PART-4 TECHNICAL SPECIFICATIONS
SECTION-1 CIVIL WORKS

1.0 CEMENT:

1.1 The cement used shall be one of the following types:

a) Ordinary Portland cement conforming to IS:269 – 1976
b) Portland Pozzolana cement conforming to IS: 1489

1.2 Whenever possible all cements of each type shall be obtained from one constant source throughout the contract. Cement of different types shall not be mixed one with the other. Different brands of cements, or the same brand of cement from different sources, shall not be used without prior notification and approval.

1.3 The cement shall be supplied either packed in bags or in silos installed for the purpose of supply. Packed cement shall be delivered to the site in original sealed bags which shall be labeled with the weight, date of manufacture, name of manufacturer, brand and type-A Cement received in torn bags shall not be used.

1.4 All cement shall be fresh when delivered and at ambient atmospheric temperature.

1.5 In fair faced elements, the cement used in the concrete for any complete element shall be from a single consignment. all cement for exposed concrete shall be from the same approved source and uniform in color.

2.0 AGGREGATES:

2.1 Aggregates from natural sources shall be in accordance with IS: 383. The Contractor shall submit to the CONSULTANT/ BHEL certificates of grading and compliance from the suppliers for all consignment of aggregate. In addition from time to time, the contractor shall test aggregate at site in accordance with MS2386 Part-I, II & III. The contractor shall allow for and provide all necessary apparatus for carrying out such tests and for supplying test records to the CONSULTANT/BHEL.

2.2 For fair-faced concrete, the contractor shall ensure that aggregates are free from iron pyrites and impurities which may cause discoloration.

2.3 FINE AGGREGATE:

2.3.1 All aggregate shall comply to IS: 2386 Part-II. The fine aggregate shall be pit sand stone dust or other approved sand. It shall be free from clay, loam, harmful chemical impurities. It shall be clean, sharp, strong, and angular and composed of hard siliceous materials.

2.3.2 Fine sand shall be within the limits of Grading Zone IV of relevant IS code. As given in Table I. When the grading falls outside the percentage limits given for sieves other than 600 micron, 300 micron and 150 micron (I.S.) sieves but not more than 5

percent, it shall be regarded as falling within this zone. The 5 percent shall be summation of excess on all other services.

TABLE- I – FINE AGGREGATE

I.S. SIEVE	**PERCENTAGE PASSING FOR GRADING**			
	Zone-I	**Zone-II**	**Zone-III**	**Zone-IV**
10mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	35-60	80-100
300 micron	5-20	8-30	8-30	20-65
150 micron	0-10	0-10	0-10	0-15

2.3.3 Coarse sand shall be within the limits of grading zone-III of relevant IS code as given in table-I. When the grading falls outside the percentage limits prescribed for the Sieves other than 600 micron, 300 micron and 150 micron (I.S. Sieves) but not more than 5 % it shall be regarded as falling within this zone. The 5 percent can be sublation of excess on all other sieves.

2.3.4 The maximum quantity of silt as determined by the method prescribed in I.S. 2386 Part II shall not exceed 8 percent. Stone dust shall be obtained by crushing hard stone and the grading as determined by the method prescribed in IS:2386 Part-II. It shall be within the limits above for the sieves other than 600 micron (I.S.) Sieves should not be more than 5 percent and for 150 micron sieve should not be more than 20 percent.

2.3.5 This shall then be regarded as falling within this zone. The 5 percent shall be summation of excess on other sieves.

2.4 **COARSE AGGREGATE:**

2.4.1 For reinforced concrete work coarse aggregate shall be crushed stone, river shingle or approved pit gravel having nominal maximum size of 20 mm and down as approved by CONSULTANT/BHEL.

2.4.2 Coarse aggregate obtained from crushed or broken stone shall be angular, hard, strong, dense, durable, clean and free from soft, friable, thin flat, elongated or flaky pieces.

2.4.3 River shingle or pit gravel shall be rounded sound, hard, clean, nonporous, suitably graded in size with or without broken fragments and free from flat particles of shale, clay silt, loam and other impurities.

2.4.4 Except where it can be shown to the satisfaction of the CONSULTANT/BHEL supply of properly graded aggregate of uniform quality can be maintained over the period of

the works, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in correct proportions as and when required.

3.0 WATER:

3.1 Water used in the works shall be potable water and free from deleterious materials. water used for mixing and curing concrete as well as for cooling and/or washing aggregate shall be fresh and clean, free from injurious amounts of oil, salts, acids, alkali, other chemicals and organic matter.

3.2 Water shall be from the source approved by the CONSULTANT/BHEL and shall be in accordance with clause 4.3 of IS: 456.

3.3 Before starting any concreting work and wherever the source of water changes, the water shall be tested for its chemical and other impurities to as certain its suitability for use in concrete for approval of the CONSULTANT/BHEL. No water shall be used until tested and found satisfactory. Cost of all such tests shall be borne by the contractor.

4.0 ADMIXTURES AND ADDITIVES:

4.1 Chemical admixtures shall be conforming to IS 9103-1979 and shall not to be used until permitted by the CONSULTANT/BHEL In case their use is permitted, the type amount and method of use of any admixture proposed by the contractor shall be submitted to the CONSULTANT/BHEL for approval.

4.2 The contractor shall further provide the following information concerning each admixture to the CONSULTANT/BHEL.

i) Normal dosage and detrimental effects if any of under dosage and over dosage.
ii) The chemical names of the main ingredients in the admixture.
iii) The chloride ion content if any expressed as a percentage by weight of admixture.
iv) Whether or not the admixture leads to the entrainment of air when used in the manufacturer's recommended dosage.
v) Where two or more admixtures are proposed to be used in any one mix, the manufacturer's written confirmation of their compatibility.
vi) In reinforced concrete, the chloride of any admixture used shall not exceed 2 percent by weight of the admixture as determined in accordance with IS: 6925 and the total chloride on in all admixtures used in concrete mix shall not exceed 0.83 percent by weight of cement.
vii) The suitability of all admixtures shall be verified by trial mixes.
viii) The addition of calcium chloride to concrete containing embedded metal will not be permitted under any circumstances.
ix) Waterproofing admixtures shall comply with IS: 2645.

5.0 PLANT/ MIXER

5.1 The contractor shall obtain the approval of the CONSULTANT/BHEL for all plant items

he proposes to use for the manufacture and placing of concrete.

5.2 The arrangement and setting of plant for the manufacture of concrete shall be agreed with the CONSULTANT/BHEL.

5.3 The contractor shall maintain all items of plant at all times in a clean and efficient working condition.

6.0 STORAGE:

All goods and products covered by these specifications shall be procured well in advance and stored as specified below:

6.1 CEMENT

i) Cement shall be stored on raised floor in dry weather proof and draught free but well ventilated shed.

ii) Cement bags shall be stacked at least 60 cm away from external walls and in stacks of not more than ten bags to avoid lumping under pressure.

iii) Cement stored during monsoons or cement expected to be in store for more than eight weeks shall be completely enclosed in 500 gauge polythene sheet so arranged that the flap closes on the top stack. The contractor shall ensure that protective polythene sheet is not damaged at any time during use.

iv) Cement of different types shall be stored in separate sheds or separate compartment of a shed. If different types of cement are mixed, the CONSULTANT/BHEL will have the discretion to reject all the cement/concrete concerned.

v) Consignment of cement shall be used in order of delivery. A record shall be kept of the batch numbers of cement deliveries in such a form that the part of the works in which the cement is used can be readily identified.

vi) The contractor shall be responsible for the storage of cement at the site and no claim will be entertained in the event of any damage occurring to cement due to faulty storage by the contractors or on account of his negligence.

vii) If cement is stored on site for a period longer than eight weeks it shall be tested to the satisfaction of the CONSULTANT/BHEL before it is used in the works.

viii) Cement which has so deteriorated in quality that it no longer conforms in all respects to the requirements of this specification will be condemned by the CONSULTANT/BHEL - and shall not be used in the works. The contractor shall immediately remove from the site all cement which has been so condemned.

6.2 AGGREGATE

i) Aggregates shall be stored as per 18:4082: 1977 on a suitable well drained raft of

concrete, timber, metal or other approved material. The storage of aggregate on the ground will not be permitted.

ii) Each size of aggregate shall be stored separately in such a manner as to prevent spillage and mixing of one aggregate with an adjacent aggregate. The dividing wells of any bins shall be of sufficient height and the aggregate shall be so deposited that a distance of 300mm shall left between the top of the division wall and any part of the aggregate stack.

iii) When stack piling, the aggregate shall not form pyramids resulting in segregation of different size particles. The stacks shall be regular and of a height not exceeding two meters.

7.0 CONCRETE MIX PROPORTIONS

Cement concrete used in the works shall be either of the two categories given below.

A) All cement concrete not designated by strength shall be treated as ordinary concrete of nominal mix as specified. The aggregates and cement shall be as specified. The aggregates and cement shall be measured by volume. Mixing water shall be measured in graduated liter cans.

B) Controlled Concrete

i) All cement concrete designated by strength shall be treated as controlled concrete. The controlled concrete shall conform to one of the grades specified here in or on the drawings. The aggregates and cement shall be measured by weight in approved weight batching equipment. Mixing water shall be measured in graduated liter cans. In case cement is supplied packed in bags one or more complete bags of cement shall used for each batch of concrete where concrete mixers are allowed to be used.

ii) The controlled concrete shall meet with the strength requirement laid down in Table 2. the aggregate cement ratio and water cement ratio to be used for obtaining the specified cube strengths given in Table 2. shall be determined in accordance with the design of the mix.

TABLE – 2

Grade of concrete	Minimum Cement Concrete Per cum	Compressive Strength of 15cm cubes(Kg/Sg.cm)	
		Preliminary Test	Work Test
M 25	410 kg	7 days / 28 days	7 days / 28 days
		235 350	175 265

iii) The contractor shall be responsible for designing mixes of the specified performance to suit the degree of workability and strength. Required for the various parts of the works.

iv) Alternative mixes may be designed by the contractor for use in both thin and narrow section and thick sections. Special mixes using finer aggregates may be designed by him for infilling pockets and narrow spaces and for regions of congested reinforcement.

v) The maximum water cement ratio for all grade of ordinary concrete shall not be more than 0.5.

8.0 STRENGTH OF CONCRETE

The compressive strength on work tests for different nominal mixes is given in following Table:-

TABLE- 3

Concrete Mix	Compressive strength	(kg/sq.cm)
	7 days	28 days
1:1:5:3	140	210
1:2:4	106	158
1:1:2	175	265

9.0 WATER CEMENT RATIO

i) The quantity of water added to the cement and aggregate during mixing shall be such as to produce a concrete having sufficient workability to enable it to be properly compacted to be worked into the corners of the shuttering and around reinforcement.

(ii) Due amount shall be taken of the variation of moisture content, within any consignment of aggregate and any variations due to watering, exposure to rain or drying weather. The contractor shall carry out regular moisture content tests in accordance CONSULTANT and results submitted to him.

(iii) In case of ordinary concrete the maximum value of water cement ratio shall be 0.50 and in the case of controlled concrete the water cement ratio is determined by the mix design.

(iv) The contractor shall exercise particularly tight control on the water content for fair-faced concrete the color of which is sensitive to small variations of water in the mix.

(v) When a suitable water cement ratio has been determined and agreed by the CONSULTANT it shall be maintained throughout the corresponding part of works. Approved tests shall be undertaken periodically by the contractor to satisfy the CONSULTANT of the maintenance of the consistency. However the amount of water added to a mix other than for fair faced concrete may be reduced below the agreed design amount with the consent of the CONSULTANT if the contractor is able to demonstrate that such a reduction is consistent with producing concrete of the required workability and characteristic strength.

(vi) The contractor shall frequently test the concrete for slump cone test. The slump at the

actual location of placing as measured in accordance with the methods laid down is IS:1199 shall be as per IS.456.2000.

10.0 APPROVAL OF DESIGN MIXES, IF ANY.

10.1 The contractor shall submit to the CONSULTANT/BHEL for comment sufficient evidence based on trial mixes that .for each grade of concrete, the intended workability, the proposed mix proportions and method of manufacturers will produce concrete of the required quality.

10.2 The contractors shall obtain from the CONSULTANT/BHEL his written approval on the mix design for each grade of concrete before any concrete of that grade is placed in the works.

10.3 For each grade of concrete, three separate batches of concrete shall be made by the contractor using materials typical of the proposed supply and under full-scale site conditions.

10.4 The workability of each of the trial batches shall be determined and 6 specimen preliminary test cubes shall be tested at 7 days and the remaining 3 cubes of each set shall be tested at 28 days.

10.5 Following agreement with the CONSULTANT/BHEL on the trial mix proportions should the contractor wish to make substantial changes in the materials or in the proportions of the materials to be used in mix, the CONSULTANT/ BHEL will require further trial mixes to be made and their results submitted for the comments prior to such materials for proportions being adopted by the contractor.

11.0 **CONCRETE TESTING, PRODUCTION AND PREPARING**

11.1 **TEST CUBES**

i) The strength of concrete either in assessing the suitability of the trial mixes or when placed in the works shall be determined from 150mm cubes made, cured, stored, transported and tested in accordance with IS:516

ii) Test cubes shall be made as per CPWD specification for mandatory test.

iii) Test cubes shall be made under the direct supervision of the competent person appointed by the contractor to supervise all Stages of the preparation and placing of concrete. They shall be made by the contractor in the presence of the CONSULTANT generally from concrete taken at the point of discharge from the mixer and the contractor shall provide suitable facilities in the form of a hut or other covered protection as agreed with or directed by the CONSULTANT" for the storing and curing of the test cubes during the first 24 hours after making them and until they are sent to the testing laboratory.

iv) Test cubes shall be marked and dated in such a manner that the trade and the part of

the works in which the concrete they represent has been placed can be readily identified.

v) Testing shall be done in the field laboratory only; in special case with due approval of CONSULTANT testing may be allowed in laboratory approved by the CONSULTANT and the results shall be submitted promptly by the contractor to the CONSULTANT.

11.2 WORK TESTS

i) When concrete of a particular grade is first used in the works, 2 cubes shall be taken from 3 separate batches during each of the first 7 days of using that grade. Of these 6 cubes made daily, 3 cubes (each cube representing concrete made of a different batch) shall be tested at 7 days and the remaining 3 cubes shall be tested at 28 days.

ii) If the concrete strength determined from such 28 days cube tests does not reach the characteristic strength for that grade, the materials and/or their proportions for that grade shall be modified by the contractor to the satisfaction, of the CONSULTANT.

11.3 CONCRETE PRODUCTION

Batching plant with water meter, control panel and of capacity 30-40 m3/hour shall be used for production of all major concreting e.g. in raft, walls, ramps, beams, slabs etc. Necessary approval shall be obtained from CONSULTANT before the batching plant arrangement is installed at site.

11.4 CONCERTE MIXING

(i) All concrete in the correct proportion of ingredients approved by the CONSULTANT whether ordinary or controlled, shall be mixed in an approved mixer for the minimum time necessary to ensure adequate quality and uniform distribution of the materials. The cement and aggregates shall normally be first mixed dry until all particles of aggregate are coated with cement after which the water shall be added.

(ii) Allowance shall be made for the moisture content of the aggregate when calculating the amount of water to be added for each mix.

(iii) The temperature of the aggregate, water and cement when added to the mixer shall be such that the temperature of the concrete at the time of placement is less than 40 deg. c.

(iv) Materials for concrete shall be deposited into the drum while it is in rotation. Mixers shall not be loaded beyond their rated capacity and each batch shall be completely discharged from the drum before recharging takes place.

(v) Facilities shall be provided to spray the mixer drum with cool water between batches and on the completion of concreting the drum shall be washed down. The surface of the mixer drum shall be maintained in a clean condition at all times.

(vi) Re-tampering and/or mixing of concrete which has partially hardened and set will not

be permitted under any circumstances.

11.5 **CONCRETE TRANSPORTING**

(i) The period between mixing the concrete and placing it in the final position shall be kept to a minimum and the delivery of concrete shall be co-ordinate with the rate of placement to avoid delays in delivery and-placement.

(ii) Concrete shall be handled from the place of mixing to the place of final deposit by methods, which prevent segregation, loss of ingredients and contamination and maintain the required workability.

(iii) Should any segregation have occurred in any batches arriving at the place of deposition, such batches shall be rejected and shall not be allowed to use.

(iv) Where concrete is conveyed by chutes, the chutes shall be made of metal or fitted with metal linings. The approval of the CONSULTANT shall be obtained for the use of chutes more than 3 meters long.

(v) All plant and equipment used in the transportation of concrete shall be thoroughly cleaned before and after each working period and at all changes of concrete mixes.

(vi) All major concreting shall be done by concrete pump. A concrete pump of capacity 38-40m3/hr. shall be installed for the purpose and necessary approval for the concrete pump delivery system with adequate boom length, pipe line and associated items shall be obtained before installation of the concrete pump. There shall also have the provision of an approved standby system incase of any eventualities for transporting the concrete.

11.6 **PREPARATON BEFORE CONCRETING**

(i) The inside surface of the forms against which concrete is to be placed shall be clean and free from dried or hardened spattering or coatings of concrete. The forms shall be well wetted before placing concrete.

(ii) When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean, thoroughly wetted and covered with 12mm layer of freshly mixed mortar composed of cement and sand (in the same ratio as the cement and sand in the concrete mix) immediately before placing of concrete.

(iii) Concrete shall be handled from the place of mixing to the place of final deposit by methods which prevent segregation, loss of ingredients and contamination and maintain the required workability.

11.7 **PLACING**

(i) Concreting of any portion of the works shall be done only in the presence of the representatives of the CONSULTANT.

(ii) Concreting shall be carried out continuously between construction, contraction or expansion joints, shown on the drawings or agreed with CONSULTANT. The

contractor shall closely follow the sequence of concreting where such is specified in the drawings. If concreting is interrupted before reaching the predetermined joint an approved construction joint shall be provided after obtaining necessary approval from CONSULTANT.

(iii) Immediately before placing of concrete for columns and walls, the reinforcement within and the old concrete at the bottom of the formwork shall be given a coating of cement sand mortar of the identical materials and proportions to be used in the subsequent concrete, to prevent the loss of fine material from the initial concrete pour.

(iv) Concrete shall be deposited as nearly as is practicable to its final position and shall not be dumped in a large quantity at any point to be run or worked along the formwork manually or with vibrators. Concrete shall not be deposited at a faster rate than it can be placed and compacted.

(v) Concrete shall 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 with the use of vibrators in a manner directed by the CONSULTANT

(vi) For members having thickness more than 300 mm, the concrete shall be placed in layers not greater than 300 mm thickness and thoroughly compacted before succeeding layers are placed. Concrete of thickness less than 300mm shall be placed in single operation to the full thickness of slabs, beams and similar members. No concrete shall be placed on concrete which has set sufficiently to cause shall be placed on concrete which has set sufficiently to cause the formation of planes of weakness and where there is likely to occur due to unforeseen circumstances the procedure to be followed shall be as for clause 2.2.18 of this specification.

11.8 **COMPACTION**

(i) Each layer of concrete whilst being deposited shall be compacted by approved methods to form a dense material with all surface free from honey combing, air holes or other blemishes. The contractor shall use mechanical vibration for all concrete and shall take care that internal vibrators shall not be brought into contact with the reinforcement or there formwork. An adequate number of vibrators shall be used to ensure that compaction of concrete is achieved within 10 minutes of placing. Particular attention shall be given to the compaction of concrete around the water bars to ensure that no voids or p areas are left.

(ii) Compacting shall cease as soon as excess water appears on the face of concrete. Any water accumulating on the surface of newly placed concrete shall be removed by approved methods and no further concrete shall be placed thereon until such water has been removed.

(iii) Notwithstanding the requirements regarding mix design, should it be found that the proportion of water in the mix is such the laitance forms before compaction (i.e.

completion of expulsion of that air) is complete; the quantity of water in the mix shall be reduced. If required, approved admixture / plasticizer could be used to achieve necessary workability. Whenever either of the aforesaid procedures' are to be adopted, an additional set of 6 cubes for testing at 7 or 28 days shall be made from the changed mix. The time elapsed between the discharge of the concrete from the mixer and the completion of compaction shall not exceed 30 minutes. A sufficient number of spare vibrators shall be kept readily accessible to the place of deposition of concrete to assure adequate vibration in case of breakdown of those in use.

11.9 **FINISHES**

(i) All concrete surfaces shall have a good, dense finish. Except for slabs the face of concrete for which from work is not provided shall be smoothed with a steel or wooden trowel to provide a finish equal to that face where formwork is provided.

(ii) The top surfaces of all floor and roof slabs specified as smooth shall be leveled and trawled before the concrete sets to a smooth finish at the levels of falls shown on the drawings. The trawling shall be done at such a time and in such a manner than an excess of mortar is not brought to the surface of concrete nor the aggregate displaced. The top surfaces of concrete slabs specified to receive an integral finish shall be uniformly roughened by deep hacking before the finish is laid.

(iii) Immediately after striking the formwork and removing any superficial water, honeycombed areas in normal unfinished concrete shall be inspected by the CONSULTANT and where directed the contractor shall immediately make good at his own expense such honeycombing in accordance to the instruction and guide line of CONSULTANT whilst the concrete is still green. All air holes shall be similarly filled in.

(iv) The contractor shall be responsible for providing an adequate key in concrete where plastering or rendering is specified to be applied. Hacking of the concrete surface immediately after striking the formwork will be permitted.

(v) The faces of all fair faced concrete shall be of even colour throughout, free from air bubbles, cracks, honeycombing or other blemishes and will be inspected by the CONSULTANT immediately after the formwork has been struck. Such faces shall not be rubbed down after striking the formwork to remove fins, excrescences or any similar imperfections without the prior permission of the CONSULTANT.

(vi) Concrete surface finishes shall be according to the requirements and all instructions by the CONSULTANT' with regard to the method of achieving such finishes shall be implemented.

11.10 **CURING AND PROTECTION**

(i) Walking on concrete shall not be permitted for at least 24 hours after it has been placed in position or for such additional length of time as the CONSULTANT may direct.

(ii) Immediately after compaction and completion of any surface finishes, the concrete shall be protected from the evaporation of moisture by means of polythene sheeting, wet Hessian or other similar material kept soaked by spraying. As soon as the concrete has attained a degree of hardening sufficient to withstand surface damage, moist curing shall be implemented and maintained for a period of at least 15 days after casting.

(iii) Method of curing and their duration shall be such that the concrete will have satisfactory durability and strength and members will suffer a minimum distortion, be free from excessive efflorescence and will not cause, by its shrinkage, undue cracking in the works.

(iv) The top surfaces of slabs and other horizontal surfaces shall be cured by impounding water in cement mortar bunds. Steeply sloping and vertical formed surfaces shall be kept completely and continuously moist prior to and during the striking of formwork by applying water to the top surfaces and allowing it to pass down between the formwork and the concrete.

(v) The Contractor shall give careful consideration to the curing methods and conditions for fair faced concrete. Components which are specified to have exposed concrete finish shall receive the same curing treatment. Moreover water used for curing shall be clean so as not to discolor the concrete.

(vi) All fair-faced concrete shall be protected from damage from the time of striking the formwork. All edges and surfaces of such concrete shall be protected from' chipping using notched timber or aluminum corner pieces or other suitable covers which shall be maintained in place until the completion of the works.

11.11 CONSTRUCTION JOINTS

(i) Construction joints shall be made only where shown on the drawings. Where the contractor wishes to form joints in concrete other than those shown on the drawings, he shall submit his proposals giving the position, form and treatment of such joints to the CONSULTANT for his approval.

(ii) Vertical construction joints shall be formed against a stop board and horizontal construction joints shall be formed in horizontal level.

(iii) Except where shown otherwise on the drawings, reinforcement shall continue through construction joints.

(iv) As soon as possible after the formwork has been struck for vertical joints or after the concrete has set in horizontal joints, the surface laitance of the hardened concrete on the face of the joint shall be removed to expose the coarse aggregate in such a manner that the loosened particles of aggregate and damaged concrete are not left on the surface. The exposed face shall be swept clean of foreign matter and laitance. Feathered construction joints will not be permitted. Immediately before placing the

new concrete, neat cement grout shall be poured over the old concrete followed for horizontal joints by a 12mm thickness of sand cement mortar of the same materials and proportion to be used in the new concrete.

11.12 **CONTRACTION JOINTS**

Contraction joints required will be as shown on the drawings. Contraction joints shall not be hacked, wetted or mortared before concrete is placed against them.

11.13 **EXPANSION JOINTS**

(i) Expansion joints shall be provided where shown on the drawings. They shall be constructed with an initial gap between the adjoining parts of the works of the width specified in the drawings. The contractor shall ensure that no debris is allowed to enter expansion joints.

(ii) Expansion joints shall be provided with joints filler, a joint sealing compound and in water proof concrete water bar.

A) Open joint fillers
Where shown on the drawings, open joints in the structure shall be filled with one of the following of expansion joint fillers:

a) In internal areas a material conforming to IS:1838 containing bitumen emulsion fibers or cork granules bound together with natural resin;

b) In external areas a material comprising closed cell rubber or containing cork granules bound together with natural resin.

(iii) The joints filler shall be easily and uniformly compressible to its original thickness, tamparable, easily cut or sawn, robust, durable, resistant to decay due to termite or weathering, unaffected by water and free of any constituent which will bleed into or stain the concrete.

(iv) The joint filler shall be of same thickness of the joint width, it shall extend through the full thickness of the concrete unless otherwise specified and shall be sufficiently rigid during handling and placing to permit the formation of straight joints.

JOINT SEALING COMPOUNDS:

(v) Joint sealing compounds shall be in accordance to IS: 037- 1965 and approved by CONSULTANT and shall seal joints concrete against the passage of water prevent the ingress of grit or other foreign material and protect the joint filler. The compound shall have good extensibility and adhesion to concrete surfaces and shall be resistant to flow and weathering.

(vi) Polysulphide joints where specified on the drawings shall be sealed with polysulphide liquid polymer, stored, mixed, handled applied and cured strictly in accordance with

the manufacturer's written instructions. Such joints shall be formed to the correct dimensions, thoroughly cleaned and treated with recommended primer strictly in accordance with the manufacturer's written instructions prior to sealing. The Contractor shall use only competent personnel experienced in the application of polysulphide for such work.

(vii) Where specified in the drawings, rubber! Bituminous-based sealants shall be of an approved manufacture. The treatment of the joint and the use of sealing compound shall be strictly in accordance with the manufacturer's written instructions.

WATER BARS

(viii) Where water bars are shown on the drawings, the joints shall incorporate approved PVC external type water bar complete with all necessary moulded or prefabricated intersection pieces assembled- in accordance with the drawings with the drawings with bends and butt joints in running lengths made by heat welding in an electrically heated jig.

(ix) Jointing and fixing of water bars shall be carried out strictly in accordance with the manufacturer's written instructions.

(x) The water bars shall be installed so that they are securely held in their correct position during the placing and compacting of the concrete.

(xi) Where reinforcement is presented adjacent to water bars, adequate clearance shall be left between the reinforcement and water bars to facilitate compaction of the concrete.

(xii) Double headed nails may be used in the edge of the water bar outside the line of the external grooves for fixing purposes, but no other holes shall be permitted through the water bars.

11.14 **INSERTS**

The Contractors shall fix all necessary inserts such as steel plates, pipe sleeves, bolts etc. and made provision of holes, pockets, dowels etc., in the formwork to enable subsequent fixing of supports, brackets, ceilings, pre-cast members etc., as indicated on the drawings, called for in the schedule of quantities or as required by the CONSULTANT. In-situ concrete inserts shall be as per IS: 1946 and of a type approved by the CONSULTANT.

Nothing extra over and above the provision as per the priced schedule of quantities shall be paid to the contractor on this account.

