocols

- SIP/H.323
- ISDN BRI/PRI-QSIG

17. Unified Messaging:

The system should be capable of In Skin; Card based Unified Messaging facility to provide Fax and E-mail on the same desktop. The same will be required for Future use and should be possible with additional Hardware or equipment from the same OEM.

18. **Unified Messaging:** The system offered should be equipped with a Communication Software to enhance the functioning of the subscriber user by integration with the PC, Features like, Click to Dial, Chat functioning, Missed Calls, Microsoft Outlook Integration, Speed Dial search by Name and Dial, FWD Set and Cancel, should be supported by the Software. Existing PC have to be used for the functioning of the software. The same should be supported for Digital/ Analog

Phones/Proprietary IP Phones. The Basic versions should be available with Unlimited Activations as default functionality.

19. **UCD/ACD:** The system should support ACD routing for Contact Center/Helpdesk functionality, with Queue Message announcing Caller, waiting number and time, without using any 3rd Party Hardware. The same will be required for Future use and should be possible with additional Hardware or equipment from the same OEM.

20. Diagnostic & Enhanced Maintenance Facility

Internal

The system shall have in-built diagnostic features. The system should be programmable using

Browser, without using /installing any Application in the PC. The offered system shall have remote maintenance facility over IP. The system should have in - built Web Server for Remote Web-based Maintenance and support, SNMP, FTP, HTTPS, IMAP4, NTP, NAS connectivity ON NFS, in case of an error an email should to the Administrator, conveying the error message. The system should be capable of firmware update through FTP/USB/PC

The system shall be capable of working in a suitably ventilated non-air-conditioned environment. System design shall be immune to noise from various sources like power supplies, lighting system etc. The Power Supply of the equipment should be Fan cooled to provide maximum uptime.

All components should be rated for continuous operation of the system. It should be designed in such a way that any damage in any circuit /subassembly /assembly should be self-containing and should not be propagate to other parts of the system. The system should support Hot Swappable facility for Trunk, Extension & Interface Cards.

EPABXs operating on AC shall have in built battery charging arrangement within the Power Unit for providing battery Backup for 1hr minimum. Batteries for this purpose shall be ordered Separately

21. ATTENDANT CONSOLE:

The offered exchange should include 1 No. of Attendant Console. Exchange shall be capable of supporting up to a minimum of 2 nos. of Attendant Consoles. The administrator should be able to monitor the status of trunks & should be capable of attending /holding multi calls at one time. The Attendant Console should have dual color LED Indication for differentiating between the used & self-used lines. It should also have a Large Graphic Display, to distinguish between Trunk calls and Extension calls.

Following minimum facilities in console shall be

- 6 lines Graphic Display with LCD backlit
- Visual Display of Calling & Called Station
- Missed Call List, minimum 10 calls
- Volume Control
- Handset and Headset MIC Mute
- Keypad Dialing
- Computer Software based Call Control with Caller ID Display, Call Hold, Call transfer, Conference, Speed Dialing, Presence for Specified Extensions, Missed Call, Contact List of 1000 Users, Call Data Report for Operator response Functioning

- InterfaceforHeadsetOperations-Wired
- ElectronicHookSwitchControlPort(EHS)
- BusyOverride
- SubscriberIdentityforincomingCall
- CallSplitting
- TrunktoTrunkaccess/Transfer
- TransferoftrunkcalltoanotherConsole
- Breakingintobusyextensionwithaninterruptiontone
- ExternalLineHold
- CallParking
- Selectivepickupofcallson Hold
- CallPickup
- CamponBusy
- NightServiceControl
- DSS(Directstationselection)withatleast40keysindication.
- OHCA,OffHookCallAnnouncement(incaseofBusyOperator)
- CallWaiting

22. SubscriberFacility

(i) The offered system shall have the capability of assigning to use extension a variety of specified services. Further class of service restriction shall be available to the subscribers.

Callforwardingshallbeavailableintheofferedsystem

(ii) Thesystemshallsupportabbreviateddialingsystemfor numbers.

(iii) The system shall be capable of allowing the users to access all the facilities from any extension of the EPABX. The system shall allow user to assign passwords to their phonesto prevent misuse of subscriber's facilities

provided.

(iv) Least cost routing through alternate public networks on different time of day basis shall be available

(v) Night Service: When night service is activated, the operator calls shall be routed to predefined answering position.

23. The offered system shall have the following minimum features for the subscriber:

Hot line Attendant Recall

Call forwarding preset/busy/No answer Call Hunting

Automatic Call Back Call Waiting

Station Cam on Call back on busy

Hunting method change for each type of calls

DND (Do Not Disturb)

DND O (Do Not Disturb Override) Consultation hold

Call Pickup

Call Parking and Retrieve

Extension to extension intercom barring Storage of last number dialed

Discriminative Ringing-between Internal and external Calls

Walking Station Class of Service Busy Override

Auto Answer on Digital Phones Boss- Secretary Functioning

One Extension for Sr. executives (2 Digital Phones should work in parallel as a single extension, Table / Sofa Concept)

24. The offered system shall have the following minimum features for the Digital subscriber

(Basic Digital)

- 1 Line Graphic LCD Display with Back Lit
- Missed Call List, minimum 10 numbers
- Headset Provision, 2.5mm or similar
- Minimum 8 DSS/BLF Keys for easy dialing
- Full Duplex Speakerphone Quality
- Prefixed keys for MIC Mute, Redial, Auto Answer, Volume Control, Navigation Keys
- Multipleringtones
- Open Listening/Offhook Monitor
- Automatic Redial with Programmable time difference.
- OHCA, Off Hook Call Announcement ^{Internal}

- CallWaiting
- ExtensionListSearchbyAlphabet

25. XDP(In-built or with external Adaptor, If External Adaptor the cost to be included in Phone) The offered system shall have the following minimum features for the Digital subscriber

(Executive Digital)

- 3LineGraphicLCDDisplaywithBackLit
- MissedCallList, minimum 10 numbers
- Headset Provision, 2.5mm or similar
- Minimum 20 DSS/BLF Keys for easy dialing
- Full Duplex Speakerphone Quality
- Prefixed keys for MIC Mute, Redial, Auto Answer, Volume Control, Navigation Keys
- Multipleringtones
- Open Listening/Offhook Monitor
- Automatic Redial with Programmable time difference.
- OHCA, Offhook Call Announcement
- CallWaiting
- ExtensionListSearchbyAlphabet.
- XDP(In-built or with external Adaptor, If External Adaptor the cost to be included in Phone)

24. The system should support UCD/ACD based routing and MIS reporting. The group members should be able to LOG IN and LOG OUT for Receiving Calls on the Analog and Digital Phone. The Data should be available on the MIS Reporting Software.
25. The system should support ACD based Reporting for Future use by Activating Feature Key

S.no	Features	Specifications	Compliance	Remarks

1	Main IP-PBX Telephone Exchange , (covering Main units & Slaves units)	Main Unit with IP Card, Universal Slots, SMPS Power Supply having a capacity of 2 PRI / 16 CO Lines / 84 Digital / 200 IP Extensions / 1172 Analog extensions, expandable to at least 2000 Extension, Including License, System is inclusive of all cables & accessories required from exchange to MDF / IDF through proper cable managers / cable tray etc. (Pls refer to specifications for details)		
	SYSTEM FEATURE AND FACILITIES:			
2	Central Processing Unit:	The Central Processing Unit of the EPABX shall be Next Generation Converged, Linux based Unified Communication Server, with in-built, Ethernet LAN Port Connectivity, and Maintenance Port, MOH Connectivity, External Paging Connectivity, and USB Port for Up-gradation Purpose. No additional hardware or ports shall be utilized for these functions.		
3	Operating System:	The system should be ready to connect Analog Phones and Digital Phones. In addition, the system should support IP extensions, (Proprietary IP and SIP Phones of the same make as the EPABX / IP-PBX) using MGCP / SIP Protocol resp. The operating system of EPABX should be reliable or proprietary make and should be protected against loss / alteration of memory due to power failure / unauthorized command or due to any other faulty condition. The system should support Auto Restore of data in case of Power Failure; No Manual intervention should be required and all Features and facilities should be working on Power Restore.		
4	Network:	The EPABX system should support DHCP server, built-in Router / functionality with capability to its own Network. The system should support the below mentioned Trunk and Interface Protocols - ISDN PRI - IP H.323 - SIP - QSIG		

5	Voice Response System:	The system shall be equipped with integrated (in-built) Voice Response System (VRS) with a minimum of 4 channels for voice processing applications allowing the incoming call to be directly connected to the desired extension number after the voice response from the VRS. OGM messages could be uploaded as wave file using PC, to be used to Voice Response from within the system, without using any 3rd Party Hardware. The system should support DISA restriction to designated subscriber through Programming. At least 16 Multi Levels of DISA / Voice Prompt should be supported by the system.		
6	Voice Mail:	The system shall be equipped with an integrated (in-built) 4 Port Voice Mail System to be accessible to all ports of the EPABX. The recording time for voice Mail should be 200 Hours, Expandable to 1000 hours without using any 3rd Party device. The User shall be able to access the system internally or remotely from any phone and shall be able to record standard / personal greetings within the mailbox. The Voice mail should be equipped for 2-way Manual Call Conversation recording by Attendant Console in case of an Emergency, by giving a command on the Attendant Console / Digital Phone or PC.		
7	Conversation Recording :	System should be equipped for 2-way call recording and should have option to select different extensions for recording based on number of Licenses available for simultaneous recordings. Supervisor should be able to select and record Analog/Digital/Proprietary IP phones without using any 3rd party Hardware or Application		
8	Conference :	It shall be possible for Digital extension user to initiate a conference of maximum 8 parties each and for Analog Phones a 3 Party Conference with any combination of internal stations & outside circuits to talk to each other at the same time on the conference circuit, (Ad hoc Conference without using Conference Bridge). It should support 30 Party Conference capacity for a meet-me conference facility, both by Analog and Digital Phone users. The system should support Group Dial for Outbound Calls where participants can be dialed using ISDN PRI Lines. Up to 8 such groups should be supported by the system		
9	VOIP- Voice over IP:	The system shall support Voice over IP (VOIP) applications; the system should support SIP trunks, SIP and H.323 Protocol for Gateway functioning, SIP Extensions for remote extensions, the remote Extensions should be able to work without any VPN and use Built-in functioning of the EPABX System.		

10	Music-On-Hold:	The system shall support in-built music-on-hold. It shall also be able to upload wave file for customized Music on Hold		
11	Message Waiting Indication for Voice Mail:	The system shall have facility for lighting a Message Waiting Lamp provided on Digital Phones the Analog Extensions Telephone Instruments should get a Voice prompt Notification of the Waiting Message on the voice mail unit.		
12	Networking:	The offered system shall be capable of networking with other exchanges using normal LAN cable, signaling interfaces like, E1, ISDN, BRI, PRI and IP Trunking. The system support in built Logical Partitioning, without any external hardware or Software on an external device or OPC. Log for Logical Partitioning should be available for audit and control purposes		
13	DECT/IP DECT:	The system should support DECT Handsets for Future Wireless communication. The DECT Base unit and the DECT Phones should be of the same make as that of the EPABX Main Unit. The Base Station should also support connectivity on LAN , i.e. IP DECT Base Station		
14	Networking with Multiple Exchanges / Remote Sites	The system should support IP networking with other remote sites on VOIP connectivity. The remote sites should be of the same make as the make of the Central EPABX/IP- PBX (No 3rd Party Gateway is to be used). The Command and Control of the entire Network should be with the Central unit and the slave / remote site should work Seamlessly without any feature loss.		
15	Unified Messaging:	The system should be capable of In Skin; Card based Unified Messaging facility to provide Fax and E-mail on the same desktop. The same will be required for Future use and should be possible with additional Hardware or equipment from the same OEM		
16	UCD/ACD:	The system should support ACD routing for Contact Center/Helpdesk functionality, with Queue Message announcing Caller, waiting number and time, without using any 3rd Party Hardware. The same will be required for Future use and should be possible with additional Hardware or equipment from the same OEM.		

17	ATTENDANT CONSOLE:	<p>The offered exchange should include 1 No. of Attendant Console.</p> <p>Exchange shall be capable of supporting up to a minimum of 2 nos. of Attendant Consoles. The administrator should be able to monitor the status of trunks & should be capable of attending / holding multi calls at one time. The Attendant Console should have dual color LED Indication for differentiating between the used & self-used lines. It should also have a Large Graphic Display, to distinguish between Trunk calls and Extension calls. *More Details See Specification.</p>		
18	Subscriber Facility:	<p>The offered system shall have the following minimum features for the subscriber: Hot line, Attendant Recall, Call forwarding preset/busy/No answer, Smart Desk for Walking Extension / Free seating across Campus, Call Hunting, Automatic Call Back, Call Waiting, station Camp on Call back on busy, Hunting method change for each type of calls *More Details See Specification.</p>		
19	The Digital Phones should have these minimum features and specification On (Basic Digital - Type I)	<p>1 Line Graphic LCD Display with Back Lit, Missed Call List, minimum 10 numbers, Headset Provision, 2.5 mm or similar, Minimum 8 DSS / BLF Keys for easy dialing Full Duplex Speakerphone Quality. *More Details See Specification.</p>		
20	The Digital Phones should have these minimum features and specification On (Executive Digital - Type II)	<p>3 Line Graphic LCD Display with Back Lit, Missed Call List, minimum 10 numbers, Headset Provision, 2.5 mm or similar, Minimum 20 DSS / BLF Keys for easy dialing Full Duplex Speakerphone Quality. *More Details See Specification.</p>		

21	The Analog Phones should have minimum features and specification On (Analog Handsets-Basic No Sp-phone) TYPE-I	2 Line LCD Display, LCD Contrast level – 4 Levels Caller ID memory, minimum 30 numbers, Redial Memory – 5 Numbers Flash timing – Programmable, Speaker Phone – No, Ringer Volume – Off / Low / High, Wall Mountable – Yes Battery – Not required, Time Display		
22	The Analog Phones should have minimum features and specification On (Analog Handsets-Basic with Sp-phone) TYPE-II	2 Line LCD Display, LCD Contrast level – 4 Levels Caller ID memory, minimum 30 numbers, Redial Memory – 5 Numbers Flash timing – Programmable, Speaker Phone – Yes Ringer Volume – Off / Low / High, Wall Mountable – Yes, Battery – Not required, Time Display		
23	CD/ACD based routing and MIS reporting	The system should support UCD/ACD based routing and MIS reporting. The group members should be able to LOG IN and LOG OUT for Receiving Calls on the Analog and Digital Phone. The Data should be available on the MIS Reporting Software. Queue Messages should be available by default in case the members are All Busy, Routing to Operator / Supervisor should be available		
24	Cabling and MDF	Cabling & Termination from EPABX upto MDF/IDF with their accessories required will be in supplier's scope. Internal Cable, LAN Network, OFC, and UPS will be in the scope of the department		

26.0 AudioVisualSystem

Technical Specifications:

The bidder should refer the block schematic in conjunction to the specification for providing the appropriate Make and Model. The bidder shall consider the brands from the approved list only. Bidders can quote only one Make & Model against each line item. If any line item needs multiple items to meet the total specification the bidders must mention, Make & Models for all the sub items with respective OEM part no's & model nos. The same cannot be changed once quoted. Clarification if any will be asked for the quoted models only. The bidder has to submit a detailed AV & control schematic with the quoted make & Model along with the technical bid.

1. 5000 Lumens DLP Projector

DLP (Laser Phosphor) Projection System with an Ultra Short Throw Lens is hereby proposed. The projection system features a high brightness of 5000 or more Lumens, ensuring clear and vibrant visuals even in well-lit environments. It also supports 3D capability, enhancing the immersive viewing experience for compatible content. With a resolution of 1920 x 1200, the projection system delivers sharp and detailed imagery, providing excellent visual clarity. The contrast ratio of 1800:1 or better further enhances the image quality, offering rich and deep color reproduction. The system incorporates a long-lasting illumination life of 20000 hours, reducing maintenance requirements and ensuring prolonged usage. For seamless connectivity, the system is equipped with HDMI and HDBaseT inputs, enabling easy integration with various multimedia devices and sources. This ensures flexibility and compatibility for different connectivity needs. The supply of the projection system will be completed, including a mounting bracket and other necessary accessories for convenient installation and operation. The comprehensive package ensures a hassle-free setup and optimal performance.

Projection Screen Motorized projection screen with a diagonal size of 115 inches and an aspect

ratio of 16:10. The screen shall be equipped with a Tubular Motor controlled by a low voltage relay for seamless operation. To ensure safety and compliance, the screen fabric should adhere to DIN 4102-1 Class B2 standards, certifying it as a fire-resistant material. It should be capable of sustaining a temperature range of 23 ± 2 °C and a relative humidity of $50 \pm 6\%$, making it suitable for various environmental conditions. The screen should incorporate an Anti-Heat Cut Off feature, safeguarding against potential risks or accidents at the installation site. Furthermore, a heavy dowel shall be provided to maintain the screen's flatness and stability during operation. The screen fabric must meet the requirements of Class B2 building materials, ensuring its fire resistance and safety. The complete package will include all standard accessories necessary for installation and operation.

75" Interactive Display 4K 75-inch interactive professional display. The display shall provide an immersive touchscreen experience and support simultaneous multi-user writing, enhancing collaboration and productivity. The display shall have the following specifications:

Resolution: 3,840 x 2,160

Brightness: 350 nits or higher

Contrast: 3000:1 or higher

Viewing Angle (H/V): 178 degrees

Response Time: 6 MS or faster

Built-in Speakers: 10W x 2

Input: 2 x HDMI, 1 x DP, Stereo Mini Jack, RS-232, RJ-45, IR. The display should seamlessly support keyboard and mouse input and offer a touch response time of 6 MS or faster. It shall feature heat semi-strengthened glass and provide 20 touch points using a passive pen with a magnet. Additionally, it should be equipped with an embedded Wi-Fi/BT module and include useful features like a document viewer, video player, web browser, and whiteboarding app. The display's CPU shall have a clock speed of 1.7 GHz quad-core or better, with memory consisting of 1.6 GHz 64-bit 3.0 GB, and a storage capacity of 16 GB. To minimize glare, the display shall have an anti-glare film, along with a shatter-proof film for added durability. It shall also be coated with an anti-

microbial layer for hygiene purposes. Moreover, the display shall have the capability to connect up to 50 users, allowing up to 4 users to collaborate simultaneously from tablets, mobiles, or PCs over the network. It should be supplied with the necessary mounting bracket shall be supplied as required.

2. 85" Interactive Display

4K 85-inch interactive professional display. The display shall provide an immersive touchscreen experience and support simultaneous multi-user writing, enhancing collaboration and productivity. The display shall have the following specifications:

Resolution: 3,840 x 2,160

Brightness: 350 nits or higher

Contrast: 3000:1 or higher

Viewing Angle (H/V): 178 degrees

Response Time: 6 MS or faster

Built-in Speakers: 10W x 2

Input: 2 x HDMI, 1 x DP, Stereo Mini Jack, RS-232, RJ-45, IR. The display should seamlessly support keyboard and mouse input and offer a touch response time of 6 MS or faster. It shall feature heat semi-strengthened glass and provide 20 touch points using a passive pen with a magnet. Additionally, it should be equipped with an embedded Wi-Fi/BT module and include useful features like a document viewer, video player, web browser, and whiteboarding app. The display's CPU shall have a clock speed of 1.7 GHz quad-core or better, with memory consisting of 1.6 GHz 64-bit 3.0 GB, and a storage capacity of 12 GB. To minimize glare, the display shall have an anti-glare film, along with a shatter-proof film for added durability. It shall also be coated with an anti-microbial layer for hygiene purposes. Moreover, the display shall have the capability to connect up to 50 users, allowing up to 4 users to collaborate simultaneously from tablets, mobiles, or PCs over the network. It should be supplied with the necessary mounting bracket shall be supplied as required.

65" 4K UHD Display65" 4K display panel boasts a diagonal screen size of 65 inches, providing a stunning visual experience. With a resolution of 3840×2160 pixels, shall offer a sharp and detailed picture quality. The display's brightness should be 350 cd/m^2 or better and have a 1200:1/4000:1 or better contrast ratio. ensuring vibrant and vivid colors. The viewing angle is wide, allowing for clear visibility from both horizontal and vertical perspectives at 178° each. For connectivity, the panel shall include two or more HDMI inputs, 2 x USB 2.0, Additionally, it shall have one 3.5 mm Stereo Audio output for easy connection to external audio devices. The display shall have a built-in speaker system that delivers powerful sound with a total output of 20 W (10 W + 10 W), enhancing the audio experience while eliminating the need for external speakers, Certificate: CE, FCC, BIS, UL etc. complete with standard accessories as required.

3. 55" 4K UHD Display

55" 4K display panel boasts a diagonal screen size of 55 inches, providing a stunning visual experience. With a resolution of 3840×2160 pixels, shall offer a sharp and detailed picture quality. The display's brightness should be 350 cd/m^2 or better and have a 1200:1/4000:1 or better contrast ratio. ensuring vibrant and vivid colors. The viewing angle is wide, allowing for clear visibility from both horizontal and vertical perspectives at 178° each. For connectivity, the panel shall include two or more HDMI inputs, 2 x USB 2.0, Additionally, it shall have one 3.5 mm Stereo Audio output for easy connection to external audio devices. The display shall have a built-in speaker system that delivers powerful sound with a total output of 20 W (10 W + 10 W), enhancing the audio experience while eliminating the need for external speakers, Certificate: CE, FCC, BIS, UL etc. complete with standard accessories as required.

43" 4K UHD Display43" 4K display panel boasts a diagonal screen size of 43 inches, providing a stunning visual experience. With a resolution of 3840×2160 pixels, shall offer a sharp and detailed picture quality. The display's brightness should be 350 cd/m^2 or better, shall have 3000:1 or better contrast ratio. ensuring vibrant and vivid colors. The viewing angle is wide, allowing for clear

visibility from both horizontal and vertical perspectives at 178° each. For connectivity, the panel shall include two or more HDMI inputs, 2 x USB 2.0, Additionally, it shall have one 3.5 mm Stereo Audio output for easy connection to external audio devices. The display shall have built-in speaker system delivers powerful sound with a total output of 20 W (10 W + 10 W), enhancing the audio experience while eliminating the need for external speakers, Certificate: CE, FCC, BIS, UL etc. complete with standard accessories as required.

4. Network Conferencing Camera -type-1

Network 4K PTZ Conference camera for Presenter with 12x optical zoom & 80-degree horizontal coverage. Low Noise CMOS 4K image sensor with User-configurable resolution and quality for IP streams (up to 1080p). HDMI resolutions up to 4K30 and SDI-3G resolution up to 1080p60. Image rotation controls to allow for inverted mounting using ceiling bracket. Minimum Illumination - 0.5 Lux @ (F1.8, AGC ON), Horizontal Rotation Range - $\pm 170^\circ$, Vertical Rotation Range - -30° to $+90^\circ$, White Balance controls- Auto, indoor, outdoor, one-push, manual, specified colour temperature. Power – PoE & AUX. Wall mounting bracket included.

5. Network Conferencing Camera – Type-2

4K Network PTZ Conference camera for Participants with 12x optical zoom & 80-degree horizontal coverage. Low Noise CMOS 4K image sensor with User-configurable resolution and quality for IP streams (up to 1080p). HDMI resolutions up to 4K30 and SDI-3G resolution up to 1080p60. Image rotation controls to allow for inverted mounting using ceiling bracket. Minimum Illumination - 0.5 Lux @ (F1.8, AGC ON), Horizontal Rotation Range - $\pm 170^\circ$, Vertical Rotation Range - -30° to $+90^\circ$, White Balance controls- Auto, indoor, outdoor, one-push, manual, specified colour temperature. Power – PoE & AUX. Wall mounting bracket included.

6. Recorder & Streamer

Recording, Streaming & Webcasting Hardware simultaneously, Built-in 4x HDMI & IP Inputs with

4x Line Inputs, 2x HDMI Outputs. The system should be capable to record up to any four inputs simultaneously in a single frame and as well as individual sources simultaneously. Should have minimum 1TB inbuilt storage and can be connected to local NAS storage. The system should be able to support minimum 3 unicast streams. The recorded files should have the option of time and date stamp. OEM should be CE, FCC, RoHS & BIS Certified

7. AV over IP Encoder

1G HDMI Video Encoder. Inputs- 3 HDMI capable of streaming of 3-HDMI sources simultaneously. Resolution-up to 4K60 4:4:4, Power - PoE and AUX PSU. Ports Connections - RS232, GPIO, Audio Inputs, Audio Output & USB-B port supporting AV USB Bridging for software or web-based conferencing applications. Content Protection: HDCP 2.2 compliant, EDID Management. Dante/AES67 Audio Support. Mounting accessories included. USB-B for Software or web-based Conferencing can be added by required additional hardware to fulfil the requirement. If Encoder is capable of streaming only one input, match the qty as per the requirement (3 inputs).

8. Wireless Presentation Device

Wireless Presentation Solution that revolutionizes the way presentations are conducted. This solution enables seamless wireless presentation of 4K content, eliminating the need for cumbersome cables and allowing for a truly wireless experience. The Wireless Presentation Solution boasts several advanced features, including app-free functionality, wireless touch capabilities, and extended screen support. Users can effortlessly share their screens without the need for any additional applications or software. With the ability to support up to four shared screens simultaneously, multiple presenters can collaborate and share content effortlessly. Additionally, users can annotate directly in Office 365 apps and share their notes with other devices or the front-of-room display, promoting enhanced collaboration and engagement. The device shall support a wide range of display resolutions, including up to 4K, Full HD 1080P, and UXGA/WUXGA, ensuring crystal-clear visuals. It shall Provide HDMI / VGA / mini-DisplayPort, and analog audio outputs. Furthermore, the solution incorporates enterprise management features, enabling centralized control and management of the wireless presentation system. This simplifies

administration, enhances security, and streamlines deployment across the organization. The supply of the Wireless Presentation Solution shall include all necessary components and accessories for seamless installation and operation.

9. Smart Podium

Digital Podium in a Metallic Frame. The podium shall include a 21-inch Full HD Interactive Display with an Electromagnetic Pen. The Interactive Panel should have Motorized Tilting capabilities. The podium should also provide provisions for installing a Gooseneck Microphone, an Interactive Panel, a Keyboard Tray, a Visualizer Tray, and space to store AV equipment. The Interactive Display should feature a full HD resolution of 1920x1080, utilizing IPS LCD technology with an aspect ratio of 16:9. The brightness should be 250 cd/m², and the contrast ratio should be 1000:1. The Pen Type used should be Pressure-sensitive and cordless. The top connectivity plate of the podium should include HDMI, USB x 2 and a Power socket for external Laptop connectivity. It should also feature a built-in 4 x 2 HDMI Matrix Switcher supporting 4K@60Hz (4:4:4, 8-bit), as well as 16-bit Deep Color, HDR (High Dynamic Range), 3D contents, HD audio, and other features defined by the HDMI 2.0 specification. Additionally, it should support Audio De-embedding for internal connectivity. The podium should have a built-in 9 U Rack space to accommodate AV Equipment. It should be supplied with an i5 Mini PC with Windows 10, as well as a Keyboard and Mouse, as required.

10. Flush Mount Cable Cubby

Flush Mount Cable Cubby with premium features. The cable cubby shall be specifically designed with a slow-motion flip-open cover and include multi-format cables to accommodate various connectivity needs. The cover of the desktop socket shall be made of aluminum alloy finishing, ensuring durability and a sleek appearance. It shall be designed to seamlessly integrate into office furniture, providing a seamless and aesthetically pleasing solution. The cable cubby shall feature a soft opening mechanism, prioritizing user comfort and safety during operation. It shall provide connectivity such as 2 x Universal Power outlets, 2 x USB-A Charger ports, 1 x HDMI port, 1 x USB port, and 1 x RJ-45 Network port. These versatile connectivity options enable easy integration with

a range of devices and ensure efficient data and power transfer. The supply of the cable cubby will include all standard accessories required for installation and operation, ensuring a comprehensive and hassle-free solution.

4x4 HDMI Matrix Switcher 4x4 HDMI Matrix Switcher with Audio Output. Should enable for the seamless switching between All Inputs and Outputs. HDMI Switcher should support for 18Gbps resolutions, including 4K@60Hz (4:4:4, 8-bit), ensuring high-quality video transmission. Compatibility with 16-bit Deep Color, HDR (High Dynamic Range), HD audio, and other features specified in the HDMI 2.0 specification. Should have EDID management feature, providing options to select from built-in default EDID, EDID copied from connected sink devices, or a configurable EDID. Should support for a resolution of 4096x2160p@60 @4:4:4 or higher. Should be HDCP compliance, ensuring compatibility with protected content. The Switcher should be supplied with standard accessories necessary for its operation. It should be designed to provide a reliable and efficient solution for managing multiple HDMI sources and displays, supporting high-resolution video, audio, and advanced HDMI features.

11.1:2 HDMI distribution Amplifier

A 1x2 HDMI distribution amplifier meeting the following specifications: The HDMI distribution amplifier should have the capability to support downscaling of video signals. Should be able to handle resolutions up to 4096x2160 @ 60 with a 4:4:4 chroma subsampling, ensuring high-quality video output. Should supports High Dynamic Range technology, enabling superior contrast and color accuracy in the displayed content. The device should be fully HDCP compliant to ensure secure content transmission and compatibility with protected sources. Should incorporate EDID management, allowing for automatic and reliable detection and configuration of connected display devices.

12.1:4 HDMI distribution Amplifier

A 1x4 HDMI distribution amplifier meeting the following specifications: The HDMI distribution

amplifier should have the capability to support downscaling of video signals. Should be able to handle resolutions up to 4096x2160 @ 60 with a 4:4:4 chroma subsampling, ensuring high-quality video output. Should supports High Dynamic Range technology, enabling superior contrast and color accuracy in the displayed content. The device should be fully HDCP compliant to ensure secure content transmission and compatibility with protected sources. Should incorporate EDID management, allowing for automatic and reliable detection and configuration of connected display devices.

13.HDMI Extender

HDMI and Control Extender Set that offers seamless transmission of uncompressed HDMI signals over a single CATx cable. This advanced solution enables efficient and reliable signal extension for enhanced connectivity. The extender set should support HDMI 1.4 or better with 3D and 4k capabilities, ensuring compatibility with high-definition content. It should be HDCP compliant, allowing for secure transmission of protected content. The extender set should be capable of transmitting uncompressed signals up to a distance of 100 meters, providing flexibility in installation. Furthermore, the extender set should support audio formats up to 7.1 channels, including Dolby TrueHD and DTS-HD, delivering exceptional sound quality and immersive audio experiences. To simplify installation and operation, the extender set should feature built-in RS-232, IR control, and Power over Ethernet (PoE) capabilities, eliminating the need for additional cables and power supplies. This enables seamless control and extension of signals over a single CATx cable, reducing clutter and enhancing convenience. The extender set should have a minimum bandwidth of 10.2Gbps, ensuring reliable and high-speed data transmission. The transmitter unit should be equipped with 1 x HDMI input and 1 x HDBT (HDBaseT) output, while the receiver unit should have 1 x HDBT input, 1 x HDMI output, and support for RS-232 and IR pass-through, allowing for easy integration with control systems. The supply of the HDMI and Control Extender Set will include all necessary components and accessories required for successful installation and operation.

14.Wall Plate Type Transmitter

A Wall Plate type 2x1 HDMI transmitter. The transmitter should be equipped with the following ports: 1x HDMI input, 1x VGA input, 1x Audio input, and 1x HDBT output. It must be capable of sending video audio and Data signals over a single CAT x cable, reaching distances of up to 100 meters. The device should support power over HDBT, allowing it to receive power through the same CAT x cable, and it should also have the option of being powered locally. Automatic switching between inputs should be supported, enabling seamless transitions. Furthermore, the HDMI transmitter should have the ability to support resolutions up to 4096×2160p@60, ensuring high-quality video output. It should also include support for CEC bypass, allowing for easy control of connected devices. To ensure compatibility with various content sources, the HDMI transmitter must be HDCP compliant. Additionally, it should support EDID management, allowing for efficient communication and negotiation between the connected devices.

15.HDBT Receiver

An HDBaseT Receiver. The receiver should be capable of supporting 3D and 4K content, and it should be compatible with DVI 1.0. It must be able to handle resolutions of up to 4K@60Hz, ensuring high-definition video output. The HDBaseT Receiver should include support for CEC bypass, enabling seamless control of connected devices. It should be designed to transmit video, audio, and data over a single CAT X cable, with a maximum transmission distance of 100 meters, offering convenient and efficient connectivity. For ease of control and integration with other devices, the receiver should support bidirectional IR/RS-232 control pass-through, allowing for communication in both directions. The device should have 1x HDBT Input and 1x HDMI output, facilitating connectivity with compatible audio-visual equipment. Additionally, to ensure content security and compliance with copyright protection standards, the HDBaseT Receiver must be HDCP compliant. Efficient EDID management support is also essential, as it enables smooth communication and optimal resolution negotiation between connected devices.

16.Digital Chairman Unit

Should have Integrated Flush Mount Chairman Discussion Unit with Gooseneck Microphone of minimum Length 400mm with Bi-colour led ring indication (red / green) complete with

Windscreen Chairman Discussion Unit with built-in Digital Signal Processing

Unit with Priority and Next-in-Line Configuration Priority button silences all delegate microphones and allows only the chairperson to speak. Next-in-line button gives the floor to the next speaker in a waiting list of speakers who requested to speak. Shielded microphone, immune to mobile phone interference (RFI Shielding), Loop-through, daisy-chain cabling, Different LED Signalling for Mic On/Off OR Request-to-Speak Push Button, Audio Quality 16Bit digital

Frequency Response: 30Hz-15kHz, Polar Pattern: Unidirectional, Cardioid

Max SPL @ 1kHz: 110dB SPL, S/N Ratio: 67dB-A, Connection: Screw Lock

Material: Brass / Steel. Certification: CE

17.Digital Delegate Unit

Should have Flush Mount Delegate Discussion Unit with Gooseneck Microphone of minimum Length 500mm with Bi-colour led ring indication (red / green) complete with Windscreen (Shared between Two delegates), Delegate Discussion Unit with built-in Digital Signal Processing, Unit with Microphone On / Off Button, Shielded microphone, immune to mobile phone interference, Loop-through, daisy-chain cabling

Different LED Signalling for Microphone On/Off OR Request-to-Speak Push Button

Audio Quality 16Bit digital, Frequency Response: 30Hz-15kHz, Polar Pattern: Unidirectional, Cardioid, Max SPL @ 1kHz: 110dB SPL, S/N Ratio: 67dB-A

Connection: Screw Lock, Material: Brass / Steel, Certification: CE

18.Digital Audio-Conferencing control unit

Should have up to Central Conference Controller with Recording & Web Server, Conference Controller with built-in Digital Signal Processing, control up to minimum 50 Discussion Unit and expandable up to 150 Discussion Unit by configuring multiple Controller Unit, Controller unit with 4 Bus Connection. 4 Branches. OR 2 Closed Loop for redundancy mechanism.

Control & Configure the Controller via the Integrated Web Server. Should be able to call camera present for look at me feature using built-in or external controller Two USB Connections to connect USB Storage Device for Direct Recording of the Meeting. The Second USB Storage Device will take over automatically in-scenario the First USB Storage get full. Camera Control Integration Capability Controller with LCD display to implement several Conference Mode: Direct access, Request, push to

talk, FIFO, Vox control, Selectable Voice Activation Digital Acoustic, Feedback Reduction with Audio Input & Output for connectivity with external system like amplifier, microphone & audio/video conference system, Audio Quality 16Bit digital With Power Saving Mode allows controller to sleep state if it has been left ON, Headphone Port, Certification: CE

19.Surface Mount Speakers

High-quality Passive Two-Way Wall-Mount Speaker. This exceptional audio solution should be designed to provide clear and immersive sound experiences for diverse applications and venues.

Key Specifications:

The speaker shall be equipped with a high-performance 6.5-inch LF transducer or better, delivering robust and precise low-frequency output and a high-quality 1-inch HF transducer or better. The speaker should offer 30 Watts or more RMS power @8 Ω impedance and includes 70V/100V transformer taps, ensuring versatility in audio installations. Should have a wide Frequency Range spanning from 80 Hz to 18 kHz, Ensuring full spectrum sound reproduction. The speaker features a sensitivity rating of 85 dB or better, ensuring efficient sound conversion and clear audio output. The loudspeaker should provide a broad 130° or better conical coverage, delivering even and consistent sound dispersion across the listening area. The speaker should have a maximum Peak SPL of 105 dB, providing ample audio projection for various settings. The speaker package should include a complete mounting kit, simplifying and facilitating the installation process.

20.Ceiling Speaker

6.5" Two-way Ceiling-Mount Loudspeaker with a back can. The loudspeaker shall be designed to deliver high-quality audio performance and reliable sound reproduction. The loudspeaker should have a minimum continuous power rating of 30 Watts or better, ensuring sufficient power handling capability for clear and impactful sound output. It should also possess a sensitivity of at least 86 dB SPL or better, enabling efficient sound distribution and coverage within the designated area. To

ensure effective sound dispersion, the loudspeaker should provide a coverage angle of 110° or better, allowing for even sound distribution across the listening area. Additionally, it should be capable of delivering a maximum peak SPL of at least 110 dB or better, providing ample volume for various applications. The rated impedance of the loudspeaker should be 8 /16 Ohms, ensuring compatibility with standard audio systems. It should also feature transformer tapping options of 70V/100V with power settings of 30 and 15 Watts or better. This allows for flexible installation in systems utilizing distributed audio setups. The loudspeaker should incorporate high-quality transducers, with a minimum 6.5-inch LF (low-frequency) driver or better, and a coaxially mounted HF (high-frequency) driver of at least 0.8 inches or better. This configuration ensures accurate sound reproduction across the frequency spectrum. The supply of the loudspeaker shall include OEM-supplied mounting brackets for easy and secure installation.

2x60 watts AmplifierDual Channel Class-D Amplifier with the following specifications:

The amplifier should have 2 channels, each providing 60 watts per channel at 8Ω/4Ω, ensuring powerful and efficient audio delivery. The amplifier should support 70V/100V in bridge mode, enhancing versatility and catering to diverse speaker configurations. Should have a Signal to Noise ratio greater than 100 dB, the amplifier ensures minimal noise interference, ensuring pristine and clear sound reproduction. Should have a Frequency Response spans from 20 Hz to 20 kHz, allowing for accurate and faithful audio reproduction across the entire audible spectrum. Should equipped with user-friendly Front Panel Indicators, the amplifier features Power status, per-channel Signal strength, as well as Protect/Limit indications, enabling easy monitoring and diagnostics. The successful bidder is expected to provide all necessary mounting accessories, ensuring seamless installation and integration into the existing audio setup.

21.4x60 watts Amplifier

Quad Channel Class-D Amplifier with the following specifications:

The amplifier should have 4 channels, each providing 60 watts per channel at 8Ω/4Ω, ensuring

powerful and efficient audio delivery. The amplifier should support 70V/100V in bridge mode, enhancing versatility and catering to diverse speaker configurations. Should have a Signal to Noise ratio greater than 100 dB, the amplifier ensures minimal noise interference, ensuring pristine and clear sound reproduction. Should have a Frequency Response spans from 20 Hz to 20 kHz, allowing for accurate and faithful audio reproduction across the entire audible spectrum. Should be equipped with user-friendly Front Panel Indicators, the amplifier features Power status, per-channel Signal strength, as well as Protect/Limit indications, enabling easy monitoring and diagnostics. The successful bidder is expected to provide all necessary mounting accessories, ensuring seamless installation and integration into the existing audio setup.

22.8 Channel Amplifier

An eight Channel Class-D amplifier. Each channel of the amplifier should provide a minimum power output of 200W at 8 Ω /4 Ω /70V/100V or better, ensuring ample power for a variety of audio setups. The amplifier should support power sharing or Bridge/Parallel modes, allowing for improved power distribution and flexibility in different configurations. Should have Frequency Response: 20 Hz – 20 kHz or better, ensuring a wide range of audio reproduction. Signal to Noise ratio: >100 dB or better, indicating high-quality audio with minimal background noise. Input impedance: >10k, balanced or unbalanced or better, offering compatibility with various audio sources. The amplifier should have front and rear panel indicators for Power, signal (per channel), limit/mute/protected, or better, providing visual feedback for monitoring purposes. Additionally, it is preferred for the amplifier to have remote standby and power-saving features, such as Auto-standby, promoting energy efficiency and convenience. The amplifier shall ensure reliable and powerful audio amplification, meeting the requirements of a wide range of applications.

Audio Mixer 12-Input 2-Bus Mixer with XENYX Mic Preamps and British EQ, a professional-grade audio mixing solution. The key features of this mixer are as follows:

The mixer shall be equipped with 4 or more-pre-amp mic inputs, providing versatile connectivity options for microphones and other audio sources. Each channel includes 1 post-fader FX send, allowing precise control over the FX signal level for individual channels. It offers Main mix outputs,

along with separate control room, phones, and stereo CD/tape outputs, providing comprehensive audio monitoring and routing capabilities. The CD/tape inputs should be assignable to either the main mix or control room/phones outputs, offering flexible integration of external audio devices. With high-quality XENYX mic preamps and British EQ, this 12-Input 2-Bus Mixer ensures exceptional audio performance and professional sound shaping capabilities. It should be suitable for a wide range of applications, including recording studios, live performances, and audio production setups. Our team will handle the supply, installation, testing, and commissioning to ensure a seamless and efficient audio mixing experience.

Digital Signal ProcessorDigital Signal Processor, shall offer advanced audio processing capabilities for various applications. The DSP shall provide enhanced control and management of audio signals. The DSP shall include a minimum of 12 Mic/Line inputs and 12 Line outputs, allowing for flexible audio routing and connectivity. The bidder can offer single or multiple products to meet the requirement. Each microphone input shall support phantom power. The DSP shall feature a minimum of 12 or more AEC channels. This enables effective echo cancellation and improved audio quality, particularly in conferencing or telecommunication applications. To facilitate network audio integration, the DSP shall support a minimum of 8x8 Dante channels and provide compatibility with up to 128x128 network audio channels via Dante/AES67 or a similar protocol. This ensures seamless integration with networked audio systems and simplifies audio routing. For audio conferencing, the DSP will offer POTS and SIP Softphone integration, allowing for seamless integration with telephony systems and audio-conferencing solutions. The DSP shall also feature a USB port supporting AV USB Bridging, enabling compatibility with software or web-based conferencing applications. This allows the DSP to emulate USB Audio and USB Video drivers, enhancing compatibility and versatility for conferencing purposes. The DSP will incorporate high-quality 24-bit A/D-D/A converters or better, ensuring accurate audio signal conversion. It shall operate at a sample rate of 48 kHz or better, delivering high-fidelity audio reproduction. The input frequency response will be 20 Hz to 20 kHz or better, and the input dynamic range will exceed 109 dB or better, providing excellent audio performance. The supply of the DSP will include all necessary components and accessories for installation and operation.