With the prior agreement of the CONSULTANT expansion type fasteners may be used by the Contractor in hardened concrete.

11.15 **CRACKS**

(i) If any cracks develop in the reinforced cement concrete construction which in the opinion of the CONSULTANT may be detrimental to the strength of the construction, the contractor at his own expense shall test the structural element in question. If under these test loads the cracks shall develop further the contractor at his own expense shall dismantle the construction, cart away the debris, replace the construction and carryout all consequential work there to at no extra cost. If the cracks are not detrimental to the stability of the construction in the opinion of the CONSULTANT the contractor at his own expense shall grout the cracks with pneumatically applied mortar or epoxy grout or by other specified treatment as directed by the CONSULTANT at his own expense and risk he shall also made good al other building work such as plaster, moulding, surface finish of floors, roofs, ceiling etc. which in the opinion of the CONSULTANT have suffered damage either in appearance or stability owing to such cracks.

(ii) The repair work shall be carried out to the satisfaction of the CONSULTANT. The decision of the Engineer-in-Charge as to the extent of the liability of the contractor in the above matter shall be final and binding on the contractor.

11.16 LOAD TESTING ON COMPLETED STRUCTURES

(i) During the period of construction or within the defect liability period the CONSULTANT may at his discretion order the load testing of any completed structure or any part thereof if he has reasonable doubts about the adequacy of the strength of such structure for any the following reasons:

a) Results of compressive strength on concrete test cubs.

b) Premature removal of formwork.

c) Inadequate curing of concrete.

d) Over loading during the construction of the structure or part thereof.

e) Carrying out concreting of any portion without prior approval of the CONSULTANT.

f) Honey combed or damaged concrete which in the opinion of the CONSULTANT is particularly weak and will affect the stability of the structure to carry the design load, more so in important or critical areas of the structure.

g) Any other circumstances attributable to alleged negligence of the contractor which in the opinion of the CONSULTANT result in the structure or any part thereof being of less than the expected strength.

(ii) All the loading tests shall be carried out by the contractor strictly in accordance with the instructions of the CONSULTANT. Such tests should be carried out only after expiry of minimum 28 days or such longer period as directed by the CONSULTANT.

(iii) The structure should be subjected to a super imposed load equal to 1.25 times the specified superimposed load assumed in the design. This load shall be maintained for a period of 24 hours before removal. During the test, struts strong enough to take the whole load shall be placed in position leaving a gap under the members as directed.

(iv) The deflection due to the superimposed load shall be recorded by sufficient number of approved deflect meters capable of reading up to 1/500 of a cm and located suitably under the structure as directed by the CONSULTANT. If within 24 hours of the removal of the superimposed load, the structures do not recover at least 75% of the deflection under the superimposed load, the test loading shall be repeated after a lapse of 72 hours. If the recovery after the second test is less than 80% of the maximum deflection shown during the second test, the structure shall be considered to have failed to pass the test and shall be deemed to be unacceptable.

(v) In such cases the part of the work concerned shall be taken down or cut out and reconstructed to comply with the specifications. Other remedial measures may be taken to make the structure secure at the discretion of the CONSULTANT. Moreover, such remedial measures shall be carried out to the complete satisfaction of the CONSULTANT.

(vi) All costs involved in carrying out the tests and other incidental expense thereto shall be borne by the contractor regardless of the result of the tests. The Contractor shall take down or cut out and reconstruct the defective work or shall make the remedial measures instructed at his own cost.

(vii) In addition to the above load tests, non destructive test methods such as core test and ultrasonic pulse velocity test shall be carried out by the Contractor at his own expense if so desired by the CONSULTANT. Such tests shall be carried out by an agency approved by the CONSULTANT and shall be done under expert’s guidance using only recommended testing equipment. The acceptance criteria for these tests shall be in accordance to IS:1959 and IS:456-1978.

11.17 **DEFECTIVE CONCRETE WORK**

If the results of load test or core test on any concrete structure found unsatisfactory or unacceptable, the concrete work and the structure shall be removed and redone by the contractor at his own risk and coast as instructed by CONSULTANT.

11.18 **SUPERVISION**

All concreting work shall be done under strict supervision of the qualified and experienced representatives of the Contractor as well as those of the CONSULTANT. The contractor's supervisor who are in-charge of concreting work shall be skilled in this class of work and shall personally superintend all the concreting operations.

11.19 **QUALITY CONTROL**

The CONSULTANT reserves the right to make changes in the mix proportions including increasing the cement content or/and a change in the Contractor's control procedure, should the quality control during process of the work prove to be inadequate in CONSULTANT's opinion and the contractor shall carry out the same at

no extra cost to the corporation. All the concrete work shall be true to level, plumb and square within the acceptable tolerance. The corners, edges and arises in all cases shall be unbroken and finished properly and carefully.

11.20 **TOLRANCES**

The acceptable tolerances for formed concrete surfaces shall be as given below:

Variation in cross sectional dimensions of columns and beams and in the thickness of slabs and walls. -6 mm and + 12 mm

12.0 **WATER PROOFING TREATMENTIN BASEMENT**

This section of specification shall cover all work of water proofing treatment in basement raft and wall as shown in drawings and recommended by the manufacturer for such specialized work.

12.1 **SPECIALIST AGENT**

The water proofing treatment shall be carried out by an approved specialist agency.

12.2 **INSPECTION BEFORE COVERING**

No work under this section shall be commended until the surfaces have been inspected and approval obtained from the CONSULTANT prior to commencement of the work. No water proofing work shall be covered until it has been thoroughly checked, inspected and approved by the CONSULTANT. All defects notice shall be made good as directed and the areas inspected again before covering up.

12.3 **SURFACE PREPARATION**

Lean concrete surface to receive water proofing treatment shall be thoroughly cleaned I all dust and the foreign matter. It shall be wetted before applying the treatment.

12.4 **ACRYLIC POLYMER DAMP PROOF COMPOUND (APDPC)**

Acrylic base chemical shall be of approved make and conforming to IS:2645:1975

12.4.1 **APPLICATION**

After completion of all preparatory, ancillary work needed in connection with the structure the following operation are to be executed.

(i) **Operation - I below R.C.C. floor slab / raft**

Over the evenly laid bedding course of lean concrete, cement slurry admixed with acrylic based chemical conforming to IS : 2645:1975 at the rate of 1% by weight of ordinary cement or as recommended by the specialized agency shall be applied on the prepared concrete surface.

A layer of 20 mm thick (minimum) cement sand mortar of ratio 1:4 (1 cement: 4 coarse

sand) admixed with the specified acrylic based chemical conforming to IS :2645: 1975 at the rate of 1 % by weight of cement or recommended by the specialist agency and 12 mm down stone aggregate shall be evenly laid over the bed.

15 to 20 mm thick approved rough quarry finished low porosity Kota stone shall be laid over 15 mm thick cement mortar 1:4 cement and coarse sand mortar admixed with acrylic based polymer. A gap of about 15 mm is kept between the stone slabs.

The joints between the stone slabs shall be raked and cleaned and grouted with cement slurry admixed with acrylic based polymer @ 1 % by weight of cement as recommended by the specialist agency. The top surface of stone layer including 20 mm thick cement mortar 1:4 admixed with acrylic based polymer and 12 mm down stone aggregate is to be laid over.

(ii) **Operation -II R.C.C. basement wall.**

Rough quarry finished low porosity Kota stone slabs 15-20mm thick shall be laid parallel to the vertical wall with the help of cement paste applied on the internal face of stone slabs, leaving a gap of 15-20 mm between the external face of RCC wall and internal face of the stone slabs which will be cement grouted admixed with acrylic based polymer recommended by the specialist agency.

The stone slabs shall be fixed side by side without leaving any gap between the edges. In order to fix the bottom most layer of stones a grooves is to be made in the top layer of the treatment and the stone slabs fixed in it to ensure the water tightness at the junction of the walls and raft. Maximum of two to three horizontal layers of rough stones are to be laid in a day.

12.4.2 **DURABILITY AND PERFORMANCE**

Specialist water proofing specialist agency shall furnish proof of durability of the system carried out based on long term performance as basement raft slabs and walls, will be completed in two stages. The adequacy of the system to meet the above requirement shall be established by the above said agency. All materials and the technique to be used shall satisfy provision of IS : 1645 and IS :6494.

13.0 **STRUCTURAL STEEL**

All finished rolled steel sections shall be of wieldable quality in accordance with latest edition of IS 226 and shall be approved by the CONSULTANT/ BHEL.

14.0 **Fabric**

Fabric reinforcement for concrete shall be of square or oblong mesh of hard-drawn steel wire, electrical resistance welded and shall conform with IS : 1566 "Hard-drawn Steel Wire Fabric for Concrete Reinforcement".

15.0 **Steel Reinforcement**

Steel reinforcing bars shall be TMT conforming to IS :14786-1979 or IS : 1139-1966 (Grade Fe 415) or mild steel bars conforming to Grade I of IS : 432 (Part I) - 1966.

15.1 **Stamping or Marking**

The steel shall be marked or stamped with a private mark for the purpose of identification as may be directed by the CONSULTANT.

16.0 **FORM WORK**

16.1 **General**

(i) Form work shall include all temporary or permanent forms of moulds required for forming the concrete which is cast-in-situ together with all temporary construction required for their support.

(ii) Formwork shall be of rigid construction true to shape and dimensions. It shall be strong enough to withstand the dead and live loads and forces caused by ramming and vibrations of concrete and other incidental loads, imposed upon it during and after casting of concrete. It shall be made sufficient rigid by using adequate number of ties and braces. Screw jack or hard board wedges, were required shall be provided to make up any settlement in the form work either before or during the placing of concrete.

(iii) Forms shall be so constructed as to be removable in sections in the designed sequence without damaging the surface of concrete or disturbing other sections. All form work should be easy to strip after concreting and form work must be erected with this consideration in mind. Care shall be taken to see that no pieces remain keyed into the concrete. Details of formwork shall be properly designed by the Contractor and relevant drawings together with calculations for strength and deflection shall be submitted to the CONSULTANT for approval before commencement of formwork erection.

(iv) The completed formwork shall be inspected by the CONSULTANT on receipt of information in this regard from the Contractor, before the reinforcement bars are placed in position. Minimum 2 complete sets of approved set of form work system for the total area in the typical floor shall always be available in usable condition.

16.2 **Materials for Formwork**

(i) Formwork surface in contact with concrete (sheathing) shall be of steel or plywood as approved by the CONSULTANT/ BHEL and of approved thickness. Approved hard wood section may be used for the frame work of shuttering board only. Sheathing for the form work of column shall be of steel with approved thickness.

(ii) Props used for centering shall be of adjustable steel props as approved by CONSULTANT.

16.2.1 **Formwork for fair face concrete**

(a) Formwork for fair face concrete must be fabricated from best quality new Marine ply having hard-core face, of minimum 18mm thickness (11 ply).

(b) The Contractor shall prepare a drawing for the fair face shuttering work and obtain necessary approval from the CONSULTANT/ BHEL before fabricating the same.

(c) All joints in boards for such formwork shall be carefully designed, no repair on the form finish concrete will be accepted.

d) Construction joints shall be positioned as indicated in the drawings or as instructed by CONSULTANT.

(e) There shall not be any visible patches, strains for effloresce in the fair faced concrete.

(f) Nails / screw with smooth and well dressed heads only will be used to avoid any massing of the concrete surface.

(g) Only non staining from oil, release agent shall be used with due approval from CONSULTANT.

c) Use of ties shall be minimum.

16.3 **Checking of props & wedges**

Before the concreting is started, the props and wedges shall be thoroughly checked to see that these are intact and take suitable action in case these are loose. While the concreting is in progress sufficient number of carpenters shall be readily available at site.

16.4 **Surface Treatment for Formwork**

The surfaces of timber formwork that would come in contact with concrete shall be coated with soap solution, raw linseed oil, or form oil of approved material to prevent adhesion of concrete to formwork.

16.5 **Removal of Formwork**

The formwork shall be so removed as not to cause any damage to concrete due to shock or vibration. In a slab and beam construction, sides of beam shall be stripped first, then the under sides of slab and lastly the underside of the beam.

Formwork must be so designed that they can be stripped in the order required i.e. i) Shutters to vertical (non-load bearings) faces e.g. columns boxes, beam sides, wall forms. ii) Shutters forming sophists to slabs, horizontal and inclined which carry only

light load, e.g. slabs, roofs, floors and canopies etc. Sophist's shutters carry heavy load e.g. beam and girder bottom.

The whole of the formwork should be planned and a definite scheme of operation worked out.

16.6 **Approval of CONSULTANT**

In no circumstances should forms be struck until the concrete reaches strength of at least twice the stress to which the concrete may be subjected at the time of striking but not before the period a specified herein below. Where ordinary Portland cement is used as indicated below and where the formwork should be left longer as it would assist curing and further construction, forms should be eased carefully in order to prevent the load being suddenly transferred to concrete. The removal of centering and shuttering is to be done with the approval of the Engineer-in-Charge. Removing time of Formwork shall be as IS-456:2000. The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

16.7 **Damage to Concrete**

The Contractor is to make good at his own expense any injury to the concrete work and any damage caused by or arising from the removal and striking of formworks and supports.

16.8 **Discoloration**

Formation of blotches and stains due to detachment of formwork panel from the concrete when adjacent portion in the same lift is still adhering shall not be allowed to occur and for this purpose all shutters shall be struck off at the same time. Use of old and new plywood in the same board or different quality boards or mixing shutter panels of different numbers of uses shall be totally avoided to get rid of discoloration.

16.9 **Ties**

Use of ties shall be very much restricted and as far as practicable formwork shall be supported without the ties by propping against staging erected firmly for the purpose.

16.10 **Clean up**

After forms are stripped, all materials to be reused shall be thoroughly cleaned. All nails shall be pulled from the plywood board and no nail shall be bent over by hammering against the face of the material if reuse of forms is planned. Holes bored through sheathing for forms ties shall be plugged by driving in common corks or foamed plastics. Patching plaster may also be used to fill small holes, with approval of Engineer-in-Charge. After cleaning and before re-fixing each formwork either of plywood or metal mould shall be got approved by the Engineer-in-Charge.

17.0 **Bending Schedule**

The Contractor shall be responsible for preparing, checking all bar bending schedules against the drawing and obtain approval from CONSULTANT before cutting and bending and fixing of steel commences. Contractor shall get satisfied that the steel can' be fixed according to the drawing and also can be transported to the Site. The contractor shall remove from site at his own risk and cost any steel reinforcement bar fixed in position with out obtaining prior approval of bar bending schedule from Engineer-in-Charge.

17.1 **Bending and Cutting of Reinforcing Steel Bars**

Reinforcement shall be to the size and shape as shown in drawings and bent cold, correctly and accurately in accordance with IS:2502 "Code of Practice for Bending and Fixing Bars for Concrete Reinforcement". Hooks, L-bends, ties, binding wires & any other subsidiary reinforcement, which are not shown in the drawing but may be necessary to keep the reinforcement in its correct position shall be provided by the contractor as per instructions of CONSULTANT. Only authorized spacers, laps and, chairs will be measured and paid for separately. As far as possible laps in bars shall be avoided. Any laps and chairs provided by the Contractor other than authorized as per approved bar bending schedule will be considered to have been provided by the Contractor for his own convenience and shall not be measured for payment.

17.2 **Bending and Overlapping**

Preferably, bars of full length shall be used, overlapping of bars, where necessary, shall be done in accordance with the drawings or as directed by CONSULTANT and as specified in IS:456-1978.

Wherever facility is available, welding of bars shall be resorted to in lieu of overlap. The location and type of welding shall be as approved by the CONSULTANT as shall be done in accordance to IS: 2751-1966.

17.3 **Placing in Position**

Reinforcement bars shall be placed in position as shown in the drawings. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.90 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during the deposition of concrete. The concrete cover shall not be less than that specified in the drawings. Tuck welding shall also be permitted in lieu of binding with steel wire if approved by CONSULTANT.

17.4 **Storage of Steel Reinforcement**

It shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. Steel reinforcement, shall be stored clear of the ground, on rack or otherwise supported, covered in bundles indicating the type, number, size, length, diameter and date of delivery to the site of the bars or fabric reinforcement as per relevant I.S. Code and as Directed by the CONSULTANT.

17.5 **Approval of Reinforcement**

The Contractor must obtain the approval of the CONSULTANT to the reinforcement fixed in position, before any concrete is deposited on the shutters.

17.6 **Fixing of Fabric Reinforcement**

Fabric reinforcement shall be fixed flat in the works over areas shown in drawings. Adjoining sheets of fabric shall overlap by at least one complete square or 60 x diameters of the bars crossing the lap, whichever is the greater overlap. Loose bars shall not be used in conjunction with fabric reinforcement except where shown on the drawings. Loose small pieces of fabric shall only be used where they are essential for fitting into small confined parts of the works as approved.

18.0 **Concreting**

(i) The concrete, which will flow sluggishly into the forms and around the reinforcement without any segregation shall be determined by slump tests. The slump to be used shall be minimum required for proper concreting and compaction depending upon the concentration of reinforcement structural member to be connected.

(ii) Concreting shall be commenced only after the CONSULTANT/ BHEL has inspected the centering, shuttering and reinforcement as placed and passed the same. Shuttering shall be clean and free from all dirt, saw dust, pieces of wood, or other foreign material, and shall be treated as described hereinbefore.

(iii) The concrete shall be deposited in its final position in a manner to preclude segregation of ingredients. In deep trenches and footings, concrete shall be laced through chutes as directed by the CONSULTANT/ BHEL In case of columns and walls, the shuttering shall be so adjusted that the vertical drop of concrete is hot more than 1.5 meters at a time.

(iv) During cold weather, concreting shall not be done when the temperature falls below 4.5 degree C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone at contractor's risk & cost. During hot weather, precaution shall be taken to see that the temperature of wet concrete does not exceed 38 degree C. No concrete shall be laid within half an hour of the closing time of the day, unless permitted by the CONSULTANT. It is necessary that the time between mixing and placing of concrete shall not exceed 30 minutes so that the initial setting process is not interfered with.

(v) Concrete shall be compacted into a dense mass immediately after placing, by means of mechanical vibrators designed for continuous operations. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layer is placed.

(vi) Concreting shall be carried out continuously up to the construction joints, the position and details of which shall be as directed by the CONSULTANT Such joints shall be

kept to the minimum and shall not be located in valleys. The joints shall be kept at places where the shear force is the minimum and these shall be straight and at right angles to the direction of main reinforcement.

(vii) When stopping the concrete on a vertical plane in slabs and beams and any other R.C.C. work an approved stop-board shall be placed with necessary slots for reinforcement bars or any other obstruction to pass the bars freely without bending. The. Construction joints shall be keyed by providing a triangular or trapezoidal fillet nailed on the stop-board. Inclined or feather joints shall not be permitted. Any concrete flowing through- -the joints of stop-board shall be removed soon after the initial set. When concrete is stopped on a horizontal plane, the surface shall be roughened and cleaned after the initial set.

(viii) When the work has to be resumed, the joint shall be thoroughly cleaned with wire brush and loose particles removed. A coat of neat cement slurry at the rate of 2.75 kg of cement per square meter shall then be applied on the roughened surface before fresh concrete is laid.

(ix) Expansion joints shall be provided as shown in the structural drawings or as directed by the CONSULTANT. The filling of these joints with bitumen filler, bitumen felt or any such material with the provision of copper or brass plate, etc.

(x) After the concrete has begun to harden i.e. about 1 to 2 hours after its laying, it shall be protected from quick drying with moist gunny bags, sand or any other materials approved by the CONSULTANT After 24 hours of laying of concrete, the surface shall be cured by flooding with water of minimum 25mm depth, or by covering with west absorbent material. The curing shall be done for a minimum period of 15 days.

(xi) For all slabs the top surface shall be furnished even and smooth with wooden trowel, before the concrete begins to set. Where so specified, the surfaces shall be given a linear deeply scratched surface by a steel broom or other approved tool while the concrete is still green to receive the specified finish on top.

(x) Immediately on removal of forms, the R.C.C. work shall be examined by the CONSULTANT before any defects are made good.

18.0 **BRICK WORK**

18.1 **Sampling**

For carrying out compressive strength, water absorption efflorescence and dimensional tests, the samples of the bricks shall be taken at random according to the size of the lot as given in Table-2 below. The samples thus taken shall be stored in a dry place until the tests are made.

TABLE – 2

Brick designation	Lot size	Sample Size

75		
50	50, 000 bricks	20 bricks
45	if brick filed is changed	
35	and qty. received is less	
	than 50, 000 bricks	20 bricks

19.0 DOOR WINDOW & WOOD WORK

19.1 GENERAL

(i) All the timber members shall be well seasoned by any proper natural or artificial method of seasoning. The preparation of timber for joinery is to commence simultaneously with the construction of superstructure and should be completed well before fixing at site, and shall be stacked at site for observation against bending, warping etc. and for regular inspection. It should be stacked in a proper manner. As a special case, if the contractor agrees to do so, required fund shall be released to the contractor for procurement of material as certified by the Engineer-in-charge.

(ii) All timber member and joinery, in touch with masonry or concrete, shall be applied with wood preservative as approved by the Engineer-in-charge and the rate quoted shall be inclusive of the same. All rough frame work, framing for false ceiling and partition or paneling shall also be treated similarly.

(iii) All joinery, preferably, shall be tongue and groove joint and the thickness of each shall not be less than 6mm. All the joints shall be glued and pinned together with wooden pegs and the pegs shall engage all tongues.

(iv) In mortice and tenon joints all tenons shall not be less than 12mm. Thick and shall be the full width of the member. Tenons shall be glued into the mortices. Through tenons shall be pinned with wooden dowels of not less than 6mm. Dia. or with non-ferrous metal dowels. Through tenons shall be wedged if the mortices are tapered.

(v) Whether mentioned or not in the B.O.Q., all exposed faces of timber shall receive a primer coat of red oxide or similar approved primer. Quoted rates shall be inclusive of the same.

19.2 HOLD FAST

All frames of door, window, ventilator, cupboard, large glazing etc. shall be fitted with holdfast made of 40x5mm. M.S. flats, 300 to 400 mm. Long and made to shape. This shall be fixed to the adjoining structure (Masonry or concrete) by concrete blocks of length up to 250mm. And height up to 150mm. thickness shall be same as the wall where it is to be fixed or as decided by the Engineer-in-charge. Mix of concrete block shall be 1:2:4 and the exposed surfaces shall be finished smooth. Before fixing, the hold fast shall receive a coat of primer. The quoted rate of the relevant item shall be inclusive of these activities and the number of hold fast required for each post shall be as follows:

Height Of Post Up To (mm.)	Number Of Hold Fast
1500	2
1500-2100	3
2100-3000	4

Above 3000 @ 1250mm. C/C at equal spacing, but Min.-4 Nos.

19.3 **SCREWS**

All screws used shall be of Brass, Stainless steel, Oxidized Aluminum or as specified in the B.O.Q. or as instructed by the Engineer-in-charge.

19.4 **HINGES**

Hinges shall be as specified in the B.O.Q. or as instructed by the Engineer-in-charge and the number of hinges per shutter shall be as follows:

Height of Shutter Up To (mm.)	Number Of Hinges
1200	2
1200-2100	3
2100-3000	4

Above 3000 @ 1000mm. C/C at equal spacing, but Min.-4 Nos.

19.5 **HARDWARES**

Hardware's shall be provided as specified in the schedule of item. If nothing is specified or the followings are not included, it is deemed to be included in the quoted rate and shall be provided by the contractor without charging anything extra and as per the following list (Fittings shall be bright finished, natural anodized aluminum or oxidized M.S. quality) :-

a) Single Leaf Door :

300mm. Long butt 10mm. Shoot tower bolt	1 No.
Door Stopper	1 No.
Handles (125mm.)	2 Nos.

b) Double Leaf Door

300mm. Long butt 10mm. Shoot tower bolt	1 No.
150mm. Long 10mm. Shoot tower bolt	1 No.
Door Stopper	2 Nos.
Handles (125mm.)	4 Nos.

c) Window Shutter (Each)

100mm. Long 10mm. Shoot tower bolt	2 Nos.
Stay	1 No.
Handles (75mm.)	1 No.

19.6 **MEASUREMENT**

Measurement shall be done according to items specified in the B.O.Q. Where individual items are specified, shutters and frames shall be measured outer to outer and all fittings and fixtures shall be measured in number. For a composite item, exact size of the opening shall be measured and nothing shall be paid extra for the insertion of frame in the floor or wall and for the overlaps of the door shutters.

b) WALL AND CEILING FINISHING

Plaster, cladding, paneling etc. shall be so laid; it should maintain a true horizontal and vertical line and level. Workmanship shall be of best possible quality and care should be taken by the contractor to maintain uniformity in all respect, especially about the color. Before application of the finishes, the surface shall be cleaned and made free from all dust particles etc. and any oily substance shall be removed totally and the surface shall be watered properly. All joints in the masonry work shall be racked and the concrete surfaces shall be chisel marked (Hacked) and all the surfaces shall be cleaned with hard brush.

MEASUREMENT

All measurements shall be done as per the unit specified and as per actual dimensions at site. If any major variation noticed in the dimension given in the drawing for structures, it shall be considered as mistake made by the contractor and the quantity shall be measured as per the drawing or as per the site, whichever is lesser. Cutting of tiles, stones etc. if required at the edges, shall be done uniformly and no extra cost shall be paid on this account. Any major mistake found in any respect, the contractor shall be penalized as decided by the Engineer-in-charge/Architect's.

c) PAINTING, PUNNING ETC

Before application of paint, P.O.P. etc., it is to be ensured that the surface is dried completely and shall be cleaned with hard brush to remove all loose particles and dust etc. Priming coat to be applied wherever applicable, irrespective of whether it is mentioned in the specification of item or not. No extra amount shall be payable for applying priming coat and it shall be included in the quoted rate itself. At least three coats painting (Including priming coat) shall be done, brush applied paint shall be applied at least one coat in horizontal and the other in vertical direction. If the color is not uniform or any mark of patch or impression of brush is visible, it shall be removed and if required, more coats shall be applied by the contractor at his own cost

20.0 **MEASUREMENT**

Mode of measurement, deductions etc. shall be identical as for the wall and ceiling finishing, but for painting on rough and some other surfaces the flat measurement shall be increased by multiplying with the following coefficients :

Brief Description	Multiplication factor
1. Smooth cement plaster, neeru plaster, neat finished plaster etc.	1.00
2. Rough sand faced plaster	1.20
3. Pebble dashed plaster, Grit finished plaster, Grit wash etc.	1.40
4. Exposed brick or brick tile work	1.15
5. Ordinary brick work, unplastered	1.10
6. Door/window/wood work	
7. (Including frame, flat area to be measured)	
i) Fully paneled (Each face)	1.30
ii) Partly paneled partly glazed (Each face)	1.00
iii) Fully glazed (Each face)	0.80
iv) Shutter with fly proof mesh (Each face)	0.60

v) Flush door (Each face)	1.20
vi) Ply/board/flush shutter (Without frame, each face)	1.10
vii) Steel door (Without opening each face)	1.60
viii) Steel gate, grill, railing (Each face)	1.00
ix) Rolling Shutter (Each face)	1.30
8. i) Corrugated sheets (Each face)	1.20
ii) Semi corrugated sheets (Each face)	1.10
9. i) Stone Work: i) R.R. /C.R. masonry	1.20
ii) Butch work, cladding	1.30

TECHNICAL SPECIFICATIONS FOR SPECIAL ITEMS

21.0 uPVC WINDOW SYSTEMS SPECIFICATIONS

SPECIFICATIONS for the works that need to be executed and the materials to be used in the placement and installation of uPVC windows and associated products/fitting, to the entire satisfaction of CONSULTANT/ BHEL:

The following specifications describe the standards required for both manufacture and installation of windows:-

Windows

All window frames and sashes shall be manufactured from white UPVC profile, which shall have 3 hollow chambers from front to back. The outer profile shall have a front to back depth of **65/118mm.**
All sections of the frame and sash shall be reinforced in accordance with the system supplier's recommendations using galvanized mild steel in a single continuous length.

21.1 GENERAL REQUIREMENTS

Profile

The profile is to be extruded from a compound that has been blended to ensure quality and consistency. The material must be pristine white high impact modified window grade UPVC and must be colorfast and conform to **BS 7413 code**.

The profile shall be a hollow 3-chamber (across depth) profile with a outer wall thickness of 2.4mm only. The outer profile shall have a front to back depth of **65/118mm.**The profile shall be uniform and free from foreign bodies, cracks or marks.

Refer section drawing for Outer profile/transoms/sash.

Note: No profile shall contain recycled material.

Fabrication of window

- The window units shall be designed with all corner joints, transom joints and mullion joints being mitred and fusion welded.
- All excess material is to be neatly trimmed and neatly feature grooved/raised nib finish at corners, transom joints and mullion joints.
- There is to be **no mechanical joining** of the profile.
- No polishing flush of any joints will be permitted.
- The window units shall be designed so that the route of drainage is prevented from passing through the reinforcement chamber.
- The finished product shall be free from all sharp edges, burrs and the like that may be hazardous to the user.

- The dimensional tolerances on the finished outer frame height and width shall be ± 3mm. Frame assemblies shall be such that they can be installed square within a maximum difference in the diagonals of 4mm.
- In all window units, adequate drainage should be provided to permit the escape of water from platforms or horizontal members beneath each sealed unit. Monsoon Stop to be provided wherever necessary to provide barrier to excess rain water.

Reinforcement

Reinforcement shall be made from mild steel of 1.5 to 3mm thickness as per strength requirement.

The reinforcement shall be installed in accordance with the recommended actions. The reinforcement is to be installed to within 25mm of any weld in the frame and shall be in a single continuous length.

The reinforcement shall be secured to the profile so that it does not move or rattle and it maintains the structural integrity of the frame and satisfactory thermal separation. Reinforcement is to be fixed at a maximum of 100mm from the ends and then at a maximum of 400mm centers.

Glazing and Weather seals

GLAZING

Window shall be such that glazing or re-glazing on site is possible without the need to remove the outer frames from the structure of the building.

All glazing is to be packed in accordance with BPF/GGF and the system supplier's recommendations.

All beads will be cut at the correct degree recommended by the manufacturer. Glass retention clips must be fitted in accordance with the Systems supplier's recommendations.

WEATHER SEALS

The weather seal to be used in windows is to be a bubble E.P.D.M. as per ASTM-D412 &ASTM-D2240 codes.

The weather seals are to be fitted in continuous lengths and grooves. The joints in the vent weather seal are to be positioned at the bottom and in the outer frames at the top.

21.2 **SECURITY AND SAFETY**

Fasteners shall be designed so that they cannot be released from the outside by the insertion of a thin blade.

No opening light shall be openable or removable from the outside, when it is fastened in the closed position, except by use of special tools or breaking part of the window.

21.3 QUALITY CONTROL AND TESTING OF MATERIALS

Raw Material

The material from which the profiles are made shall consist substantially from white polyvinyl chloride. Only those additives and pigments may be used that are needed for the manufacture of the compound and its subsequent conversion into sound, durable extrusions of good surface finish and mechanical strength, as assessed by the requirements of this specification.

Profile Properties

Appearance and Finish

The color of the profile shall be uniform and the color of all profiles in a system shall be uniform. The profile shall be free from foreign bodies, cracks or sink marks when viewed by normal corrected vision at 90^{o} to the surface and at a distance of 1 meter in normal diffused north light.

Dimensions and Weights

The profiles shall be straight such that the longitudinal axis of the profile, as measured on the face surfaces, may deviate from the straight line by no more than 1mm per meter.

The cross section of the profile must conform in shape and dimensions and may deviate by no more than $\pm$ 0.5mm; glazing channels and seal grooves may deviate by not more than $\pm$ 0.3mm. The weight of the profile per meter must not be more than 5% below the nominal value.

Installation of Frame

Before installation the Installation Team is to make sure that the opening has been prepared and any repair work has been carried out. Allow a 5mm gap between the frame and the opening.

The new window shall be set in the prepared opening. Allow for suitable packing blocks.

The window shall be fixed into the aperture, by drilling and fixing through the outer frame, to the existing structure using ‘Fischer’ fixings, F8S type bolts.

The fixings shall be no less than 150mm from corners or transoms/mullions and at no more than 600mm centers.

When the frame is securely fixed in position then fit glass and glazing beads. Allow for any necessary glazing blocks and glass lock devices.

Check windows for correct operation before proceeding with making good.

No fixings are to penetrate the drainage channels.

The gap between masonry and the frame is to be filled with Neutral Cure Silicon (exposed to sun surface) and/or Acrylic Sealant (only for the internal surface).

The silicone joints should be covered with Architraves/trims.

Making Good

Making good to the external surface of the window frame and finish with a compatible approved low modular silicone sealant to BS5889. All trims and quadrants are to be approved by the Supervising Officer prior to fixing.

Allow for making good any disturbed plaster, brickwork and decorations internally and externally including color wash to brickwork.

Clean off excess material and check fittings and gearing.

Leave installation clean and in good working order.

GENERAL ITEMS

This specification is to be read in conjunction with any other relevant documents and drawings.

The Installation in-charge is deemed to have visited the site to ascertain the nature of the works and taken all necessary site dimensions, etc.

Sizes are not to be scaled from any drawings or sketches but should be measured on site prior to manufacture.

Any approval for alternative products must be in writing from the person named at the front of this document or his appointed representative.

Guarantees

Manufacturer to offer a warrantee on the window profile used in the manufacture of UPVC window systems for a period of 10 years from the date of installation. The Warrantee has to cover all abnormal defects in workmanship/quality. The guarantee has to be underwritten by a Company nominated Executive.

Glass Specification

Glass to be used is a single, doubled or tripled glazed of 3 to 45mm.

Extra processing like Frosting, tempering & lamination can be done to the glass from the approved glass processor by the supplier.

Glass thickness to be proposed by the supplier as per the wind load conditions prevailing at the site.

Window Accessories

Followings accessories can be provided additionally for better aesthetics & functionality.

- **Hurricane Bar:-** It is used in 3000Pa system for extra strength and also as a handle to move the sash

- **Rain Track:-**It is used in slider system 3000 Pa for acting as a restrictor against rain water.

- **Trims:-** They are used to cover the window to masonry joints.

Window Hardware

- **Slider:-** All slider door/windows are to be provided with multi point locking arrangement (Espagnollettes) with/without key locking facility as per the requirement. The hardware to be of G-U or ROTO make. The slider locking mechanism handles are of projected/flush type.

- **Casement windows**

  Friction stays: Casement window friction stays are to be of G-U or Securistyle make of appropriate size and weight bearing capacity, made of SS304. The stack height of friction stay is to be 16 + 0.5mm.

  Espagnollettes: The casement windows are to be provided with multi point locking mechanism of G-U/Avocet make and handle to suite the same.

  Supplier to provide us with all necessary calculations for Wind Load and Dead Load bearing capacity of the window members.
  Supplier to provide with the necessary copies of the hardware catalogue.

22.0 **FRAMELESS GLASS CEILING**

BQ Description

Providing & fixing suspended frameless glass ceiling. The price shall consist of 2x 4mm laminated clear glass with a translucent PVB interlayer in size of 9**00mm x 900mm** with primed edges all around. The laminated glass layer is connected to a proprietary hinged-push lock mechanical patch fitting at 4 corners of the glass. Glass panels can be hinge down at 2 corners attached to the upper part of the suspended tubular structure. Safety stainless steel wires are attached to other 2 corners which in turn connected to the lower and upper part of the push lock mechanism. The glass panels can be secured back in position by pushing the other 2 corners into upper part of the push lock mechanism. Distance between glass panels are kept at 8mm apart.

22.1 **Suspension Grid – Horizontal support profiles**

(i) All glass panels connected to a proprietary hinged –push lock mechanical patch fitting at 4 corners of the glass placed at 900 mm center to center. A wide span girder as primary profile made up of galvanized steel installed perpendicularly to a wide span girder a secondary profiles at maximum centers of 900mm, and suspended with M6 threaded rod and expansion bolts through hanging brackets at 000mm c.c.

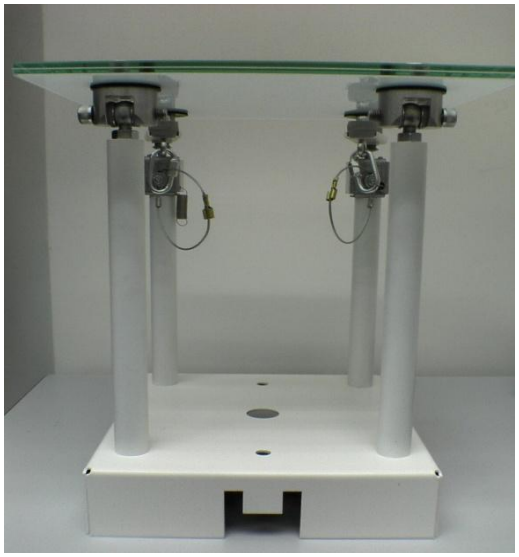
(ii) Distance between suspension rods : maximum 900 mm

(iii) Distance between primary wide span girder : maximum 900 mm

The total height should be at least 363 mm measured from the lower edge of the glass pane to the lower edge of the mounting level. When installing the cross-wide light reflector, the total height from the lower edge of the glass panel to the upper edge of the reflector should generally be at least 510 mm

22.3 **Glass Ceiling Panels**

900mm wide and 900mm length square panels in size to suit design. Glass panels are made up of @x 4mm laminated clear glass with translucent PVB with primed edges all around.



22.4 **Suspension Hangers**

(i) Suspension rods: 6mm diameter straightens G.I. Rods with chrome plated adjustment clips 900mm c.c.

(ii) Suspension threaded rods: 9mm diameter galvanized steel threaded rods with expansion bolts@900mm

22.5 **<u>Quality Assurance</u>**

Glass Ceiling products are manufactured in accordance to ISO 9001-2000 certification process.

23.0 CEILING SYSTEM

23.1 Clip in GI Metal Tile (600x600mm)

Providing& Fixing of Clip in GI metal tile ceiling System consisting of 600x600mm clip in tiles of pre coated galvanised steel in 0.5 mm thickness with bevel edge on all sides in white colour polyester powder coat finish with minimum 60 microns paint thickness with standard perforation of 2.5mm dia & open area of 16%. The back of the tile should have black acoustical fleece. The NRC should be 0.70 and suitable for Green Building application, with Recycled content of 25%.

Installation:

To comprise of 3600mm long 'C' channels spaced at 1200mm centres securely fixed to the structural soffit by support clamp & approved hangers. The last hanger at the end of each C channel should not be greater than 600mm from the adjacent wall. 3000mm spring tee bars shall be spaced at 600mm centres shall be secured at every intersection with C channel using a holding clamp perpendicular & below the C channel. Use Dp-12 connector to splice two pieces of Dp-12 main carriers. Tiles should be clipped in between two spring bars from below.

Perimeter trims to be of wall angles of white colour secured to walls at 450mm maximum centers.

23.2 OPEN CELL ALUMINIUM CEILING TILE size 600mmx600/1200mmx38-50mm

Providing and fixing in true horizontal level Open cell Aluminium lay-in ceiling tiles of size 600mmx600/1200mmx38-50mm having Humidity Resistance of 100% RH, and having Fire Performance A2-s2, d0. The tile of 'global white' color with cell size options of 100mm (72% open area).

The grid should be of "manufacturer standard supporting system" make with 15mm wide T - section flanges colour white having rotary stitching on all T sections i.e. the Main Runner, 1200 mm & 600 mm Cross Tees with a web height of 38-50mm and a load carrying capacity of 14 Kgs/M2. The T Sections have a Galvanizing of 90 grams per M2 & passed through 500 hrs of Salt test.
The Tile & Grid system used together should carry a 15 year warrantee.

Installation:

To comprise main runner spaced at 1200mm centres securely fixed to the structural soffit using manufacturer standard supporting system (specifications below) at 1200mm maximum centre. The First/Last suspension system at the end of each main runner should not be greater than 450mm from the adjacent wall.

Flush fitting 1200mm long cross tees to be interlocked between main runners at 600mm centre to form 1200 x 600 mm module. Cut cross tees longer than 600mm require independent support. 600 x 600mm module to be formed by fitting 600mm long flush fitting cross tees centrally between the 1200 mm cross tees.
Perimeter trim wall angles of size 3000x19x19mm, secured to walls at 450 mm maximum centres.

SUSPENSION SYSTEM accessories manufactured and supplied by manufacturer standards consisting of M6 Anchor Fasteners with Vertical Hangers made of Galvanised steel of size 26 x 26 x 25 x 1.2mm with a Galvanised Thickness of 80gsm, A pre Straightened Hanger wire of dia – 2.68 mm of 1.83 m length., thickness of 80gsm and a tensile strength of 344-413 MPa, along with Adjustable hook clips of 0.8mm thick, galvanised spring steel for 2.68 mm with a minimum pull strength of 110 kg. The adjustable clip also consists of a 3.5 mm aquiline wire to be used with the main runner.

23.3 **Aluminum U Shaped Baffle system for Ceiling**

Providing & Fixing U Shaped Baffle system consisting of 50 mm Blade widths, 100 mm depth & 3000mm in length made out of Aluminum of minimum 1.5mm thickness. The U shaped Baffles are installed at 200 mm centre to centre distance on the Aluminum Carrier bar.

Finishes of Baffle: RAL 9016 PPC with minimum 60 microns paint thickness.

Installation:

To comprise of 3000 mm long 'carrier bars' manufactured and supplied by the firm to be spaced at 1200mm maximum centers securely anchored to the structural soffit by 6mm/8mm threaded rods. The last hanger at the end of each carrier bar should not be greater than 600mm from the adjacent wall. The U shaped Baffles should be clipped on to the special locking arrangement provided in the carrier bar from below. Two Baffles can be joined together along the lengths using splice joints. The Baffle ends should be closed using matching edge caps.

23.4 **Wooden Ceiling**

Providing & Fixing Wooden finish Suspended Ceiling System with WOODWORKS (MICRO LOOK) EDGE TILES WITH 15 MM Silhouette Grid with Black reveal EXPOSED GRID.

The tiles with perforation pattern R3 perforation with approved laminate/natural veneer finish should have Humidity Resistance (RH) of 90%, Fire Performance Class 1(BS - 476) in module size of 600mm x 600mm x 12mm

The grid should be of make with 15mm wide T - section flanges colour white having rotary stitching on all T sections i.e. the Main Runner, 1200 mm & 600 mm Cross Tees with a web height of 43mm and a load carrying capacity of 23.71 Kgs/M2. The T Sections have a Galvanizing of 120 grams per M2 & passed through 500 hrs of Salt test.

The Tile & Grid system used together should carry a 15 year warrantee.

Installation:

To comprise main runner spaced at 1200mm centres securely fixed to the structural soffit using suspension system (specifications below) at 1200mm maximum centre. The First/Last suspension system at the end of each main runner should not be greater than 450mm from the adjacent wall.

Flush fitting 1200mm long cross tees to be interlocked between main runners at 600mm centre to form 1200 x 600 mm module. Cut cross tees longer than 600mm require independent support. 600 x 600mm module to be formed by fitting 600mm long flush fitting cross tees centrally between the 1200 mm cross tees.

Perimeter trim to be special wall angles of size 3000x19x19mm, secured to walls at 450 mm maximum centres.

SUSPENSION SYSTEM accessories manufactured and supplied by the firm World Industries consisting of M6 Anchor Fasteners with Vertical Hangers made of Galvanised steel of size 26 x 26 x 25 x 1.2mm with a Galvanised Thickness of 80gsm, A pre Straightened Hanger wire of dia – 2.68 mm of 1.83 m length., thickness of 80gsm and a tensile strength of 344-413 MPa, along with Adjustable hook clips of 0.8mm thick, galvanised spring steel for 2.68 mm with a minimum pull strength of 110 kg. The adjustable clip also consists of a 3.5 mm aquiline wire to be used with the main runner.

23.5 **WOODEN WALL PANELING**

Providing and Fixing Wooden perforated panels of width 600mm, thickness of 12mm and length 800mm or as required by the Architect/ approving engineer, made of a high density particle board substrate with a laminated facing as per the approved shade/ species & finish and a melamine balancing layer on the reverse side. The boards shall have a special perforation pattern where the visible surface has a (“Helmholtz” round perforation dia of 3mm and the reverse side with 12mm with 16mm pitch/oval perforation pattern of 32mm length, 6mm width) each. The panels shall provide a minimum sag resistance of RH90 and a fire rating class of 1 as per Part 7 of BS 476. The edges of the panels shall be grooved to receive splines for installation. The back of the perforated panel shall have sound absorbing non-woven acoustical fleece. The panels shall be mounted on special aluminium splines provided by the firm and approved by the Architect/ Engineer-in-Charge.

Installation:

Install wooden battens (provided by others) of section 50mmx50mm or as approved by the Architect on the solid wall horizontally using screws and plugs at spacing of 800mm centre-to-centre. Cut to size and screw the aluminium section frame for border

panel (GTITC002) provided by the firm over the lowest and second wooden batten. Install the wooden panels one-by-one by inserting the groove of the panel. Install the aluminium section extruded frame for inside panel (GTITC001) with the longer end away from the inserted panel and shorter edge into the groove of the installed panel. Place this against the wooden batten and screw. Continue installing rows of panels till the actual height/length is achieved. Glue or screw the glass fibre insulation on to the wall in the void formed between the wall and panels, if required. Finish off the edges using wooden moulding of matching colour (provided by others).

24.0 ATTRIUM

STEEL WORK SPECIFICATIONS:

24.1 GENERAL

This specification deals with the fabrication and erection of steel structures for all general purposes.

The contract to which this specification refers to shall be for the supply and delivery, off-loading and erection, unless otherwise stated in the order, of the whole of materials, fastening and fittings of every type which are described in or implied by this specification shown on the drawings

24.2 MATERIALS

Rolled Sections

All structural steel shall confirm to the requirements of any one of the following Indian Standards as specified.

IS 2062 Steel for General Structural purpose

IS 4923 Hollow steel section for structural use (Rectangular / Square section)

IS 1161 or

IS 1239 or

IS 3589 Steel tubes for structural purpose (Circular section) Bolts & Nuts

All bolts and nuts shall confirm to the requirements of

IS 1367 Technical supply conditions of threaded fasteners (Only relevant parts to be referred) Electrodes.

They shall confirm to the requirements of the following Indian Standards as specified.

IS 814 Specifications for covered electrodes for metal arc welding of structural steel.

24.3 FABRICATION

General

Fabrication in general shall conform to the requirements of IS 800 Code of practice for use of structural steel in general building construction.

24.4 Bolting

Lengths of the bolts shall be so adjusted that, allowing for washers, the threaded portion shall project beyond the nut by at least 6 mm or one thread whichever is more.

When nut or bolt heads bear on tapered surfaces, suitable tapered washers shall be provided.

24.5 Welding

Welding shall be in according with the following Indian Standards as applicable.
IS 816 Code of Practice for use of metal arc welding for general construction in mild steel.
IS 822 Code of procedure for Inspection of welds.

All welding procedures shall be arranged, to suit the details of joints indicated on the drawings and the position, in which welding is carried out shall be such as to ensure that the weld metal is full and satisfactorily deposited throughout the length and thickness of all joints.

Members to be welded shall be securely held in their relative position during welding, either by jigs or tack welding or any other means, and distortion of finished parts shall be minimized.

Weld defects such as cracks, lack of fusion and penetration, over-laps, undercuts, slag and porosity inclusion, piping defects, irregular beads etc. shall not be accepted.

24.6 **PAINT SYSTEMS**

All paints for the protection of steelwork shall be of the best available quality and specifications suitable for the purpose and in any case shall not fall below the minimum standards laid down in IS 1477. Where the specifications, method or extent of application of any other paint scheme approved for the work varies from those described, the recommendations and instructions of manufacturers shall be followed.

24.7 **PACKING**

All material for dispatch to site shall be so protected as to prevent damage or distortion during transit and unpacking.

All projecting plates, bars and all end of members at joints shall be stiffened, all straight bars and plates bundled, all screwed ends and machine surfaces guarded and all rivets, bolts, nuts, washers and small loose parts packed separately.

24.8 **FIELD PROTECTION**

All members and materials shall be so unpacked, stored, handled and erected at site that they are not subjected to excessive stresses and damage.

24.9 **GENERAL SAFETY**

Due considerations shall be given to all aspects of safety at all stages of construction.

Valmex FR 900 PREMIUM – type II

Base fabric Support	Din 6001	PES low - wick
Yarn dtex	DIN 53830	1100
Weave		P 2/2
Type of coating		PVC
Total Weight gr /m2	DIN 53352	900
Tensile Strength Warp / weft N/ 50 mm	DIN 53354	4300/4200
Tensile Elongation Warp / weft	DIN 53354	20 / 26
Tear Strength Warp / weft N	DIN 53363	500 / 500
Adhesion N / c	Complan Richtlinien	> 20
Cold resistance 0 C	DIN 53361	- 30
Heat resistance 0 C	Complan Richtlinien	70
Light – fastness Note	DIN 54004	> 6
Crack – resistance 100.000	DIN 53359 A	O.K
Flame Retardancy	DIN 4102 B1, CSE – RF –1 / 75 C2,California T 19, BS 7837, NFP 92 507 M2 (only for white colour)	
Finish	PVDF Lacquer top coat – lacquer on the reverse side protected against fungal and microbial attack, UV protected	

25.0 **VARIFLEX SLIDING FOLDING PARTITION**

The partitions shall comprise of flat panels, plus 1 expanding panel (telescopic element) for closure. The sound coefficient (Rw) shall be **45 dB**. The sound insulation tests of the movable walls are carried out under German DIN standard with results measured in Rw. This is a standard test in a laboratory with so called **flanking sound transmission.** This test is the most realistic because it is a measurement under site conditions including sound transmission through ceiling, doors, walls etc.

The panels shall stack at the end of the track. The thickness of each panel is 85mm including 16mm thick MDF on both sides.

The partition runs on a specially designed and firmly held track of heavy-duty aluminum in which a specially designed trolley on ball bearing runs smoothly and noiselessly. The closure of the spaces above, below and between the panels is done by a specially designed mechanism, which closes these gaps to prevent passage of sound.

***Installation*:**

The track received from the manufacturer is affixed to this structure with suitable suspension arrangement after leveling and straightening.

Also the longevity and ease of operation depends on the precision and level of track achieved before the partition is installed. Therefore the installation process is as important as the quality of the partition. As we have been in the business for the last 20 years we are well aware of the problems and take care of them before they cause any trouble.

These panels are thereafter suspended in the track and checked for smooth operation, parallel horizontal movement and sealing all around.

***Sound Baffle/Barrier*:**
After installation a sound barrier is erected between the false ceiling and the RCC ceiling using one 12.5 mm thick gypsum boards on each side of the track filled with a mineral wool mattress and fitted to a G.I. sheet framework. All cracks, joints, openings are caulked with special compound and taped over to form a solid wall of the same STC as of the partition. The efficiency in sound insulation of a partition depends on its installation, which has to be done in order to achieve the same insulation coefficient above the false ceiling as that of the movable wall.

***Levels*:**
The bottom of the track level is on the same height as the false ceiling. For more efficient sealing of sound a hard stone floor is ideal. Carpet floors also can be used after allowance for it has been made and indicated to the manufacturer.

***Finish*:**
We or the architect or the interior designer can undertake the finishing of the bare panels at the site without adding any additional weight. The materials for the purpose could be vinyl, laminate, loop pile carpet, veneer etc.

26.0 STAIN FINISHES STAINLESS STEEL HANDRAIL SYSTEM

Manufacture, supply and installation of factory finished Cantilever Glass Railing fixed on to floor by means of 100x40x4mm MS galvanized U Channel fixed on to the floor slab by making required grooves in the slab by main contractor, U channel need to be supported with MS stiffener, 15.5mm thick (8+1.52 PVB + 6mm) laminated toughened glass to be inserted into the same and the gap to be closed by rubber bushing and sealed by a structural sealant etc. LED arrangement provided in bottom U channel. 38mm dia, 1.5mm thick SS-304 handrail to be fixed by means of SS-304 unified glass brackets. All components to be as per specifications. Overall height of the railing to be 1100mm.

LIST OF APPROVED MAKES OF MATERIALS
FOR CIVIL WORK FOR RENOVATION OF BHEL OFFICE, NEW DLEHI

S.NO.	NAME OF ITEM	MAKE APPROVED
1.	ORDINARY PORTLAND CEMENT	GRADE-43/53 BIRLA UTTAM , J.K., VIKRAM, ACC
2.	WHITE CEMENT	J.K., BIRLA
3.	REINFORCEMENT STEEL	RATHI , TATA , KAMDHENU, SAIL
4.	FLUSH DOOR	JWALA, SWASTIK, DURO, ALPRO
5.	PLY, BOARD / MDF	DURO, EURO, ALPRO, MERINO, GREEN PLY,
6.	LOCK/BRASS FITTING	DORSET,GODREJ, DORMA
7.	PAINT	BURGER, SHALIMAR, ASIAN, DULEX
8.	GLASS / MIRROR	MODI/ASHI/SAINTGOBAIN
9.	C.I. PIPE	RIF/NECO/SRIF/B.C.
10.	G.I. PIPE	JINDAL/TATA
11.	G.I. FITTING	UNIK/UNCO
12.	CHINAWARE	HIND WARE, CERA, PARRYWARE
13.	C.P. FITTING	JAQUAR, PARKO, HANSA GROHE
14.	VALVES	LEADER/ZOLOTO
15.	CONSTRUCTION CHEMICAL	ROFFE, NATIONAL, FOSROCK
16.	ANTI TERMITE	VAM ORGANICS/PYRAMID
17.	S.S.SINK	JAYANA/NILKANTH
18.	R.C.C. PIPE	JAIN/IHP
19.	MANHOLE COVER	KK/PARGATI
20.	PVC PIPE	KISSAN/FINOLEX/POLY PACK
21.	FALSE CEILING & WALL PARTITION	ARMSTRONG, DURLUM, HUNTER DOUGLAS (LUXALON)
22.	GYPSUM WALL PARTITION/CEILING	BORAL/INDIA GYPSUM
23.	DOOR FITTINGS & FIXTURES	DORMA, OZONE, CARLF
24.	GLASS/S S HANDRAIL	DORMA, CARLF

S.NO.	NAME OF ITEM	MAKE APPROVED
25.	AUTOMATIC SLIDING DOOR	DORMA – GERMANY, KABA-SWITZERLAND, PORTALP – UK
26.	SLIDING & FOLDING PARTITION	DORMA (VARIFLEX), DURLUM
27.	FLOOR & WALL TILE	KAJARIA, SOMANY, RAK & NAVEEN
28.	WOODEN FLOORING	KAHR'S, PERGO & SCHEIT
29.	uPVC DOOR & WINDOWS	FENESTA, ALUPLAST, ASAHI
30.	MODULAR PARTITION/PANTRY	MERINO
31.	MODULAR FURNITURE	GODREJ, BP ERGO
32.	VENEER/LAMINATE	VENTURA, CENTURY, DURO & GREEN
33.	SIGNAGES	3M, ORACAL, & COOLEY BRITE
34.	RUBBER FLOORING	ZEN EQUIP
35.	AV	BOSE

PART-4 TECHNICAL SPECIFICATIONS
SECTION-2 ELECTRICAL WORKS

1.0 GENERAL

The electrical Installation work shall be carried out in accordance with Indian Standard Code of Practice and National Building Code. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity Supply Authority and Fire Insurance regulations, so far as these become applicable to the installation.