23. Wireless Handheld Microphone

Wireless Handheld Microphone transmitter, RF output 10mW or more, cardioid pickup pattern, Frequency Response of 20Hz to 20kHz, Frequency range: 470.2 to 1799.8 MHz, Channels: 90 or more, switching bandwidth: 56MHz or more, manage and monitor through OEM app over network (specifications includes single microphone set of transmitter and capsule), etc. and complete as required.

24. Wireless Lapel Microphone

Wireless Lapel Microphone transmitter, RF output 10mW or more, cardioid pickup pattern, Frequency Response of 20Hz to 20kHz, Frequency range: 470.2 to 1799.8 MHz, Channels: 90 or more, switching bandwidth: 56MHz or more, manage and monitor through OEM app over network (specifications includes single microphone set of transmitter and capsule), etc. and complete as required

25. Gooseneck Microphone

Cardioid condenser gooseneck microphone with Table stand base. Mute/Unmute button and status light ring. Gooseneck length min 40 cm, connector type - XLR, Impedance - $<100\Omega$, Frequency response - 50Hz - 20kHz, Max SPL -130 dB SPL.

26. All-In-One Video BAR

Supply, Installation, Testing & Commissioning of 8MP Video Conferencing Soundbar with 4K PTZ Camera, minimum FoV 120deg and 4x Zoom, Built-in Hands-Free Auto Framing Feature, should have minimum 4 Beamforming Microphone Arrays covering a distance of upto 5 meters, should have minimum 20W Speaker Element with 1x Passive Diaphragm, Frequency Response: 100Hz ~ 20KHz, USB 3.0 & Ethernet output, should be supplied with IR Remote Controller and TV Mount Bracket. Should be BIS, CE, RoHS & FCC Certified. Country of origin should not be China.

27. Control System

Comprehensive Hardware or Software-based Control System shall be proposed. The control system shall offer minimum 8 multi-purpose I/O ports that can be configured as per the specific requirements of the project. These versatile I/O ports ensure flexibility and compatibility with a wide range of devices. The control system shall be designed to seamlessly control the devices mentioned in the Bill of Quantities (BOQ). It includes perpetual licenses to connect Wall/Table mount touch screen controllers, as well as iOS and Windows devices, enabling wireless touch control capabilities. This shall allow for intuitive and convenient control over the connected devices, enhancing user experience and facilitating efficient operation. The Hardware or Software-based Control System provides a user-friendly interface for seamless device management and control. It shall offer a range of features and functionalities to ensure optimal performance and compatibility with the specified devices in the BOQ. The supply of the control system includes all necessary hardware components, software licenses, and associated peripherals required for installation and operation.

28. Wireless Touch Display

Wireless 10-inch Touch Panel with the following specifications:

Network Support: The touch panel should support Wi-Fi connectivity with compatibility for 802.11a/b/g/n/ac standards. It should be dual band, operating on both 2.4GHz and 5GHz frequencies, and feature HT80 with MIMO capabilities for enhanced wireless performance.

Bluetooth Technology: The touch panel should be equipped with Bluetooth 4.2 technology, enabling seamless connectivity with compatible devices.

Display Brightness: The touch panel's display should have a brightness of 500 nits, ensuring clear visibility in various lighting conditions.

Speaker Cable Speaker Cable with the following specifications: 1.5 Sq. mm (48/0.20mm) x 2 core cable. The cable should have an ATC copper conductor and PVC insulation. The cores should be twisted together, and the cable should have an outer jacket with a PVC sheath. This speaker cable should be designed to provide reliable and high-quality audio signal transmission. The 1.5 Sq. mm size ensures sufficient current carrying capacity, while the ATC copper conductor offers excellent conductivity. The PVC insulation provides electrical insulation and protection. The twisted cores

help to minimize interference and crosstalk, ensuring clear audio transmission. The cable should have finished with an outer jacket featuring a PVC sheath, which adds durability and protects against external factors.

29.Mic Cable

18 AWG (24/0.20mm) x 2 core ATC copper conductor, PE insulated, core twisted in a circular form, Inner sheathed with moisture Proof Polymer, braid shielded (80%) with ATC copper, outer Jacketed with Matt finish Rugged Flexible PVC.

30.HDBT Cable

Category 6A F/UTP EN Series Shielded Cable. The cable should have a 23 AWG (American Wire Gauge) size and consist of 4 pairs. It should be designed with solid annealed bare copper conductors for optimal conductivity. Should be High-density polyethylene insulation, ensuring electrical insulation and protection. The 4 pairs should be twisted in varying lays and cabled together to minimize interference and crosstalk. The cable should have a flame-rated PVC jacket for added safety and protection. It should comply with the TIA/EIA-568-C Category 6A standards, meeting the requirements for high-speed data transmission. The cable should also be compliant with NEC CMR and CEC CMR FT4 standards, ensuring it meets the necessary safety regulations. It should be RoHS compliant, indicating its adherence to environmental standards. Category 6A shielded cable shall provide reliable and high-performance data transmission while ensuring compliance with industry standards and regulations.

31.6-10 ft HDMI Cable

A high-performance 6-10 ft cable that supports signals up to 4K@60Hz (4:4:4) and Deep Color. The cable should feature Gold Plated pins and have a 28 AWG thickness. Its flammability rating should be CL3/FT4, ensuring compliance with fire safety standards. Additionally, the cable should meet the requirements of RoHS 2011/65/EU, demonstrating its adherence to environmental regulations.

32.10-15 M HDMI Cable

A 10–15-meter HDMI Active Optical Cable with the following specifications:

The cable should support 4K60 4:4:4 18Gbps bandwidth, ensuring high-quality video transmission with vivid colors and clear details. It should be Plenum rated and have a small diameter, making it suitable for installation in plenum spaces and ensuring easy cable management. The cable's video compliance should include HDMI 2.0, HDCP 2.3, and HDR, ensuring compatibility with the latest HDMI standards and technologies. The cable should utilize active circuitry in the permanent HDMI connectors, allowing for reliable and robust HDMI signal transmission over long distances. It should support HDMI signals with video resolutions up to 4K@60Hz (18.0Gbps), providing smooth and high-definition video playback. This 15-meter HDMI Active Optical Cable shall be designed to provide a reliable and high-performance solution for extending HDMI connections over long distances while maintaining excellent video and audio quality. Its advanced features and specifications make it suitable for various audiovisual applications, such as home theater setups, professional AV installations, and multimedia presentations.

33. Bulk Connectors

Various types of bulk connectors as per site requirements, including XLR Male, XLR Female, AUX, RCA, RJ-45, Velcro Tape, Cable ties, and more. These connectors will cater to different audio, video, and data connectivity needs, providing flexibility and versatility in the setup.

34. 24-Port network Switch

24-port 1000base-T Gigabit PoE+ Smart Managed Switch. The switch should support Network Protocol and Standards Compatibility, including IEEE 802.3 Ethernet, IEEE 802.3i 10BASE-T, and IEEE 802.1x. It should also have the capability to implement Access Control Lists (ACLs) at L2 (Layer 2) / L3 (Layer 3) / L4 (Layer 4). The switch shall be designed to provide reliable and efficient network connectivity, offering high-speed Gigabit Ethernet connections with Power over Ethernet (PoE+) capabilities. It shall enable the management and control of network traffic, ensuring secure and efficient data transmission. The switch will include standard accessories

necessary for its installation and operation, ensuring a complete and functional networking solution.

35.8-Port network Switch

8-port 1000base-T Gigabit PoE+ Smart Managed Switch. The switch should support Network Protocol and Standards Compatibility, including IEEE 802.3 Ethernet, IEEE 802.3i 10BASE-T, and IEEE 802.1x. It should also have the capability to implement Access Control Lists (ACLs) at L2 (Layer 2) / L3 (Layer 3) / L4 (Layer 4). The switch shall be designed to provide reliable and efficient network connectivity, offering high-speed Gigabit Ethernet connections with Power over Ethernet (PoE+) capabilities. It shall enable the management and control of network traffic, ensuring secure and efficient data transmission. The switch will include standard accessories necessary for its installation and operation, ensuring a complete and functional networking solution.

36.Wi-Fi Router/Access point

Wi-Fi router/Access point for wireless meeting collaboration. This device will enable seamless and reliable wireless connectivity for meeting collaboration purposes. The supply of the Wi-Fi router/Access point shall include all standard accessories necessary for its installation and operation. These accessories shall ensure a complete and functional wireless networking solution, providing a robust and efficient platform for collaborative meetings.

Floor Box- Type 1A Customized Floor Box with the following features:

1x Microphone Input, 2x LAN Ports, 2x Power Sockets and Provision for mounting an HDBT Transmitter. The floor box shall be designed to provide convenient connectivity solutions in a floor-mounted configuration. It shall include a dedicated microphone input for audio input, two LAN ports for network connectivity, and two power sockets for powering devices. Additionally, the floor

box shall have a provision to mount an HDBT Transmitter, allowing for seamless transmission of high-definition audio and video signals over long distances. The supply, installation, testing, and commissioning of floor box shall provide a reliable and efficient solution for convenient connectivity, enhancing the functionality of the space.

37.24 U Rack

24 U equipment rack shall be designed to house all rack-mountable equipment. The equipment rack should be equipped with internal wiring to ensure proper connectivity and organization. It should feature a front glass door to provide visibility and security for the housed equipment. Should have Heat dissipation fans to maintain optimal temperature levels within the rack and prevent overheating of the equipment. Shall have Power distribution units (PDUs) to efficiently distribute power to the various devices within the rack. The equipment rack shall also include all standard accessories required for its installation and operation. This 24 U equipment rack shall offer a secure and organized solution for housing rack-mountable equipment. With its internal wiring, front glass door, heat dissipation fans, and power distribution units, it provides a complete setup to accommodate and manage various equipment.

12 U Rack 12 U equipment rack shall be designed to house all rack-mountable equipment. The equipment rack should be equipped with internal wiring to ensure proper connectivity and organization. It should feature a front glass door to provide visibility and security for the housed equipment. Should have Heat dissipation fans to maintain optimal temperature levels within the rack and prevent overheating of the equipment. Shall have Power distribution units (PDUs) to efficiently distribute power to the various devices within the rack. The equipment rack shall also include all standard accessories required for its installation and operation. This 12 U equipment rack shall offer a secure and organized solution for housing rack-mountable equipment. With its internal wiring, front glass door, heat dissipation fans, and power distribution units, it provides a complete setup to accommodate and manage various equipment.

29.0 SPECIALCONDITIONSOFELECTRICALWORK

1.0 GENERAL

- 1.1 All electrical work shall be carried out in compliance with specifications given hereunder in this section and in compliance with Indian Standard Specifications and Indian Electricity Acts and Rules in force. The works shall also conform to any special requirement of local State Electricity Board. In any case, the above-mentioned rules, regulations etc. are not in accord, the decision of the Architect/Engineer-in-Charge regarding rules to be followed or manner of execution of work shall be final and binding.
- 1.2 Work shall be executed through licensed electrical contractor approved by the Owner/Architect. These special conditions of contract shall be read in conjunction with the General Conditions of Contract, Schedule of Quantities, Technical Specifications, Drawings and other documents relating to the work and shall have preference over laid down general conditions and specifications.
- 1.3 Notwithstanding the sub-division of the documents into these separate sections and volumes, every part of each shall be deemed to be supplementary and complementary to every other part and shall be read with and into the contract, so far as it may be practicable to do so.
- 1.4 The contractors shall mobilise and employ sufficient resources to achieve the detailed schedule within the broad frame work of the accepted methods of working and safety. The contractor shall provide everything necessary for the proper carrying out of the work, including tools, plants and other materials.

4.1.5 No additional payment will be made to the contractor for any multiple shift work or other incentive methods contemplated by him in his work schedules even though the time schedule is approved by the Architect/Engineer-in-Charge.

- 1.6 The work shall be executed as per the programme drawn or approved by the Architect and it shall be so arranged as to have full coordination with any other agency employed at site. No claim for idle labour shall be entertained nor shall any claim on account of the delay in the completion of the building work to be tenable except extension of time secured by the Contractor as stated elsewhere.
- 1.7 The Contractor shall permit free access and afford normal facilities and usual

convenience to other agencies or departmental workmen to carry out connected work or other work services under separate arrangements. The Contractor will not be allowed any extra payment on this account.

1.8 All soil, filth or other matter of any offensive nature taken out of any trench, sewer drain, cesspool or other place shall not be deposited on the surface, but shall at once be carted away by the contractor free of charge to a suitable pit or place to be provided by him.

1.9 The contractor shall provide all equipment, instruments, labour and such other assistance required by the Engineer-in-Charge for measurement of the work, materials etc.

2.0 Materials

2.1 All materials, equipment's, fittings and fixtures used in electrical works shall conform to the attached Appendix-A. All material shall be new, sound and robust in construction and well finished. Surplus material after completion of work shall be taken back by the contractor and the cost shall be recovered if the advance payment has been made earlier by the Client.

2.2 Unless otherwise stated in the conditions of contract, samples of all materials, fittings and fixtures to be supplied by the Contractor shall be submitted to the Architect/Engineer-in-charge for his approval. The contractor shall not commence the work until the samples are approved, in writing from the Owner/Architect. The Contractor shall ensure that all the materials incorporated in the work are identical in all respects with the approved sample. All samples not destroyed in testing shall be returned to the Contractor after completion of contract. No payment shall be made for samples destroyed in testing.

3.0 Drawings

3.1 The drawings, specifications and bill of quantities shall be considered as a part of this contract. Any work or materials shown on the drawings but not included in the schedule of quantities or vice versa, shall be executed as if specifically called. Drawings indicate the extent and general arrangement of various equipment's and their wiring etc. and are essentially diagrammatic. The work shall be installed if found essential to coordinate the installation of this work with other trades shall be

made without any additional cost to the Owner. The data given herein and on the drawings is as could be secured, but its complete accuracy is not for the assistance and guidance of the contractor, the exact locations, distances and levels will be governed by the space conditions. The contractor shall be responsible to check exact location of all electrical outlets, the routes and lengths of cables etc.

4.0 Clarification of Discrepancies

- 4.1 In case of any discrepancy between specifications and drawings etc. furnished by the Architect or disputes in respect thereof, the interpretation of CPK and Engineer-In-Charge shall be final and binding.

18.0 Work and Workmanship

- 18.1 The work shall be of the highest standard, and conform to the technical specifications both as regard its design and workmanship. Modern tools and first class, latest techniques shall be employed for its execution.
- 18.2 Any damage done to the building during the execution of work shall be responsibility of the contractor and it shall be made good by him, at his cost, to the entire satisfaction of the Architect.
- 18.3 All electrical work shall be executed by skilled and duly licensed electricians under the direct supervision of whole time, fully qualified electrical Engineers and Supervisors. The contractor shall produce requisite evidence regarding the qualifications of his Engineers, supervisors and other workers.
- 18.4 The contractors shall possess all the relevant and valid licenses as per the regulations of the Indian Electricity Rules and the Local Electrical Inspector's requirements.
- 18.5 The work shall have to be co-ordinated with the building work and other allied jobs/trades to the entire satisfaction of Engineer-in-Charge.

6.0 Certificate of Inspection

- 6.1 The contractor shall be responsible for getting the installation inspected and approved by the electrical Inspector and other local electric supply company as required.
- 6.2 The contractor shall obtain and deliver to the Owner the certificate of final inspection and approval of the local electrical authorities concerned. The inspection fees etc. shall be borne by the contractor which shall be reimbursed by owner on producing documentary proof.
- 6.3 In case of any defects are pointed out by the Electrical Inspector, the contractor shall remove these defects at his own cost and arrange for re-inspection or inspection by the Electrical Inspector, till such time the installation is finally approved and the required certificate is issued. The contractor shall bear all expenses and deposit the necessary fees for subsequent inspection by the Electrical Inspector.
- 6.4 The Architect shall have full powers to get the material or workmanship etc. inspected and tested by an independent agency, at the contractor's expenses in order to ascertain their soundness and adequacy.
- 7.0 Miscellaneous
- 7.1 A site order book will be maintained at site which will be in the custody of the Owner or his representative and all instructions given to the contractor will be recorded in the site order book and the same has to be signed by the contractor to comply with the instructions given therein.
- 7.2 After completion of the work the whole installation shall be tested by the contractor in the presence of the Architect Engineer-in-charge. The tests shall comply with the following I.E.E. Regulations and shall be submitted along with the final bill.
- a) The result of the insulation test shall comply with the I.E.E. Regulations 1101 to 1108A and 1008B as may be applicable.
 - b) Tests shall be carried out to ascertain that all the non-linked SP switches have been connected to the phase conductor.

- c) The continuity test of the earthing system shall comply with I.E.E. Regulations 1108 to 1109 to the latest addition. If the result of the above tests does not comply with the I.E.E. Regulations, the contractor shall be bound to rectify the faults so that the required results are obtained. The contractor shall be responsible to provide all the necessary testing instruments, such as megger insulation tester, earth tester multimeter, AVO meter etc. for carrying out the above tests.
- 7.3 The work will not be considered as complete and taken over by the employer till all the components of the work after being completed at site in all respects have been inspected/tested by the Architect/Owner to his entire satisfaction and a completion certificate issued by the Owner/Architect to this effect.
- 7.4 Shop drawing for electrical work e.g. equipment, cable earthing and conduit layout for all systems shall be prepared by contractor and got approved before starting of the work.
- 7.5 At the completion of the work and before issuance of certificate of virtual completion, the contractor shall submit 6 sets of drawing, two tracing and 2 CDs containing of each drawing to Owner of each layout drawings drawn at approved scale indicating the complete conduit wiring/cabling/earthing as installed.
- 7.6 Contractor shall submit 2 sets of photographs for electrical installation carried out.
- 7.7 The contractor will submit within 15 days of the award of work, a detailed schedule of programme of work.
- 8.0 Preamble to schedule of quantities
- 8.1 Tender shall be on the basis of item rates which shall include the cost of materials, labours, all taxes, duties and all other services required for the complete installation, testing and commissioning in accordance with the relevant IS Codes in practice including the fees for inspection together with the liabilities and obligations as detailed in the general conditions of contract. It will also be the responsibility of the tenderer to obtain all types of sanctions etc. like power/ light connections and the drawings etc. if any, required by the concerned local authorities.
- 8.2 Prices shall remain firm and free from variation due to rise and fall in the cost of materials and labours or any other price variation whatsoever whether during extended period of completion, if any.

- 8.3 Item rates shall remain valid for any variation in the estimated quantities given in schedule of quantities.
- 8.4 In order to facilitate the technical scrutiny of the various quotations, the tenderer must supply with their quotations detailed technical particulars make catalogues and erection drawings for various items under different parts specified in the schedule of quantities.
- 8.5 Power supply shall be 3phase, 4 wire, 415/230 Volts A.C. and frequency of 50 cycles per second. All-consuming devices shall be suitable for voltage and frequency mentioned above.
- 8.6 The drawing and specifications lay down minimum standard of equipment and workmanship and the deviations. In the absence of any deviations, it will be deemed that the tenderer is fully satisfied with the intents of the specifications & drawings and their compliance with the statutory and fire insurance provisions including local codes. Where the drawings and specifications conflict, the more stringent shall apply.
- 8.7 All equipments and the installations shall be tested as specified and a test certificate in the prescribed form as required by the local supply authorities shall be furnished.
- 8.8 The entire installation shall be guaranteed against defective materials or workmanship for a period of 12 months from the date of the installation certified by the consultant and taken over by the owner. During the guarantee period all the defects shall be rectified by the contractor free of cost.
- 8.9 The successful tenderer shall submit the shop drawings for wiring L.T. boards, distribution boards and any other to the consultant for approval prior to start the work. The approval of these drawings will be general and will not absolve the contractor of the responsibility of the correctness of these drawings. At least 6 copies of the approved drawings shall be supplied to the consultant for their distribution to the various agencies at site at no cost to the employer.

8.10. The position of distribution boards and switchboards may require some minor adjustments due to

either site requirements or change in structural layout. All such changes from the position, shown in the drawings, shall be required to be incorporated without any extra payment or deduction for change in length of wiring etc.

- 8.11 The tenderers must see the site conditions and take all the aforesaid and foregoing factors while quoting the rates, as no extra will be allowed on any ground arising out of or relating to the aforesaid and foregoing.
- 8.12 In single phase (230-V) A.C. supply system circuit wires of same phase shall be drawn in same conduit. For 3 phase, 4 wire wiring system wires of different colour shall be used and for insulated neutral only black colour wire shall be used.
- 8.13 The successful tenderer shall include in his rates for painting with 3 coats of synthetic enamel paint to match the surroundings or as directed by the consultant for all down rod hangers pertaining to light fixtures, fans, steel structure used for electrical work at no extra cost.
- 8.14 The successful tenderer shall supply completion drawings of the entire installation on tracing cloth as well as 3 prints of each drawing showing the complete wiring diagram as executed at site drawn to scale approved by the consultant after the completion of work but before completion certificate is given by the consultant.
- 8.15 After laying and jointing the cables shall be subject to necessary tests as stipulated in IS:5959 (Part-I):1970.
- 8.16 As more than one make is mentioned, prior approval of particular make for use shall be obtained from the Consultant as per his discretion. All samples of all electric fittings and other accessories shall be approved by the consultant prior to their installation. In case there is a substantial cost difference be indicated in the tender itself or it will be deemed that any of the specific make of material may be asked by the consultant at the quoted prices.
- 8.17 No alteration whatsoever is to be made to the text of quantities of this schedule of quantities, unless such alteration is authorised in writing by the consultant. Any such alteration or addition shall, unless authorised in writing, be dis-regarded when tender documents are considered.
- 8.18 Any error in description or in quantity or omission of items from the contract shall

not vitiate this contract but shall be corrected and demand to be a variation required by the consultants.