The work shall be carried out as per CPWD General Specifications wherever applicable

Part -I - Internal Work – 2005, as amended upto date
Part -II - External Work – 2007, as amended upto date
Part -IV - Substation Work – 2007, as amended upto date

The details of scope of work subhead wise are given in the subsequent parts. The quantities worked out in BOQ are based on particular equipment considered at design stage. The successful bidder is required to recheck the quantities based on equipment offered by him to achieve required parameters.

The successful bidder should note that the specifications furnished in the tender is of general nature only and it is the responsibility of the successful bidder to design, supply, install and commission the equipments and services required for the satisfactory performance of the installation. All the items of equipment required for the safe and satisfactory operation of the installation shall be supplied and installed by the successful bidder

1.2 WORKS INCLUDED IN THIS SECTION:

(i) 230V single phase, 2 wire and 400V 3phase 4 wire Power distribution system complete (Providing & Installing HT Panel, RMU, Compact Substation, LT Panel, etc.)
(ii) An adequate equipment earthing system
(iii) Providing & installing distribution boards
(iv) Fixing of luminaries
(v) Conduit with wires for Computer & TV System
(vi) Providing & laying of cables etc.
(vii) Lightning Protection system
(viii) External Lighting
(ix) Fire Suppression system

1.3 The successful bidder shall provide the following drawings for approval to architect/consultants/BHEL before commencement of supply/fabrication.

1.4 HT Panel, CSS and L.T. Panels

(i) General layout-Plan, section, elevations

(ii) Foundation/Fixing arrangement.

(iii) Wiring-Power & Controls

1.5 Distribution Boards

(i) General layout-Plan, section, elevations

(ii) Foundation/Fixing arrangement.

(iii) Wiring-Power & Control

Internal Electrification System:

(i) Conduit Lay-out with number and size of wires in it for various outlets.

(ii) Details of Outlet points.

1.7 Cable Routing and Earthing System:

(i) General Cable layout-Plan with sizes of Cable and Cable Trays at different floor & in Substation area.

(ii) Details of Earthing strip sizes & connections

1.8 All other drawings as indicated in various sections.

2.0 After completion of the work the successful bidder shall submit one original on R.T.F & three prints of as-built drawings along with compact disc/s (CD.s/DVD.s) containing the same before the certificate of completion is issued to him. These drawing would include;

(i) The location of all the equipment supplied & erected by the successful bidder.

(ii) Cable routes clearly indicating the sizes & number of cables.

(iii) Earthing layout - indicating the type of earth station & size of earth conductor.

(iv) Wiring diagram of the components of the distribution system.

(v) Complete single line diagram for Normal and Emergency supplies.

3.0 CODE REQUIREMENTS:

All work shall be done in accordance with the IS Code amended upto date/Indian Electricity Rules and National Building Code.

Chapter - 1

SUBHEAD I : H.T. PANELS, CSS AND H.T. CABLES

RING MAIN UNIT

1 11 KV HT PANEL (SF6) FOR SWITCHING STATIONS

1.1 GENERAL

Design, manufacture, testing, erecting, connecting and commissioning of integrated cubicle type dead front, floor mounted, free standing extendable, 2 mm thick M.S. sheet steel enclosed, front operated indoor type 11 KV switch board and in conformity with Indian Standard Specification IS:3427:1969 IS:2518 (Part – I, Sec.3) – 1980.

1.2 CONSTRUCTION FEATURES

The switch board fabricated from 2.0 mm thick MS sheet steel shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet steel shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal. All panels and covers shall be properly fitted, and squares in the frame and holes in the Panel correct positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with nuts. Self – threading screws shall be of totally enclosed design. Completely dust and vermin proof. Gaskets between all adjacent and beneath all covers shall be used to render the joints effectively dust tight. Soft compressible gaskets shall be used between all metal joints. Doors and covers to prevent ingress of dust. All sheet steel works after metal treatment shall be epoxy powder coated. A horizontal wire way with screwed cover shall be provided at the top to take interconnecting control wiring between different vertical sections. Separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker or bus bar connections.

1.3 CIRCUIT BREAKERS

11 KV SF6

Panel of 11 KV (630 Amps rating) switch board shall be provided with triple pole 11 KV indoor type SF6 circuit breaker with symmetrical breaking capacity of 350 MVA at 11 KV. All breakers shall be flush front, metal clad, draw out type and shall be provided with trip free motor power operated closing mechanism with mechanical ‘ON’ & ‘OFF’ indication. The operating handle and mechanical trip push button shall be at the front of the breaker and integrated with the breaker. Circuit breaker shall be housed in a compartment and shall be enclosed on all sides. The cradle shall be designed and constructed to permit smooth withdrawal and insertion of breaker. The movements shall be free of jerks, easy to operate and shall preferably be on steel balls/ rollers and not on flat surface. There shall be four distinct and separate status of the circuit breaker on the Cradle-Service, Test, Isolated and Maintenance. Sheet steel barriers shall be provided between phases. The following safety interlocks shall be provided.

The breaker cannot be plugged in unless it is 'OFF'.

The breaker cannot be removed when the breaker is 'ON'.

Tank cannot be removed when breaker is 'ON'.

The access to bus-bar is prevented by automatic shutters when breaker is removed.

1.4 BUS BAR CONNECTIONS

The bus bars shall be electrolytic copper and of rectangular cross section. The main horizontal bus bars shall run across the entire length of the board. The bus bar shall be supported with proper insulators at suitable intervals to withstand the electromagnetic and thermal forces arising from short circuit on the system of 350 MVA fault level at 11 KV for 1 sec. The bus bar chamber shall be provided with proper ventilation and space heater (with thermostat). The bus bar support shall be as per IS: 2544. Bus bar shall be color sleeved & colour coded.

1.5 TERMINALS

11 kV BREAKER

All doors & moveable parts shall be connected to earth bus with flexible connection. The incoming and outgoing terminal of the breaker at the rear of the panels shall be suitable to receive 11 KV XLPE aluminum conductor cables. Knockout holes of appropriate size and number shall be provided in the panel.

1.6 PROTECTIVE DEVICES

All circuit breakers shall be provided with triple pole IDMT relay for combined over current and earth fault protection, suitable for 24 volts DC power supply. The relay settings shall be high enough to over ride transformer switching surges, and fault on HV side of Transformer.

1.7 INSTRUMENT TRANSFORMERS

(i) POTENTIAL TRANSFORMERS

The incoming panel shall be provided with a 15 VA burden potential transformer for instruments and relays as per IS: 3156.

(ii) CURRENT TRANSFORMERS

All current transformers shall confirm to IS 2705/IEC 185 as amended to date. PTs and CTs shall be suitable for class 0.5 accuracy. All control circuits shall be provided with proper and adequate protective fuses. Instrument testing plugs shall be provided for testing and meters.

1.8 **WIRING**

All wiring for meters and relays shall be of Copper conductor and shall be colour coded and labeled with approved plastic beads for identification. Minimum size of control cables shall be 2.5 Sq. mm PVC insulated copper conductor cables.

1.9 **PANEL HEATERS**

Panel heaters shall be provided along the bus bar compartment to prevent absorption of Moisture.

1.10 **INDICATING LAMPS**

LED TYPE indicating lamps shall be provided for phase indication and breaker 'ON' and 'OFF' indication.

1.11 **TESTING AND COMMISSIONING**

The HV panel shall be subjected to the following tests before dispatching the same and the test certificates shall be furnished. Type test certificate shall also be furnished for review.

(i) Insulation resistance test shall be carried out between phases and phase to earth.

(ii) Mechanical endurance shall be carried out by closing and opening of the circuit breaker. Impulse withstand test of circuit breaker.

(iii) Simultaneous opening and closing of moving contacts i.e. opening time of circuit breaker on symmetrical and asymmetrical short circuit current.

(iv) Contact resistance of circuit of moving contacts i.e. opening time of circuit breaker on symmetrical and asymmetrical short circuit current.

(v) Opening and closing of Bus Bar shutter.

(vi) Opening of circuit breaker trolley in Service, Test, Isolate/ Maintenance mode.

(vii) Test certificates of CTs, PTs instruments and relays provided in the panel shall be supplied.

(viii) The HT panel shall be tested at factory after assembling all the components. The test shall be conducted as per IS standards. The successful bidder shall get the original test certificate from the factory and hand over the same in original to the BHEL/ Architect/ Consultants.

1.12 Prior to commissioning of HV Panel following tests shall be carried out:

(i) Insulation resistance test shall be carried out between phases and phase to earth.

(ii) All control & protection relays and tripping mechanism shall be checked for proper operation.

2. BATTERY TRIPPING UNIT FOR 11 KV SWITCH BOARD

Battery tripping shall be suitable for tripping 11 KV switchgear. It shall be in built in all SF6 breakers.

Chapter – 2

SUBHEAD I : H.T. PANELS, CSS AND H.T. CABLES

COMPACT SUBSTATION

1.0 **CODE & STANDARDS:**

1.1 All equipment and material shall be designed, manufactured and tested in accordance with the latest applicable Indian Standard / IEC standard.

1.2 Equipment and material confirming to any other standard which ensures equal or better quality may be accepted. In such case copies of English version of the standard adopted shall be submitted.

1.3 The electrical installation shall meet the requirements of Indian Electricity Rules (relevant IS code of practice and Indian electricity act) as amended upto date.

1.4 The Compact Sub-station offered shall in general comply with the latest issues including amendments of the following standards but not restricted to it.

Title	Indian Standards
High Voltage Low Voltage Pre-Fabricated Substation	IEC:61330
11 kV Switchgear cubicles	IS:13118, IS:3427, IEC:60694. IEC:60298
Ring main unit 11 kV grade	IS:9920, IEC:60265
Code of practice for selection, installation and maintenance of Switchgear	IS:10118
Distribution Transformer	IS: 2026
Dry Type Power Transformer	IS:11171
Colour for ready mix paints	IS:5
Enamel synthetic, exterior a)Undercoating b) finishing	IS:2932
L.T. Fuseboard Panel	IS:5039
Indian Electricity Rules	1956
Indian Electricity Act	1910

2.0 The compact substation shall be designed for

a) Compactness,

b) Fast installation,

c) Maintenance free operation,

d) Safety for worker/operator & public.

2.1 The Switchgear and component thereof shall be capable of withstanding the mechanical and thermal stresses of short circuit listed in ratings and requirements clause without any damage or deterioration of the materials.

2.2 For continuous operation at specified ratings temperature rise of the various switchgear components shall be limited to permissible values stipulated in the relevant standard and / or this specification.

2.3 **Service Conditions:**

The equipment offered shall be suitable for continuous satisfactory operation in tropical area of Installation. The Enclosure consisting of High Voltage switchgear, Low Voltage switchgear & Transformer of the Compact substation shall be designed to be used under normal outdoor service conditions. The enclosure should take minimum space for the installation including the space required for approaching various doors & equipments inside. The enclosure construction shall be such that it fully protects ingress of rain water & rusting. For this purpose, construction without welded joints is preferred.

3.0 **SPECIFIC REQUIREMENT**

The main compartments of a compact substation are that of High-voltage switchgear, Transformer, Low-voltage switchgear, corresponding interconnections (cable, flexible, bus-bars) & auxiliary equipment. The compartments shall be enclosed by a common enclosure. All the components shall comply with their relevant IS/IEC standards.

Ratings:

HT Compartment	
RMU	11kV, 21kA, SF6 insulated 3-way non extensible manual operated Compact Ring Main Unit comprising 2 nos. of load break switches as incomer of 630A with integral earth switch and 1 no of SF6 Circuit Breaker of 630A with integral earth switch, with self powered over current and earth fault relay, with shunt trip coil of 230V AC, with push button for circuit breaker manual tripping, neon live cable indicators with SF6 gas pressure monitor.
Transformer Compartment	
Transformer	11kV/433V, 1000kVA, 3 Phase, 50Hz, Dry type cast resin transformer, Dyn11, Air Natural Cooled, Double wound, with On Load tap changer, Tap range +5 to –15% in steps 1.25%, With RTCC & WTI (Digital Winding temp indicator)
LT Compartment	
ACB	Air Circuit Breaker, 4P, 433V, 1600A, 50kA, Microprocessor based release, Fixed type, Manual operated, with (O/L,S/C&E/F) Protection

3.1 **OUTDOOR ENCLOSURE:**

3.1.1 The enclosure shall be made of Galvanized Sheet Steel tropicalised to meet Indian weather conditions.

3.1.2 The base of the enclosure shall ensure rigidity for easy transport & installation.

3.1.3 The structure of the substation shall be capable of supporting the gross weight of all the equipment & the roof of the substation compartment shall be designed to support adequate loads.

3.1.4 There shall be proper / adequate ventilation inside the enclosure so that hot air inside the enclosure is directed out by help of duct. Louvers apertures shall be provided so that there is circulation of natural air inside the enclosure.

3.1.5 The complete design shall be preferably modular in design i.e. small sheets shall be joined together to make a big sheet. This helps in avoiding skewing, bending of the single sheets on doors and sides due to its own load under service. The doors shall be provided with proper interlocking arrangement for safety of operator.

3.1.6 Public Nuisance Protection: There shall be preferably no bolting arrangement on the doors and sides (periphery) so that there is no access of water, dust inside. This also ensures that the unit is well protected from public nuisance. Hinges and locks on the door shall be so designed that they are either not accessible to public from outside or can not be tampered with.

3.1.7 Interconnection: The connection of HT switchgear to Transformer shall be with the help of suitable size of cables & from Transformer to LT switchgear with the help of suitable size of Aluminium busbars. The interconnections inside the unit shall be the responsibility of the supplier.

3.1.8 Internal Fault: Failure within the compact substation either due to a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such an event may lead to the risk of injury, if persons are present. It is required that the unit shall be tested for Internal Arc fault test as per latest IEC 61330.

3.1.9 Covers & Doors: Covers & doors are part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. Additional wire mesh may be used with proper Danger board for safety of the operator. All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90 degrees & be equipped with a device able to maintain them in an open position. The top cover shall be slightly inclined so that there is no accumulation of water during rainy season or otherwise. Proper padlocking facility shall be provided for doors of each compartment.

3.1.10 Earthing: All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of

the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry. The components to be connected to the earth system shall include :

(a) The enclosure of Compact substation,
(b) The enclosure of High voltage switchgear from the terminal provided for the purpose,
(c) The metal screen & the high voltage cable earth conductor,
(d) The transformer tank or metal frame of transformer,
(e) The frame &/or enclosure of low voltage switchgear.

3.1.11 Internal Illumination: There shall be an arrangement for internal lighting activated by associated switch on doors for HV, Transformer & LV compartments separately.

3.1.12 Labels: Labels for warning, manufacturer's operating instructions etc. & those according to local standards & regulations shall be pasted / provided inside and shall be durable & clearly legible.

3.2 **Painting and Fabrication process :**

a) The paints shall be carefully selected to withstand tropical heat rain. The paint should not scale off or crinkle or be removed by abrasion due to normal handling. For this purpose two component poly-urethane paint shall be used.

b) Special care shall be taken by the manufacturer to ensure against rusting of nuts, bolts and fittings during operation. All bushings and current carrying parts shall be cleaned properly after final painting.

c) The fabrication process shall ensure that there are no sharp edges on the GI sheets used. For modular structure the two smaller units shall be joined together by Clinching Technology so that there is no piercing of the material being joined. This type of joint shall ensure robust mechanical strength to the complete structure so made.

3.3 **11KV Switchgear**

Non-extensible SF6 Insulated 11kV Compact Switchgear as required shall consist of following items:

3.3.1 Load Break Cable Switch with integral earth switch both having full making capacity shall be used for Incoming and Outgoing cables used in a ring. Suitable arc proof tested cable covers shall be provided for each cable switch. The cable covers accessible from front shall be mechanically interlocked to its corresponding earth switch and the earth switch shall be mechanically interlocked to its corresponding cable switch for safety of the operator.

3.3.2 The above Load Break Cable Switches, circuit breakers, Busbars should be mounted inside a robotically welded sealed for life with stainless steel tank. The operating mechanism of the switches and breakers shall be outside the SF6 tank and

accessible from front. The tank should be filled with SF6 gas at adequate pressure. The degree of protection for gas tank should be IP67. There shall be provision for filling the SF6 gas at site. Moreover the Stainless Steel Gas Tank shall confirm to the sealed pressure system as per IEC and ensure the gas leakage to 0.1% per year as per IEC.

3.3.3 General Finish: Totally enclosed, metal enclosed, vermin and dust proof suitable for tropical climate use as detailed in the specification.

3.3.4 Breaking & Making Capacity: The Load Break Cable Switches shall be capable for breaking rated full load current. The same along with its earthing switch shall also be suitable for full making capacity of the system as specified. The complete switchgear shall be suitable for breaking capacity of 28kA symmetrical at 11000 volts three phase.

3.3.5 The busbars should be fully encapsulated by SF6 gas inside the steel tank.

3.3.6 Cable Termination: Each Cable compartment shall be provided with three bushings of adequate sizes to terminate the incoming outgoing 11kV 3 Core cables. There shall be enough height (Minimum 450mm) from the base of the mounted switchgear so that the cables can be bent and taken vertically up to the bushings. The Cable termination shall be done by Heat shrinkable Termination method so that adequate clearances shall be maintained between phases for Termination. Access to all the cables should be possible form the front of RMU. Cable Termination boots shall be supplied by the switchgear manufacturer. Locking Arrangement: Suitable padlocking arrangements shall be provided as stated below.

(a) CB manual operating handle in the “OFF” position.
(b) Each feeder Panel operating handle in ‘Closed’ ‘Open” or ‘Earth’ position.
(c) Each isolator operating handle in ‘Closed’, ‘Open’, or ‘Earth’ position.

3.3.7 Sealed for life, the enclosure shall meet the “sealed pressure system” criteria in accordance with IEC:298 (a system for which no handling of gas is required throughout service life of approximate 20 years). There shall be no requirement to ‘top up’ the SF6 gas. In addition, manufacturer shall confirm that maximum leakage rate is lower than 0.1% per year. It shall provide full insulation, making the switchgear insensitive to the environment. Thus assembled, the active parts of the switchgear unit shall be maintenance free.

3.3.8 The switchgear & switchboard shall be designed so that the position of different devices is visible to the operator on the front of the switchboard & operation are visible as well. The switchboard shall be designed so as to prevent access to all live parts during operation without the use of tools.

3.3.9 RMU should be tested for internal arc fault test.

3.3.10 The manual operation of the circuit breaker shall not have an effect of the trip spring. This should only be discharged under a fault (electrical) trip condition, the following manual reset operation should recharge the trip spring & reset the CB mechanism in 'main off' position.

3.3.11 Protection Relays: The CB shall be fitted with microprocessor based self powered relay inside the front cover to avoid any tampering. The same shall be used in conjunction with suitable Current Transformer and Tripping Coil for fault tripping of the Circuit Breakers.

3.3.12 Tests For RMU Each type of 11kV Switchgear shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards i.e. IS:9920, IS:3427, IS:13118, IEC:265, IEC:298 and during manufacturing and on completion.

3.3.13 Routine Tests : The tests shall include but not necessarily limited to the following:

(a) Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.
(b) All wiring and current carrying part shall be given appropriate High Voltage test.

4.1 TRANSFORMER

The design and manufacture of totally enclosed Cast Resin Dry type Transformer shall comply with the applicable clauses of the latest editions of following standards. In case of any conflict, the requirements of this standard specification shall prevail.

IS : 3639	Power Transformer fittings & Accessories.
IS : 2026 [Part -I to Part- IV]	Power Transformers.
IS : 11171	Power Transformer accessories.
CBIP Specification Part – II	Power and Distribution Transformers.

4.2 CONSTRUCTIONAL DETAILS

(i) The Transformer shall be Cast Resin Dry Type, AN cooled. This shall be provided with welded sheet steel, freestanding enclosure with expanded metal screens of suitable size or louvers backed by wire-mesh. Transformer and upper body shall be suitably reinforced to prevent distortion during handling. Base channels shall be provided with skids and pulling eyes to facilitate handling.

(ii) All the fasteners and bolts shall be hot dip galvanized or Zinc passivated.

(iii) The Transformer shall be double wound core type with cold rolled grain oriented silicon steel laminations perfectly insulated and clamped to minimize vibrations and noise. Core fastening bolts shall be insulated to reduce losses and avoid hot spots. All parts of the magnetic circuit shall be effectively connected to earth system.

(iv) The winding shall be copper and shall be designed for full load current to withstand the thermal and electromagnetic stresses arising due to maximum fault level. The current carrying winding joints shall be electrically brazed.

(v) The Transformer shall be designed with particular regards to suppression of harmonic voltages.

(vi) Thermistor sensors shall be provided to measure the temperature of the low voltage winding inside the cast coils. Alarm contact shall be designed to operate at 145 deg C and trip contact at 165 deg C. The temperature protection equipment shall be suitable at 48V D.C. supply. The temperature rise of winding shall not exceed by 90 deg C by resistance on continuous full load above maximum ambient temperature of 50 deg C.

4.3 **TERMINALS AND MARSHALLING BOX**

(i) Winding shall be brought out and terminated on outdoors bushings, cable boxes or bus duct chamber.

(ii) H.T. cable box shall be suitably dimensioned to accept terminations of XLPE cable from top entry.

(iii) Terminal chamber for bus duct termination shall have a gasket cover plate bolted to it. A separate cover plate shall be provided to facilitate the connection and inspection.

(iv) Marshalling box shall be weather-tight. All protective devices and neutral CTs shall be wired by means of PVC insulated armoured cables upto marshalling box.

4.4 **TESTING**

The following Routine and Type Tests shall be performed on the transformers as per IS: 2026 as per directions of Architect/Consultants/BHEL and certified test reports submitted. Minimum two weeks' notice shall be given to Architect/Consultants/BHEL to witness the tests.

4.5 **Routine Tests**

The routine tests, including but not limited to the following shall be performed on each of the Transformers, as per the relevant standards (Note: Only NON DESTRUCTIVE test shall be performed on the transformers and test certificates for other tests conducted on other similar rated transformers shall be acceptable).

i) Measurement of winding resistance.

ii) Measurement of voltage ratio and check of voltage vector relationship.

iii) Measurement of Impedance voltage / short circuit impedance and load loss.

The power frequency test voltage for the secondary winding shall be 2.5 KV R.M.S.

4.6 Type Tests

Type test certificates are to be given in triplicate along with transformers.

4.7 ACCESSORIES

In addition to the accessories specified in the attached data sheet, Winding Temperature indicator, High Temperature Trip Point, Lifting lugs, Earthing Terminals and Micro Switch for tripping the HT panel in case of opening the door, shall also be provided within the quoted price.

The tapping and control gears shall be provided on the H.V. side. The tap changing equipment shall be suitable for carrying the fault current.

4.8 PAINTING

All metal parts shall be thoroughly cleaned to remove rust, scale, grease etc. and painted with two coats of approved colour shade over one coat of rust resisting primer. The paint shall not scale-off, crinkle or removed due to normal handling.
All metal surfaces not accessible for painting shall be made of corrosion resistant material.

4.9 RATING PLATE DETAILS

Each transformer shall be provided with a rating plate giving the details as per IS:2026 (Part-I). The marking shall be indelible and legible, and the rating plate shall be located on the front side.

Exact value of transformer percentage Impedance, as determined by tests shall be marked on it and also on the final submission of nameplate.

4.10 INSTALLATION

Installation shall conform to Indian Standard Code of Practices IS: 1886-1967, National Building Code and meet with the approval of the Electrical Inspectorate and other statutory bodies.

Transformers shall be positioned with acceptable clearance all round.

Visual inspection shall be conducted for mechanical damage to any part or parts and suitable steps shall be taken to rectify the defects immediately.

Before connecting the CSS to the supply, the housing must be earthed by two separate and distinct connections through separate copper leads. All connections to the earthing system should be visible for inspection.

The star point of LV winding shall be earthed by means of two separate and distinct earth conductors.

4.11 **COMMISSIONING**

The following pre-commissioning tests shall be conducted and test results recorded.

a) Continuity of the windings.
b) Insulation resistance between windings and also between windings and earth.
c) Earth resistance test.

In case the IR values are not found satisfactory, the transformers shall be dried out in the manner described in IS:1886-1967.

The transformer shall be energised only if the tests are satisfactory.

After energising, transformer shall be kept on `No Load' for a period of 24 hours before load is switched on. Thereafter Transformers shall be brought up to full load.

5 LT Switchgear

5.1 Neutral :– Solidly earthed at substation.

5.2 General finish:- Tropical, totally enclosed, metal-clad, weather-proof, vermin and dust proof.

5.3 Construction

5.3.1 The terminals shall be of sufficient mechanical strength and shall provide adequate electrical contact for the appropriate size of cable used. They shall be capable of receiving appropriate size of Aluminum conductors. They shall be provided with bolts, stainless steel nut and plane washers and spring washers for cable connection.

5.3.2 The enclosure shall be of sheet steel of 1.5/2 mm. CRC sheet steel, dust vermin proof, duly powder coated and wired as per standard engineering practice and CPRI tested.

5.3.3 No contact pressure shall be transmitted through insulating material & the gripping of the conductor shall take place between metal faces.

5.4 Earthing

5.4.1 Earthing arrangement shall be provided for earthing each cable, PVC cable gland, neutral busbar, chassis and frame work of the cubicle with separate earthing terminals at two ends. The main earthing terminals shall be suitably marked. The earthing terminals shall be of adequate size, protected against corrosion, and readily accessible. These shall be identified by means of sign marked in a legible manner on or adjacent to terminals.

5.4.2 Neutral bus bar strip shall be connected to Earthing terminal with help of copper strip of suitable capacity & nut-bolt arrangement.

5.5 Accessories: The following accessories shall be supplied duly mounted..

5.5.1 One incandescent lamp (with necessary fuse) to illuminate the fuse board internally.

5.6 AIR CIRCUIT BREAKER (ACB)

The air Circuit Breaker ACB shall comply with standards IS/IEC 60947-2 for circuit breaker and IEC 60947-3 for switch disconnector function

Rated making capacity (peak)shall be minimum 105kA

Circuit breaker shall be capable of carrying the full load current defined for 50^0 C with out any derating.

ACB shall have common accessories throughout the range.

From 800A onwards ACBs shall be used of 50kA(Icu=Ics=Icw for 1 sec) with microprocessor based overload, short circuit and earth fault protection.

Rating of ACB	Electrical Endurance	Mechanical Endurance
Upto 1600 A	10000 Opns	20000 Opns

The air circuit-breakers (ACB's) used in low-voltage installations shall be designed, built and tested in compliance with the standards of the IEC 60947-2 & EN 60947,

The rated insulation voltage shall be equal to or greater than 1000 V.

The rated impulse withstand voltage shall be equal to 12 kV; the device can be used for every installation category in this way, in compliance with the international standards CEI IEC 664-1

Setting range of protection release

Overload protection shall have adjustable setting from 40% to 100% of the ACBs rated.

a. Current settings in steps of 10% and adjustable time setting from 3-18m sec.

b. Short circuit protection shall have adjustable current setting from 100% to 1000% of of Ir setting.

c. The overload setting and adjustable time delay setting for fault discrimination from 50-400 m sec.

d. E/F protection if specified will have adjustable current setting from 40% to 100% of ACB rated current and adjustable time setting from 100-800m sec. It shall be possible to charge the release setting on load. There should not be any defeat facility of overload protection.Over load time setting from 0.5s, 1s, 2s, 4s….24s as field selectable curves.

e. Instantaneous protection with an adjustable pick-up and an OFF position.

f. Earth fault setting adjustable in absolute Ampere with time delay settings from 0 to 400 ms.

g. ACB shall have I2T ON/OFF facility.

h. ACB shall have LED Indication for fault differentiation.

i. ACB shall have fully rated Neutral with protection against O/L ,S/C with settings at 50%,100% and OFF.

j. ACB shall be provided with inbuilt thermal memory before and after tripping.

k. Release setting shall be thru DIAL type potentiometers as well as thru Navigation Keys.

l. ACB shall be provided with Dual Core Rogowskey Type CTs

5.7 Construction

The Air Circuit Breaker shall be of Air Break, Moulded Case, Horizontal drawout type fully interlocked or Fixed type and 4 or 3 Pole version as per BOQ, ACB shall have RoHS and WEEE compliance

5.8 Operating Mechanism

The operating mechanism shall be of the Open/Closed/Open stored energy spring type. The closing time shall be less than or equal to 70 milliseconds to ensure faster closing.

Drawout mechanism with safety requirements

The withdraw able circuit breaker shall have the following three distinct and separate positions which shall be indicated on the face of the panel.

- **"Service"** – Both main and auxiliary circuits are connected
- **"Test"** – All Auxiliary circuits are connected & main circuits are disconnected
- **"Isolated"**- Both Main and Auxiliary circuits are disconnected

i) The automatic shutters shall be integral part of breaker.

ii) Door interlock shall be provided as per standard

iii) Locking in isolated position

iv) ACB shall be provided with "Ready to close" contact.

v) ACB shall have flexibility in terminal orientation by 90 degree.

vi) ACB shall be suitable for switch disconnector function (AC23)

vii) ACB shall have continuously rated shunt trip coil.

5.9 Mechanical indicators

i) 'ON' – Circuit breaker closed.

ii) 'OFF'.- Circuit breaker open

iii) Spring charged – Ready-to-close

iv) Spring charged – Not ready-to-close

v) Spring discharged

vi) Circuit breaker in "Service" position.

vii) Circuit breaker in "Test" position.

viii) Circuit breaker in "Isolated" position.

6 TYPE / ROUTINE TEST ON COMPACT SUBSTATION :

6.1 Type Tests for Compact Substation:

The offered Compact substation should be fully type tested as per the IEC-1330

6.2 Routine Tests: The routine tests shall be made on each complete prefabricated substation.

a) Voltage tests on auxiliary circuit.
b) Functional test.
c) Verification of complete wiring.

6.3 Test Witness: Routine test shall be performed in presence of Architect/Consultants/BHEL, if so desired by Architect/Consultants/BHEL. The Successful bidder shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.

6.4 Certified reports of all the tests carried out at the works shall be furnished in three (3) copies for approval of Architect/Consultants/BHEL.

Chapter- 3

SUBHEAD I : H.T. PANELS, CSS AND H.T. CABLES

11KV HT CABLE

1. H.T.CABLES:

1.1 General

HT power cables shall be 3 core aluminium conductor XLPE steel tape armoured cable. Cables shall be ISI marked. This shall be suitable for 11 KV unearthed system. The cable shall be provided with steel armouring and tough outer PVC sheath.

The HT cables shall be brought to site on drums which shall be duly marked with name of the manufacturer and size of the cable.

The successful bidder shall ensure that for the HT cables brought at site, the test certificate in original issued by the factory before dispatch of the cable indicating the tests carried out and their results shall be produced to Architect/Consultants/BHEL. Without such certificate the cable shall not be accepted by BHEL.

HT cables shall be laid in ducts/ trenches.

The unit rate of HT cable quoted in BOQ shall be deemed to be inclusive of cost of laying both in ducts as well as in trenches. The cost shall be also inclusive of provisioning and fixing of necessary clamps and supports required for laying in ducts.

HT cable shall be suitably terminated with the help of heat shrinkable termination kit at both ends.

The cable supplied and laid shall be paid on length basis. The exact cable run will be measured after laying at site from terminal lug to terminal lug at the other end.

1.2 SPECIFICATION OF CABLES:

These cables shall have individually screened cores and be manufactured and tested according to IS:7098 (Part II) - 1973 ammended upto date & latest. The conductor for these cables shall be from electrical purity Aluminium 3/4 H or H Temper. All conductors shall be compacted circular in shape. The insulation shall be high quality cross linked Polythene - obtained by chemical cross linking of polythene molecules. The armouring applied over the common covering shall be of flat steel wires.

Each and every delivery length of the cable shall be subjected to routine tests as per IS:7098 (Part II) 1973 amended upto the date. The operating characteristics of these cables shall be as under.

i)	Permissible maximum continuous operating temperature	- 90^{o} C
ii)	Permissible short circuit temperature	- 250^{o} C
iii)	Di electric constant (Er) at 50^{o}Hz, 30^{o}C to 90^{o}C	- 2.4
iv)	Loss factor at 50Hz,30^{o} to 90^{o}C	- 0.5X100X-3
v)	Sp.Vol. resistivity at 20^{o}C	- 10^{14}Ohmcm

1.2 **LAYING OF CABLES:**

All cables shall be laid as per C.P.W.D GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS (PART-II EXTERNAL) - 2005 with all upto date amendments.

1.4 **TESTING THE CABLES:**

All cables shall be tested as per C.P.W.D GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS (PART-II EXTERNAL) - 2005 with all upto date amendments.

Chapter – 4

SUBHEAD - II

LT PANELS

1. STANDARDS:

The design, manufacture & testing of the various items are covered by the following standards:

IS 8623 – 1977	:	Factory built assemblies.
IS 4237 - 1967 gear	:	General requirement for Switchgear and Control for voltages not exceeding 1000V.
IS 2147 - 1962	:	Degree of protection provided by enclosure (low voltage switchgear and Control gear).
IS 3619 - 1966) IS 6005 - 1970)	:	Phosphate treatment.
IS 5 - 1978	:	Colour for ready mixed paints & enamels.
IS 5082 - 1969	:	Wrought aluminium for electrical purpose.
BS - 162	:	Clearance & creepage for bus systems.
IS 375 - 1963 IS 5578 - 1970	:	Marking arrangement for busbar/cable.
IS 4237 - 1967	:	Clearances & Creepages for Part I & II devices.
IS 6875	:	Push buttons & related control switches including control contactors.
IS 9224 Part I & Part II – 1973	:	HRC Fuses.
IS 2516 Part I & II – 1979	:	Alternating current circuit breakers (ACB).
II Sec. I – 1977	:	Voltage not exceeding 1000V AC or 1200V DC.
IS 3231 - 1965	:	Protective relays.
IS 3156 - 1965	:	Voltage transformers.
IS 2705 - 1981	:	Current transformers.
IS 1248 - 1968	:	Elect. indicating instruments.

2. Design Requirement

The Panels shall be designed for 415 V, 3 phase, 4 wire, 50 c/s supply.
Panels shall be rated for minimum fault level as mentioned in data sheets /Drawings.(min 50kA)

The Panel manufacturers shall apply all de-rating factors necessary to all Components to comply with the conditions detailed in this specification.
The Panel shall be totally metal enclosed, Symmetrical, stable profile frame construction, consisting of rolled hollow section with punchings in the DIN measure raster of 25mm. All profile edges rounded. Vertical profiles with two assembly levels for space-saving interior fittings. Bayable to all sides, floor mounted, free standing cubicle type with MCCB, SDF and ACB with compartmentalized design.

Switchgear and Busbars shall be arranged to permit future extension at the both ends. End of busbar shall be suitably positioned for this purpose. Panels at extreme ends shall have opening which shall be covered by using screwed plates. Details of extended bus-bar and opening shall be clearly indicated in the suppliers drawing.

The height of the panel should not be more than 2200 mm. Maximum operating height shall be approximately 1850 mm above the floor level and minimum operating height shall be approximately 350 mm above floor level for compartment type panel.

The spare feeders shall be provided on the top side of each vertical section of feeder. The total depth of the panel shall be adequate for proper cabling space. All Panels which are arranged side by side or other panels of that room shall have same height and depth.

Approximately Depth of single front panel : 400 mm / 600 for wardrobe type

Approximately Depth of double front panel : 800 mm

Minimum feeder section width shall be 400 mm and minimum height of the feeder shall be 150 mm.

Structures, including doors and panels, shall be capable of withstanding the internal pressure created by faults within the structure (equal to the maximum fault-current rating for a specified duration) without danger to the operating personnel. The minimum standard required is detailed in IS 3427. Type test certificates shall be provided by the successful bidder.

Structures shall be capable of bearing static load of Max 1.4 Tonne viz., cubicle module rack in, rack out and in no case the frame/base plate shall deform during the normal specified operation.

Structures shall be provided with barriers to prevent the transfer of ionized gases between adjacent compartments except busbar chambers.

Switchgear panel shall generally be self-ventilating with louvers .

Interlocks, busbar shutters, covers, etc. shall be provided to prevent incorrect or unsafe operation, and to prevent access to live parts. Interlocks shall be provided to prevent opening of the front doors of cubicles whilst the circuit breaker / switch is in the closed position.

Key interlocking shall be provided on door of incoming, outgoing and sectionalized Units.

All circuit breaker / MCCB / SDF shall have provision for padlocking. Padlocking facility for multiple locks shall be provided in the Off / Test / Isolated position in compartment type of panels.

Switchgear shall be designed and constructed to facilitate inspection, cleaning, repair and maintenance and to ensure absolute safety during operation, inspection and maintenance. It shall be possible to work safely within individual compartments whilst the other switchgears are energized.

Similar parts and components shall be interchangeable.

All hardware shall be corrosion resistant. All joints and connections of the panel members shall be Zinc passivated, high quality plated steel bolts(self tapping), and secured against loosening.

All Cubicles / panels shall comprise of rigid welded structural frames made pressed and roll formed CRCA sheet of thickness 14 SWG (2mm). This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker, main horizontal busbars, vertical risers and other front mounted accessories, etc.

Cladding of the frames (Covers), partitions and doors shall be of min. 14 SWG (2 mm) sheet. All cable gland cover plates shall be made of 10SWG (3.0mm) thick sheets steel and should be of 1 part. All sheet steel work forming the exterior of switchboards shall be smoothly finished, leveled and free from flaws. The corners shall be rounded.

The structure shall be mounted on a rigid channel base frame of minimum standard plinth 100mm height. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation(Transport plinth).

Each compartment shall be provided with a hinged door interlocked with SDF/MCCB/breaker housed inside the compartment so that door cannot be opened unless the SDF/MCCB/breaker is in 'OFF' position. Hinged shall be Concealed and bolted type. Doors shall be provided with right angle turn type door lock.

Panel shall be single/double front type as mentioned in the SLD; single front type panel shall not have access from rear side for operation and for maintenance purpose. Each switchgear shall also be fitted with a label indicating the switchgear rating and duty. Each relay, instrument switch, breaker and contactor shall be provided with a separate label.

Vertical cable chamber housing of minimum length 300 mm shall be provided for the cable end connections, and power/control cable terminations and shall be provided with suitable hinged door. A Horizontal Cable chamber of minimum height 100 or 200mm shall be provided for cable glanding purpose. The design shall ensure generous availability of space of ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in and adjacent section.

A cover plate at the top of the vertical section, provided with a ventilation hood where necessary. Any aperture for ventilation shall be covered with a perforated sheet having less than 1 mm diameter perforations to prevent entry of vermin.

Front and rear doors shall be fitted with dust tight Poly Eurethene form gaskets which can withstand a maximum temperature of 65Deg C continuous with easy operating type fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust. The doors shall have concealed hinges. Removable covers shall be provided on the front/rear side of vertical/horizontal Busbar chamber of the cubicles with torx screw

Set of horizontal main bus bars shall be provided and busbar rating shall be of uniform cross section throughout the length and made of Copper/Aluminium. The vertical bus bars shall be housed in separate fully enclosed chamber of minimum width 300 mm and accessible from front and rear shall be tapped off from main horizontal bus bars. A separate horizontal enclosure for all auxiliary power and control buses if required. Busbars shall be provided with the minimum clearance in air as specified and horizontal busbar chamber should be minimum of 300mm height.

All busbar taps shall be insulated with close fitting non hygroscopic, thermally modified hard PVC of high dielectric strength to provide a permanent high dielectric non-aging and non tracking protection impervious to water, tropical condition and fungi. The insulation shall be non-inflammable and self extinguishing and in fast colors to indicate phases. The continuous operating temperature max 91Deg C and fire protection corresponding to UL 94-V0

The joint shall be insulated in such a way as to provide for accessibility of contact bolts for maintenance. The dielectric strength and properties shall hold good for the temperature range of 0°C to 90°C. If insulating sleeve is not coloured, busbars shall be colour coded with coloured bands at suitable intervals. Both main horizontal and vertical busbars serving modules shall be insulated.

Busbar joints shall be bolted & projections shall be insulated. Spring washers shall be provided to ensure good contact at the joints. Busbars shall be thoroughly cleaned at the joint locations and suitable contact grease shall be applied just before making a joint.

The busbars shall be located in air insulated enclosures. Direct access or accidental contact with the busbars and primary connections shall not be possible. All apertures and slots shall be protected by baffles to prevent accident shorting of busbars by the entry of maintenance tools. To provide a tight seal between cubicles, bushing or insulating panels shall be provided for busbars crossing from one cubicle to another.

Incoming/ Outgoing terminals of the individual feeders shall be provided with insulated shrouds to avoid accidental contact with live parts.

All operating devices shall be incorporated in the front of panel and shall be flush/semi-flush mounted.

The apparatus and circuits shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary of degree of safety.

Apparatus forming part of the panel shall have the minimum clearances as per relevant IS. Clearances shall be maintained during normal service conditions. Creepage distances shall comply with those specified in relevant standards.

All insulating material shall be of DMC/SMC to withstand the effects of high humidity, high temperature, tropical ambient service conditions etc.

The lifting eyes bolts (combination angle at bayed conditions) for each shipping section. Functional units such as circuit breakers and fuse switches vertical section shall be provided with space heater controlled by thermostat.

Metallic/insulated barriers shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact.

Extra protection covers(See thro' acrylic cover) over removable cover providing access to live power equipment/circuits shall be provided with tool operated fasteners to prevent unauthorized access.

Provision shall be made for permanently earthing the frames and other metal parts of the panel by the independent connections(unique feature of TS8 automatic polarization). All identical equipment and corresponding parts be fully interchangeable without any modification (LH to RH assembly).

Panel shall be complete with inter-panel wiring.

One metal sheet shall be provided between two adjacent vertical sections running to the full height of the switchgear except for the horizontal busbar compartment. However each shipping sections shall have metal sheets at both ends (Divider sheet is optional used as removable part at site).

After isolation of the power and control connections of a circuit, it shall be possible to safely carry out maintenance with the busbars and adjacent circuits alive.

3. **Metal treatment & finish:**

All steel work used in the construction of the panel should have undergone rigorous metal treatment process.

Oil, Grease, Dirt and Swarf shall be thoroughly removed by High pressure (1bar) warm (50DegC)multidirectional jets using Alkali Chemicals & DM water free from hazardous chemical.

After pressurized conveyor system cleaning, finishing shall be carried out with DM Water, followed by final Uniform coating with special nano ceramic coating - applied by high pressure jets and the coating should be environment friendly and free from phosphate and COD/BOD and deprive of toxic heavy metals like Fe & Zn (Improve the adhesion property of powder).

First primer should be EC dip coat(RAL 7035)Like in automobile industry, which is free from any heavy metals, chromates and silicon thereby ensuring the RoHS compliance and Over the Primer, the final powder coating of RAL 7035 paint shall be applied and the overall paint thickness should not be above 80-130 microns. The sample sheet for the finishing paint shall be approved by Architect/Consultant/BHEL.

The final finished thickness of paint film on steel shall not be less than 80 microns.

Finished painted appearance of equipment shall present aesthetically pleasing appearance, free from dents and uneven surface.
Metal parts of the Panels should have a convincing corrosion protection by undergoing 168 hours of salt spray testing to DIN ISO 7253.
The Panels should have compliance certificate for RoHS and WEEE standards.

4. **Busbars**

Busbars and connections shall either be manufactured from non flammable hard drawn copper or Aluminium. The continuous operating temperature max 130 Deg C and fire protection corresponding to UL 94-V0 at sufficiently close interval to prevent busbar sag and shall effectively withstand electromagnetic stresses in the event of short circuit capacity for one second.

Busbars including branch connections shall be fully insulated except in the cable/busduct compartment(s). FRP/Hylam shrouds shall be provided at joints and tapoffs. Busbars exposed to air shall be silver plated.

Main busbar shall be rectangular cross section and shall have same cross sectional area throughout the length of the switchgear. The current rating of the neutral busbar may be half of the phase busbars. Busbars shall be capable of carrying the rated current at 415 V continuously. The busbars shall be designed to withstand a temperature rise of maximum 80Deg C above the ambient. Successful bidder has to submit the Bus bar calculation of each panel along with GA drawing at the time of drawing approval with certificate and doscumentation if required.

The main horizontal busbars shall run throughout the entire length of the panel and shall be accessible for maintenance from the front as well as rear. Busbar chamber shall have separately screwed covers. All busbars, links etc. shall be provided with 3 mm thick FRP sheet/Hylam sheet to prevent accidental contacts.

The busbar shall be arranged such that minimum clearances between the busbar are maintained as below.

Between phases	:	60mm min.
Between phases and neutral	:	60mm min.
Between phases and earth	:	60mm min.
Between neutral and earth	:	60mm min.

The busbar shall be of three phases and neutral system with separate neutral and earth bar. The busbar and interconnection between busbar and various components shall be of high conductivity, hard drawn and High tensile bolts and spring washers shall be provided at all busbar joints.

Busbars and interconnection shall be insulated with heat-shrink sleeves of applicable grade and marked to indicate the phase colouring, which shall be red, yellow, blue and black unless specified otherwise. Necessary de-rating due to insulation shall be considered for sizing the busbars.

Busbars, at bus section switches, shall be arranged to permit safe work with one bus-section de-energized. In addition it shall not be possible for arcs to transfer across a section or coupler.

Branch connections shall be sized as per the circuit breaker / switch rating.

An earthing busbar sized for the full rating of the Panels shall be provided along the full length of the switchgear structure with provision for earth cable / bar connections at each end. It shall be possible to disconnect the earth cable / bar connection to facilitate use of megger, when required. Where frame leakage protection is specified a separate insulated bus bar is required in addition.

Busbars and connections shall be adequately sized, braced and supported to withstand the mechanical forces and thermal effects resulting from the switchgear rated short circuit current and carry certification from a recognized testing authority.

The busbar shall be rated for the frame size of the main incoming breaker /ACB/SDF. Above 63 Amp MCCB/SDF incomer/outgoing shall be considered busbar only.

All bus connections, joints and taps shall be short and as straight as possible, and applied with contact grease in the mating surface.

5. ACB

Refer Chapter-2 for detailed technical specifications.

6. SAFETY INTERLOCKS

The following safety interlock shall be provided for each module:

i) When ACB is ON door cannot be opened - electrically or mechanically. (Defeat interlock to be provided.)

ii) Padlocking in OFF position (locks to be provided)

iii) Castell interlocks for feeder co-ordination as per B.O.Q./ Drawings.

7. MCCB

i) The power contacts shall be insulated in an enclosure made of a thermosetting material from other functions such as operating mechanism, case, trip unit and auxiliaries.

ii) All poles shall operate simultaneously for circuit breaker opening, closing and tripping.

iii) The MCCB shall equip a double breaking type rotary contact mechanism, having current limiting feature to limit let through energy on the installation.

iv) MCCB shall be suitable for Positive Isolation complying with IEC 60947-2 & 7-27.

v) MCCB shall offer class II front face as per IEC 60664

vi) The trip unit shall be Thermal-magnetic type up to 250A and Electronic type over 250 A. Thermal magnetic release shall provide adjustable settings for O/L (70 to 100%) and Short ckt fixed. Microprocessor based release shall have adjustable settings for O/l, S/c, E/F protections

vii) All MCCBs shall be equipped with front operated rotary handles

viii) MCCB shall have provision of modular ground fault protection.

ix) It shall not be possible to by-pass / switch off the S/C, E/F protection in MCCB. The E/F setting shall be provided with 15% to 60% with time delay of 0.3 to 3 seconds. LED Indication shall be provided in case of earth Fault. E/F Module shall have Test Push Button for self diagnostic features without tripping the ckt breaker.

x) MCCB shall have cross bolted termination to withstand higher short circuit levels.

xi) MCCB shall comply with RoHS & WEEE norms

Operation

i) Push to trip facility shall be provided on the panel door
ii) The MCCB shall be provided spreader links and phase barriers (Optional)
iii) The accessories shall be front fit table and shunt coils shall be continuously rated.
iv) MCCB shall be provided with Common snap fit auxiliaries throughout the range.

8.0 MINIATURE CIRCUIT BREAKERS (MCB)

8.1 The MCBs shall be of the completely moulded design suitable for operation at 240/415 Volts 50 Hz, single phase/3-phase and neutral system. MCBs shall be quick make and break type conforming to relevant standards. Housing shall be heat resistant and have high impact strength. MCBs shall be flush mounting type and shall be provided with trip free manual operating liver with ON/OFF indications.

8.2 MCBs shall be provided with magnetic thermal releases for over current and short circuit protection.

8.3 MCBs shall have quick make and break non-welding self wiping silver alloy contacts rated for 10 kA short circuit at 230/415 volts in accordance with IEC 60898 and IS : 8828 - 1996 as per the BOQ & the drawing both on the manual and automatic operation. The MCB shall confirm to Class 3 Energy Limitation. Each pole on the breaker shall be provided with inverse time thermal over load and instantaneous over current tripping elements, with trip-free mechanism. In case of multi-pole breakers, the tripping must be on all the poles and operating handle shall be common.

8.4 Breakers must conform to IEC 60898 with facility for locking using padlock with hasp in OFF position. Copper Pressure clamp terminals for stranded/solid conductor insertion are acceptable up to 10sqmm size and for higher ratings, the terminals shall be suitably shrouded.

8.5 MCB shall have a minimum life expectancy of 20,000 operations.

9. COMBINATION FUSE SWITCH UNITS and ON LOAD CHANGE OVER SWITCH FUSE UNITS

These Units should comply with IS: 4064 amended upto date. These should be suitable to accommodate high rupturing capacity cartridge fuse-links complying with IS: 2208 amended up to date and having a certified rupturing capacity of not less than 35KVA, at 440Volts.

9.1 CONSTRUCTION

The unit housing shall be of robust construction designed to withstand the hardest conditions met in industry. It should have double breaks per phase to ensure complete isolation of the fuse links when the unit is in the `off' (isolation) position. The ‘on' and ‘off' positions of the handle shall be clearly indicated. The action of the switch should be positive. The contacts of all units should be silver-plated.

Interlocks must be provided to ensure that the enclosure cannot be opened until the switch is in the 'off' position. It should, however, be possible for a competent examiner to operate the switch with the enclosure open by releasing a suitable interlock.

The switch should have an external earthing terminal to enable the enclosure to be earthed. The arrangement and disposition of the parts in the unit should provide for straight through connections thereby avoiding looping in of cables. The unit should be fitted with top and bottom detachable end cover and provision should be made for fixing cable boxes to the flanges of the unit in place of end covers.

The unit should be capable of breaking the stalled current of the largest induction motor with which it is likely to be associated. If necessary, the successful bidder should be prepared to produce type test certificates set out in the appropriate Indian standards with which the unit complies.

9.2 MODULES

9.2.1 INCOMER

The incomer shall be as indicated in B.O.Q. / Drawing.

9.2.2 OUTGOING FEEDERS

The outgoing feeders shall be as indicated in B.O.Q. / Drawing. Irrespective of the panel depths, the panels shall be coupled front flush. Each outgoing feeder shall have the provision for Cable/bus duct connection from the bottom/top.

10. CONTROL WIRING

All control wiring shall be done as a standard, using 1.5 sq.mm. multistrand PVC insulated copper wires. These shall be black in colour for AC and grey in colour for DC. The C.T. connections shall be done using 2.5 sq.mm. multistrand PVC insulated copper wires of red colour.

The outgoing control wires shall be terminated from the equipment terminals to control terminal block in cable chamber. Whenever required, PVC channels shall be used for wire routing. On either ends of these wires self locking yellow ferrules with black letters shall be provided. Multistrand wire termination shall be provided with crimping type lugs.

11. INTER-MODULE WIRING

The control wiring between modules located in the same vertical section shall be connected at the respective terminal blocks/terminals. These shall be routed through the cable duct in PVC wire channels.
Inter connections between adjacent cubicle in the same shipping sections shall be done in a similar way.

12. CURRENT TRANSORMERS

Current transformer meant for metering & protection shall be mounted on the bus links either on the incoming side or outgoing side as the case may be. They shall be wired and terminated suitably for external connection.

13. FUSES

All fuses shall be of the HRC cartridge type, conforming to IS: 2208 mounted on plug-in type of fuse bases having a prospective current rating of not less than 50 KA. Fuses shall be provided with visible operation indicators to show that they have operated. Insulated fuse pulling handle shall be supplied with each control panel.

14. INDICATING INSTRUMENTS & METERS

Electrical indicating instruments shall be flush mounted digital type having min. 96 mm square dial.

15. CONTROL AND SELECTOR SWITCHES

Control and instrument switches shall be of the rotary type and shall be provided with properly designated plate. Control switches shall have momentary contacts spring return to centre with pistol grip handle. Instrument and selector switches shall have stay put contacts.

16. PUSH BUTTONS

All push buttons shall be of push to actuate type having 2 `NO' and 2 `NC' self reset contacts. They shall be provided with designation plates, engraved with their functions, push button contacts shall be rated for 10 amps at 415V A.C. and 0.6 Amp, inductive breaking at 220V D.C.

17. INDICATING LAMPS

Indicating lamps shall be of the filament type having double contact bayanet caps and low watt consumption. Lamps shall preferably be provided with series resistors to prevent short circuiting of control supply of filament fusing. Colour of lens shall be as per enclosed drawing/data sheet. Lamp grip shall be supplied along with the panel so that replacement of the bulb can easily be done from the front of the panel.

CAPACITOR CONTROL PANEL BOARD

(a) The capacitor control panel shall be integrated with LT Panel sheet steel clad vermin proof inside the compact Sub-Station. This shall be complete with incomer, TPN bus bar chamber with aluminium bus strips PVC sleeved, switchgear, capacitors, all instruments, power factor relays and other accessories as described in BOQ/ Drawings.

(b) Power Factor Relay:- Power factor relay shall be complete with all accessories for sensing of power factor of the system and initiating correcting action (for switching in or cutting out of required number of capacitors) including step controller reversing mechanism, time delay and no volt relays, power factor meter etc.

(c) Auto/ Manual Selectors Switch:- One auto/ manual selector switch shall be provided for automatic or manual operation of capacitors.

(d) Capacitor Bank:- Power factor correction capacitors shall be suitable for three phase, 415 volt, 50 Hz frequency system for indoor use at ambient temperature of 50^{o}C. The capacitors shall be complete with metallic zinc coated steel enclosures with mounting frame and cable termination enclosures. Every element of each capacitors unit shall be provided with its own built-in silvered fuse. The capacitors shall have suitable discharge device to reduce the residual voltage from crest value of the rated voltage to 50 V or less within one minute after capacitors is disconnected from the source of supply. The loss factor of capacitors shall not exceed 0.005 for capacitors with synthetic impregnates, the capacitors shall withstand voltage of 2500 V AC (power frequency test voltage) for one minute. The insulation resistance between capacitors terminals and containers when test voltage of 500 V DC is applied shall not be less than 50 mega-ohms. The manufacturer test certificate for capacitors shall be submitted with the panel.

18. DRAWINGS

The successful bidder shall provide the following drawings for approval to Architect/Consultant/BHEL before commencement of supply/ fabrication.