8.19 All measurements shall be taken in accordance with the Indian Standard Electrical Installation in buildings method of Measurements of IS:5908:1970, unless otherwise specified.

8.20 The contractor shall provide, within one month after completion of the work or along with the final bill, three sets of manuals properly bound which shall contain the following information:

- a) Description of installation items using main items of equipments.
- b) Description of all equipments and system operation with troubleshooting manuals.
- c) Line diagram of each system including main feature of equipments and showing method of setting controls.
- d) Method of fault finding, routine, adjustment and wiring diagram.
- e) Description of routine maintenance, oil and greasing points and recommended lubricants.
- f) Manufacturer's service manuals for all equipments.
- g) Spares reference manuals.

8.21 The contractor shall provide the following at no extra cost to the Employer:

- a) Danger Notice Boards
- b) Treatment for electric shock giving details of FIRST AID TREATMENT with chart diagrams (mounted in suitable frame).
- c) Line wiring diagrams of the electrical system mounted in suitable frame.

8.22 The contractor will remove all the debris & surplus earth from worksite (belonging to his work) free of

Note: -

- 1 The contractor will use one of the approved makes as approved by the Department
- 2 In case of different quality / pattern of same make, the pattern / quality shall be approved by the Department.
- 3 For materials / equipment / to be used in items of work for which approved makes are not given herein, the makes of such materials / equipments shall be as decided by Department
- 4 If any major equipment is using a small component of make other than that given as a standard component with the equipment, the same shall be accepted subject to approval of Engineering-in-charge
5. Equipment / Gadget / Civil Fittings meeting the design / Stipulated performance parameters as per DBR from among the list of approved makes shall be considered even if insignificant deviations from the stipulated specification are observed / offered equipment / Gazette / Other civil fittings after due verification and approval of the department.
6. If the Equipment / Gadget / Civil Fittings of required specification is not available as per the list of approved than a upgraded model of same make has to be used. If it is not available with same make than other equivalent makes may be considered as offered by the contractor after due verification and approval of the department for which contractor shall be provide the OEM certificate in this regards that the particular Equipment / Gadgets / Civil Fittings has been discontinued

Supply Installation testing and commissioning of manual score board as per ICC / BCCI norms as required.
1 Nos.

End of Section

SUB HEAD :1 CCTV Surveillance Work

Scope of work involves IP based CCTV system for security comprising of PTZ/ fixed camera, cabling, digital recording, HD display system with display and hardware & software support both for indoor and external surveillance.

CCTV cameras and storage server/ NVR shall have compliance for interoperability. The proposed IP CCTV camera: NVR and VMS shall have cyber security certificate BIS, UL, EN, CE, FCC certifications. The proposed IP CCTV camera, NVR and VMS shall be compliant to original licensed H.265 video compression for recording and streaming. The recorded images to be stored for at least 30 days.

The proposed camera should use signed firmware to validate the firmware's integrity before accepting to install it.

The proposed camera should use secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.

The proposed camera should have built in feature of Brute force delay protection to prevent camera from hacking.

The camera shall provide a platform allowing the upload of third-party analytics applications into the camera.

The proposed camera should have a built-in Memory of 1024 MB RAM, 512 MB Flash

The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.

The OEM should have own RMA centre located in India for at least 10 years or more.

MTBF of minimum 100,000 hours for cameras

The camera should send trigger via HTTP/HTTPS to IP Speaker for active alerts.

The proposed camera should be NDAA compliant.

The Camera to be provided by the bidder should not have Hisilicon chipset/Processor.

The OEM should either have an IPR of technology (for both Software and Hardware) being deployed in offered models or Design for each offered model registered in their company name.

OEMs of equipment, Hardware, Software and Firmware (proposed to be supplied for this tender) own the Intellectual Property Rights of Hardware and "Source Code" of Firmware & Software, and that they are actual manufacturers, and are not getting any 3rd party manufacturing done e.g., branding & reselling in India through importing/ trading from a country that shares a Land Border with India.

5Years OEM Warranty

IR PTZ Cameras with mounting arrangement & power supply in weather-proof enclosure should be provided at all parking entrances and main gates of the campus.

License for camera & software for minimum 10 years.

CCTV Camera Dome (for indoor/ Outdoor application): -

Supply, installation, testing and commissioning of 5 MP Dome camera with following specifications:

Sr. No.	Camera Characteristics	Minimum Specifications
1	Sensor type	1/2.7" progressive scan RGB CMOS
2	True Day and Night	The camera shall provide a removable IR-cut filter, providing day/night functionality
3	Lens type	The camera shall be equipped with a varifocal 3-8 mm IR-corrected megapixel P-Iris lens with a 5MP image sensor and The camera shall provide remote zoom and remote focus functionality.

4	Field of View	The camera shall be equipped with P-Iris, providing a horizontal field of view between 100°-40°
5	Sensitivity	The camera shall meet or exceed the following illumination specifications: a. Color: 0.15 lux at 50 IRE, F1.3, B/W: 0.05 lux at 50 IRE, F1.3, 0 lux with IR illumination on
6	Shutter Speed	The camera shall incorporate an electronic shutter operating in the range of 1/33,000s to 2s.
7	Video Compression	The camera shall provide independently configured H.264, H.265 and Motion JPEG streams.
8	Total sensor pixels & FPS	The camera shall support video resolutions including: 5MP (2592x1944) at up to 25 frames per second (50Hz mode) with WDR using H.264, H265 or Motion JPEG.
9	Video Streams	Minimum Two simultaneous H.265 streams in 5MP at 25/30 fps or four simultaneous H.265 streams in HDTV 1080P at 60 fps or eight simultaneous H.265 streams in HDTV 1080P at 25/30 fps.
10	Smart compression	The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage: a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements. b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
11	Image Settings	The camera shall support manually defined values for: a. Saturation b. Brightness c. Sharpness d. Contrast
12	Intelligent defog	The camera shall incorporate automatic defog functionality
13	IR Range	The camera shall be equipped with built-in IR LEDs with adjustable angle of illumination and intensity and with a range of up to 40 m (130 ft) with a wavelength of 850 nm

14	IP addresses	<p>a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.</p> <p>b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature.</p> <p>c. The camera shall provide support for both IPv4 and IPv6.</p> <p>d. The camera shall provide support for IPv6 USGv6.</p>
15	Protocol	1. The camera shall incorporate support for at least HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP/RTSPS, TCP, UDP, RTCP, DHCPv4/v6, SSH, LLDP, CDP, MQTT.
16	Text Overlay	Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds
17	Security	The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
18	Password Protection	Restrict access to the built-in web server by usernames and passwords at three different levels.
19	Centralized certificate management	Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services
20	Hardware for data security	<p>The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL6+.</p> <p>The product shall include a tamper-resistant hardware module. The module shall use a Trusted Execution Environment (TEE), providing a set of cryptographic features suitable for protecting private keys from unauthorized access.</p>
21	Signed Firmware	The use of signed firmware validates the firmware's integrity before accepting to install it

22	Secure Boot	The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
23	Brute force attacks	The proposed camera should have builtin feature of Brute force delay protection to prevent camera from hacking.
24	Connectivity	Profile G,S,T and M
25	Application Programmers Interface	The camera shall provide a platform allowing the upload of third-party applications into the camera.
26	Analytics	The camera shall support advanced video analytics capabilities with a built-in hardware-accelerated object detect engine, capable of automatically detecting several simultaneously visible objects metadata from a set of pre-trained object categories (such as vehicles, license plates, people and faces). line crossing, object in area, Cross line counting, Loitering, occupancy, Video Motion Detection, Tampering, Audio Detection
27	Ethernet	The camera shall be equipped with one 10BASE-T/100BASE-TX PoE Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).
28	Digital I/O (Alarms)	The camera shall be equipped with one digital (alarm) input and one digital output.The output shall be able to provide 12 V DC, 15 mA.
29	Local Storage	The camera shall have built-in SD card slot upto 1 TB and The camera shall incorporate encryption functionality for the SD card (AES-XTS-Plain64 256bit).
30	Audio In	The camera shall be equipped with one 3.5 mm jack for line/mic input.
31	Audio Out	Speaker pairing
32	Encoding	AAC-LC 8/16/32/44.1/48 kHz, G.711, G.726
33	Housing	IP52 and IK10 impact-resistant aluminum enclosure
34	Power	The camera shall support power over Ethernet IEEE 802.3at Type 1 Class 3
36	Access log	The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart.

37	Firmware Update	The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
38	Operating Temp	Operate in a temperature range of 0 °C to 50 °C
39	Operating Humidity	Operate in a humidity range of 10–85% RH
40	WDR approved	The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.
41	Camera OS	The camera shall operate Linux-based platform, and include a built-in web server.
42	Cybersecurity Approval	The camera OS should be ETSI EN 303 645
43	Certifications	NIST SP500-267,UL/cUL, IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-14,EN 55035, EN 55032 Class A, IEC/EN 60529 IP52/IP66, IEC/EN 62262 IK10, BIS
44	Memory	2048 MB RAM, 8192 MB Flash
45	Protocol	The Camera to be provided by the bidder all the components / parts / assembly / software used in the offered hardware and software, should not be complying to GB28181, GB/T 28181-2011; GB/T28181-2011; GBT 28181-2011; GBT28181-2011 standards. There should be no option to activate or deactivate these standards in the camera web page/Settings.
46	Active alerts on speaker	The camera should send trigger via HTTP/HTTPS to IP Speaker for active alerts.
47	NDAA Compliant	The proposed camera should be NDAA compliant.
48	Chipset/Processor	The Camera to be provided by the bidder should not have Hisilicon chipset/Processor.
49	Warranty	5 Years OEM Warranty

CCTV Camera Bullet (for indoor/ Outdoor application): -

Supply, installation, testing and commissioning of 2 MP Bullet camera with following specifications:

Sr. No.	Camera Characteristics	Minimum Specifications
1	Sensor type	1/2.8"Progressive Scan CMOS or better
2	True Day and Night	The camera shall provide a removable IR-cut filter, providing day/night functionality
3	Lens type	The camera shall be equipped with a varifocal 3-9 mm lens with and a 2 MP image sensor and The camera shall provide remote zoom and remote

		focus functionality.
4	Field of View	The camera shall be equipped with P-Iris, providing a horizontal field of view between 113°-37°
5	Sensitivity	The camera shall meet or exceed the following illumination specifications: a. Color: 0.1 lux at 50 IRE, F1.6, B/W: 0.05 lux at 50 IRE, F1.6, 0 lux with IR illumination on
6	Shutter Speed	The camera shall incorporate an electronic shutter operating in the ranges of - 1080p @25/30 fps: 1/50,500 s to 2 s
7	Video Compression	The camera shall provide independently configured H.264, H.265 and Motion JPEG streams.
8	Total sensor pixels & FPS	The camera shall support video resolutions including: 2 MP (1920x1080) at up to 25 frames per second (50Hz mode) with WDR using H.264, H265 or Motion JPEG.
9	Video Streams	Minimum 4 simultaneous Streams @ H.265 with 25fps @1920 x1080 or better
10	Smart compression	The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage: a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements. b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
11	Image Settings	The camera shall support manually defined values for: a. Saturation b. Brightness c. Sharpness d. Contrast
12	Intelligent defog	The camera shall incorporate automatic defog functionality
13	IR Range	The camera shall be equipped with built-in IR LEDs with adjustable angle of illumination and intensity and with a range of up to 40 m (131 ft) with a wavelength of 850 nm

14	IP addresses	<p>a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.</p> <p>b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature.</p> <p>c. The camera shall provide support for both IPv4 and IPv6.</p> <p>d. The camera shall provide support for IPv6 USGv6.</p>
15	Protocol	1. The camera shall incorporate support for at least HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP/RTSPS, TCP, UDP, RTCP, DHCPv4/v6, SSH, LLDP, CDP, MQTT.
16	Text Overlay	Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds
17	Security	The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
18	Password Protection	Restrict access to the built-in web server by usernames and passwords at three different levels.
19	Centralized certificate management	Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services
20	Hardware for data security	The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL6+.
21	Signed Firmware	The use of signed firmware validates the firmware's integrity before accepting to install it
22	Secure Boot	The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
23	Brute force attacks	The proposed camera should have builtin feature of Brute force delay protection to prevent camera from hacking.
24	Connectivity	Profile G,S,T and M

25	Application Programmers Interface	The camera shall provide a platform allowing the upload of third-party applications into the camera.
26	Analytics	The camera shall be equipped with a built-in, Machine-learning processing unit capable of executing neural network algorithms, such as object detection, classification and segmentation (including vehicle types, license plates, people and faces. line crossing, object in area, Loitering, Video Motion Detection, Tampering, Time in area.
27	Ethernet	The camera shall be equipped with one 10BASE-T/100BASE-TX/1000BASE-T PoE Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).
28	Digital I/O (Alarms)	The camera shall be equipped with one digital (alarm) input and one digital output.The output shall be able to provide 12 V DC, 15 mA.
29	Local Storage	The camera shall have built-in SD card slot upto 1 TB and The camera shall incorporate encryption functionality for the SD card (AES-XTS-Plain64 256bit).
30	Audio In	The camera shall be equipped with one 3.5 mm jack for line/mic input.
31	Audio Out	Speaker pairing
32	Encoding	AAC-LC 8/16/32/44.1/48 kHz, G.711, G.726
33	Housing	IP66/IP67-, and NEMA 4X-rated IK10 impact-resistant aluminum enclosure
34	Power	The camera shall support power over Ethernet IEEE 802.3at Type 1 Class 3
35	Access log	The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart.
36	Firmware Update	The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
37	Operating Temp	Operate in a temperature range of -40 °C to 60 °C
38	Operating Humidity	Operate in a humidity range of 10–100% RH (condensing).
39	WDR approved	The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.
40	Camera OS	The camera shall operate Linux-based platform, and include a built-in web server.

41	Cybersecurity Approval	The camera OS should be ETSI EN 303 645
42	Certifications	NIST SP500-267,UL/cUL, IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-14,EN 55035, EN 55032 Class A, IEC/EN 60529 IP66, IEC/EN 62262 IK10, BIS
43	Memory	1024 MB RAM, 512 MB Flash
44	Protocol	The Camera to be provided by the bidder all the components / parts / assembly / software used in the offered hardware and software, should not be complying to GB28181, GB/T 28181-2011; GB/T28181-2011; GBT 28181-2011; GBT28181-2011 standards. There should be no option to activate or deactivate these standards in the camera web page/Settings.
45	Active alerts on speaker	The camera should send trigger via HTTP/HTTPS to IP Speaker for active alerts.
46	NDAA Compliant	The proposed camera should be NDAA compliant.
47	Chipset/Processor	The Camera to be provided by the bidder should not have Hisilicon chipset/Processor.
48	Warranty	5 Years OEM Warranty

CCTV Camera Bullet (for indoor/ Outdoor application): -

Supply, installation, testing and commissioning of 5 MP Bullet camera with following specifications:

Sr. No.	Camera Characteristics	Minimum Specifications
1	Sensor type	1/1.2.8" progressive scan RGB CMOS
2	True Day and Night	The camera shall provide a removable IR-cut filter, providing day/night functionality
3	Lens type	The camera shall be equipped with a varifocal 3-8 mm IR-corrected megapixel P-Iris lens with a 5MP image sensor and The camera shall provide remote zoom and remote focus functionality.
4	Field of View	The camera shall be equipped with P-Iris, providing a horizontal field of view between 105°-38°
5	Sensitivity	The camera shall meet or exceed the following illumination specifications: a. Color: 0.1 lux at 50 IRE, F1.3, B/W: 0.05 lux at 50 IRE, F1.3, 0 lux with IR illumination on
6	Shutter Speed	The camera shall incorporate an electronic shutter operating in the range of 1/33500s to 1/5 s.
7	Video Compression	The camera shall provide independently configured H.264, H.265 and Motion JPEG streams.

8	Total sensor pixels & FPS	The camera shall support video resolutions including: 5MP (2592x1944) at up to 25 frames per second (50Hz mode) with WDR using H.264, H265 or Motion JPEG.
9	Video Streams	Minimum Two simultaneous H.265 streams in 5MP at 25/30 fps or eight simultaneous H.265 streams in HDTV 1080P at 25/30 fps.
10	Smart compression	The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage: a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements. b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
11	Image Settings	The camera shall support manually defined values for: a. Saturation b. Brightness c. Sharpness d. Contrast
12	Intelligent defog	The camera shall incorporate automatic defog functionality
13	IR Range	The camera shall be equipped with built-in IR LEDs with adjustable angle of illumination and intensity and with a range of up to 40 m (131 ft) with a wavelength of 850 nm
14	IP addresses	a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server. b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature. c. The camera shall provide support for both IPv4 and IPv6. d. The camera shall provide support for IPv6 USGv6.
15	Protocol	1. The camera shall incorporate support for at least HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP,DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP/RTSPS, TCP, UDP,RTCP, DHCPv4/v6, SSH, LLDP, CDP, MQTT.

16	Text Overlay	Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds
17	Security	The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
18	Password Protection	Restrict access to the built-in web server by usernames and passwords at three different levels.
19	Centralized certificate management	Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services
20	Hardware for data security	The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL6+. The product shall include a tamper-resistant hardware module. The module shall use a Trusted Execution Environment (TEE), providing a set of cryptographic features suitable for protecting private keys from unauthorized access.
21	Signed Firmware	The use of signed firmware validates the firmware's integrity before accepting to install it
22	Secure Boot	The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
23	Brute force attacks	The proposed camera should have builtin feature of Brute force delay protection to prevent camera from hacking.
24	Connectivity	Profile G,S,T and M
25	Application Programmers Interface	The camera shall provide a platform allowing the upload of third-party applications into the camera.
26	Analytics	The camera shall support advanced video analytics capabilities with a built-in hardware-accelerated object detect engine, capable of automatically detecting several simultaneously visible objects metadata from a set of pre-trained object categories (such as vehicles, license plates, people and faces). line crossing, object in area, Loitering, occupancy, Video Motion Detection, Tampering

27	Ethernet	The camera shall be equipped with one 10BASE-T/100BASE-TX/1000BASE-T PoE Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).
28	Digital I/O (Alarms)	The camera shall be equipped with one digital (alarm) input and one digital output.The output shall be able to provide 12 V DC, 15 mA.
29	Local Storage	The camera shall have built-in SD card slot upto 1 TB and The camera shall incorporate encryption functionality for the SD card (AES-XTS-Plain64 256bit).
30	Audio In	The camera shall be equipped with one 3.5 mm jack for line/mic input.
31	Audio Out	Speaker pairing
32	Encoding	AAC-LC 8/16/32/44.1/48 kHz, G.711, G.726
33	Housing	IP66/IP67-, and NEMA 4X-rated IK10 impact-resistant aluminum enclosure
34	Power	The camera shall support power over Ethernet IEEE 802.3at Type 1 Class 3
35	DC Input, Power	The camera shall be equipped with one DC input connector - 10–28 V DC
36	Access log	The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart.
37	Firmware Update	The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
38	Operating Temp	Operate in a temperature range of -40 °C to 60 °C
39	Operating Humidity	Operate in a humidity range of 10–100% RH (condensing).
40	WDR approved	The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.
41	Camera OS	The camera shall operate Linux-based platform, and include a built-in web server.
42	Cybersecurity Approval	The camera OS should be ETSI EN 303 645
43	Certifications	NIST SP500-267,UL/cUL, IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-14,EN 55035, EN 55032 Class A, IEC/EN 60529 IP66, IEC/EN 62262 IK10, BIS
44	Memory	2048 MB RAM, 8192 MB Flash

45	Protocol	The Camera to be provided by the bidder all the components / parts / assembly / software used in the offered hardware and software, should not be complying to GB28181, GB/T 28181-2011; GB/T28181-2011; GBT 28181-2011; GBT28181-2011 standards. There should be no option to activate or deactivate these standards in the camera web page/Settings.
46	Active alerts on speaker	The camera should send trigger via HTTP/HTTPS to IP Speaker for active alerts.
47	NDAA Compliant	The proposed camera should be NDAA compliant.
48	Chipset/Processor	The Camera to be provided by the bidder should not have Hisilicon chipset/Processor.
49	Warranty	5 Years OEM Warranty

CCTV Camera ANPR Bullet (for indoor/ Outdoor application): -

Supply, installation, testing and commissioning of 2 MP ANPR Bullet camera with following specifications:

Sr. No.	Camera Characteristics	Minimum Specifications
1	Sensor type	1/2.8"Progressive Scan CMOS or better
2	True Day and Night	The camera shall provide a removable IR-cut filter, providing day/night functionality
3	Lens type	The camera shall be equipped with a varifocal 3-9 mm lens with and a 2 MP image sensor and The camera shall provide remote zoom and remote focus functionality.
4	Field of View	The camera shall be equipped with P-Iris, providing a horizontal field of view between 113°-37°
5	Sensitivity	The camera shall meet or exceed the following illumination specifications: a. Color: 0.1 lux at 50 IRE, F1.6, B/W: 0.05 lux at 50 IRE, F1.6, 0 lux with IR illumination on
6	Shutter Speed	The camera shall incorporate an electronic shutter operating in the ranges of - 1080p @25/30 fps: 1/50,500 s to 2 s
7	Video Compression	The camera shall provide independently configured H.264, H.265 and Motion JPEG streams.
8	Total sensor pixels & FPS	The camera shall support video resolutions including: 2 MP (1920x1080) at up to 25 frames per second (50Hz mode) with WDR using H.264, H265 or Motion JPEG.
9	Video Streams	Minimum 4 simultaneous Streams @ H.265 with

		25fps @1920 x1080 or better
10	Smart compression	<p>The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage:</p> <ul style="list-style-type: none"> a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements. b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements
11	Image Settings	<p>The camera shall support manually defined values for:</p> <ul style="list-style-type: none"> a. Saturation b. Brightness c. Sharpness d. Contrast
12	Intelligent defog	The camera shall incorporate automatic defog functionality
13	IR Range	The camera shall be equipped with built-in IR LEDs with adjustable angle of illumination and intensity and with a range of up to 40 m (131 ft) with a wavelength of 850 nm
14	IP addresses	<ul style="list-style-type: none"> a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server. b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature. c. The camera shall provide support for both IPv4 and IPv6. d. The camera shall provide support for IPv6 USGv6.
15	Protocol	1. The camera shall incorporate support for at least HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP,DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP/RTSPS, TCP, UDP,RTCP, DHCPv4/v6, SSH, LLDP, CDP, MQTT.
16	Text Overlay	Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds

17	Security	The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
18	Password Protection	Restrict access to the built-in web server by usernames and passwords at three different levels.
19	Centralized certificate management	Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services
20	Hardware for data security	The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL6+.
21	Signed Firmware	The use of signed firmware validates the firmware's integrity before accepting to install it
22	Secure Boot	The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
23	Brute force attacks	The proposed camera should have builtin feature of Brute force delay protection to prevent camera from hacking.
24	Connectivity	Profile G,S,T and M
25	Application Programmers Interface	The camera shall provide a platform allowing the upload of third-party applications into the camera.
26	Analytics	The camera shall be equipped with a built-in, Machine-learning processing unit capable of executing neural network algorithms, such as object detection, classification and segmentation (including vehicle types, license plates, people and faces. line crossing, object in area, Loitering, Video Motion Detection, Tampering, Time in area.
27	Ethernet	The camera shall be equipped with one 10BASE-T/100BASE-TX/1000BASE-T PoE Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).
28	Digital I/O (Alarms)	The camera shall be equipped with one digital (alarm) input and one digital output.The output shall be able to provide 12 V DC, 15 mA.
29	Local Storage	The camera shall have built-in SD card slot upto 1 TB and The camera shall incorporate encryption functionality for the SD card (AES-XTS-Plain64

		256bit).
30	Audio In	The camera shall be equipped with one 3.5 mm jack for line/mic input.
31	Audio Out	Speaker pairing
32	Encoding	AAC-LC 8/16/32/44.1/48 kHz, G.711, G.726
33	Housing	IP66/IP67-, and NEMA 4X-rated IK10 impact-resistant aluminum enclosure
34	Power	The camera shall support power over Ethernet IEEE 802.3at Type 1 Class 3
35	Access log	The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart.
36	Firmware Update	The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.
37	Operating Temp	Operate in a temperature range of -40 °C to 60 °C
38	Operating Humidity	Operate in a humidity range of 10–100% RH (condensing).
39	WDR approved	The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.
40	Camera OS	The camera shall operate Linux-based platform, and include a built-in web server.
41	Cybersecurity Approval	The camera OS should be ETSI EN 303 645
42	Certifications	NIST SP500-267,UL/cUL, IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-14,EN 55035, EN 55032 Class A, IEC/EN 60529 IP66, IEC/EN 62262 IK10, BIS
43	Memory	1024 MB RAM, 512 MB Flash
44	Protocol	The Camera to be provided by the bidder all the components / parts / assembly / software used in the offered hardware and software, should not be complying to GB28181, GB/T 28181-2011; GB/T28181-2011; GBT 28181-2011; GBT28181-2011 standards. There should be no option to activate or deactivate these standards in the camera web page/Settings.
45	Active alerts on speaker	The camera should send trigger via HTTP/HTTPS to IP Speaker for active alerts.
46	NDAA Compliant	The proposed camera should be NDAA compliant.
47	Chipset/Processor	The Camera to be provided by the bidder should not have Hisilicon chipset/Processor.

48	Warranty	5 Years OEM Warranty
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PTZ Camera (for outdoor application):

Supply, installation, testing and commissioning of 4 MP PTZ camera with following specifications:

Sr. No.	Camera Characteristics	Minimum Specifications
1	Sensor type	1/2.9" Progressive Scan CMOS or better
2	True Day and Night	The camera shall provide a removable IR-cut filter, providing day/night functionality
3	Lens type	The camera shall be equipped with a varifocal 4.5 – 135 lens with and a 4MP image sensor and The camera shall provide with autofocus and auto-iris.
4	Zoom ratio	The camera shall be equipped with a motorized 30x optical zoom lens and 12x digital zoom or better
5	PTZ	Pan: 360° endless, Tilt 0° to 90° Pan and Tilt speed : 0.1°–220° /sec Provide more than 255 manually set preset positions
6	Tour	Provide a tour functionality which allows the dome to automatically move between selected presets using an individual speed and viewing time for each preset.
7	Field of View	The camera shall be equipped with P-IRIS, providing a Horizontal field of view: 57°–2°
8	Sensitivity	The camera shall meet or exceed the following illumination specifications: a. Color: 0.2 lux at 50 IRE, F1.6, B/W: 0.05 lux at 50 IRE, F1.6, 0 lux with IR illumination on
9	Shutter Speed	The camera shall incorporate an electronic shutter operating in the range of 1/50,000 s to 1/2 s.
10	Video Compression	The camera shall provide independently configured H.264, H.265 and Motion JPEG streams.
11	Total sensor pixels & FPS	The camera shall be designed to provide video streams in 4MP (2688x1512) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264, H265 or Motion JPEG.
12	Video Streams	Minimum 2 simultaneous H.265 streams in HDTV 4MP at 25/30 fps.
13	Smart compression	The camera shall support scene adaptive bitrate control with one of the following capabilities to lower bandwidth and storage: a. Automatic dynamic Region of Interest to reduce bitrate in unprioritized regions in order to lowering bandwidth and storage requirements. b. Automatic dynamic Group of Pictures to lower bandwidth and storage requirements c. Automatic dynamic Frames per Second to lower bandwidth and storage requirements

14	Image Settings	The camera shall support manually defined values for: a. Saturation b. Brightness c. Sharpness d. Contrast
15	Electronic Image Stabilization (EIS)	The camera shall incorporate a function for Electronic Image Stabilization (EIS) for real-time image stabilization.
16	Intelligent defog	The camera shall incorporate automatic defog functionality
17	IR Range	The camera shall be equipped with built-in IR LEDs with adjustable angle of illumination and intensity and with a range of up to 200 m with a wavelength of 850 nm
18	IP addresses	a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server. b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a computer with an operating system supporting this feature. c. The camera shall provide support for both IPv4 and IPv6. d. The camera shall provide support for IPv6 USGv6.
19	Protocol	The camera shall incorporate support for at least HTTPS, HTTP/2, TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, DNS/DNSv6, DDNS, NTP, NTS, RTSP, RTP, SRTP/RTSPS, TCP, UDP, RTCP, DHCPv4/v6, SSH, LLDP, CDP, MQTT.
20	Text Overlay	Provide the possibility to choose different font sizes for embedded on-screen text, and to use white or black text on at least four different backgrounds
21	Security	The use of HTTPS and TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
22	Password Protection	Restrict access to the built-in web server by usernames and passwords at three different levels.
23	Centralized certificate management	Provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services

24	Hardware for data security	The product shall include a tamper-resistant hardware module, certified to at least Common Criteria EAL6+.
25	Signed Firmware	The use of signed firmware validates the firmware's integrity before accepting to install it
26	Secure Boot	The use of a secure boot process, based on the use of signed firmware, ensures that the camera can boot only with authorized firmware.
27	Brute force attacks	The proposed camera should have builtin feature of Brute force delay protection to prevent camera from hacking.
28	Connectivity	Profile G,S,T and M
29	Application Programmers Interface	The camera shall provide a platform allowing the upload of third-party applications into the camera.
30	Analytics	The camera shall support advanced video analytics capabilities with a built-in hardware-accelerated object detect engine, capable of automatically detecting several simultaneously visible objects metadata from a set of pre-trained object categories (such as vehicles, license plates, people and faces). Built-in Analytics - line crossing, object in area, Loitering, Cross line counting, Video Motion Detection, Shock detection and Autotracking.
31	Ethernet	The camera shall be equipped with one 10BASE-T/100BASE-TX Ethernet-port using a RJ45 connector and shall support auto negotiation of network speed and transfer mode (full and half duplex).
32	Temperature control	The camera should have a built-in temperature control mechanism.
33	Local Storage	The camera shall have built-in SD card slot upto 1 TB and The camera shall incorporate encryption functionality for the SD card (AES-XTS-Plain64 256bit).
34	Housing	IP66, and NEMA 4X-rated IK10 impact-resistant aluminum enclosure
35	Power	The camera shall support power over Ethernet IEEE 802.3bt Type 4
36	Access log	The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart.
37	Firmware Update	The manufacturer must provide firmware with long-term support that only contains corrections for critical bugs, security flaws and performance issues.

38	Operating Temp	Operate in a temperature range of -20 °C to 50 °C, Maximum temperature : 65 °C during peak hours
39	Operating Humidity	Operate in a humidity range of 10–100% RH (condensing).
40	WDR approved	The camera shall incorporate forensic wide dynamic range functionality providing up to 120 dB dynamic range.
41	Camera OS	The camera shall operate Linux-based platform, and include a built-in web server.
42	Cybersecurity Approval	The camera OS should be ETSI EN 303 645
43	Certifications	NIST SP500-267,UL/cUL, IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-14,EN 55035, EN 55032 Class A, IEC/EN 60529 IP66, IEC/EN 62262 IK10, BIS
44	Memory	1024 MB RAM, 512 MB Flash
45	Protocol	The Camera to be provided by the bidder all the components / parts / assembly / software used in the offered hardware and software, should not be complying to GB28181, GB/T 28181-2011; GB/T28181-2011; GBT 28181-2011; GBT28181-2011 standards. There should be no option to activate or deactivate these standards in the camera web page/Settings.
46	Active alerts on speaker	The camera should send trigger via HTTP/HTTPS to IP Speaker for active alerts.
47	NDAA Compliant	The proposed camera should be NDAA compliant.
48	Chipset/Processor	The Camera to be provided by the bidder should not have Hisilicon chipset/Processor.
49	Warranty	5 Years OEM Warranty

All-in-One Recording, Viewing and Management Solution with VMS:

Sr. No.	Description	Required Parameters
1	No. of Cameras supported	96 CH Included and can be upgraded to 150 CH by additional licenses.
2	Processor	Intel® Xeon® Silver
3	Memory	2x 16 GB
4	Storage	192 TB (12x16 TB) hot swappable Enterprise Class HDD, 160 TB usable space after RAID 6 RAID levels: 0, 1, 5, 6, 10
5	Operating Systems	Microsoft Windows 10 IoT Enterprise Operating system drive: 240 GB SSD

6	Network Card	2x RJ45 Ports 1GBPS
7	Recording	Shall support recording up to 150 video channels with a total recording rate up to 1.5 Gbit/s.
8	Software	Compatible with Cameras, Encoders including HD, Standard resolution, High Resolution, Pant Tilt, Zoom, Thermal, Cameras, Access Control, IP Speakers, Alarm IO Modules
9	Security	Support for encrypted operating system drive and recording drive FIPS 140-2 level 2 certified Trusted Platform Module (TPM 2.0)
10	Video compression	H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles, H.265 (MPEG-H Part 2/HEVC) Main Profile, MPEG-4, Motion JPEG
11	Map function	Support Required
12	PTZ Control	Required
13	Smart Search for recordings	Required
14	Playback	Up to 64x or frame by frame Up to 25 cameras synchronized playback
15	Export	Manual and scheduled export, Digital signature on exported recordings, Password protection when exporting to ZIP, Export to ASF, MP4 and MKV
16	Scheduled recording	The software shall allow recordings for continuous, motion based, event based, or customized as per user/ scheduled
17	Alarm Manager	Yes Required
18	Microsoft Active Directory support	Yes, multiple user access levels with password protection using local or Windows domain users (Active directory)
19	Event triggers	Events triggered by video motion detection, Active Tampering Alarm, Cross Line Detection, External I/O, Action button, System triggers and device event triggers, Manual Triggers, Edge Based Analytic Triggers
20	Power	2 x 800 W hot-plug redundant power supplies
21	Connectors	2x USB 2.0,1x USB 3.0,2x VGA,2x iDRAC dedicated Ethernet port,2x RJ45 1 Gbps
22	Operating conditions	10 °C to 35 °C (50 °F to 95 °F)

23	Certification	IEC/EN/UL 60950-1, IEC/EN/UL 62368-1, EN 62311, NOM-019-SCFI-1998, NDAA (National Defense Authorization Act), 55032 Class A, EN 55024, EN 55035, EN 61000-3-2, EN 61000-3-3,
24	Form Factor	Rack/ Tower
25	Warranty	5 Years

VMS- Video Management System:

SERVER for Viewing :

Intel i7 latest generation or equivalent AMD latest generation RAM: 16 GB (8 GB recommended for larger systems) Operating system: 64-bit operating system, 256 GB SSD, Nvidia T600 or similar, 1x NIC @ 1 Gbps,

VMS Software:

Sr. No.	Video Management System
1	The video management software shall be of manufacturer's official product line, designed for commercial and/or industrial 24/7/365 use.
2	The video management software shall be based upon standard tools and proven technology using open and published protocols
3	The specified unit shall be manufactured in accordance with ISO 14001.
4	The specified unit shall be compliant with the EU directives 2011/65/EU (RoHS) and 2012/19/EU (WEEE)
5	The specified unit shall be compliant with the EU regulation 1907/2006 (REACH).
6	The specified software shall support relevant parts of the following video standards: 1. Video a. SMPTE 296M (HDTV 720p) b. SMPTE 274M (HDTV 1080p) c. SMPTE ST 2036-1 (UHDTV)
7	Interoperability a. Support video from IEC 62676-2-3 conformant devices b. Support video from ONVIF Profile S conformant devices
8	The specified software shall meet the following standards: 1. MPEG-4: a. ISO/IEC 14496-10 Advanced Video Coding (H.264) b. ISO/IEC 14496-2 (Profiles ASP and SP) (MPEG-4 Part 2)
9	The proposed VMS Clients can connect to multiple servers simultaneously.

10	c. The video management app shall provide full functionality when operated in the following environment: 1. One of the following versions: a. Apple iOS 10.3 or higher b. Google Android 5.0 or higher
11	The video management software shall accept video and audio from network cameras and video encoders compliant with relevant parts of IEC62676-2-3.
12	The proposed VMS should have Private network setup with cloud connectivity
13	The proposed VMS web client using Cloud Connect for server acces.
14	Cloud Services:- cloud web client
15	The video management software shall support traditional network cameras and video encoders as well as thermal network cameras.
16	The video management software shall, when operating in a fully supportive environment, be able to record at least 70 individually configured full frame rate video streams in full HDTV 1080p (1920x1080 pixels) over IP networks
17	The video management software shall, when operating in a fully supportive environment, be able to record full frame rate video streams in 4K Ultra HD (3840x2160) over IP networks.
18	The video management software shall provide a total recording capacity of at least 2100 frames per second.
19	The video management software shall, for each channel: a. Support Motion JPEG recording in a selectable range up to 30 fps. b. Support MPEG4 Part 2 recording in a selectable range up to 30 fps. c. Support H.264 recording in a selectable range up to 120 fps. d. Support Baseline, Main and High Profile H.264 decoding in up to 120 fps. e. Support Main Profile H.265 decoding in up to 120 fps. f. Support dynamic media profile selection for live view with all supported profiles.
20	The video management software shall support the use of wide angle / 360 degree camera.
21	Transmission a. The video management software shall allow for video to be transported over: 1. Multipart HTTP (Unicast) 2. RTP or RTSP over HTTP (Unicast) 3. MP4 over HTTPS (mobile apps)
22	The video management software shall support the following audio specifications:
23	The video management software shall support two-way, full duplex audio encoded with the video stream with supported network cameras (one-way for third-party cameras).
24	The video management software shall support the following audio quality: 1. 24bit LPCM 2. AAC-LC 8/16/32/48 kHz 3. G.711 PCM 8 kHz, G.726 4. ADPCM 8 kHz 5. Opus 8/16/48 kHz
25	It shall be possible to assign/link a microphone or speaker to a defined video device.

26	The video management software shall support active echo cancellation and noise reduction.
27	<p>The video management software shall support the following Input/Output functionality:</p> <ol style="list-style-type: none"> 1. Accept notifications and alarms from an unlimited number of auxiliary devices connected to the network. 2. Received notifications and alarms shall be able to generate events within the video management software.
	Client functionality
28	a. The video management software shall be equipped with a graphical user interface, providing the following functionality:
	1. Display up to 25 different video streams.
	2. Display up to 100 different video streams using multiple split views.
	3. Support optimized rendering for smooth display of video in resolutions up to 4K.
	4. Provide real-time navigation between multi-views using a quick view button.
	5. Support drag and drop of video sources within the user interface.
	6. Support multiple screens when operating on a computer supporting this.
	7. Be able to display facility maps with interactive camera icons to call up live video and audio from the selected camera.
	<p>8. Be able to import graphical map data in the following formats:</p> <ol style="list-style-type: none"> a. JPEG b. BMP c. PNG d. GIF
	9. Access to functions such as floor plans, video streams, split views, input/outputs, playback, snapshots and alerts shall be configurable on a user level.
	10. Support any aspect ratio provided by the camera, including landscape format (4:3 and 16:9 aspect ratio) and corridor format (3:4 and 9:16 aspect ratio).
	11. Availability in at least 20 different languages and include support for double byte character set.
29	The video management software shall provide the following user functionality.
	<ol style="list-style-type: none"> 1. Live view functionality: <ol style="list-style-type: none"> a. Single camera live view b. Multi-views c. Sequence views d. Multi Ultra HD camera live views (3x 4K views) e. Flexible live view configuration f. Site maps and web page view g. Digital PTZ

	<p>2. Recording functionality:</p> <ul style="list-style-type: none"> a. Continuous recording b. Locking of prioritized recordings c. Scheduled recording - customization of weekday and weekend recordings d. Event driven recording e. Manually initiated recording f. Individually and configurable resolution and frame rate for each video source. g. Unlimited recorded material based on availability of storage device. h. Smart search for recordings based on camera, date and timeline visualization i. Video and audio shall be recorded using a manufacturer-designed format preventing manipulation of the content and shall contain information about date, time and source of the recorded material. j. Retrieval of failover recordings from cameras or encoders.
	<p>3. Playback functionality:</p> <ul style="list-style-type: none"> a. Synchronized playback from up to 36 cameras of at least four different recorded video streams, up to 64x or frame by frame. b. Playback at least eight simultaneous full frame rate Full HDTV 1080p (1920x1080 pixels) video streams. c. Export (manual or scheduled) multiple selected video and audio sequences to ASF-formats together with standalone player. d. Digital signature on exported recordings.
	<p>4. Search functionality</p> <ul style="list-style-type: none"> a. Provide an ability to search for video based upon the following criteria's: <ul style="list-style-type: none"> 1. Time & Date 2. By camera 3. Motion detection within a customizable area of the video 4. Video streaming content b. Support so called scrubbing for effective search functionality.
30	PTZ functionality:
	a. The video management software shall for each video channel
	1. Provide the ability to control Pan, Tilt and Zoom functionality directly from the user interface.
	2. Provide at least 100 preset positions, camera depending.
	3. Support guard tour functionality, which allows the PTZ device to automatically move between selected presets using an individual viewing time for each preset
	4. Support PanTilt control by clicking in the image to move the camera using the mouse.
	5. Support zoom control by selecting an area in the image using the mouse.
	6. Support the use of hotkeys, joystick, keyboard and other control boards.
31	Event functionality
	a. The video management software shall be equipped with an event functionality, supporting events triggered in a camera, encoder or other network connected device, and include support for the following triggers:

	<ul style="list-style-type: none"> b. Detectors functionality <ul style="list-style-type: none"> 1. Video motion detection 2. Audio detection 3. Alarm functionality c. Hardware functionality d. Storage functionality <ul style="list-style-type: none"> 1. Failover recording recovery - recovery of local recordings in camera or encoder after connection disruption 2. Recording error 3. Storage full e. System functionality <ul style="list-style-type: none"> 1. Embedded third-party applications 2. Cross Line Detection 3. Action button 4. Lost connection to network camera, encoder or network disk 5. Schedule 6. External I/O and external HTTPS triggers 7. Device event triggers f. Response to triggers shall include: <ul style="list-style-type: none"> 1. Selecting predefined live-view 2. Visual and audible notification 3. Recording of video at defined image quality and frame rate 4. Storing of pre-alarm video at the captured frame rate 5. Activating external outputs on a camera, encoder or other network connected device 6. PTZ control functionality 7. Notification of event, using email or HTTP
32	The video management software shall provide an event history list, containing up to one year of history
33	<ul style="list-style-type: none"> a. The video management software shall incorporate support for at least IP, HTTP, HTTPS, TCP, ICMP, RTSP, RTP, RTCP, SMTP, DHCP, UPnP, DNS, Bonjour and LDAP. b. The SMTP implementation shall include support for SMTP authentication.
34	<ul style="list-style-type: none"> a. The video management software shall operate using static or dynamic IP addresses. b. The video management software shall provide support for addresses provided by a Dynamic Name Server (DNS). c. The video management software shall allow for automatic detection of cameras and encoders using UPnP and Bonjour.
35	<p>Time</p> <ul style="list-style-type: none"> a. The video management software shall utilize NTP as provided by the server. b. The video management software shall support multiple date formats for regional adoption.
36	<ul style="list-style-type: none"> a. The video management software shall provide the following: <ul style="list-style-type: none"> 1. Authentication of nodes using Kerberos 2. Authentication using Microsoft Active Directory 3. Restrict access to the systems by usernames and passwords at a minimum of three

	different levels.
37	<p>The video management software shall:</p> <ol style="list-style-type: none"> 1. Provide the ability to create multiple users of the system, either from local PC users or through Active Directory, each with individual definable user rights. 2. Provide the ability to assign IP address and configure new and replaced cameras and encoders. 3. Provide an ability to back up system configuration. 4. Provide the ability to upgrade firmware in individual cameras and encoders. 5. When connected to Internet, be able to locate suitable firmware updates and download these. 6. Provide an ability to create a system report of the complete system. This report shall include at least camera name, IP-address and firmware version. 7. Utilize a license model supporting unlimited and flexible system growth where scalability is only limited by overall server performance. 8. Support defining of individual database retention per camera for a selectable number of days or hours.