(i) General layout-Plan, section, elevations
(ii) Foundation
(iv) Wiring-Power & Control

Chapter - 5

SUBHEAD - VIII

LT CABLES

1. General

LT power cables shall be of 1100 volts grade XLPE insulated PVC sheathed steel armoured cable (XLPE) conforming to IS-1554. The size of the cables shall be as given in BOQ/Drwaings.

The cables shall be brought to site on drums which shall be duly marked with the name of the manufacturer and the size of the cable.

Successful bidder shall ensure that all tests as required as per IS are carried out for cables of each drum separately, before they are dispatched from the factory. The original copy of the test certificates which shall be complete with all test results, duly signed and stamped by the factory authorities, shall be handed over to Architect/Consultants/BHEL for verification and record when the material is received at site. The cables shall not be accepted without receipt of test certificate from the factory in original.

The LT cable shall be laid in trenches and through pipes where there are road crossings or paved surfaces.

Successful bidder shall mark the cable routes on the ground, get them approved from the Architect/ Consultants/BHEL, before cable trenches are dug and RCC pipes under the roads and pavements are laid. Simultaneously successful bidder shall get the width and depth of each section of cable trench approved by the Architect/Consultants/BHEL. The width shall be based on the number of cables to be laid in each trench and sand cushioning.

The cables shall be laid on cable trays fixed in the cable trenches.

For cable laid in ground, cable markers of design and size as required by BSES are to be provided on the cable route, at every bend and at 25 metre of straight section.

Cable supplied and laid shall be paid on length basis. The exact cable run will be measured after laying at site from terminal lug to terminal lug at the other end.

Cable pulling shall be carried out in approved manner by using rollers, corner rollers and hydraulic jacks for lifting of cable drums.

At no location the cable bend shall exceed the limits specified in the IS for various sizes and sections.

Irrespective of the test certificate issued by the factory, all cables shall be Megger tested before laying after laying & before back filling of trenches. Record of these

tests for each length of cable shall be signed by the successful bidder, Architect and BHEL and kept by BHEL.

2. SPECIFICATION

2.1 MEDIUM AND LOW PRESSURE:

Cables should be steel armoured XLPE insulated PVC sheathed with fire retardant compound Aluminium conductor conforming to the quality as specified in the BOQ. All cables, accessories and other materials should conform to IS Specifications. The jointing work should be carried out by a competent authorised cable jointer.

2.2 **LAYING OF CABLES**

All cables shall be laid as per C.P.W.D GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS (PART-II EXTERNAL) - 2005 with all upto date amendments.

2.3 **TESTING THE CABLES**

All cables shall be tested as per C.P.W.D GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS (PART-II EXTERNAL) - 2005 with all upto date amendments.

3. CABLE TERMINATION

3.1 Cost of all necessary cable terminating accessories such as glands, supporting clamps/ lugs/ hardware etc. shall be deemed to be included in the unit rate under item of BOQ.

3.2 The conductor end shall be crimped with hydraulic crimping machine. The method shall be required by BSES as per their practice.

3.3 Spliced end of the cable conductor should be immediately crimped with lugs. Bare conductor should not be left open to the atmosphere.

3.4 All the strands of a conductor must be fitted in the lugs and no cutting of strands will be allowed under any circumstances.

3.5 Appropriate size of holes shall be drilled on the cable gland plate so that the gland after tightening is firmly secured with the gland plate. Cost of glands shall be deemed to be included in the quoted rates of cable laying and termination.

3.6 Lugs of proper size should be selected to match the bus bar holes or terminal holes with holes of lug/ thimbles. Cost of studs/ lugs/ thimbles shall be deemed to be included in the quoted rates of the laying and termination of cables.

3.7 Cable straight joint: No cable joint shall be permitted in any portion. However, if the particular length required for any particular section is more than the permissible length on a single drum by the factory, only then straight joints shall be permitted. Successful bidder shall arrange the maximum length as permitted on the cable drums from the factory, so that, only the minimum number of joints, which is essential, is permitted. The method of jointing shall be suitable for the type of cable being laid; jointing kit shall be of joint boxes, connectors, insulation tape crimping tools, etc. The core crossing is not allowed at straight joints. Position phasing shall be carried out before the cable is cut. The method of jointing and location shall be as required by BSES.

3.8 The cost of making the joint including all material and equipment required shall be deemed to be included in the unit rates of cable quoted in BOQ. The length of the joint shall also be measured on linear basis as cable is laid.

Chapter - 6

SUBHEAD – III & IV

Distribution & Wiring

1 SCOPE

This chapter covers the general technical requirements and measurement system of the various components in Internal Electrical Installation works.

2 TERMINOLOGY

The definition of terms shall be in accordance with IS:732-1989 (Indian Standard Code of Practice for Electrical Wiring), except for the definitions of point, circuit, and sub-main wiring, which are defined hereunder.

3 POINT WIRING

3.1 Definition

A point (other than socket outlet point) shall include all work necessary in complete wiring to the following outlets from the controlling switch or MCB. The scope of wiring for a point shall, however, include the wiring work necessary in tapping from another point in the same distribution circuit.

Ceiling rose or screwless connector (in the case of points for ceiling/exhaust fan points, pre-wired light fittings, and call bells).

Ceiling rose (in the case of pendants except stiff pendants).

Back plate (in the case of stiff pendants).

Lamp holder (in the case of goose neck type wall brackets, batten holders and fittings which are not pre-wired).

Note: - In the case of call bell points, the words "from the controlling switch or MCB" shall be read as “from the ceiling rose/connector meant for connection to bell push".

3.2 Scope

Following shall be deemed to be included in point wiring.

Conduit, accessories for the same and wiring cables between the switch box and the point outlet.

All fixing accessories such as screws, raw plug etc. as required.

Metal switch boxes for control switches, regulators, sockets etc, recessed in walls.

Outlet boxes, junction boxes, pull-through boxes etc, including metal boxes if any, provided with switch boards for loose wires/conduit terminations.

Control switch or MCB, as specified.

Ceiling rose or connector as required.

Connections to ceiling rose, connector, socket outlet, lamp holder, switch etc.

I nterconnecting wiring between points on the same circuit, in the same switch box or from another.

Protective (loop earthing) conductor from one metallic switch box to another in the distribution circuits, and for socket outlets. (The length of protective conductor run along with the circuits is included in the scope of points).

The circuit wiring in conduit and wiring between various switches/switch boxes on the same circuit.

3.3 Measurement:

3.3.1 Point Wiring:

Unless and otherwise specified , there shall be no linear measurement for point wiring for light points, fan points, exhaust fan points, 5/6amp plug points, 15/16 amp plug points and call bell points.

These shall be measured on unit basis by counting only.

No separate measurement will be made for interconnections between points in the same distribution circuit and for the circuit wiring including protective (loop earthing) conductors between metallic switch boxes.

3.3.2 Point wiring for socket outlet points:

The metal box with cover, switch/MCB, socket outlet and other accessories shall be measured and paid as a part of the item only.

3.3.3 Group control points wiring:

In the case of points with more than one point controlled by the same switch, such points shall be measured in parts i.e.(a) from the switch to the first point outlet as primary point and for the subsequent points, the distance from that outlet to the next one and so on, shall be treated as secondary point(s).

No recovery shall be made for non-provision of more than one switch in such cases.

3.3.4 Twin control light points wiring:

A light point controlled by two numbers of two way switches shall be measured as two points from the fitting to the switches on either side.

No recovery shall be made for non-provision of more than one ceiling rose or connector in such cases.

3.4 CIRCUIT AND SUBMAIN WIRING

3.4.1 Circuit wiring

Circuit wiring shall mean the wiring from the distribution board upto the tapping point for the nearest first point of that distribution circuit, viz. upto the nearest first switch box. No measurement/ extra payment shall be made for circuit wiring.

3.4.2 Submain wiring

Submain wiring shall mean the wiring from one main/distribution switchboard to another.

3.4.3 Measurement of submain wiring

The sub main wiring shall be measured on linear basis and paid for separately.

3.4.4 OTHER WIRING WORKS:

Except as specified above for point wiring, circuit wiring and submain wiring, other types of wiring shall be measured separtely on linear basis along the run of wiring depending on the actual number and sizes of wires run.

3.5 SYSTEM OF DISTRIBUTION:

3.5.1. Control at the point of entry of supply

There shall be a circuit breaker on each live conductor of the supply mains at the point of entry.

3.5.2 Distribution:

The wiring shall be done on a distribution system through main and/or branch distribution boards.

Main distribution board shall be controlled by a circuit breaker. Each outgoing circuit shall also be controlled by a circuit breaker.

The branch distribution board shall be controlled by a circuit breaker. Each outgoing circuit shall be provided with a miniature circuit breaker (MCB) of specified rating on the phase or live conductor.

The loads of the circuits shall be divided, as far as possible, evenly between the number of ways of the distribution boards, leaving at least one spare circuit for future extension.

The neutral conductors (incoming and outgoing) shall be connected to a common link (multiway connector) in the distribution board and be capable of being disconnected individually for testing purposes.

`Power' wiring shall be kept separate and distinct from `Lighting' wiring, from the level of circuits i.e., beyond the branch distribution boards.

Wiring shall be separate for essential loads (i.e., those fed through standby supply) and non essential loads throughout.

3.5.3. Balancing of Circuits:

The balancing of circuits in three wire or poly phase installations shall be arranged before hand to the satisfaction of the Architect/consultants/BHEL.

3.5.4 Wiring System:

Wiring shall be done only by the Looping system. Phase or live conductors shall be looped at the switch boxes and neutral conductors at the point outlets.

Lights, fans and call bells shall be wired in the lighting circuits. 15/16A socket outlets and other power outlets shall be wired in the 'Power' circuits. 5/6A socket outlets shall be wired in the lighting circuits.

The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of a linked switchgear.

3.5.5 Run of Wiring:

The wiring shall be in recessed/surface PVC conduit. Due consideration shall be given for neatness, good appearance and safety.

3.5.6 Passing through walls or floors:

When wiring cables are to pass through a wall, these shall be taken through a protection (steel) pipe tube of suitable size such that they pass through in a straight line without twist or cross in them on either end of such holes. The ends of metallic pipe shall be neatly bushed with porcelain, PVC or other approved material.

All floor openings for carrying any wiring shall be suitably sealed after installation.

3.6 Joints in wiring:

No bare conductor in phase and/or neutral or twisted joints in phase, neutral, and/or protective conductors in wiring shall be permitted.

There shall be no joints in the through-runs of cables. If the length of final circuit or submain is more than the length of a standard coil, thus necessitating a through joint, such joints shall be made by means of approved mechanical connectors in suitable junction boxes.

Termination of multistranded conductors shall be done using suitable crimping type thimbles.

3.7 RATINGS OF OUTLETS:

Incandescent lamps shall be rated at 100W.

Exhaust fan, fluorescent tubes, compact fluorescent tubes, HPSV lamps etc. shall be rated according to their capacity. Control gear losses shall be also considered as applicable.

5/6A and 15/16A socket outlet points shall be rated at 100 W and 500 W respectively, unless the actual values of loads are specified.

3.8 CAPACITY OF CIRCUITS:

Lighting circuit shall not have more than a total of 10 points of light, fan and socket outlets, or a total connected load of 800W, whichever is less.

Power circuit shall have only two outlet per circuit.

3.9 GENERAL REQUIREMENTS OF COMPONENTS:

3.9.1 Quality of materials:

All materials and equipments supplied by the successful bidder shall be new. They shall be of such design, size and material as to satisfactorily function under the rated conditions of operation and to withstand the environmental conditions at site.

3.9.2 Ratings of components

All components in a wiring installation shall be of appropriate ratings of voltage, current, and frequency, as indicated in BOQ/Drawings.

All conductors, switches and accessories shall be of such size as indicated in BOQ/Drawings.

3.9.3 Conformity to Standards

All components shall conform to relevant Indian Standard Specification, wherever existing. Materials with ISI certification mark shall be preferred.

A broad list of relevant Indian Standards is given in Appendix `A'. These Indian Standards, including amendments or revisions thereof upto the date of tender acceptance, shall be applicable in the respective contracts.

3.9.4 Interchangeability

Similar parts of all switches, lamp holders, distribution boards, switchgears, ceiling roses, brackets, pendants, fans and all other fittings of the same type shall be interchangeable in each installation.

3.10 CABLES:

3.10.1 Wiring cables

Conductors of wiring cables shall be of copper. The wiring cables shall be of certified FRLS type.

The smallest size of conductor for `lighting' circuits shall have a nominal cross sectional area of not less than 1.5 sq mm. The minimum size of conductor for 'power' wiring shall be 4 sq mm.

3.11 WIRING ACCESSORIES

3.11.1 Control switches for points

Control switches (single pole switches) carrying not more than 16A shall be of clamp on type complete with plate, as specified, and the switch shall be "ON" when the knob is down.

The type and current rating of switch controlling a group of points, or discharge lamps, or a single large load, shall be specified in Drawings.

Control switch shall be placed only in the live conductor of the circuit. No single pole switch or fuse shall be inserted in the protective (earth) conductor, or earthed neutral conductor of the circuit.

3.11.2 Socket outlets

Socket outlets shall also be of clamp on type complete with plate. These shall be rated either for 5/6A, or 15/16A. Combined 6/16A six pin socket outlet shall be provided in `power' circuits wherever specified.

Socket outlets and plugs shall only be of 3 pin type; the third pin shall be connected to earth through protective (loop earthing) conductor. 2 pin or 5 pin sockets shall not be permitted to be used.

The control switches for the 5/6A and 15/16A socket outlets shall be kept along with the socket outlets.

3.11.3 Switch box covers

These shall be moulded type of suitable size.

3.12 FITTINGS-Indoor type

The conductors are required to be drawn through tube popularly known as conduit. The tube or channel must be free from sharp angles or projecting edge, and of such size as will enable them to be wired with the conductors used for the final circuit without removing the braiding or sheathing. As far as possible all such tubes or channels should be of sufficient size to permit looping back.

Fittings using discharge lamps shall be complete with power factor correction capacitors, either integrally or externally. An earth terminal with suitable marking shall be provided for each fitting for discharge lamps.

3.13 SWITCHGEAR AND CONTROLGEAR - General aspects:

All items of switchgear and distribution boards (DBs) shall be metal clad type.
The types, ratings and/or categories of switchgear and protective gear shall be as specified in the BOQ/Drawings.

RCBs (ELCBs) where specified, shall conform to the requirements of current rating, fault rating, single phase or three phase configuration and sensitivity laid down in the BOQ.

While each outgoing way of distribution board (DB) shall be of miniature circuit breaker (MCB) as specified, and of suitable rating on the phase conductor, the corresponding earthed neutral conductor shall be connected to a common neutral terminal block and shall be capable of being disconnected individually for testing purposes.

(i) Independent earth terminal block:

Every distribution board (single phase as well as 3 phase) shall have an earth terminal block identical to, but independent from neutral terminal block, to enable termination of protective (loop earthing) conductors (incoming as well as outgoings) individually by screwed connection and without twisting.

Earthing terminal (1 for single phase and 2 for 3 phase) shall be provided on the metal cladding of switches and DBs for body earthing. These shall be suitably marked.
Knock out holes, with or without end plates as per standard design of manufacturers, shall be provided in the metal cladding of switches and DBs for termination of conduits/cables.

3.14 PRE-WIRED MCB DISTRIBUTION BOARDS:

Prewired MCB DBs shall be provided as specified in BOQ/Drawings.

The complete board shall be factory fabricated and shall be duly pre-wired in the works, ready for installation at site. All the boards shall be double door.

The board shall be of wall mounted, cubical type construction, fabricated out of 1.6mm thick sheet steel, with stove enameled paint finish.

The board shall also be provided with a loose wire box as a compartment for the complete width and, depth of the board, and of minimum height of 125mm in case of TPN DB's, and 100mm in case of SPN DB's.

The board shall be provided with a hinged cover of 1.6mm thick sheet steel in the front.

Knock out holes at the bottom, and detachable plate with knock out holes at the top of the board shall be provided.

Each distribution board shall be provided with a circuit list giving details of each circuit which it controls and the current rating of the circuit, and the size of the MCB.

The board shall be complete with the following accessories:-

(a) 200 A copper busbar(s).
(b) Neutral link.
(c) Common earth bar.
(d) DIN bar for mounting MCBs.
(e) Wago type terminal connectors suitable for incoming and outgoing cables.
(f) A set of indication lamps with HRC cartridge fuses for each phase of the incoming supply.
(g) Earthing stud(s).

The board shall be fully prewired with single core PVC insulated copper conductors/insulated solid copper links, and terminated on to extended type terminal connectors, suitable for connections to the sizes of the respective conductors.

All incoming and outgoing wiring to the prewired MCBDB's shall be terminated only in the Elemex type extended terminal connectors to be provided within the DB. The terminal connectors shall, therefore, be so provided as to facilitate easy cable connections and subsequent maintenance.

A common copper earth bar shall be provided within the loose wire box. The common neutral bar as well as the terminal connectors shall, however, be provided within the main compartment just below the loose wire box.

3.15 MINIATURE CIRCUIT BREAKERS (MCB's):

'C' series MCB's shall be invariably used for motor loads, halogen lamp fittings, sodium/mercury discharge lamps and all `power' circuits.

Ratings, number of poles, type as MCB or isolator, etc. shall be as specified in the BOQ. Refer Chapter-4 for MCBs.

3.16 Switch/socket board & distribution board locations

Switch/socket board and distribution boards shall be located as indicated on the drawings.

3.17 SWITCH/SOCKET BOARD INSTALLATION:

Where it is required to terminate a number of conduits on a board, it may be convenient to provide a suitable MS adopter box for the purpose. Such boxes shall be provided with the prior approval of the Architect/consultants/BHEL and this will not be paid for separately.

All wires to the switch boards shall be bushed at the entries to avoid damage to insulation.

No apparatus shall project beyond any edge of the panel.

All unused holes in the boards and in the mountings shall be plugged suitably to avoid entry of insects.

3.18 WIRING OF SWITCH/SOCKET BOARDS AND DISTRIBUTION BOARDS:

All connections between pieces of apparatus, or between apparatus and terminals on a board shall be neatly arranged in a definite sequence, following the arrangement of the apparatus mounted thereon, avoiding unnecessary crossings.

Cables shall be connected to terminals either by crimped or soldered lugs, unless the terminals are of such a form that they can be securely clamped without cutting away of cable strands.

All bare conductors shall be rigidly fixed in such a manner that a clearance of at least 2.5 cm is maintained between conductors of opposite polarity or phase, and between the conductors and any material other than insulating material.

The incoming and outgoing cables shall be neatly bunched and shall be fixed in such a way that the door shall be capable of swinging through an angle of not less than 90 degrees.

3.19 MARKING OF APPARATUS:

(i) Marking of earthed neutral conductor

On the switchgear, the earthed conductor of a two wire system, or an earthed neutral conductor of a multi-wire system, an indication of a permanent nature shall be provided to identify the earthed neutral conductor. In this connection Rule 32(1) of Indian Electricity Rules 1956 (see Appendix C) shall be referred to. The neutral conductor shall be black in colour.

(ii) Main earthing terminal

The main earthing terminal in the main distribution board shall be permanently marked as "SAFETY EARTH - DO NOT REMOVE".

Wherever a board is connected to a voltage higher than 250V, all the terminals or leads of the apparatus mounted on it shall be marked in the following colours to indicate the different poles or phases to which the apparatus or its different terminals may have been connected:

Three phases - Red, Blue & Yellow AND Neutral - Black

Where a four wire, three phase wiring is done, the neutral shall preferably be in one colour, and the other three wires in another colour.

All marking required under this rule shall be clear and permanent.

3.20 ATTACHMENT OF FITTINGS AND ACCESSORIES:

3.20.1 Conduit wiring system

All accessories like switches, socket outlets, call bell pushes and regulators shall be fixed in flush pattern inside the switch/regulator boxes. Accessories like ceiling roses, brackets, batten holders, etc. shall be fixed on metal outlet boxes. The fan regulators shall also be fixed in metal outlet boxes.

Cadmium plated brass screws shall be used to fix the accessories to their bases.

The switch box / regulator box shall be mounted with their bottom 1.25m from floor level, unless otherwise directed by the Architect/consultants/BHEL.

Dash fasteners shall be used for fixing to walls or ceiling.

3.21 FANS REGULATORS AND CLAMPS:

3.21.1 Exhaust fans:

Exhaust fans shall conform to relevant Indian Standards.

Exhaust fans shall be erected at the places indicated on the drawings. For fixing an exhaust fan, a circular hole shall be provided in the wall to suit the size of the frame, which shall be fixed by means of rag bolts embedded in the wall. The hole shall be neatly plastered to the original finish of the wall. The exhaust fan shall be connected to the exhaust fan point, which shall be wired as near to the hole as possible, by means of a flexible cord, care being taken to see that the blades rotate in the proper direction.

3.21.2 Regulators:

The metallic body of regulators of exhaust fans shall be connected to earth by protective conductor.

Chapter – 7

SUBHEAD - IV

P.V.C. CONDUIT WIRING SYSTEM

1 SCOPE:

This chapter covers the detailed requirements for wiring work in P.V.C. conduits.

2 MATERIALS

2.1 Conduits

All rigid conduit pipes shall be of P.V.C. and be ISI marked. The wall thickness shall be not less than 2.0 mm for conduits upto 32 mm dia. and not less than 2.5 mm for conduits above 32 mm dia.

The maximum number of PVC insulated cables conforming to IS:694-1990 that can be drawn in one conduit is given size wise in Table I, and the number of cables per conduit shall not be exceeded. Conduit sizes shall be selected accordingly in each run.

No P.V.C. conduit less than 20mm in diameter shall be used.

2.2 Conduit accessories

The conduit wiring system shall be complete in all respects, including their accessories.

All conduit accessories shall be of grip type.

Bends, couplers etc. shall be solid type.

All conduit accessories shall be fixed with the help of P.V.C. jointing compound.

2.3 Outlets

The switch box or regulator box shall be made of GI on all sides, except on the front. The wall thickness shall not be less than 1.2 mm (18 gauge) for boxes up to a size of 20 cm X 30 cm, and above this size 1.6 mm (16 gauge) thick GI boxes shall be used.

Where a large number of control switches and/or fan regulators are required to be installed at one place, these shall be installed in more than one outlet box adjacent to each other for ease of maintenance.

An earth terminal with stud and 2 metal washers shall be provided in each GI box for termination of protective conductors and for connection to socket outlet/metallic body of fan regulator etc.

Clear depth of the box shall not be less than 51 mm, and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.

3 INSTALLATION:

3.1 (i) Conduit joints.

The conduit work of each circuit or section shall be completed before the cables are drawn in.

Conduit pipes shall be joined by means of suitable P.V.C. jointing compound.

Cut ends of conduit pipes shall have no sharp edges, nor any burrs left to avoid damage to the insulation of the conductors while pulling them through such pipes.

The Architect/Consultants/BHEL, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc., after they have been prepared, shall be submitted for inspection before being fixed.

(ii) Bends in conduit

All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with a bending radius of not less than 7.5 cm, or alternatively, by inserting suitable solid type normal bends, elbows or similar fittings, or by fixing MS inspection boxes, whichever is most suitable for the particular situation.

No length of conduit shall have more than the one quarter bend from outlet to outlet.

(iii) Outlets

All outlets such as switches, wall sockets etc. shall be flush mounting type.

All switches socket outlets and fan regulators shall be fixed on sheet cover of the same manufacturer as that of the accessories.

3.2 Additional requirements

(i) Making chase

The chase in the wall shall be neatly made, and of ample dimensions to permit the conduit to be fixed in the desired manner.

The conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.

(ii) Fixing conduits in chase

The conduit pipe shall be fixed by means of stapples, J-hooks, or by means of saddles, not more than 60 cm apart.

(iii) Fixing conduits in RCC work

The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.

Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius which will permit easy drawing in of conductors.

Location of inspection / junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

(iv) Fixing inspection boxes

Suitable inspection boxes to the minimum requirement shall be provided to permit inspection, and to facilitate replacement of wires, if necessary.

These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS:2667-1977.

Suitable ventilating holes shall be provided in the inspection box covers.

(v) Fixing switch boxes and accessories

Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type.

(vi) Fish wire

To facilitate subsequent drawing of wires in the conduit, GI fish wire of 1.2 mm (18 SWG) shall be provided along with the laying of the recessed conduit.

(vii) Bunching of cables

Cables shall always be bunched so that the outgoing and return cables are drawn into the same conduit.

Where the distribution is for three phase loads only, conductors for all the three phases and neutral wire shall be drawn in one conduit.

3.3 Earthing requirements

The entire system of metallic conduit work, including the outlet boxes and other metallic accessories, shall be mechanically and electrically continuous by proper joints. The conduit shall be continuous when passing through walls or floors.

Protective (loop earthing) conductor(s) shall be laid along the runs of the conduit between the metallic switch boxes and the distribution boards/ switch boards, terminated thereto. These conductors shall be of such size and material as specified. Depending upon their size and material, the protective earth conductors shall be either drawn inside the conduits along with the cables, or shall be laid external to the conduits. When laid external to the conduits, this shall be properly clamped with the conduit at regular intervals.

The protective conductors shall be terminated properly using earth studs/ earth terminal block etc. as required.

Gas or water pipe shall not be used as protective conductor (earth medium).

TABLE I

Maximum number of PVC insulated 650/1100 V grade copper conductor cable conforming to IS:694-1990 which can be drawn through a conduit

Nominal cross-sectional area of conductor in sq. mm.	20 mm		25 mm		32 mm		38 mm		51 mm	
	S	B	S	B	S	B	S	B	S	B
1	2	3	4	5	6	7	8	9	10	11
1.50	5	4	8	7	16	10	-	-	-	-
2.50	4	3	7	5	10	8	-	-	-	-
4	3	2	6	5	9	7	-	-	-	-
6	2	-	5	4	8	6	-	-	-	-
10	2	-	3	2	5	4	7	6	-	-
16	-	-	2	2	3	3	6	5	10	7
25	-	-	-	-	3	2	5	3	8	6
35	-	-	-	-	-	-	3	2	6	5

Note :
The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.

The columns headed '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 by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
Conduit sizes are the nominal external diameters.

Chapter - 8

SUBHEAD - IV

METALLIC CONDUIT WIRING

1 SCOPE:

This chapter covers the detailed requirements for wiring work in metallic conduits.

1.1 MATERIALS

1.1.1 Conduits

All rigid conduit pipes shall be of steel and be ISI marked. The wall thickness shall be not less than 1.6 mm (16 SWG) for conduits upto 32 mm dia. and not less than 2 mm (14 SWG) for conduits above 32 mm dia. These shall be solid drawn or reamed by welding, and finished with stove enamelled surface.

The maximum number of PVC insulated cables conforming to IS:694-1990 that can be drawn in one conduit is given sizewise in Table I, and the number of cables per conduit shall not be exceeded. Conduit sizes shall be selected accordingly in each run.

No steel conduit less than 20mm in diameter shall be used.

1.1.2 Conduit accessories

The conduit wiring system shall be complete in all respects, including their accessories.

All conduit accessories shall be of threaded type, and under no circumstances pin grip type or clamp grip type accessories shall be used.

Bends, couplers etc. shall be solid type.

1.1.3 Outlets

The switch box or regulator box shall be made of sheet metal on all sides, except on the front. The wall thickness shall not be less than 1.2 mm (18 gauge) for boxes upto a size of 20 cm X 30 cm, and above this size 1.6 mm (16 gauge) thick MS boxes shall be used. The metallic boxes shall be duly painted with anticorrosive paint before erection as per chapter 10 of these Specifications.

Where a large number of control switches and/or fan regulators are required to be installed at one place, these shall be installed in more than one outlet box adjacent to each other for ease of maintenance.