Annexure-III

TECHNICAL SPECIFICATION OF INTERNAL ELECTRIFICATION WORKS

1.ILLUMINATION DESIGN:

a.INPUT DATA

Entire playing arena for Football field of dimensions as per attached drawing shall be considered for the purpose of lighting design by the bidders. Bidders are also requested to take into consideration obstructions due to canopy over the spectators while working out the lighting design. Bidders are advised to visit the site and carry out detailed site survey before quoting.

b.LIGHTING PARAMETERS

Following illuminance parameters shall be considered for the purpose of lighting design and which is also required output:

☑Horizontal Illuminance is to be considered at ground level In addition to the above, following parameters needs to be considered.

☑Glare restriction: Glare rating (GR) ≤ 50 .

☑ColorTemperatureoflamp:5700K (± 350 per ANSI CCT standard)

☑Project Maintenance factor to be considered: max 0.85

c. Provision for International Lighting:- High Mast Pole i/c foundation shall be designed as per Lux level defined in Table-A.

d.The switching arrangement needs to be done as per below tabulated lux level .

TABLE-A

S.No Event Application -
Area

Minimum
Average
horizontal
illuminance

Uniformity

U1:MIN/MAX U2:MIN/AVG

1 National (Non
Televised)

Foot Ball
Ground 1250Lux 0.4 0.6

2 Practice Foot Ball

Ground 800Lux 0.4 0.6

The aiming of fixtures shall be as per events provided in Table-A. However, each fitting shall have individual MCBs also. The switching pattern of the fitting shall be such that by

switching on/off by single/combination switch per pole. The schematic diagram shall be displayed and MCBs marked in the panel accordingly. The design & drawing of Electrical Panel shall be got approved from Engineer-in-charge before installation.

d. Agency shall submit computerized lighting design print outs showing the locations of high masts, illuminance plot for vertical and horizontal illuminance values, glare parameters and summary of lighting parameters achieved by them after award of work, which shall be approved by Engineer- in- Charge prior to execution of work.

e. Agency shall submit design of High mast poles, Foundation, Fixtures, Panels and after that complete design and all items as per requirement of AUTHORITY shall be prepared and got approved from competent authority after award of work and prior to execution. All this is in the scope of agency and nothing extra shall be paid on this account.

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SCOPE OF WORK:

Illumination design of the stadium as per above guidelines and approval from competent authority and validation of the same by measurement of illumination levels in the presence of Engineer-in-charge at site. The bidder / OEM must have to be qualify the below mentioned technical parameters during evaluation of technical Bid.

LED Package

1. Identical high power LED packages of 3 watt minimum to 5 watt maximum are to be used in all lamps.
2. The Average Lumen Maintenance summary needs to be submitted at the different case temperature (Soldering Point) at Ts: 55 oC, 85 oC & 105 oC.
3. The Colour Rendering Index (CRI): ≥ 70
4. Maintenance factor: 0.9 for LED
5. Correlated Colour Temperature (CCT): 5700K + 350K
6. The estimate Life span of LED should be $> 90,000$ hours at driving current of LED to a minimum of 1000 mA and maximum of 1500 mA. The graphical chart for of the TM – 21 needs to be submitted at the different case temperature (Soldering Point) at Ts : 55 oC, 85 oC & 105 oC. For all the three test condition the estimated life hours must be > 90000 (as reported L70)
7. Also as per L90 to estimate of life should $> 90,000$ hours at at driving current of LED to a minimum of 800 mA and maximum of 1500 mA. The graphical chart for of the TM – 21 needs to be submitted at the different case temperature (Soldering Point) at Ts : 55 oC, 85 oC & 105 oC. For all the two test condition the estimated life hours must be > 90000 (as reported L90).
8. LM – 80 test report along with TM – 21 report needs to be submitted.
9. The photo biological safety norms need to be submitted as per IEC 62471 / EN 62471 / IS 16108.

LUMINARIES TECHNICAL DETAILS:

1. The wattage of the LED Luminaries minimum 950 Watt & maximum to 1500 Watt.
2. The system efficacy of the Luminaries should be ≥ 110 Lm / W. With CRI – ≥ 70 .
3. The Ingress Protection Should not less than IP 66.
4. The Impact Resistance should not less than IK 08.
5. The offered weather proof LED Luminaire is provided with secondary lens / optics. The same shall of PMMA / Borosilicate glass / Polycarbonate type.
6. Total Harmonic Distortion should be less than 10% for the complete fixture.
7. The fittings shall be provided with pre-installed terminal blocks with Cu. Lugs suitable for termination

of 3C x 2.5 sq.mm. copper cable. Offered weather proof LED light fittings shall be suitable for bracket mounting.

8.The product should comfortable with Ambient Temperature: 0 oC to +50 oC

9.The flood light should be a state of the art design allowing easy mounting.

10. The fixture with mounting accessories to be supplied as per site requirement. The housing of the Sports flood light must be Modular type with Pressure die cast aluminum housing with fins The aim & adjustable bracket having smooth finish powder coated embossed / Engraved / printed with company logo.

11. The product Luminaire must be modular type. However, if modular type is provided then maximum 3 (Three) Nos module are allowed with proper air gap for natural cooling. The Heat sink to be suitably designed & properly integrated with the Luminaire body itself for effective cooling of the LED.

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12. The required hardware & fasteners for installation of the offered weather proof LED Luminaire shall be supplied along with each Luminaire. All the supplied hardware & fasteners shall be of Stainless Steel (SS).

13. The type test report/ certificate as per relevant standards on selected sample need to be submitted as per IS: 10322.

14. The bidder / OEM has to provide the test report for LED junction temperature should not $\geq 85^{\circ}\text{C}$ at the ambient temperature of 25°C and with internal surge protection of minimum 5KV.

15. The BIS of the complete product needs to be provided with the technical bid.

16. The Force driven cooling by Fan/ Liquid cooling single housing Luminaire is not acceptable. The cooling of Luminaire including LED lamp, LED driver, electronic components and all accessories shall be through natural cooling only.

17. The LM 79 from UL/NABL/Third party Lab, LM80, Polar diagram, Cone diagram, IES file, catalogue needs to be submitted during the Bid to evaluate the above parameters.

18. Flood light should be having 5 years warranty. The Firm will arrange the 5 years warranty certificate from the manufacturer clearly mentioning the details of the fitting supplied to AUTHORITY under this contract.

Driver Technical Details:

1.The bidder / OEM has to provide the test report for LED junction temperature should not $\geq 85^{\circ}\text{C}$ at the ambient temperature of 25°C and with internal surge protection of minimum 5KV.

2.The driver should be epoxy encapsulated within the light fixture that has separate optical & driver compartment, driver single Integrated constant current potted electronic driver. The fixture, with the encapsulated driver inside, must be IP-66 compliant.

3.Serviceability of LED Luminaries: The driver can be replaced at site if required.

4.The efficiency shall be more than 85 % in all cases at all times during project period.

5.Maintenance friendly and a separate compartment in main housing for external SPD or external fixing arrangement (bolted only) for external SPD below the light on the non-light emitting surface of the housing.

6.Protection from Voltage surges (SPD) Firm may provide appropriate surge protection arrangement, at each Flood Light, to protect the Flood Light from switching surges, which are expected / prevalent in Flood Light supply networks in India. Additionally, as per ANSI C 136.2-2014/ UL-1449/ IEC 61643-11, External Surge protection (SPD) with Thermal Protection (TMOVs) of minimum 10KV/5KV with capability to withstand a minimum of 15 pulses of 10KV/5KV to be separately installed (fixed

with screws) with each fixture below the Light with IP 66 protection for incoming and outgoing wires on SPD and Light. Alternatively, the external SPD may be provided inside the driver compartment or special enclosed compartment adjoining the driver compartment or adjoining it with proper fixing (bolting / DIN rail arrangement) for SPD inside. The SPD shall follow IEC 62305 & IEC 61643-11-2011.

7. Housing - Electrical Compartment of Driver box contains cable glands for cable entries, and push in terminals for mains and control input. Electrical connection box of floodlight contains cable glands and push-in terminals enabling electrical connection to driver box. The end-caps can be easily opened to access the bolts to aim the floodlight; the slot-hole in the bracket facilitates flexible installation.

8. BIS certificate / Safety test for Drivers as per IS: 15885 is must be submitted for driver.

9. The driver should be EMI/EMC Compliance as per IEC:61547.

10. The driver safety requirement needs to be qualify as per IEC:61347-2-13/EN:61347-2-13/IS:15885-2-1.

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TECHNICAL SPECIFICATIONS OF THE EQUIPMENTS:

HIGH MASTS

High masts shall be polygonal, continuously tapering, hot dip galvanized with suitable fixed type head frame for mounting the flood light fixtures.

Polygonal high masts offered shall have following special features

1. Masts shall be structurally designed in accordance with PLG 7– latest edition considering the gust wind speed as per IS 875 prevailing in the region.

2. The steel used in the construction of the masts shall comply with IS 2062 grade E350 / BS EN 10025 or Equivalent having minimum yield strength of 350 N/Sq. mm.

3. The High mast shall be of continuously tapered, polygonal cross section, presenting a good and pleasing appearance and shall be based on proven In-Tension design conforming to the standards referred to above to give an assured performance and reliable service.

4. The mast shaft shall be manufactured from high tensile steel plates confirming to IS 2062/ BS EN 10025 having minimum yield strength of (Grade 65) 350N/Sq.mm and silicon content less than 0.06%.

5. For the environmental protection of the mast, the entire fabricated mast shall be hot dip galvanized internally and externally having a uniform average coating of 85 microns for plates more than 6 mm and 70 microns for plates 6 mm and less thickness. The Zinc shall have minimum 99.995% purity confirming to IS 209.

6. The length of any individual segment shall be such that it can be easily transported and erected. All similar parts shall be made strictly inter-changeable. Mast segments, as far as possible, shall be fabricated in single piece. In case of restriction due to the size of hot dip galvanizing bath, pole segments having outer diameter more than 1mtr may be fabricated in two halves and seamlessly welded after galvanizing. After seamless welding of both halves, surface of the welded portion shall be cleansed and prepared. Two welded portions shall be galvanized by suitably dipping in hot zinc bath or by metallizing using molten zinc technique. For metallizing, the process as per ANSI/AWS WCZ/D19.0-72 or other National/International standard/Guidelines shall be followed. The thickness of zinc coating by metallizing shall not be less than the minimum specified for hot dip galvanizing.

7. The masts sections shall be joined at site by slip-stress-fit method and minimum overlap

distance shall be 1.5 times the diameter at penetration.

8. The mast structure shall be suitable to sustain an assumed maximum reaction arising from a wind speed as per IS 875 Part-3 2015 (three second gust) and shall be measured at a height of 10 meters above ground level.

9. The design life of the mast shall be 25 years. The force co-efficient taken for design of the twenty-sided polygonal structure is to be established from the wind tunnel test data.

10. All welding shall be undertaken and performed as per WPS/PQR in strict accordance with BS 5135 or AWS D1.1.

11. The head frame cross arm brackets shall be of suitable steel construction.

12. The high mast manufacturer should have in-house civil, structural and product design facilities and the shaft is to be manufactured from ISO 9001, ISO 14001 and ISO 45001 certified factory taking care of all aspects of design, quality, environment and safety.

The Luminaries supplier shall have their own in-house testing facilities for testing of photometry, other electrical and mechanical parameters of luminaries with facilities to prepare illumination design for said application.

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13. All MS parts including hardware shall be hot dip galvanized as per BSEN-ISO1461 or equivalent.

Platform and Head frame of the Mast.

1. Stadium mast shall have a fixed head frame at the top of the mast. The head frame shall be with a 15-degree tilt for aiming the luminaries to the proper points. The tilt also helps the maintenance man, while working on the top.

2. The head frame shall have a shaft section like other mast sections in the middle and cross arms to mount required number of luminaries. Suitable provision shall be provided in the cross arms for fixing of luminaries and support the cables. Suitable opening on each side of the shaft and window in back side is to be provided to take and facilitate passing the cables to the luminaries through cross arms.

3. An inspection opening shall be provided on the head frame shaft. Support shall be welded on the head frame shaft to suspend the luminaire cables from the top. Cables are to be bunched and supported with stainless steel suspension ropes of suitable length. No other equipment shall be mounted in the path of the cables inside the mast as it will affect the safety of electrical cables for the luminaries.

4. Lightning finial shall be provided on the mast top of the shaft. Provision to be made on the top cross arm to mount the aviation obstruction light accessible from the ladder.

5. A suitable platform shall be provided on top of the mast. The platform shall be such that the maintenance man can safely stand on the platform and work. The platform shall have protective railing on three sides for safety purposes. There shall be ladders from the platform to the top of the head frame for access to the luminaries mounted on the cross arms. Safety rope is to be provided to hook the PPE (Full body harness).

6. The platform shall have suitable docking facility for the man rider unit to enable the maintenance man to enter the platform from the man rider unit.

7. The connection between the head frame and mast top shaft is by a flanged joint and bolted together. No slip joints in this position shall be used.

8. Access to the floodlights on the head frame shall be by a minimum number of four vertical ladders of the full head frame height.

Man rider Unit

1. Access to the mast head frame flat form shall be by a detachable and mobile man-rider unit with a minimum safe load carrying capacity of 300 Kg. The unit shall be of galvanized steel construction with twin cage arrangement along with spring loaded wheels encasing the mast shaft for proper balancing and to avoid swaying of cage while climbing. Suitably rated motor and double drum winch shall be installed in the base of mast. The hoisting arrangement shall comprise of AISI 316 grade stainless steel wire ropes of 8 mm diameter and cast aluminum pulley with gunmetal bush bearing. The unit will have a climb rate not in excess of 9 meters per minute and shall contain required safety features. Man rider will incorporate secondary fall arrester system for protection against failure of the main rope.
2. Man-rider should be detachable type with wheels for moving from one location to other and common for all the masts of the stadium.
3. A portable control box fabricated out of 14swg CRCA sheet housing and finished with powder coating of shade 631 as per IS:5 comprising 32A TPN MCB incomer, contactors suitable for the rating of motor for raising and lowering operation of the man rider. Push button to raise and lower the man rider is to be provided with 5 m cable to operate from a

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distance. There shall be 32 Amp TPN plug wired to the control box to take power to control box. A Three pin socket is to be provided on control box to hook the motor plug.

4. Aviation Obstruction Light : Supply of Single dome aviation obstruction lights of type LED AOL. Two numbers per mast.

FEEDER PILLAR

Work of feeder Pillar shall be carried out as per AUTHORITY for Electrical works Part –I (internal) -2013 and & Part –II (External) 1994 amended up to date. Supplying , erection , testing and commissioning of floor mounted double door outdoor type feeder pillar of suitable size (as per design requirement) fabricated out of minimum 1.6mm/ 2.00 mm thick nominal CRCA MS sheet (2 mm outer and 1.6 mm inner) with suitably thick angle iron frame of suitable dimensions and suitable to accommodate and S/F of all required accessories there in i/c connection , interconnection with suitable size copper wire , numbering , power coated after applying pretreated by seven tank process and making brick foundation complete as required Standard :

The equipment shall confirm to this specification and latest revision of following codes with all amendments: -

S. No. Title Indian Standard

- 2.1 IS 5039 Specification for distribution pillars below 1000V AC
- 2.2 IS 13947 part 2 Low Voltage switchgear
- 2.3 IS 8623 Specification for low voltage switchgear
- 2.4 IS 12063 Classification of degrees of protection provided by enclosures of electrical equipment.
- 2.5 IS 13703 Low voltage HRC fuses
- 2.6 IS 5 Color of ready mixed paints
- 2.7 IS 191 Specification for copper
- 2.8 IS 5082

Wrought Aluminum & Al alloy plates & sheets for electrical applications

2.9 IS SP72 Sports Lighting

3.1 Supply Voltage 3 phase neutral, AC 415Volt +/-10%

3.2 Supply Frequency 50 Hz +/- 5%

3.3 Location of panel

Outdoor, on complete refurbished area

Nehru

place

3.4 Pollution Heavily Polluted and Dry

3.5 Humidity 90% maximum

3.6 Ambient Temperature Average 40 Deg C, Maximum 50 Deg C

3.7 Incoming supply to feeder pillar

From distribution transformer or Main
feeder

panel pillar panel

3.8 Seismic Zone 4

1.Complete design/drawings of feeder Pillar, Nos, their locations etc to be got approved from Engineer in Charge prior to execution of work.

2.Suitable M.S. top cover with suitable slop, overhang shall be provided for protection against

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rain/weather etc.

3.Detachable cable gland plates 3 mm thick shall be provided at the bottom having suitable knock out for compression glands. Adequate space shall be provided below the same for safe bending & termination of cables.

4.The enclosure shall be provided with ventilation louvers covered with the wire mesh, lifting hooks, supporting legs, double earth terminals with double nuts & washers.

5.The internal arrangement shall be compartmentalized for incoming, outgoing switch gears/bus bars & design shall be such as to permit suitable arrangement for incoming & outgoing cables. Provision shall be made for lighting inside the feeder pillar.

6.All incoming and outgoing switch gears shall be properly marked, indicating the connected load, cable sizes, and outgoing connections etc as required.

7.Interconnection of the various mountings on the feeder pillar shall be done using PVC insulated conductor or solid strips with PVC taping / sleeving of appropriate sizes. Termination shall be made such that local heating is avoided. Feeder pillar shall be pre-treated with 7 tank process followed by powder coating.

8.All the metal work of feeder pillar shall be painted prior to erection with one coat of anti-rust primer. After fabrication, they shall be painted with two coats of appropriate enamel paint as required, on all sides wherever accessible

All connections and inter connection wires inside the feeder pillar shall be provided with tags / ferrules for identifications.

■ TECHNICAL FORMAT-750 KVA DieselGenerator Set

<u>S.No.</u>	<u>Parameter</u>	<u>Details to be Filled by Vendor</u>
1	DGSetRating	750
2	Makesmodel	Engine: SGB 750 PR-IV Alternator: /LS/MECCALTE/CG
3	EngineDetails	Model: 6M33G4D4/5 No.ofCylinders:6 Cooling Type: RADIATOR Aspiration:TURBOCHARGED BHP: 885 Displacement: 19.6 Ltrs.
4	AlternatorDetails	Make: /LS/CG/MECCAL TE Brushless:Yes InsulationClass:H AVR:Yes
5	FuelType	High-SpeedDiesel(HSD)
6	FuelConsumption (100%Load)	149liters/hour
7	FuelConsumption(75% Load)	117liters/hour
8	StartingSystem	ThroughController
9	ControlPanel	AMF Panel: No Type:Manual/Auto ControllerMake/Model:DEIFSGC420
10	AcousticEnclosure	CPCB IV Compliant Sound≤75dBA@1m SheetThickness(Base/Doors):1.6mm

<u>S.No.</u>	<u>Parameter</u>	<u>DetailstobeFilledbyVendor</u>
11	Compliance	CPCBIVCertification:Yes
12	Dimensions(L×W×H)	7200mm×2200mm×3395mm
13	Weight	10530kg(Totalsetweight)
14	BatteryDetails	No.ofBatteries:2 Rating: 150AH Make:EXIDE
15	CoolingSystem	RadiatorType:RADIATOR Air Flow: NA CoolantType:Coolant
16	LubricationSystem	OilCapacity:61L RecommendedChangeInterval:500hrs./oneyear
17	FuelTankCapacity	990liters(BaseTank)
18	ExhaustSystem	SilencerType:Residential PipeDiameter:200 mm
19	LubeOilConsumption	<0.3%ofFuelConsumption
20	NoiseLevel	≤75dBA@1meter(CPCBIVNorms)
21	Warranty	Engine:5C5years Alternator:2years CompleteDG:2years/6000hrs
22	ServiceSupport	NearestServiceCenter:VIBHUTIKHAND,GOMTINAGAR, LUCKNOW
23	NumberofFreeService Visits	1Nos.withinwarrantyperiod

<u>S.No.</u>	<u>Parameter</u>	<u>DetailstobeFilledbyVendor</u>
24	DeliveryTime	3-4WeeksfromPO
25	InstallationScope	Excluded
26	Certificates	CPCBIV/ISO/FactoryTest/TypeTest:(Attachcopies)
27	ControlPanelFeatures	Protections:LLOP,HWT,Overspeed Display Type: Digital RemoteMonitoring:Yes
28	SafetyFeatures	EarthFault,EmergencyStop,AutoShutdown
29	PaintFinish	PowderCoated/CEDCoated Corrosion Resistant: Yes
30	OtherInclusions	AVMs,FoundationBolts,ToolKit,DocumentSet,FirstFill(OilC Coolant) and Def also



■ TECHNICAL FORMAT- 500 KVA Diesel Generator Set

<u>S.No.</u>	<u>Parameter</u>	<u>Details to be Filled by Vendor</u>
1	DG Set Rating	500
2	Makes model	Engine: Alternator
3	Engine Details	Model: No. of Cylinders: 6 Cooling Type: RADIATOR Aspiration: BHP: Displacement:
4	Alternator Details	Model: Make: Brushless: Insulation Class: AVR:
5	Fuel Type	High-Speed Diesel (HSD)
6	Fuel Consumption (100% Load)	
7	Fuel Consumption (75% Load)	
8	Starting System	Through Controller
9	Control Panel	AMF Panel: Type: Manual / Auto Controller Make / Model:
10	Acoustic Enclosure	CPCB IV Compliant Sound \leq 75 dBA @ 1m Sheet Thickness (Base / Doors): 1.6mm

<u>S.No.</u>	<u>Parameter</u>	<u>DetailstobeFilledbyVendor</u>
11	Compliance	CPCBIVCertification:Yes
12	Dimensions(L×W×H)	
13	Weight	
14	BatteryDetails	No.ofBatteries: 2Rating: 150AH Make:EXIDE
15	CoolingSystem	RadiatorType:RADIATOR Air Flow: NA CoolantType:Coolant
16	LubricationSystem	OilCapacity:34L RecommendedChangeInterval:500hrs./oneyear
17	FuelTankCapacity	
18	ExhaustSystem	SilencerType:Residential Pipe Diameter:105 mm
19	LubeOilConsumption	<0.3%ofFuelConsumption
20	NoiseLevel	≤75dBA@1meter(CPCBIVNorms)
21	Warranty	Engine:5C5years Alternator:2years CompleteDG:2years/5000hrs
22	ServiceSupport	NearestServiceCenter: D-56, VIBHUTI KHAND, GOMTI NAGAR, LUCKNOW
23	NumberofFreeService Visits	1Nos.withinwarrantyperiod
24	DeliveryTime	2-3WeeksfromPO

<u>S.No.</u>	<u>Parameter</u>	<u>Details to be Filled by Vendor</u>
25	InstallationScope	Excluded
26	Certificates	CPCBIV/ISO/FactoryTest/TypeTest:(Attachcopies)
27	ControlPanelFeatures	Protections:LLOP,HWT,Overspeed Display Type: Digital RemoteMonitoring:Yes
28	SafetyFeatures	EarthFault,EmergencyStop,AutoShutdown
29	PaintFinish	PowderCoated/CEDCoated Corrosion Resistant: Yes
30	OtherInclusions	AVMs,FoundationBolts,ToolKit,DocumentSet,FirstFill(OilC Coolant) and Def also

END OF ELECTRICATION SPECIFICATIONS

TECHNICAL SPECIFICATION OF HVAC

Air conditioning System Design :

The air conditioning of above areas shall be done with the help of VRF System , as per the cooling requirements and as per areas and rooms shown in the drawings and as per the capacities required.