An earth terminal with stud and 2 metal washers shall be provided in each MS box for termination of protective conductors and for connection to socket outlet/metallic body of fan regulator etc.

Clear depth of the box shall not be less than 60 mm, and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.

1.2 INSTALLATION:

(i) Conduit joints

The conduit work of each circuit or section shall be completed before the cables are drawn in.

Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. Threads on conduit pipes in all cases shall be between 13 mm to 19 mm long, sufficient to accommodate pipes to full threaded portion of couplers or accessories.

Cut ends of conduit pipes shall have no sharp edges, nor any burrs left to avoid damage to the insulation of the conductors while pulling them through such pipes.

The Architect/consultants/BHEL, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc., after they have been prepared, shall be submitted for inspection before being fixed.

No bare threaded portion of conduit pipe shall be allowed, unless such bare threaded portion is treated with anticorrosive preservative or covered with approved plastic compound.

(ii) Bends in conduit

All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with a bending radius of not less than 7.5 cm, or alternatively, by inserting suitable solid type normal bends, elbows or similar fittings, or by fixing MS inspection boxes, whichever is most suitable for the perticular situation.

No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

(iii) Outlets

All outlets such as switches, wall sockets etc. shall be flush mounting type.

All switches socket outlets and fan regulators shall be fixed on sheet cover of the same manufacturer as that of the accessories.

1.3 Additional requirements

(i) Making chase

The chase in the wall shall be neatly made, and of ample dimensions to permit the conduit to be fixed in the desired manner.

The conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.

Fixing conduits in chase

The conduit pipe shall be fixed by means of stapples, J-hooks, or by means of saddles, not more than 60 cm apart.

All threaded joints of conduit pipes shall be treated with approved preservative compound to secure protection against rust.

(iii) **Fixing conduits in RCC work**

The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.

Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius which will permit easy drawing in of conductors.

Location of inspection / junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

(iv) **Fixing inspection boxes**

Suitable inspection boxes to the minimum requirement shall be provided to permit inspection, and to facilitate replacement of wires, if necessary.

These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS:2667-1977.

Suitable ventilating holes shall be provided in the inspection box covers.

(v) **Fixing switch boxes and accessories**

Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type.

(vi) **Fish wire**

To facilitate subsequent drawing of wires in the conduit, GI fish wire of 1.2 mm (18 SWG) shall be provided alongwith the laying of the recessed conduit.

(vii) **Bunching of cables**

Cables shall always be bunched so that the outgoing and return cables are drawn into the same conduit.
Where the distribution is for three phase loads only, conductors for all the three phases and neutral wire shall be drawn in one conduit.

1.4 Earthing requirements

The entire system of metallic conduit work, including the outlet boxes and other metallic accessories, shall be mechanically and electrically continuous by proper screwed joints, or by double checknuts at terminations. The conduit shall be continuous when passing through walls or floors.

Protective (loop earthing) conductor(s) shall be laid along the runs of the conduit between the metallic switch boxes and the distribution boards/ switch boards, terminated thereto. These conductors shall be of such size and material as specified.

Depending upon their size and material, the protective earth conductors shall be either drawn inside the conduits alongwith the cables, or shall be laid external to the conduits. When laid external to the conduits, this shall be properly clamped with the conduit at regular intervals.

The protective conductors shall be terminated properly using earth studs/ earth terminal block etc. as required.

Gas or water pipe shall not be used as protective conductor (earth medium).

TABLE I

Maximum number of PVC insulated 650/1100 V grade copper conductor cable conforming to IS:694-1990 which can be drawn through a conduit

Nominal cross-sectional area of conductor in sq. mm.	20 mm		25 mm		32 mm		38 mm		51 mm		64 mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1	2	3	4	5	6	7	8	9	10	11	12	13
1.50	5	4	10	8	18	12	-	-	-	-	-	-
2.50	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6

Note:

The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.

The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.

Conduit sizes are the nominal external diameters.

Chapter – 9

SUBHEAD - IV

FLOOR TRUNKING

Under Floor Raceways

The under floor duct for “in screed” system shall be of “galvanized sheet” steel, galvanized to 275g/m^3 in compliance with the standards of EN 10327. The under floor duct shall be of box type construction with base rolled over the cover and spot welded to give required rigidity with a standard loading capacity of 750N according to VDE 0634 (before screed laying) and shall prevent the seepage of concrete and screed water. The standard length of the duct shall be of 2.5 mtrs. The duct must have two or three compartments to accommodate different types of cables (Power, Data & Telecommunication) the two and three compartment ducts are divided using fixed sheet steel dividers. Coupler shall be used to connect the standard lengths of the ducts in screed covered system. The end cap should lock in to the duct with out additional accessories to protect against dust or other foreign particles inside the duct. The riser bends should be easily mounted as well for quick entry of cables in the under floor system.

Under floor Junction and Service Outlet Boxes suitable for Carpet Application:-

Under floor Junction and service outlet boxes shall be robust in its construction with a base plate and side walls manufactured from 1.6mm thick galvanized sheet steel. Height of the under floor junction and service outlet boxes shall be adjustable from 65-100mm. Carpet protection frame of Junction and service outlets shall be manufactured from hard wearing, Halogen free material polyamide with matt surface. Lid shall have a 4mm thick galvanized sheet steel for ensuring maximum rigidity and providing adequate load bearing capacity. The junction and service outlet boxes shall be able to withstand a load of 1.5KN per sq inch as per DIN VDE 0634. Junction and service outlet boxes should have knock outs for duct entry in all the four sides for quick and easy installation. Junction and service outlet boxes shall be substantially dimensioned to eliminate congestion and to provide ample working space within. Junction boxes shall be supplied with cross over bridges for segregation of power, data and telecommunication cables. Lid shall have a 5mm carpet recess and shall be easily removable for installation / wiring of sockets and reversible to facilitate connection to floor box from either side.

Under floor Junction & Service Outlet Boxes for Tile Marble and wooden application

The Underfloor Junction and Service Outlet Boxes shall be robust in its construction with a base plate and side walls manufactured from galvanized steel and main leveling frames made of aluminium with die-cast zinc corners. Height of the Underfloor Service outlet and Junction Boxes shall be adjustable from 70 to 125mm inline with the height of the screed level for higher screed structures. The Junction and Service outlet boxes shall have suitable dimensions to eliminate congestion and to provide ample working space within the box. Junction Box shall be supplied with cross-over bridges for seperation of power, data & telecommunication cables. The sides of the Underfloor boxes shall be pre punched on all the four sides for duct.

The Frame cover for Tile, Marble and wooden application shall be manufactured from Stainless steel cassette with 15/20/25mm height options to support floor finishing stone of different heights. The Stainless steel frame cover shall also be fitted with a 4mm thick sheet steel plate for ensuring maximum rigidity and providing adequate load bearing capacity. The frame shall have a seal for Knock protection and to prevent ingress of dirt and water through the gap between the cassette and frame. The box should have a minimum load bearing capacity of 15KN.

Installation:

Underfloor trunking system shall be installed strictly as per manufacturer's instructions and to a level of workmanship to ensure that all the underfloor boxes are consistently in level with the screed and any part of the boxes is not detected below and or above the floor slab. Failure to comply in this respect, the affected boxes shall be re-installed by the successful bidder, as directed by Architect/Consultants/BHEL.
Cross-over bridges shall be installed at the junctions as required, to ensure that adequate seperation of power, data and telecommunication cables are maintained.
Equipotential earth bonding shall be carried out as per manufacturer's recommendations.

Quality Assurance and Compliance:

The successful bidder must demonstrate that the work in this section is carried out by experienced personnel. Any work not meeting the required standard will be removed at the discretion of BHEL. The mock installation shall have to be inspected and certified by the manufacturer as directed by Architect/Consultants/BHEL.

WALL MOUNTED TRUNKING

"Wall trunking with cover made of Lead free polyvinylchloride (ROHS complied) with a standard length of 2 metre, suitable for fixing switches and sockets. The trunking shall have all accessories like partition, Internal corner cover, External corner cover, T intersection cover, Flat Angle cover , cover clip, etc for cable management."

Chapter – 10

SUBHEAD – VI

TELEPHONE SYSTEM

EPABX system and the Handsets already installed in BHEL House shall continue to be used. The wiring from the exchange upto the telephone points shall be in the scope of the contractor. The designs for the same shall be subject to approval by BHEL.

Chapter – 11

SUBHEAD - VII

STRUCTURED CABLING FOR CATV SYSTEM

1 CATV SYSTEM

1.1 COAXIAL CABLES

The coaxial cables shall be of wideband type with operation upto 860 MHz capability, with PE dielectric and PVC jacket.

The cables shall meet or exceed the following specifications

	6 Foam Series	**11 Foam Series**
IS Standard IS:14131	5CA4	7CA4
Centre Copper Conductor Dia.	1.02 mm	1.63 mm
Dielectric Dia.	4.57 mm	7.11 mm
Dielectric Material	Cellular PE	Cellular PE
Outer Dia.	7.0 mm	10.03 mm
Bending Radius	>75 mm	>115 mm
Impedance	75 Ohms	75 Ohms
Return Loss	>23 dB	>23 dB
Attenuation at 20° C	Max dB/100 Mtr	Max dB/100 Mtr
5 MHz	1.9	1.25
45 MHz	5.25	3.5
300 MHz	11.65	7.38
450 MHz	14.45	9.02
550 MHz	16.1	9.97
860 MHz	20.1	12.52

1.3 4 WAY SPLITTER BOX

These shall be of ultra wide band width and of hybrid type

These shall have a flat frequency response over the entire operating range.

These shall have a aluminium cast housing for high frequency radiation resistance.

The splitters shall be available in 2 way, 3 way & 4 way Configurations.

The Splitters shall be meet or exceed the following specifications

Through Loss	7.5 dB
Isolation	> 20 dB
Screening Factor	> 75 dB

1.4 TV ROOM OUTLET

The Room Outlet shall have IEC Male Plug fixed for mating with IEC Female Plug of Connecting Lead.

The Room Outlet shall have either a screw clamp connection or 'F' Connector connections for connecting In-house Cable to Room Outlet.

The Room Outlet shall provide DC isolation for centre conductor between TV Set and Distribution network.

The room outlet shall meet or exceed the following specifications

	End of line type	**Through type**	**Splitter type**
Through Loss	---	1 dB	3.5 dB
Branch Loss	0.5 dB	12 dB	3.5 dB
Screening Factor	>50 dB	>50 dB	>50 dB
Impedance	75 Ohms	75 Ohms	75 Ohms

1.5 CONNECTING LEADS

The connecting leads shall use a standard Coaxial cable of 75 ohms Impedance.
(at least RG-6)
The connecting leads shall have a male plug at both ends.
The connectors used at both ends shall confirm to DIN 42325 and should be moulded on to the cable.
The length of the connecting lead shall be 1.5 m
The connecting lead shall have a screening factor of >50 dB.

The CATV points shall be provided for all ED cabins in the Televisions (provided by BHEL) and for all GM cabins in PCs (provided by BHEL). The Dish and set-top boxes shall be provided by BHEL. The successful Bidder has to do the cabling of the entire system. CATV points are not required in CMD, Directors and CVO Offices which have been equipped with DTH already.

Chapter – 12

SUBHEAD - VII

Network Cabling

The network cabling should be undertaken through OEM certified installer/s only.

All nodes should be certified for Cat-6 performance. Each node should be tested through Fluke Test machine and hard copy of the test report, for each node, should be submitted to BHEL. All Cat-6 parameters should be fully complied.

All network cable, connectors and component should be of one single make (Systimax/Simon/Panduit/Schneider) and minimum 20/25 years system / components warranty should be provided from the OEM.

Each rack should be supplied with following accessories

1. 45U vertical cable manager double sided, UL approved - 2Nos.
2. Strain relief bracket – 4 Nos.
3. Grounding and bonding for the rack should comply BICSI TDM Manual, 10th Edition and J-STD-607-A, TIA-942, IEEE std. 1100, UL and CSA. Can be used to ground equipment mounted in cabinets which meet EIA-310-D and installer should bond all cabinet members to the rack grounding strip.
4. Power strip with six sockets multipurpose with ON/OFF switch and indicator-2Nos.
5. Air sealing gourmet - 2Nos.
   The colour codes for cables, I/Os and patch cords shall be as approved BHEL.

Item	Description
Cat6 Patch Cable (1 Mtr, 2 Mtr)	Constructed of Category 6, 24 AWG UTP stranded cable and Modular Plugs; plug contacts plated with 50 microinches of gold for superior performance. Exceed ANSI/TIA-568-C.2 Category 6 and ISO 11801 Class E standards. Plug meets all applicable ANSI/TIA/EIA-968-A requirements and exceeds IEC 60603-7 specifications. Meet requirements of IEEE 802.3af and IEEE 802.3at for PoE applications.Each patch cord is 100% performance tested to component limits and wired T568B. Slender strain relief boot provides easy access in high density applications.Plug uses an integral pair manager to optimize performance and consistency by reducing untwisting of conductors within the plug.Perform in center of TIA/EIA component range, ensuring interoperability and excellent performance. Labels on patch cords provide identification of performance level, length, and quality control number. Patented tangle-free latch prevents snags and provides easy release, saving time on frequent moves, adds, and changes.Optional patch cord color bands snap on and off individual patch cables offering endless color-coding options.Optional

	RJ45 plug lock-in device blocks unauthorized removal of cable, IP phone, other networking equipment, or critical connection.Third party tested for Category 6 component compliance.RoHS Compliant.
Cat6 Information Outlet	Tool less termination Technology. Exceed requirements of ANSI/TIA-568-C.2 Category 6, IEEE 802.3an-2006, and ISO 11801 Class E channel standards. Exceed requirements of ANSI/TIA-568-C.2 Category 6 and IEC 61156-5 Category 6 component standards.Meet requirements of IEEE 802.3af and IEEE 802.3at for PoE applications. Each jack is 100% tested to ensure NEXT and RL performance and is individually serialized for traceability.Utilize enhanced technology for jack terminations which optimizes performance by maintaining cable pair geometry and eliminating conductor untwist. Contacts plated with 50 microinches of gold for superior performance.No punchdown tool required; termination tool ensures conductors are fully terminated by utilizing a smooth forward motion without impact on critical internal components for maximum reliability. Optional termination tool reduces termination time by 25%, ideal for high volume installations. Can be re-terminated a minimum of twenty times. White termination cap designates Category 6 performance and provides positive strain relief; helps control cable bend radius and securely retains wires. Terminate 4-pair, 22 – 26 AWG, 100 ohm, solid or stranded twisted pair cable.Universal termination cap is color-coded for T568A and T568B wiring schemes. Accept 6 and 8-position modular plugs without damage. Can be clearly identified with optional labels and icons. Compatible with Modular Patch Panels, Faceplates, and Surface Mount Boxes.Optional Dust cap keeps out dust and debris while not in use. Optional RJ45 Blockout device blocks out unauthorized access to jack modules and potentially harmful foreign objects, saving time and money associated with data security breaches, network downtime, repair and hardware replacement.RoHS Compliant. Be made of Module housing - ABS with Wire cap - Plastic and Strain relief clip - Plastic.
Dual Faceplate	Angled Faceplates shall be available in 2 port single gang for vertical applications and shall accept all modules for UTP, STP, fiber-optic, and audio/video applications.Faceplates shall be available in sloped design with labels. Sloped design shall increase wall depth to improve the bend radius control. Supplied with two 1" long, #6 – 32 slotted head screws. RoHS Complaint, Material - ABS.
Quad Faceplate	Angled Faceplates shall be available in 4 port single gang for vertical applications and shall accept all modules for UTP, STP, fiber-optic, and audio/video applications.Faceplates shall be available in sloped design with labels. Sloped design shall increase wall depth to improve the bend radius control. Supplied with two 1" long, #6 – 32 slotted head screws. RoHS Complaint, Material - ABS.

Cat6 Cable	High performance, Category 6, (CM), 4-pair, UTP copper cable. Copper conductors are 23 AWG construction with HDPE insulation. Roll of 1000 Feet/305m. Conductors are twisted in pairs, separated by an integrated pair divider, and protected by a flame-retardant PVC jacket.Exceeds all ANSI/TIA-568-C.2 Category 6 and ISO 11801 2nd Edition Class E channel requirements.Exceeds all ANSI/TIA-568-C.2 and IEC 61156-5 Category 6 component requirements.Meet requirements of IEEE 802.3af and IEEE 802.3at for PoE applications.Conductors are twisted in pairs with four pairs contained in a flame retardant PVC jacket separated by a divider.Third party tested to Category 6 component compliance.Maximum installation tension of 25 lbs (110 N). Installation temperature range: 32°F to 122°F (0°C to 50°C).Operating temperature range: 4°F to 120°F (-20°C to 60°C).Cable diameter: 0.225 in, (5.7mm) nominal. Frequency Channel characterized to 650 MHz, 400 MHz above the standard for better field performance. Easy payout, reel-in-a-box and descending length markings on cable speed installation. Supports the following applications: Ethernet 10BASE-T, 100BASE-T (Fast Ethernet), 1000BASE-T (Gigabit Ethernet) and 10GBASE-T; 1.2 Gb/s ATM; Token Ring 4/16. Should be RoHS Compliant
Angular Jack Panel -Unloaded	24-port angled patch panel with labels, supplied with six factory installed front removable snap-in faceplates.Mount to standard TIA/EIA 19" rack or 23" racks with optional extender bracket. Angled design allows cable to flow to each side of the rack and eliminates the need for horizontal cable managers by enabling patch cords to be routed directly into vertical cable managers. Allow labeling scheme and port identification to be visible at all times.Allow front access to installed modules for easy moves, adds and changes. Accept IO/ Modules for UTP (including Category 5e and Category 6), Fiber Optic and Coax, which snap in and out for easy moves, adds and changes. RoHS Complaint
Strain relief bracket	Strain relief bar extends 2" off the rack; supports, manages, and provides proper bend radius protection.Mount vertically or horizontally to standard TIA/EIA 19" racks. Hook & Loop Cable Ties can be used for additional cable management

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SUBHEAD - VIII

SANDWICH BUS BAR TRUNKING/RISING

1. SCOPE

This section covers the technical requirements of Design, manufacture, test at works, supply of 433V, LT Bus bar trunking.

2. STANDARDS

The equipment covered by this specification shall unless otherwise stated, be designed, constructed and tested in accordance with the latest revisions of relevant International standards 439 – 2 (2000).

IEC 529	:	Degree of Protection provided by enclosures
IEC 439-2 (Part–II)	:	Particular requirements for Bus trunking systems.
IEC 947 (Part-III)	:	Specification for Low voltage Switchgear and Control Gear.

3. GENERAL

Busbar trunking system shall be used for the Sub Distribution of Electrical energy.

Busbar trunking shall have provision for plugging of tap off boxes into the live busbar.

The supply of support materials like clamps, steel channels etc, shall also be included in the scope of the successful bidder and nothing extra shall be paid for the same.

Busbar trunking enclosure shall be dust and vermin proof and rectangular in cross section. It shall be rigid and robust in construction and shall be treated to prevent any possibility of corrosion. Joints in the enclosure shall be bolted and shall be provided with neoprene gasket, all retaining catches, screws, bolts and nuts etc.

Busbar trunking shall be manufactured in standard lengths of 3.0 Mtrs. The Bus Ducts being used for indoor use for power distribution shall be with arrangements for 2 to 3 tap off in 3 meter length as per requirement. The out-door bus trunking shall not have any openings at all except for ventilation.

4. BUSBAR SYSTEM

The bus-bar systems shall be produced and tested as “type-tested Switchgear combinations” (TSC), and shall be equipped with fully covered connectors having at least four poles for plug-in tap off boxes.

The bus bars shall be **Sandwich type** and made up of high conductivity Aluminium. The bus bars shall have a continuous current rating as mentioned in BOQ.

The busbar surface shall be tinned, with the contact. The individual conductors shall have a high quality, heat-resistant insulation rated for conductor

In their functional position, they shall be horizontally pluggable, on edge or flat, and in each position they shall be operable at continuous nominal current and at an ambient temperature of 40° C the type of protection shall be IP 42 which can be raised upto IP-55 with accessories.

The conductor should be in sequence of RYBN or NRYB. The cross section of neutral conductor should be same as phase conductor.

4.1 Feeding System

All busbar systems shall be equipped with a central, or end feeder cabinet with suitably rated MCCB.

Necessary extension chambers for easy terminations of incoming cable shall also be provided.

4.2 Expansion Joints

The bus bar systems shall be equipped with standard expansion joints or with expansion bolts in each unit length to compensate thermal elongation of the bus bars.

As far as local conditions permit, the longest busbar unit lengths shall be used to minimize electrical losses at the butt or bolted connections of the bus bars.

The busbar junction points shall be marked with plastic phenolic or aluminium labels.

4.3 Tap-Off Points

Tap off points shall be provided in-door bus ducts at every 1000mm intervals, to make connections to the live bus bars safely. These points shall be provided with safety shutters to prevent inadvertent touching of bus bars when no tap off box is fitted and to ensure that no foreign matter enters busbar chamber.

4.4 Accessories

All suspension fixings shall be fully tested and approved exclusively as suitable for the installation with particular regard to ambient temperature, environment and loading.

The bus system shall be assembled from standard approved components completed at the factory and suitable for the application. Fully certified fireproof bulkheads shall be incorporated within horizontal and vertical section direction changes and where the system penetrates fire rated sections of the building.

5. EARTHING

Bus bar trunking enclosure shall be earthed by a continuous copper earth bar, running on both the sides of the enclosure throughout the length of the Bus bar trunking.

Earth connection shall be brought to the end feed box from connection to the 4 core incoming cable.

6. TESTS

Bus bar trunking shall be completely assembled, adjusted and tested for operation under stimulated conditions to ensure proper functioning of all equipments.

6.1 TYPE TESTS

The Bidder shall furnish two sets of type test certificates for all the tests conducted on similar equipment.

1. Short time current test.
2. Temperature Rise Test

6.2 Drawings and Documents

The following drawings and documents shall be furnished in six (6) copies within one week of receipt of order.

a. General arrangement drawing of the bus bar trunking showing,
1. Overall Dimensions for Different rating.
2. Terminal locations.
3. Total weight / meter.
4. Sectional views.
5. Fixing details.
6. Sectional view of Tap Off Box.

b. Single Line Diagram.
c. Technical details for Fuse switches.
d. Manufacturing schedule and test schedule.
e. Calculation for busbar sizing.
f. O & M Manual.

7. TECHNICAL PARTICULARS

S. No.	Description	Details
(i)	Service	Indoor
(ii)	Normal System Voltage	415V
(iv)	Frequency	50 Hz
(v)	System Earthing	Earthed
(vi)	No of Phases	3ϕ 4 Wire
(vii).	Enclosure	
a.	Material	GI
b.	Thickness	1.5 (mm)
c.	Degree of Protection	IP 42 for indoor/ IP 55 for outdoor with canopy.
(viii).	BUS Insulator	
a.	Material	FRP/ PROPYLENE SLEEVING ON CONDUCTORS 'B' CLASS INSULATION MYLER TAPE, GLASS RE-ENFORCED POLYESTER AT JOINTS
	Earth Bus (Copper)	25 x 4 or 50 x 6 mm as specified.
	Reference Standard	IEC: 439-2 (Part-II)

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SUBHEAD - IX

EARTHING:-

1.1 SCOPE:

This chapter covers the essential requirements of earthing system components and their installation. For details not covered in these Specifications, IS Code of Practice on Earthing (IS: 3043-1987 ammended upto date) shall be referred to.

1.2 APPLICATION

The electrical distribution system in the campus is with earthed neutral. In addition to the neutral earthing, provision is made for earthing the metallic body of equipments and non-current carrying metallic components in the sub-station, as well as in the internal electrical installations.

Earthing requirements are laid down in Indian Electricity Rules, 1956, as amended from time to time, and in the Regulations of the Electricity Supply Authority concerned.

1.3 MATERIALS

1.3.1 EARTH ELECTRODES

Bury grounding conductor 30 inch below grade. The type of earth electrode shall be Chemical earth electrode.

1.4 LOCATION FOR EARTH ELECTRODES

Normally an earth electrode shall not be located closer than 1.5 m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building; in such cases, electrodes may be located further away from the building, with the prior approval of the Architect/consultants/BHEL.

The location of the earth electrode will be such that the soil has a reasonable chance of remaining moist as far as possible. Entrances, pavements and road ways, should be avoided for locating earth electrodes.

1.5 INSTALLATION

1.5.1 ELECTRODES

1.5.1.1 Various types of electrodes

Plate electrode shall be buried in ground with its faces vertical, and its top not less than 3 m below the ground level.

When more than one electrode (plate/pipe) is to be installed, a separation of not less than 2 m shall be maintained between two adjacent electrodes.

1.5.2 Artificial treatment of soil

The electrode shall be surrounded by Chemical compound as indicated in tender drawings

1.6 EARTHING CONDUCTOR (Main earthing lead)

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

The earthing conductor from the electrode up to the building shall be protected from mechanical injury by a medium class by 40 mm dia. medium class GI pipe in the case of strip. The protection pipe in 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 due co-ordination with the building work.

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

1.7 PROTECTIVE (Loop earthing/earth continuity) CONDUCTOR

Earth terminal of every switch board in the distribution system shall be bonded to the earth bar/terminal of the upstream switch board by protective conductor(s).

Two protective conductors shall be provided for a switch board carrying a 3-phase switchgear thereon.

The earth connector in every distribution board (DB) shall be securely connected to the earth stud/earth bar of the corresponding switch board by a protective conductor.

All metallic switch boxes and regulator boxes in a circuit shall be connected to the earth connector in the DB by protective conductor (also called circuit protective or loop earthing conductor), looping from one box to another upto the DB.

The earth pin of socket outlets as well as metallic body of fan regulators shall be connected to the earth stud in switch boxes by protective conductor. Twisted earth connections shall not be accepted in any case.

1.8 EARTH RESISTANCE

The earth resistance at each electrode shall be measured. No earth electrode shall have a greater ohmic resistance than 5 ohms as measured by an approved earth testing apparatus.

Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, such as additional electrode(s), different type of electrode, or artificial chemical treatment of soil etc., as may be directed by Architect/consultants/BHEL.

1.9 MARKING:

Earth bars/terminals at all switch boards shall be marked permanently, "E" or as;

Main earthing terminal shall be marked "SAFETY EARTH - DO NOT DISCONNECT".

TABLE VIII

MATERIALS AND SIZES OF EARTH ELECTRODES

Type of Electrode	Material	Size
Plate	Copper	60 cm x 60 cm x 3 mm thick.
Plate	GI	60 cm x 60 cm x 6 mm thick.

1. MAINTENANCE FREE EARTHING

1.1. GENERAL

(i) Self-contained ground electrode(s) using electrolytically enhanced grounding where specifically indicated on the drawings.

(ii) The electrode shall operate by hygroscopically extracting moisture from the atmosphere to activate the electrolytic process.

(iii) Electrode shall be 100% self-activating, sealed and maintenance free. No additions of chemical or water solutions required.

(iv) To achieve specific earth resistance, manufacturer be contacted for engineering and applications support.

1.2. TECHNICAL SPECIFICATIONS

1.2.1 **Types & Technical Specifications (Long Life Maintenance Free Earthing Solution)**

System Model / Type	Soil	Warranty (years)	Current Capacity	Electrode Details			TF Qty(Bags)	Test Well Cover
				Length **(feet)**	Outer Dia. **(inch)**	Thickness **(mm)**		
C-TEG-10S/ TRIPODE-Cu-50-3	NonRocky	30	1kA/9Sec	10	2	2	3	Polypl astic

(i) The specifications with performance warranty and technical spec details shown in the tables.

(ii) The ground rod shall be filled from the factory with non-hazardous metallic salts to form the electrolytic process and enhance the grounding performance.