1.Outdoor Units

The system shall be VRF (Variable Refrigerant Flow) system. The system shall adopt the inverter technology for energy saving and shall use R410A Eco-friendly refrigerant for green environment and shall connect multiple indoor units for independent operation with long piping / high elevation / big capacity. The system shall be able to operate at cooling as well as heating mode. Outdoor unit shall operate continuously without tripping up to 53 deg. C DBT in cooling mode. The outdoor unit shall have a powder coated finish. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. Outdoor unit shall consist of BLDC inverter scroll compressors (All Inverter), Inverter fan motor, electronic expansion valve, oil separator, and accumulator. Outdoor unit shall have High pressure switch, high pressure sensor, reverse phase protection, Self-diagnosis and Soft start as safety devices or functions.

The sum of connected capacity of all indoor air handlers shall range from 50% to 130% of outdoor rated capacity.

Condenser Fins should be coated with Anti-Corrosive Layer (Epoxy Acrylic coating) in addition to Hydrophilic Coating.

The heat pump system should consist of 100% inverter driven advanced flash injection scroll compressor, optimized DSH (Discharge Superheat Control), AI enabled technology, factory fitted microprocessor based self-diagnostic & on device inverter check.

All outdoor units shall be able to perform in duty cycle mode to optimize wear and tear of system when more than one outdoor unit is connected to a circuit. Outdoor units must also be equipped with four way valve for necessary provision of heating during winters.

Outdoor unit (individual modules) shall have a sound rating no higher than 67 dB (A) at 1m distance from the front of the unit.

The heat pump outdoor unit shall have a high pressure safety switch, high voltage fuses, over-current protection, phase detection protection, thermal fan protection, low pressure protection, compressor overcurrent protection, fan motor voltage protection and intelligent logic to ensure proper operation within unit design limitations and operational parameters.

The frequency of the inverter compressor shall be variable from 10 to 160Hz to modulate capacity.

Outdoor unit shall have a Peak Demand Control feature to reduce power consumption during Peak Hours.

The inverter compressor PCB(s) shall be cooled with liquid refrigerant circuit(s) and air-cooling fins to operate at optimal temperatures and to prevent failure due to overheating.

All outdoor units above 16 HP shall have minimum two Scroll Inverter Compressors and be able to operate even in case one of compressor is out of order.

The heat pump outdoor unit shall have the ability to operate with a maximum height difference of 110 meter between the outdoor unit and the lowest indoor unit. Maximum allowable refrigerant piping length in a system shall be 1,000 meter. The greatest length should not exceed 200 (220 equivalent) meter between outdoor unit and the farthest indoor unit.

Indoor units on Heat Pump system shall have a maximum vertical separation of 50 meter between the highest and lowest indoor units.

Selected modules should have minimum COP 3.7 at 100% load and 7.5 at 50% load in cooling mode at AHRI Condition and each module should have all inverter compressor/unit.

The outdoor units must deliver a minimum of 100% of nominal capacity at 39 Deg C outdoor temp.

The fan static pressure of the outdoor unit shall be minimum 75 Pa to avoid hot air recirculation

The heat pump outdoor unit shall be capable of operating in cooling mode between (-5°C to 53°C) outside ambient temperatures.

The heat pump outdoor unit shall be capable of operating in heating mode between (-20°C to 18°C) ambient temperatures.

The heat pump outdoor unit shall have a high efficiency, individual oil separators for each compressor plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

The heat pump outdoor unit shall have a flat-plate type sub-cooler to sub-cool liquid refrigerant further to increase capacity and performance with long pipe lengths and to decrease refrigerant sounds at indoor equipment.

The heat pump system shall have optional night quiet modes to reduce unit sound level.

The heat pump outdoor unit shall allow temporary disabling of individual compressors to allow system operation at reduced capacity after a compressor or compressor component related issue (when more than one compressor is present in system). Disabling of a compressor shall temporarily remove error codes and allow system operation.

The heat pump outdoor unit compressors shall have a soft-start function to reduce electricity demand during system start and to increase compressor reliability.

In the event of system error due to outdoor unit failure, the heat pump outdoor unit shall display codes that specify a precise error and which outdoor unit PCB is the cause.

The heat pump system shall support system auto-addressing allowing system commissioning without manually configuring indoor unit addresses.

Outdoor unit PCB must have conformal coating for protection complying with IEC 50721-3-3 3C3 Class) and have NABL accredited lab certificate not older than 3 years

Outdoor Unit manufacturer should be of OEM of its compressor

Inverter PCB cooling: Cooling of the inverter PCB shall be conducted by way of high pressure, sub-cooled liquid refrigerant via heat exchanger attached to rear side of inverter PCB. The full capacity flow of refrigerant shall pass through the heat exchangers to maximize the cooling effect of the PCBs and to aid in the evaporation process and capacity of the outdoor coil during the heating mode. The recovered heat of the PCBs must be used to enhance the overall heating process, other uses or dissipation of heat to ambient shall not be permitted.

All electronic PCBs shall comply to IEC 60571/EN 50155 for dry heat test, dust & sand test etc, compliance documents shall be submitted for approval. Also all electronic PCBs shall have protection against direct spikes & surges in the power supply inbuilt as defined in IEC 60571. Type test report not older than 3 years shall be submitted

The Bidder should comply with BIS certification

Unit Cabinet:

The chassis shall be fabricated of galvanized steel and finished with a powder coated baked enamel.

VRF ODU are powder coated from factory with 80 GSM - 100 GSM Pure Polyester

Fan:

All fan motors shall be variable speed BLDC type.

All fan motors shall have inherent protection, thermal protection, and have permanently lubricated bearings, and be completely variable speed.

The outdoor unit shall have vertical discharge airflow.

Refrigerant:

R410A refrigerant shall be required for the heat pump system.

Additional refrigerant amount shall be based on installed refrigerant pipe diameters and lengths and indoor equipment model number and quantity.

Modular systems shall require outdoor refrigerant kits for module connection provided by the manufacturer

Coil:

Condenser Fins should be coated with factory made Anti-Corrosive Layer (Epoxy Acrylic coating) in addition to Hydrophilic Coating. Anti-Corrosion coating material should have 3000 Hr Salt spray test.

The heat exchanger shall consist of two separate circuits to enhance the heat pump defrost cycle. The unit shall use the entire coil initially for the defrost cycle. To resume heating faster in extreme conditions, the upper section shall return to heating operation while the lower section continues to defrost.

Compressor:

The compressors shall have flash injection capability to increase performance in heating mode. This will be automatically enabled by the outdoor unit(s) by forcing saturated refrigerant as a liquid flash mix directly into the scroll compression cycle increasing mass flow and overall system capacity. Compressors without flash injection shall not be present in the VRF heat pump system.

All compressors shall be modulation capable, flash injected, DC inverter, scroll type.

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths. Oil sensor to monitor the level of oil in compressor. The compressor(s) will be equipped with an internal thermal overload.

The compressor(s) shall be mounted to avoid the transmission of vibration.

Electrical:

The outdoor unit electrical power shall be 415 Volts, 3 phase, 50 hertz.

The outdoor unit shall be controlled by integral microprocessors.

The control circuit between the indoor units and the outdoor unit shall be 0.5VDC - 7VDC completed using stranded, annealed copper conductor, 1.5 sq.mm, shielded, two-core cable to provide total integration of the system.

STANDARD SPECIFICATION OF INDOOR UNITS

1.0 INDOOR UNITS

This section deals with supply, erection, testing and commissioning of Various Type Of Indoor Units confirming to general specification and suitable for the duty selected. The type, capacity and size of indoor units shall be as specified in Detailed Bill of Quantities.

2.0 GENERAL

Indoor units shall be either ceiling mounted cassette type, or ceiling mounted ductable type or floor standing type or wall mounted type or other as specified in BOQ. Each unit shall have electronic control valve to control refrigerant flow rate respond to load variations of the room and fan/blower motor should be BLDC type for Low noise performance

a) The address of the indoor unit shall be set automatically in case of individual and group control

b) In case of centralized control, it shall be set by liquid crystal remote controller
The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing.

The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins. Each coils shall be factory tested at 21kg/sqm air pressure under water.

Unit shall have cleanable type filter fixed to an integrally moulded plastic frame. The filter shall be slide away type and neatly inserted.

Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling or cooling and heating.

Each unit shall be with wired LCD type remote controller. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self-diagnostic features for easy and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flap individually as per requirement.

2.2 CEILING MOUNTED CASSETTE TYPE UNIT (ROUND FLOW TYPE)

The unit shall be ceiling mounted type. The unit shall include pre-filter, fan section and DX-coil section. The housing of the unit shall be powder coated galvanized steel. The body shall be light in weight and shall be able to suspend from four corners. The fan shall be aerodynamically designed diffuser turbo fan type. Also Units shall have an external attractive panel for supply and return air. Unit shall have four way supply air grilles on sides and return air grille in center. Each unit shall have high lift drain pump, fresh air intake provision (if specified) and very low operating sound. All the indoor units regardless of their difference in capacity should have same decorative panel size for harmonious aesthetic point of view. It should have provision of connecting branch ducts.

3.3 CEILING MOUNTED DUCTABLE TYPE UNIT

Unit shall be suitable for ceiling mounted type. The unit shall include pre filter, fan section & DX coil section .The housing of unit shall be light weight powder coated galvanized steel. The unit shall have high static fan for Ductable arrangement.

Indoor unit must have feature of ESP adjustment to meet CFM requirement.

3.4 CEILING SUSPENDED TYPE

Unit shall be suitable for ceiling suspended arrangement below false ceiling. The unit include pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

3.5 HIGH WALL MOUNTED UNITS

The units shall be wall-mounted type. The unit includes pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel. Unit

shall have an attractive external casing for supply and return air.

3.6 FLOOR STANDING TYPE

Unit shall be suitable for floor standing arrangement. The unit include pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

3.7 CENTRALIZED TYPE REMOTE CONTROLLER

A multifunctional compact centralized controller shall be provided with the system.

The controller should be Touch Screen LCD remote controller to act as an advanced air-conditioning management system to give complete control of VRV / VRF air-conditioning Equipment, It should have ease of use for the user and must have a user friendly panel and LCD display.

It shall be able to control up to minimum 128 indoor units with the following functions:-

- a) Starting/stopping of Air-conditioners as a zone or group or individual unit.
- b) Temperature settling for each indoor unit or zone.
- c) Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.
- d) Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, troubleshooting information.
- e) OPTIONAL-Display of air conditioner operation history.
- f) OPERATIONAL-Daily management automation through yearly schedule function with possibility of various schedules.
- g) BMS compatibility

The controller shall have wide screen user friendly LCD display and can be wired by a non-

polar 2 wire transmission cable to a distance of 1 km. away from indoor unit.

AIR HANDLING UNITS (AHRI CERTIFIED)

The double skin Ceiling suspended Air Handling Units shall be provided with Centrifugal/plug fans & dx cooling coil section, filter sections, motor drive package etc.

The Air Handling Units shall be of double skin construction with 23 mm thick PUF injected insulation. The detailing of the same shall be in tender specifications.

The AHU's sub-panels shall be located in AHU Room and in case of Ceiling Suspended AHU, the same shall be located in its vicinity preferably above the false ceiling. The four wall and the ceiling of the AHU/TFA Rooms shall be acoustically lined.

The TFA units shall be of double skin construction with 48 mm thick PUF injected insulation and having thermal break profile. The TFA unit shall be provided with energy recovery wheel to reduce fresh air load on ac system

HEAT RECLAIM VENTILLATION

In order to achieve the purpose of better indoor air quality, the Heat Reclaim Ventilation (HRV) unit must exchange the heat between supplied fresh air and exhausted air in order to bring the outside air closer to indoor temperature and humidity conditions thus it must recover the thermal energy of exhaust air and reuse it for supplied fresh air .this must lead to ventilation without increasing the load and

thus saving in running cost.

It shall be possible to interlock this HRV system with operation of HRV system to simplify installation and improving the efficiency of air-conditioning. It shall be possible to set automatic ventilation mode so that heat exchange mode and ventilation mode can be automatically selected to enhance energy conservation.

The casing of HRV units shall be made of galvanized steel plate insulation with self extinguishable polyurethane the must have air filters of multi directional fibrous filter.

The heat exchanger element must be design without any moving parts for higher durability and reliability, it should have high permeability high efficiency specially processed paper which is flame retardant and fungi proof to keep air clean.

Ventilation System

1. General :

The ventilation fan shall be complete in all respects and shall generally comply with the following specifications given below :

2. Inline Fans :

2.1 General :

The inline fan shall be complete in all respects and shall comply with the following specifications :

2.2 Fans :

The fan shall be complete with centrifugal impeller, casing, direct driven motor, vibration isolators etc.

2.2.1 Housing :

The housing shall be constructed of hot rolled GSS sheet metal construction. Housing metal shall be either spot welded or screwed or mounted together with the rivets. The housing shall indicate arrow showing rotation, make, model and duty condition.

2.2.2 Fan Wheel :

Fan wheel shall be forward/backward curved type and it shall be statically and dynamically balanced.

2.2.4 Ball Bearing :

The ball bearing shall be completely maintenance free and can be used in any mounting position at maximum indicted temperature. The bearing lubricant shall be suitable for min. ambient temperature of 15C. For applications at max.indicated ambient temperature life expectancy LIO is 40,000 hours minimum.

3. VENTILATION FANS

:

3.1. CABINET FAN SECTION

The ventilation unit shall be of single skin construction housing comprising of various sections such as fan, filter section etc. fabricated of 18G pre-coated or powder coated galvanized steel sheet from outside. All corner supporting frames shall be of extruded aluminum section.

3.2 The centrifugal forward curve fan (DIDW) & motor shall be mounted on the common base of Aluminum, inside the housing including anti-vibration.

3.3 The fan outlet shall be connected to the casing with the help of fire retardant flexible canvass.

3.4 The fan shall be complete with motor, belt pulley with all accessories.

3.5 Fan motors shall be 415 □ 10% volts, 50 cycles, 3 phase, squirrel – cage, totally enclosed fan cooled with IP – 55 protection. Motor shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided.

3.6 Each unit shall be provided with a factory assembled filter section with 50 mm thick washable synthetic type air filters having efficiency 90% down to 10 micron with extruded aluminum frame.

3.7 The opening for access doors and gaps between sections shall be provided with the neoprene rubber T gasket fixed in the extruded sections.

4. AXIAL FLOW FANS

4.1 The Axial Fan Blades shall be of Cast Aluminum of aerofoil design for high efficiency and high static pressure. The blades shall be joined together on cast aluminum hub.

4.2 The mounting ring shall be of CRCA/sheet steel with steel brackets to connect the frame, with the Fan/Motor assembly. Rubber mounts shall be provided between the mounting frame and the mounting brackets.

4.3 Fan shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved for construction shop drawings.

4.4 Casing shall be constructed of heavy gauge MS sheet coated with 220 GSM zinc powder. Fan casing, motor mount and straightening vane (wherever specified) shall be of welded steel construction. Motor mounting plate shall be minimum 20mm thick and machined to receive motor flange.

4.5 Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bonderized, primed and finish coated with enamel paint.

4.6 Rotor: hub and blades shall be cast aluminium or cast steel construction. Blades shall be die-formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blades mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually readjusted at site upon installation, for obtaining actual air flow values, as specified and quoted.

4.7 Motor shall be energy efficiency squirrel-cage, totally-enclosed, fan cooled standard round frame, constant speed, continuous duty, single winding, suitable for 415+ 10% volts, 50 cycles, 3 phase AC power supply, provided with class 'F' / 'H' insulation as specified in schedule of quantity. Motor shall be specially designed for quiet operation. The speed of the fans shall not exceed 1000 RPM for fans with

impeller diameter above 450 mm, and 1440 RPM for impeller diameter 450 mm or less. For lowest sound level, fan shall be selected for maximum efficiency or minimum horsepower. Motor conduit box shall be mounted on exterior of fan casing and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.

4.8 Drive to fan shall be provided through belt drive with adjustable motor sheave and standard sheet steel belt guard with vented from for heat dissipation. Belts shall be of oil-resistant type.

4.9 The Exhaust fans & motor shall be suitable for operation at minimum 250 deg C for 2 hours.

4.10 Vibration isolation: The assembly of fan and motor shall be suspended from the slab by vibration isolation suspension of rubber-in-sheet type.

Sheet Metal Work & Air Distribution

Scope :

The scope of work shall include supply, fabrication and installation of site fabricated G.I. sheet metal duct as shown in the relevant duct drawing, testing at site, loading & unloading of G.I. sheets at site, and shifting the G.I. sheets and other hardware from site stores to exact location inside the office complex. The packing shall be suitable for marine transportation purpose and all other natural disasters and the same shall be transported to respective office warehouses to achieve a guaranteed commercial operation of the same to the entire satisfaction of client.

6.1 Materials

Ducts shall be made of either galvanized steel sheets or aluminum sheets. The galvanized steel sheet shall confirm to IS: 277 – 1977 Aluminum shall be of grade SIC of B-3 as specified in IS: 177 – 1974.

Thickness of sheet shall be as per the table given below:

Maximum Side (mm)	Thickness (mm)	
	Galvanized Steel Sheet	Aluminum Sheet
Up to 750 mm	0.63	0.80
751-1500	0.80	1.00
1501-2250	1.00	1.50
2250-2500	1.20	
Plenums and Ducts above 2500	1.60	

- The bracing shall be as per ISS 655-1964. Supports for ducts at 2.4m distance apart up to 2250/1.2m distance apart for larger ducts.

- Ducts shall be rectangular in cross section and fabricated in accordance with the following table :

Maximum Side of Duct (mm)	Minimum Thickness of Sheet (mm/SWG)	Transverse Joints	Reinforcement	Hang er Rod Dia (mm)
Up to 400	0.63 (24 SWG)	25mm pocket/s slip	Cross Break	8
401 to 750	0.63 (24 SWG)	25mm pocket/s slip	25 X 25 X 4.2 Girth angle @ 1000 mm c/c	8
751 to 900	0.80(22SWG)	38x38x4.2 Companion Flanges	25 X 25 X 4.2 Girth angle @ 1000 mm c/c	8
901 to 1500	0.80(22SWG)	38x38x4.2 Companion Flanges	38x38x4.2 Girth angle @ 760 mm c/c	10
1501 to 2250	1.00(20SWG)	38x38x4.2 Companion Flanges	38x38x4.2 Girth angle @ 760 mm c/c	10
2250 and above	1.25(18 SWG)	50x50x4.2 Companion Flanges	50x50x4.2 Girth angle @ 610 mm c/c	12
Plenums	1.25(18 SWG)	50x50x6.4 Companion Flanges	50x50x6.4 Girth angle @ 610 mm c/c	12

Girth angles and companion flanges shall be mitered and welded at corners and riveted to duct sheets at 75mm centers. Flanged joints shall be made with 9.5-mm GI bolts spaced at 1.5cm centers and provided with 4.2mm rubber or 6.0mm. All joints and seams shall be rendered airtight. All duct seams and joints to be sealed with silicon sealant to stop supply air leakage. Duct panels are not to be cross-broken if insulated. Longitudinal seams shall be inside groove of Pittsburgh type. All ducting supports, bracing and framework shall be painted with 2 coats of epoxy primer and 2 coats of epoxy paint min. (50 microns).

6.2. Accessories:

- All dampers, except where shown, shall be louver dampers having multiple opposed blades type or with parallel blades of airfoil construction. The construction of the dampers shall be robust and tight fitting. They should be made from 18 gauge galvanized sheets. The depth should be minimum of 150mm and flanges of 40mm. Blades shall be connected with a suitable linkage for operation by an extending lever, which shall have a locking quadrant with positions of the damper indicated on it. Dampers and their operating device shall be made robust, easily operable and accessible through suitable access doors in the ducts.
- Dampers shall be provided in ducts at every branch supply or return air duct connections whether or not indicated on the drawings for the proper volume control and balancing the system.
- Where shown, splitter dampers shall be installed. This damper consists of double thickness airfoil blade hinged on the downstream edge. The operating lever shall extend outside the duct and insulation with an airtight hub and locking arrangements. The thickness of the damper blades shall be the same as the duct in which they are installed but not less than 1.5mm thickness.

- Fire dampers shall be motorized / solenoid type wherever specified shall be provide in the ducts to minimize spreading of fire through ducts, i.e. points where duct passes fire (rated 1 ½ hrs. or more) wall or slab. Fire dampers shall be 230mm – deep and face area as required. The outlet casing of the damper shall be fabricated out of 12 gauges M.S. sheet duly epoxy painted with two coats. The louvers shall be provided with smooth pivoted linkage, tripping mechanism of steel bar with heavy-duty spring assembly and provision of motor. The louvers to be arranged to pivot and hold in an open position and can be closed by an electrically operated motor. The damper is used in conjunction with a smoke alarm system. The entire assembly shall be duly epoxy primer of 2 coats (epoxy paint) or aluminum spray painted. The dampers shall be designed for automatic as well as manual tripping.
- Motors shall be rated for fire damper (spring to close power to open) operation and shall be suitable for outdoor installation (IP55). Fire dampers are closed on a signal from the fire control module. Module supply and wiring by fire control contractor.
- Motorised dampers should be single flap dampers with 18 gauge construction with Belimo or Equivalent make spring return type. Opening time should be more than 75secs. And closing time should be 30secs. The power shall be given from the electrical panel and will be routed through the unit.
- 300mm X 300mm access panels with gasket neoprene and stud bolt type shall be provided near lower dampers/ splitters dampers and fire damper. All main ducting work shall be accessible throughout using tight fitted hinged access doors. Doors shall be cemented sponge rubber gaskets of 6mm thickness. Felt is not acceptable. In the case of insulated ducts with access doors, the same shall be properly insulated, such that it can be operated without damaging the duct insulation and there should be no condensation either on the access doors or on the ducts when the plant is running.

6.3. Installation Guidelines

- The duct fabrication and installation shall generally confirm to IS 655-1963.
- All ducts shall be supported from the concrete slab or beams. Duct supports shall be fixed through the use of two anchor fasteners for each leg. The anchor fasteners shall be of approved make. If ducting is supported from steel structure, Beam Clamps shall be provided. In no case shall the duct be supported from the false ceiling hangers or be permitted to rest on a hung ceiling.
- Transverse joints shall be provided with rubber gaskets (6mm thk.) of nonflammable type. Use of felt shall not be permitted.
- Wherever the ducts are acoustically lined, the duct size shall be increased by the thickness of the duct lining.
- The contractor shall provide and neatly erect all sheet metal work as per the specifications and drawings. This work ,in all its parts and details, shall meet with the approval of the Engineer
- The contractor shall make all necessary allowances and provisions for beams, pipes or other obstructions in the ducting, whether or not the same has been shown in the drawings. Wherever necessary to avoid beams or other structural works, plumbing or other pipes / conduits, the ducts shall be transformed, divided or curved to one side as approved or directed by the Engineer. However the required cross-sectional area shall be maintained.
- All metal work shall be done in dead or furred down spaces so as not to cause any delay to other contractors on the building.
- If a duct cannot be installed as shown in the drawings, the contractor shall install the duct between the required points by any path available subject to the approval of the Engineer and Architect.
- All ducts shall be rigid and shall be adequately supported with standing seams, tees or angles of ample size wherever required to keep the ducts true to shape, prevent buckling, vibration and breathing.
- All duct joints shall be tightly fitted using rubber gasket of nonflammable type and all interior surfaces shall be smooth. Bends shall be made with radius not less than one-half of the width of the duct or with properly designed interior curved vanes. Two vanes shall be spaced such that the aspect ratio of each of the individual elbows formed by the vane will be about five to one.

- All sheet metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans, shall be constructed from 16G galvanised iron thoroughly stiffened with 25mm X 25mm angle iron braces and fitted with all necessary doors as required to give access to all parts of the apparatus. Doors shall not be less than 46 cm X 71cm. Sheet Metal connections to indoor units shall be flexible, double thickness fiberglass cloth or equivalent nonflammable material of 100mm long.
- Where metal ducts or sleeves terminate in woodwork, brick or masonry openings tight joints shall be made by the means of closely fittings heavy flanged collars.
- Resistoflex or similar vibration isolation material of 6mm thickness shall be provided between ducts and duct support.
- Where ductwork is connected to rotating equipment duct such as fans, air handling units (indoor unit of split/package system), the connections shall be made with double thickness nonflammable flexible material, 100mm long.

6.4. Grilles and Diffusers:

- **Supply Air Side Wall Outlets**
- Wherever specified in the B.O.Q. shall be in Aluminum construction.
- **Double Deflection Grilles:**
- Wherever specified in the B.O.Q. shall be in Aluminum construction. Aluminum double deflection grills for supply air shall be provided with vertical and horizontal adjustable bars and an approved blade damper adjustable from the front face of the grille. The grilles will be powder -coated in a shade as given in the schedule of finishes of this handbook.

- **Fixed Bar Linear Grilles**

Fixed bar grilles will be in extruded aluminum construction. Bars shall be fixed in position using vertical tie bars. Bar spacing shall not exceed 12mm and the grilles shall have 60% free area. Deflection angle of the bars shall be 0. The grilles will be powder coated in a shade as per the owner/architect. Irrespective of grille finish, vertical tie bars shall be powder coated in Matt black. Supply air outlets shall be provided with volume control dampers to be installed in the duct collar. Dampers shall be in black Matt powder coated finish. Where required by the Architects/Consultants, the grilles shall be provided with a margin on all sides. Supply air outlets shall be provided with end closure pieces for the supply portion of the grille. The end closure pieces shall not come to the grille face.

- Continuous grilles shall butt with hairline joints and be provided with interlocking splines.
- All return air grilles shall be similar and equal to the above as determined by consultants.
- All exhaust air grilles shall be similar and equal to the supply air grilles specified above.

6.5 Ceiling Outlets:

Square / Rectangular Diffusers:

Shall be of aluminum construction wherever specified in the BOQ. Corners of inner and outer cores shall be assembled to provide precise mitered corners. Supply air diffusers shall be provided with multi blade butterfly dampers. Damper flaps shall be provided with a nylon worm gear assembly for ease of operation. Diffusers will be powder -coated in a shade as approved by client/Architect. Diffuser shall be half step down type.

6.6 Guidelines for Installation of Grilles/Diffusers

Installation of the grilles/diffusers shall be done by the air conditioning contractor irrespective of the type/model of false ceiling systems. The diffusers will have to be individually suspended from the duct and aligned to match the ceiling line level. In case gypsum or any other false ceiling system, all wooden frames, rectangular or circular for supply/return/exhaust air diffusers will be provided by the Air conditioning contractor.

All air outlets/return air inlets in the same room shall be of the same size unless otherwise specified.

Grilles and diffuser samples must be submitted to the consultants for prior approval before procurement and installation

Insulation

7.1 **General:**

The Insulation of refrigerant piping, drain piping, ducting etc. shall be carried out as per specifications given below :

7.2 **Materials**

The materials to be used for insulation shall be as follows. Unless some other material is specifically mentioned elsewhere.

7.3 **Duct Insulation**

Air Duct Insulation

Duct located INDOOR spaces shall be insulated to the following thickness:

	Location	Layer	Thickness	Material
a)	Non-air conditioned spaces			
i)	Cold supply duct with air at 12°C		19mm	Class O Nitrile Rubber
ii)	Cold return duct with air at 24°C	One	19mm	Same as above
b)	Air conditioned spaces			
i)	Cold Supply duct with air at 12°C	One	19mm	Class O Nitrile Rubber
ii)	Return duct with air at 24°C	One	19mm	Same as above

Nitrile Rubber for duct insulation shall be reinforced with glass cloth and applied as follows:

- Clean the duct surface & apply thin film of adhesive on the back of the insulating material sheet and then on to the metal surface.
- When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond.

- c) Treated woven glass cloth shall be cut to size as per duct perimeter with an additional 50mm for the overlap of the covering material.
- d) Spread thin film of adhesive on the 50mm overlap and close the seam

7.4 Other Insulation:

7.4.1 The material for acoustic treatment of ducts. Rooms. Roofs etc. shall be resin bonded fibre glass. As described earlier. Conforming to I.S. 8183 of 1976. The density of fibre glass shall be 32 Kg/cub.m and the material shall be in the form of rolls of uniform density. The k value at 10 degree centigrade. Shall not be less than .028 kcal/mhr/ C.

Wherever insulation is to be carried out inside the duct. Fibre tissue is to be installed and contractor to ensure that no fibres of insulation material get mixed up with supply /return air.

8 Drain Piping :

8.1 Insulation of drain piping shall be carried out using 6 mm thick insulation tube of closed cell nitrile rubber having a K value of 0.034 W/(M.K) at mean temperature of 10 degree centigrade and a density of not less than 80 Kg/m³.

8.2 Installation :

- 8.2.1 The piping shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.
- 8.2.2 Cut insulation tube longitudinally and put on pipe and seal the joints with adhesives and Aluminium tape (as approved by the manufacturers)

8.3 Refrigerant Piping :

Suction line of the refrigerant shall be insulated with 19/13 mm insulation as specified.

8.4 Ducting :

- 8.4.1 The ducts shall be insulated with the insulation sheet as follows :
- 8.4.2 Duct Insulation thickness shall be as follows :
Duct in conditioned space - 9 mm thick

8.5 Accoustic Lining :

- 8.5.1 The acoustic lining shall consist of 25mm resin bonded glass wool of density 32kg/m³ then it shall be covered by 0.5 mm perforated aluminum sheet having 3 mm perforation at 6 mm centers.
- 8.5.2 The duct surface shall be cleaned from inside.
- 8.5.3 Then the insulation shall be fixed inside the duct.
- 8.5.4 The insulation shall be converted with RP tissue paper.
- 8.5.5 The insulation shall then be covered with 0.5 mm perforated Al sheets.
- 8.5.6 The sheet and the insulation shall be secured to the duct by means of cadmium plated bolts, nuts and washers. The end shall be completely sealed off so that no insulation material is exposed.

Tests at site

1 General

The Contractor shall perform all inspection and tests of the air conditioning and ventilation systems as a whole and of components individually as required, under the supervision of the Engineer, in accordance with the provisions of the applicable 'ASHRAE' standards or approved equal, and as per Site requirements.

2 Piping System

- a) In general, pressure tests shall be applied to piping only before connection of equipment and appliances. In no case shall piping, equipment or appliances be subjected to pressures exceeding their test ratings.
- b) Tests shall be completed and approved before any insulation is applied.
- c) After tests have been completed, the system shall be drained and cleaned of all dust and foreign material. All strainers, valves and fittings shall be cleaned of all dirt, fillings and debris.

3 Duct Work

- a) All branches and outlets shall be tested for air quantity, and the total of the air quantities shall be within plus three percent (5%) of fan capacity.
- b) Volume dampers and splitter dampers shall be tested for proper operation.

4 Balancing and Adjustment

All air handling ventilation equipment, duct work and outlets shall be adjusted and balanced to deliver the specified air quantities indicated, at each inlet and outlet, on the drawings. If these air quantities cannot be delivered without exceeding the speed range of the sheaves or the available horse power, the Engineer shall be notified before proceeding with the necessary rectification and balancing of air distribution system.

5 Electrical Equipment

- a) All electrical equipment shall be cleaned and adjusted on Site before application of power.
- b) The following tests shall be carried out:
 - 1) Wire and Cable continuity tests.
 - 2) Insulation resistance tests, phase to phase, phase to earth, and phase to neutral on all circuits and equipment, using a 500 Volt meggar.
 - 3) The earth resistance between conduit system and earth must not exceed half (0.5) OHM.
 - 4) The phase rotation tests.
 - 5) Operating tests on all protective relays to prove their correct operation before energizing

the main equipment.

- 6) Operating tests on all starters, circuit breakers, etc.

6 Performance Tests

- a) The installation as a whole shall be balanced and tested upon completion, and all relevant information, including the following shall be submitted to the Engineer in charge/consultant.
- i) Computed capacity of each air-conditioning unit.
- ii) Air volume passing through each unit, ducts, grille, etc.
- iii) Differential pressure readings across each filter, fan and coil, and through each condenser.
- iv) Electrical current readings, in amperes of full and average load running, and starting, together with name plate current of each electrical motor.
- b) Daily records shall be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream 'ON-COIL' of each cooling coil. Also, suction temperatures and pressures for each refrigerating unit and the current and voltage drawn by each machine.
- c) Any other reading shall be taken which may subsequently be specified by the Engineer/consultants.

7 Miscellaneous

- a) The above tests are mentioned herein to provide amplification but not by way of limitation, to the provisions of Conditions of Contract and Specification. Duration of the tests shall be not less than 120 continuous hours. These tests shall be carried out, in summer as well as in monsoon and winter period, during the defects liability period.
- b) The date for commencement of all tests listed above shall be subject to the approval of the Engineer and in accordance with the requirements of this Specification.
- c) The Contractor shall provide the skilled staff and all necessary instruments, and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system, if the Engineer requests such a test for determining specified or guaranteed data, as given in the Specifications or on the Drawings.
- d) Any damage resulting from the tests shall be repaired and/or damaged material replaced, all to the satisfaction of the Engineer.
- e) In the event of any repair or any adjustment having to be made, other than normal running adjustments, the tests shall be void and shall be recommenced after the adjustment or repairs have been completed.
- f) The Contractor shall inform the Engineer when such tests are to be made, giving sufficient notice, to enable the Engineer to be present.

- g) Complete records of all tests shall must be kept by the contractor, and 3 copies of these and all location drawings shall be furnished to the Engineer/consultants.
- f) The Contractor may be required to repeat the test as required, should the ambient conditions at the time, in the opinion of the Engineer, not give sufficient and suitable indication of the effect and performance of the installation as a whole, or of any part, as required.

Mode of Measurement

1 General

This specification covers measurement of various items/materials at site.

2 Unit Prices in the Schedule of Quantities

The item description in the Schedule of Quantities is in the form of a condensed resume. The unit price shall be held to include every thing necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum of all the individual item prices shall represent the total price of the installation ready to be handed over.

The unit price of the various items shall include the

All equipment, machinery, apparatus and materials required as well as the cost of any tests which the consultant may request in addition to the tests generally required to prove quality and performance of equipment.

All the labor required to supply and install the complete installation in accordance with the specifications.

Use of any tools, equipment, machinery, lifting tackle, scaffolding ladders etc. required by the contractor to carry out his work.

All the necessary measures to prevent the transmission of vibration.

The necessary material to isolate equipment foundations, from the building structure, wherever necessary and suggested by the Engineer.

Storage and insurance of all equipment apparatus and materials.

The Contractor's unit price shall include all equipment, apparatus material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipment, apparatus, material and labour usual and necessary to complete the system even though not specifically shown, described or otherwise referred to.

3 Measurements of Sheet metal ducts, grilles/diffusers, etc.

a) Sheet Metal Ducts

All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars and other fittings. Gaskets, nuts, bolts vibration isolation pads, vanes are included in the basic duct items of the B.O.Q.

The unit of measurements shall be the finished sheet metal surface area in metre squares. No extra shall be allowed for overlaps.

All the guide vanes, deflectors access panels, splitter dampers within the duct work shall be considered as part of the duct and nothing will be paid extra on this account.

The unit duct price shall include all the duct hangers, supports and 'Hilti' metallic fasteners as well as any materials and labour required to complete the duct frame.

b) Box Dampers

Box dampers wherever shown or required in ducts shall be measured as per finished inside cross-sections and paid as per the calculated area in sq.m.

c) Grilles/Diffusers

All measurements of grilles/diffusers shall be the nominal outlet size excluding the outer flanges.

The square or rectangular grilles/diffusers shall be measured in plain sq.m.

All round diffusers shall be measured by their diameters in centimetre.

All linear diffusers shall be measured as per actual length in meters.

4 Measurements of Piping, Fittings, Valves, Fabricated Items

a) Pipe

(Including Water Piping, Oil Piping, L.P. Gas Piping, Air Piping, Vacuum Piping, etc.)

All pipes shall be measured in linear meter (to the nearest Cm.) along the axis of the pipes and rates shall be inclusive of all fittings e.g. tees, bends, reducer, elbows, hanger support bracket, etc. Deduction shall be made for valves in the line.

The rate quoted shall be inclusive of cutting holes, 'Hilti' metallic fasteners and inclusive of all items as specified in specifications and Schedule of Quantities.

Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces, wherever specified or required by the Engineer-in-Charge.

Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowances being made for providing the same.

The length of the pipe for the purpose of payment will be taken through the centre line of the pipe and all fittings (e.g. tees, bends, reducers, elbows, etc.) as through the fittings are also presumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above the fittings. For valves and flanges, section 1.16.3.2 below applies:

c) Structural Supports

Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and schedule of quantities or as required at site by Engineer-in-Charge.

5 Painting

Painting of all pipes, supports, valves and fittings shall be included with the cost of these items. Nothing extra shall be paid for this work.

Painting of grilles/diffusers, tanks and equipment wherever required shall be in the cost of these items.

6 Insulation

Measurement of insulation for vessels, piping, equipment and ducts shall be made over the bare uninsulated surface area of the metal.

a) Pipes

The measurements for insulation of piping shall be made in linear meters through all valves, flanges, and fittings. Pipes/bends shall be measured along the centre line radius between tangent points. If the outer radius is R1 and the inner radius is R2, the centre line radius shall be measured as $(R1+R2)/2$. Measurement of all valves, flanges and fittings shall be taken in running metre of pipe line as if they are also pipe lengths. Nothing extra over the above shall be payable for insulation over valves, flanges and fittings in pipe line/routings. Fittings that connect two or more different sizes of pipe shall be measured as part of the larger size.

b) Ducts

The measurements for insulation of ducts shall be made in actual square meters of bare uninsulated duct surface.

In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for damper, flanges, fittings shall be for the surface dimension for the connecting duct. Nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

d) Accessories Insulation

The unit of measurement for accessories such as expansion tank, pumps, chiller heads etc. shall be of uninsulated area in square meters. In case of curved or irregular surfaces, measurements shall be taken along the curves. The unit insulation price shall include all necessary adhesives, vapour proofing and finishing materials as well as additional labour and material required for fixing the insulation.

e) Acoustic Duct Lining

In case of acoustic lining of air ducts, measurements of the bare inside duct surface in square metre, shall be final for billing purpose.

The insulation/acoustic treatment shall include cost of battens/sections, supports, adhesives, vapour proofing, finished tiles/boards/sheets as well as additional labour and materials required for completing the work.

f) Roof and Wall Insulation and Acoustic Treatment

The unit of measurement for all underdeck roof insulation wall insulation, wall/roof acoustic panel shall be the acoustic uninsulated area of walls, roofs, to be treated, in square metres.

The insulation/acoustic treatment shall include cost of battens supports, adhesives, vapour proofing, finished boards/sheets as well as additional labour and materials required for completing the work.

g) Acoustic Baffle Boxes (wherever required)

The unit of measurement shall be the exposed inside face of the acoustic baffle boxes in square meters.

The unit price shall include all hold fasts, nuts, bolts connecting the size of wall opening and making it good as well. Any additional materials and labour to fabricate and fix the boxes.

LIST OF BUREAU OF INDIAN STANDARD CODES

IS:277-1992	-	Galvanised steel Sheet (plain & corrugated)
IS:544-1985	-	Dimension for pipe Threads
(Reaffirmed 1996)		
IS:778	-	Valves (gate/globe/check type)
IS:655-1963	-	Metal Air Ducts
IS:13095-1991	-	Butterfly Valves
IS:659-1964	-	Air-conditioning (safety codes)
IS:1239-1990/92	-	Mild Steel Pipes
IS:325	-	3 phase induction motor
IS:822	-	Code of procedure for inspection of welds
IS:900	-	Code of practice for installation and maintenance of motors
IS:6392	-	Steel Pipe Flanges
IS:1822	-	Motor starters for voltage not exceeding 650 Volts
IEC	-	Relevant Sections
IS:996	-	Single phase small A.C. Motors
IS:4894-1987	-	Centrifugal Fans
IS:1554(I)	-	PVC Insulated (heavy duty)electric cables for working Voltage upto and including 1100 Volts
IS:8623-1993	-	Bus Bar Trunking System
IS:8828-1996	-	Miniature Circuit Breakers
& IEC898-1995		
IS:9537-1981 Part II	-	Rigid steel conduit for electrical wiring
IS:10810-1989	-	Method of Test of Cables
IS:13947-1989	-	Circuit Breakers
IS:13947-1993	-	Switches,disconnectors,fuse combination units
IS:139-1993(Part IV)	-	Contactors & Motor Starters
Duct Fabrication standards	-	-SMACNA
ASHRAE Handbooks	-	Application 1995
	-	fundamentals 1997
	-	System & equipment 1996
	-	Indoor Air Quality 62-1982