(iii) Ground rod shall be a minimum of ten feet long. TerraDyne Model # TG-10S or TRIPODE –Cu-50-3 or equivalent may be used.

OR

Selection of models depends on the user choice.

(iv) A Solid Tinned AWG Cu ground cable shall be exothermically welded to the side of the rod for conductor connection OR 40x5mm OR 50x5mm OR 100x150x6mm used for conductor connection.

(v) If rocky or excavation condition are poor Model # TerraDyne® TG-10L or equivalent may be used with same Dia and Thickness. Only the difference in this model is L shaped with 36" vertical riser (shape) and rest in horizontal shape.

OR

(vi) The Crowfoot Bar earthing systems used for is one of the best alternate of Maintenance Free Earthing in the Rocky area.

(vii) A Solid Tinned AWG Cu ground cable/50x5mm copper plate shall be exothermically welded to the side of the rod for conductor connection

1.3. Protective Test Well

(i) Polyplastic well for non-traffic applications. Includes bolt down flush cover with "breather ports." TerraDyne® Model #910 or equivalent may be used.

–OR–

(ii) Fiberlyte well for traffic and industrial applications. Wheel loading 4.5 Tons. TerraDyne® Model #FL8-TB or equivalent may be used.

1.4. Environment Friendly Backfill Material

(i) Non-corrosive, electrically conductive and ground enhancing backfill. TerraFill® Model # TF-50 or equivalent will lower the contact resistance to earth by up to 63 % when used in conjunction with copper grounding equipment.

1.5. Excavation

(i) Bore a hole into the earth (minimum diameter 6"). Hole should be bored to allow installed unit to be as close to vertical as possible

(ii) A 14" hole must be provided for the cover box.

(iii) Depth of hole must be 6" deeper than the vertical length of the system.

(iv) Top vent ports must be left open to the atmosphere for continuous air circulation by using the protective test well provided.

(v) Plate Type Earthing (Cu/GI), Crow Foot Earthing and Cu Claded rod earthing, the mixing procedure of Backfill will be same as like in the electrolytic Earthing.

1.6. Installation

(i) Remove sealing tapes from the bottom of unit only. Tapes must be saved and made available to the electrical inspector to verify removal and proper installation. Do NOT remove the green and white “Bury to Here” marker from the top of the unit.

(ii) Position the unit in the hole. Use green and white “Bury to Here” marker as a guide to depth in which unit shall be buried. Three bags of backfill material are included with each 10' electrode.

(iii) Pour backfill material around electrode in augured hole. Do not mound backfill past green and white marker.

(iv) Place box with cover over the top of the electrode so that the cover is at grade level. Use backfill to stabilize box around the electrode. This keeps the breather holes free of obstruction and debris. Top of box should not contact the top of the electrode.

(v) Remove top sealing tape ONLY after backfill is complete. This prevents soil from blocking the vent ports.

Above installation must be taken place in presence of UL listed company.

1.7. Connection

Connect grounding conductor to ground rod pigtail exothermally.

It shall be carried out as per C.P.W.D GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS (PART-I INTERNAL) - 2007 with all upto date amendments.

Chapter – 15

SUBHEAD - X

ADVANCED LIGHTNING PROTECTION SYSTEM

1.1 SCOPE

Supply and installation of Early Piezo Electric Transducer based Early Streamer Emission Technology (ESE) based Lightning arrester consists essentially of the following:

1.2 AIR TEMINAL

Air Terminal shall be a advance technology based dynamic device which Capture the lightning downward leader falling under protection radius i.e. upto 70 meters by ending up streamer and convey the lightning discharge through connected down conductor to the ground. It becomes preferred point for lightning strike within protection radius of 79 Meters.

1.3 TRANSDUCER (piezoelectric stimulator):

Transducer shall be in the lower part of the head and consisting of piezoelectric ceramics stressed in an insulating container combined with a simpler and completely reliable loading system (CEA and Franklin patents). A high-voltage cable running along with interior of the pole connects the simulator to the emitter point.

1.4 DOWN CONDUCTOR

Down Conductor shall be a conductor, which conducts lightning discharge captured by Air Terminal to the ground.

1.5 EARTHING SYSTEM

The earthing shall be as per IS3043.

1.6 EARTH CONDUCTIVITY IMPROVER

Earth Conductivity improver shall be non-leaching soil treatment, which can dramatically improve earth resistance and impedance. A maximum resistance level of 10 Ohms is permitted for a lightning protection earth. It is highly recommended that the lowest possible earth impedance be obtained. A level of 1 ohm is desirable.

1.7 EARTH BONDING SYSTEM

Earth bonding shall be installed between lightning earth & communication earth.

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SUBHEAD - XI

EXTERNAL LIGHTING

1. **FEEDER PILLAR**

1.1 LT distribution feeder pillar shall be 1.1 KV weather proof, dust and vermin proof suitable for outdoor use. They should have access for sufficient ventilation & heat dissipation. The details of the mounting and there connections shall be as listed against item given in BOQ. Feeder pillar shall conform to mechanical specifications given herein after.

1.2 Feeder pillar shall be weather proof, dust and vermin proof suitable for outdoor use and free standing. The feeder pillar boxes shall be mounted on concrete foundation. The concrete foundation shall be in PCC 1:2:4, 450 mm deep and 150 mm above the ground and 150 mm projection all round.

1.3 The feeder pillar shall be fabricated out of 3 mm thick CRCA sheet steel duly stove enamel painted both sides open able with locking arrangement. A gland plate (removable) shall be provided at the bottom of feeder pillar for mounting of cable glands. Suitable lifting hook shall be provided at the top. The successful bidder shall get the fabrication drawing approved from the Architect/Consultants/BHEL before actually getting it fabricated.

1.4 All distribution feeder pillar shall be provided with electrolytic aluminium bus bar of current carrying capacity as specified in BOQ. The current density of aluminium bus bar shall not exceed 100 Amps per Sq.cm. of the cross sectional area of the bus bar. Bakelite phase separator/ DMC-SMC bus bar supports shall be provided.

1.5 For connections and interconnections solid links shall be used for tapping above 63 Amps and with thimbles wires below 63 Amps. Rating of the solid links and wires shall be that of the capacity of the feeder (incoming/ outgoing).

1.6 Only Neoprene gasket shall be used at all joints for doors/ covers etc.

1.7 The earth bus bar should be located at the top of the panel as shown on drawing. It shall be of aluminum strip of 40 mm x 6 mm size.

1.8 A switch, a batten holder and a lamp shall be provided in feeder pillar so as to switch ON and OFF the lamp. The batten holder should be suitably fixed.

1.9 A danger plate shall be fixed on feeder pillar.

1.10 The feeder pillar should be complete with all necessary interconnections, small wiring suitable labels made out of white plastic with black inscriptions.

2. STREET LIGHT POLE

2.1 The street light poles shall be fabricated out of 80 mm dia MS pipe 4 mm thick and 3 meter long. Each pole shall be provided with MS base plate 300 mm x 300 mm x 6 mm thick welded at the bottom. The pole shall be fixed on ground with concrete foundation in PCC 1:2:4 over 75 mm thick CC 1:3:6 as shown on the drawing.

2.2 410 SP 22 of overall length 7.0 mtrs. On the top of the pole an additional overhang of 1.20 m length shall be provided for fixing street light luminair.

2.3 On each pole one junction box of size 250 x 200 x 75 mm weather proof made out of 2 mm thick MS sheet with hinged cover and rubber gasket shall be provided. In this weather proof box one 6 Amps SP MCB and earthing stud and 4 way 30 amp terminal block shall be provided.

2.4 Two number 32 mm dia. G.I. pipes each of 1.0 m length for incoming and outgoing cable protection with cable glands shall be provided at the base of the pole.

2.5 Two number single core 2.5 sq.mm PVC insulated stranded copper conductor weather proof cable of 1100 volt grade, ISI marked shall be provided from junction box to the street light luminair/ fixture on the pole. On the pole at junction box location a holes shall be drilled for entry of electric wire for street light fixture.

2.6 Steel pole and junction box shall be painted with two coats of aluminium paint over one coat of steel primer.

2.7 The rate quoted against item for Poles shall be deemed to include all items as described in the BOQ and specified above.

Chapter - 17

SUBHEAD - XII

AEROSOL BASED FIRE SUPPRESSION SYSTEM

1 Materials

The Suppression system shall be Condensed Aerosol Potassium Based. The Condensed Aerosol should be confirming to NFPA 2010 standards. The Condensed Aerosol shall be certified by UL. The system should be non-toxic. It should be non corrosive.

During operation of the system the decomposed products should not be acidic in nature (and should not contain hydrogen fluoride, hydrogen bromide, hydrogen chloride or other acids)

It should not contain (e.g. nitro guanidine or nitrocellulose). System should be certified for zero ozone depletion & Zero Global warming by reputed lab. Fire suppression container should be non-pressurized. Fire suppression container should be made of Stainless Steel so that it is corrosion resistant. Fire extinguishing system must electrically operate with a suitable power Source, and be activated through fire alarm panel.

System should suitable for all Classes of Fire like A, B and C.

2 The Fire extinguishing system should have following features:

At the bottom of the system there shall be an End Plate discharge outlet and sealing for the even distribution of the extinguishing agent.

The design of the system must cover total flooding of the area volume as specified and calculated and not object protection.

3 Environmental conditions

The Fire Suppression system will be fitted where the environmental condition will be :
a) Temperature of use: - 50°C to +54°C

b) Global warming potential - 0

c) Ozone depletion potential - 0

d) Humidity: Up to 98 % during rainy season.

4 Electrical Actuator Characteristics

Resistance: 1.4 – 2.0 Ohms

Minimum Parallel Circuit Firing Current: 0.5A each, for 0.050 Seconds.

Minimum Series Circuit Firing Current: 1.0A for 0.050 Seconds.

Specified Maximum Test Current: ≤ 0.025A.

Specified Maximum Supervisory Current: ≤0.005A.

5 WIRING OPTIONS

When wired in series, we recommend a minimum of 1.0 ampere; however the rise time for this firing current must be kept below 0.0005 second in order to assure that all the items function before the first item to function opens the electrical circuit.

When wired in parallel or individually, we require a minimum of 0.5 ampere.

We also recommend that the function current be kept below approximately 20 amperes.

The voltage that would be required depends on the wiring used in the complete circuit.

Since the resistance of our item, with only the wires that are part of it, is about 2 ohms, the rest of the wiring in the circuit and any internal impedance of the supply must be added together to determine the required voltage. Remember that the item functions solely on the current that actually passes through it.

As an example (Parallel Wiring): 6 items are to be connected to a control panel in parallel. Therefore, the recommended minimum current that the control panel must supply is 3 amperes (6 x 0.5 ampere). The wiring for each of 5 of these circuits is, including the resistance of the device, 7 ohms, but the 6th device has a total resistance, because of longer wiring, of 13 ohms. Therefore, the voltage required would be that to function the highest resistance item of 13 total ohms of 13 ohms x 0.5 amperes = 6.5 volts.

Chapter-18

TESTING OF INTERNAL ELECTRICAL INSTALLATIONS:-

1.0 SCOPE

This chapter describes the details of tests to be conducted on complete internal electrical installations, before commissioning.

1.1 GENERAL

1.1.1 Tests

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

1. Insulation resistance test.

2. Polarity test of switch.

3. Earth continuity test.

4. Earth electrode resistance test.

1.2 Witnessing of tests

Testing shall be carried out for the completed installations, in the presence of and to the satisfaction of the Architect/consultants/BHEL by the successful bidder.

All test results shall be recorded & submitted to the Architect/consultants/BHEL.

1.3 Test instruments

All necessary test instruments for the tests shall be arranged by the successful bidder.

1.4 INSULATION RESISTANCE

1.4.1 The insulation resistance shall be measured by applying voltage between earth and the whole system of conductors, or any section thereof with all MCB.s in place, and all switches closed, all lamps in position, or both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure, provided it need not exceed 500 volts. Where the supply is derived from a poly phase A.C. system, the neutral pole of which is connected to earth either directly or through added resistance, the working pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.

1.4.2 The insulation resistance shall also be measured between all the conductors connected to one pole, or phase conductor of the supply, and all the conductors connected to the neutral, or to the other pole, or phase conductors of the supply with all the lamps in position and switches in "off" position.

1.4.3 The insulation resistance in megaohms measured as above shall not be less than 12.5 megaohms.

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

1.5 POLARITY TEST OF SWITCH

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

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

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

1.6 TESTING OF EARTH CONTINUITY PATH

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

1.7 MEASUREMENT OF EARTH ELECTRODE RESISTANCE

1.7.1 Two auxiliary earth electrodes, besides the test electrode, shall be placed at suitable distance from the test electrode (see figure). A measured current (I) is passed between the electrode 'A' to be tested and an auxiliary current electrode 'C', and the potential difference between the electrode 'A' and auxiliary potential 'B' is measured (V). The resistance of the test electrode 'A' is then given by:

$R=V/I$

1.7.2 Stray currents flowing in the soil may produce serious errors in the measurement of earth resistance. To eliminate this, hand driven generator shall be used.

If the frequency of the supply of hand driven generator coincides with the frequency of stray current, there will be wandering of instrument pointer. An increase or decrease of generator speed will cause this to disappear.

1.7.3 At the time of test, the test electrode shall be separated from the earthing system.

1.7.4 The auxiliary electrodes shall be of 13 mm diameter mild steel rod driven upto 1 m into the ground.

1.7.5 All the three electrodes shall be so placed that they are independent of the resistance area of each other. If the test electrode is in the form of a rod, pipe or plate, the auxiliary current electrode 'C' shall be placed at least 30 m away from it, and the auxiliary potential electrode 'B' shall be placed mid-way between them.

1.7.6 Unless three consecutive readings of test electrode resistance agree, the test shall be repeated by increasing the distance between electrodes A and C upto 50 m, and each time placing the electrode B midway between them.

1.8. TEST CERTIFICATE

On completion of an electrical installation, a certificate shall be furnished by the successful bidder to Architect/Consultants/BHEL for approval. Test certificate by the local Electric Supply Authorities shall also required to be submitted.

APPENDIX - I

TERMINOLOGY

This appendix indicates some of the commonly used and important terms, relevant for the Internal EI works.

1. **Exposed conductive part** - A conductive part of electrical equivalent, which can be touched and which is not normally live, but which may become the earth potential.

2. **Direct contact** - Contact of persons or livestock with live parts which may result in electrical shock.

3. **Indirect Contact** - Contact of persons or livestock with exposed conductive parts made live by a fault and which may result in electric shock.

4. **Live Part** - A conductor or conductive part intended to be energized in normal use, including a neutral conductor but, by convention, not a PEN conductor.

5. **Touch Voltage** - The potential difference between a grounded metallic structure and a point on the earth surface separated by a distance equal to the normal maximum horizontal reach of approximately 1 meter.

6. **Danger** - Danger to health or danger to life or limb from shock, burn or injury from mechanical movement to persons (and livestock where present), or from fire attendant upon the use of electrical energy.

7. **Earth** - The conductive mass of the earth, whose electric potential at any point is conventionally taken as zero.

8. **Earth electrode** - A conductor or group of conductors in intimate contact with and providing an electrical connection to earth.

9. **Earth fault loop impedance**- The impedance of the earth fault current loop (phase to earth loop), starting and ending at the point of earth fault.

10. **Earth leakage current** - A current which flows to earth, or to extraneous conductive parts, in a circuit which is electrically sound.

11. **Earth conductor** - A protective conductor connecting the main earth terminal to an earth electrode.

12. **Residual current** - The algebraic sum of the instantaneous values of current flowing through all the live conductors of a circuit at a point of the electrical installation.

13. **Residual current device (RCD)** - A mechanical switching device, intended to cause the opening of the contacts when the residual current attains a given value under the specified conditions.

14. **Switchboard**- An assembly of switchgear with or without instruments, but the term does not apply to a group of local switches in a final circuit.

15. **Switchgear** - An assembly of main and auxiliary switching apparatus for operation, regulation, protection or other control of electrical installations.

APPENDIX-II

SAFETY PROCEDURE

1. The Indian Electricity Rules 1956, as amended upto date, are to be followed in their entirety. Any installation or portion of installation which does not comply with these rules should be got rectified immediately.

2. The detailed instructions on safety procedures given in B.I.S. Code No. 5216-1969- "Code of Safety Procedures and Practices in Electrical Works" shall be strictly followed.

3. No inflammable materials shall be stored in places other than the rooms specially constructed for this purpose in accordance with the provisions of Indian Explosives Act. If such storage is unavoidable, it should be allowed only for a short period and in addition, special precautions, such as cutting off the supply to such places at normal times, storing materials away from wiring and switch boards, giving electric supply for a temporary period with the permission of Architect/consultants/BHEL shall be taken.

4. The electrical switchgears and distribution boards should be clearly marked to indicate the areas being controlled by them.

5. Before energizing on an installation after the work is completed, it should be ensured that all tools have been removed and accounted, no person is present inside any enclosure of the switch board etc. any earthing connection made for doing the work has been removed.

LIST OF APPROVED MAKES OF MATERIALS
FOR ELELCTRICAL WORK FOR BHEL OFFICE, NEW DLEHI

S. No.	Description	Makes
1.	Air Circuit Breaker (ACB)	1. L&T 2. ABB 3. Siemens 4. Schneider 5. GE
2.	Moulded Case Circuit Breaker (MCCB)	1. L&T 2. ABB 3. Siemens 4. Legrand 5. Schneider 6. GE
3.	Pre-wire MCB Distribution Board	1. L&T 2. ABB 3. Siemens 4. Legrand 5. Schneider 6. GE
4.	MCB, RCCB	1. Legrand 2. Seimens 3. Haiger 4. ABB 5. Schneider 6. GE 7. Merlin Gerin
5.	FUSE SWITCH DISCONNECTOR	1. Larsen & Toubro 2. Siemens
6.	Copper Conductor PVC Insulated Wires (660 V grade)	1. Finolex 2. National 3. Delton 4. Polycab
7.	M.S. / PVC Conduit	1. B.E.C. 2. AKG

S. No.	Description	Makes
8.	5/15/20 amps switch and socket	1. Legrand 2. ABB 3. NorthWest. 4. Clipsal (Opale) 5. MK 6. Anchor (Woods)
9.	Lugs	1. Dowell's 2. Asian
10.	E.L.C.B.	1. Legrand. 2. Siemens 3. Haiger 4. ABB 5. Schneider 6. GE
11.	Luminaires	1. Philips 2. Wipro 3. Crompton Greaves 4. Trilux
12.	XLPE Aluminium Conductor Armoured cables upto 1100 V Grade	BHEL Power sector approved
13.	Copper Conductor Telephone Wires	1. Finolex 2. National 3. Delton 4. Polycab
14.	Copper Conductor Co-axial T.V. Cable	1. Commscope. 2. Systimax
15.	Sandwich type bus ducts/ Rising Mains/ Bus Ducts	1. GE 2. Schneider 3. ABB 4. L&T
16.	Industrial Sockets & Plugs	1. Siemens 2. Schneider 3. Crompton 4. Legrand 5. GE
17.	Telephone Tag Blocks	1. Krone 2. Panduit 3. Systimax

S. No.	Description	Makes
18.	Aerosol Fire Suppression System	1. Statx 2. Pyrogin
19.	Exhaust Fan	1. Crompton Greaves 2. Alstom 3. Usha 4. Khaitan
20.	Floor/Wall Race Ways System	1. MK 2. Legrand 3. Schneider
21.	CT/PT	1. Siemens 2. AE 3. Indotech 4. HPL
22.	MFM/ Ammeter/ Voltmeter/ Phase indicator	1. Siemens 2. AE 3. Indotech 4. HPL
23.	Capacitors	1. Siemens 2. EPCOS
24.	Cable jointing kit	1. Raychem
25.	LED Luminaires	1. Philips 2. Instapower 3. Goldwyn 4. Trilux
26	HT Cables	BHEL Power sector approved.
27.	Occupancy Sensor	1.Schneider 2.MK 3.Wipro
28.	Panels & Distribution Boards	BHEL Power sector approved.
29.	Pre-wired MCB Distribution Boards	1. Siemens 2. Schneider 3. L&T 4. Legrand 5. GE

NOTES: The Successful bidder shall get the samples of all the items not covered in this list, approved from the Architect/Consultant/BHEL before commencing the supply.

APPENDIX - VI

LIST OF INDIAN STANDARDS (IS)

IS : 374 - 1979	Ceiling fans and regulators (3rd revision)
IS : 694 - 1990	PVC insulated Electric cable for working voltage upto and including 1100 volts.
IS : 732 - 1989	Code of practice for electrical wiring and installation
IS : 1255 - 1983	Code of Practice for installation and maintenance of Power Cables upto and including 33 KV rating (Second Revision)
IS : 1258 - 1987	Bayonet lamp holders(Third revision)
IS : 1293 - 1988	Three pin plugs and sockets outlets rated voltage upto and including 250 volts and rated current upto and including 160 amps.
IS : 1554 - 1988 (Part - I)	PVC insulated (Heavy Duty) electric cables for working voltages upto and including 1100 volts.
IS : 1646 - 1982	Electrical installation fire safety of buildings (general) Code of practice.
IS : 1651 & 1652 - 1991	Stationary cell and batteries, lead acid type
IS : 1885 - 1971	Glossary of items for electrical cables and conductors
IS : 1913 – 1978	General and safety requirements for fluorescent lamps luminaries Tubular.
IS : 2026 – 1977 to 81 (Part-I to IV)	Power Transformer
IS : 2071 - 1974 - 76	Methods of high voltage testing
IS : 2309 - 1989	Protection of building and allied structures against lightning
IS : 2551-1982	Danger notice plate.
IS : 3043 - 1987	Code of practice for earthing.
IS : 3480 - 1966	Flexible steel conduits for electrical wiring.
IS : 3837 - 1976	Accessories for rigid steel conduit for electrical wiring.
IS : 4146 - 1983	Application guide for voltage transformers
IS : 4615 - 1968	Switch socket outlets.
IS : 5133 - 1969 (Part -I)	Boxes for the enclosure of electrical accessories.

IS : 5216 - 1982 (Part-I)	Guide for safety procedures and practices in electrical work.
IS : 5424 - 1969	Rubber mats for electrical purposes.
IS : 5578 & 11353-1985	Marking and arrangement of bus bars
IS : 7098 - 1985 (Part - II)	Cross linked polyethylene insulated PVC sheathed cables. For working voltages from 3.3 KV upto and including 33 KV
IS : 8130 - 1984	Conductors for insulated electric cables and flexible cords
IS : 8623 -1977 (Part -I)	Factory built assemblies of switchgear and control gear for voltages upto and including 1000 V AC and 1200 V D C.
IS : 8623 - 1980 (Part -II)	Bus Bar trunking system
IS : 8828 - 1996	Miniature Circuit Breakers
IS : 9537 - 1981	Rigid Steel Conduits for electrical wiring (Second Revisions)
IS : 10810 - 1988	Methods of test for cables.
IS : 11171 – 1985	Specifications for dry type transformers
IS : 12640 - 1988	Earth Leakage Circuit Breakers
IS : 13947-1989	Moulded Case Circuit Breakers
IS : 13947 - 1993	Degree of protection provided by enclosures for LV switchgear and control gear.
IS : 13947 - 1993	General requirement for switchgear and control gear for voltage not exceeding 1000 Volts.
IS : 1651 & 1652 1991	Stationary cells and batteries lead acid type.

APPENDIX – VII

ABBREVIATIONS

The following abbreviations have been used in the accompanying Specifications, drawings and BOQ.

CU	stands for copper.
GI	stands for Galvanized Iron (Mild Steel)
V	stands for Volts
MV	stands for Medium Voltage (110 V ,230 V ,415 V, 600 V)
LV	stands for Low Voltage (32 V & Below)
LT	stands for Low Tension
PVC	stands for Polyvinyl Chloride
AMP	stands for Amperes
KWH	stands for Kilowatt Hours
KW	stands for Kilo Watts
BIS	stands for Bureau of Indian Standards
IS	stands for Indian Standards
IEE	stands for Institution of Electrical Engineers - London
NEC	stands for National Electrical Code
VCB	stands for Vacuum Circuit Breaker
ACB	stands for Air Circuit Breaker
RCCB	stands for Earth Leakage Circuit Breaker
MCB	stands for Miniature Circuit Breaker
MCCB	stands for Moulded Case Circuit Breaker
SP	stands for Single Pole
DP	stands for Double Pole
TP	stands for Triple Pole
TPN	stands for Triple Pole and Neutral
4 Pole	stands for 3 phase and neutral of same capacity (size)
MDB	stands for Main Distribution Board
SDB	stands for Sub Distribution Board
FDB	stands for Final Distribution Board

PART-4 TECHNICAL SPECIFICATIONS
SECTION-3 PLUMBING WORK

1. SCOPE OF WORK

The successful bidder shall furnish all labour, materials and equipment (except those to be supplied by BHEL) as listed under BOQ and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of the complete Plumbing / Sanitary System as described in the Specifications and as shown on the drawings. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract. The Plumbing / Sanitary System shall comprise of following:

a. Sanitary Fixtures and Fittings.
b. Internal Water Supply.
c. External Water Supply
d. Internal Drainage (Soil, Waste & Vent)
e. External Sewerage and Drainage
f. Pumps & Equipment, Solar Panel and Mechanical Equipments.
g. Other Miscellaneous Items.

2. DRAWINGS

The Plumbing / Sanitary System Drawings listed under **Appendix-I**, which may be issued with tenders, are diagrammatic only and indicate arrangement of various systems and the extent of work covered in the contract. These Drawings indicate the points of supply and of termination of services and broadly suggest the routes to be followed. Under no circumstances shall dimensions be scaled from these Drawings. The architectural/interiors drawings and details shall be examined for exact location of equipment and water supply / drainage piping etc.

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

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

The successful bidder shall examine all architectural, structural, plumbing, and electrical and other services drawings and check the as-built works before starting the work, report to the BHEL any discrepancies and obtain clarification. Any changes found essential to coordinate installation of his work with other services and systems, shall be made with prior approval of the Architect/Consultant/BHEL without additional cost to the BHEL.

3.0 SHOP DRAWINGS

3.1 All the shop drawings shall be prepared on computer through AutoCAD System based on Architectural Drawings, site measurements and Interior Designer's Drawings. Within one month of the award of the contract, successful bidder shall furnish, for the approval of the Architect/Consultant/ BHEL, two sets of detailed shop drawings of all equipment and materials including layouts for Pump room, Typical toilets drawings showing exact location of supports, flanges, bends, tee connections, reducers, detailed piping drawings showing exact location and type of supports, valves, fittings etc; external insulation details for pipe insulation etc; electrical panels inside/outside views, power and control wiring schematics, cable trays, supports and terminations. These shop drawings shall contain all information required to complete the Project as per specifications and as required by the Architect/Consultant/BHEL. These Drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all items of equipment, also the details of all related items of work by other bidders. Each shop drawing shall contain tabulation of all measurable items of equipment/materials/works and progressive cumulative totals from other related drawings to arrive at a variation-in-quantity statement at the completion of all shop drawings. Minimum 6 sets of drawings shall be submitted after final approval along with CD.

Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer strictly from the manufacturers listed in Appendix-III.

When the Architect/Consultant/BHEL makes any amendments in the above drawings, the successful bidder shall supply two fresh sets of drawings with the amendments duly incorporated along with check prints, for approval. The successful bidder shall submit further five sets of shop drawings to the BHEL for the exclusive use by the BHEL. No material or equipment may be delivered or installed at the job site until the successful bidder has in his possession, the approved shop drawing for the particular material/equipment/installation.

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

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

3.4 Samples of all materials like valves, pipes, insulation, control wires etc shall be submitted to the BHEL prior to procurement. These will be submitted in two sets for approval and retention by BHEL and shall be kept in their site office for reference and

verification till the completion of the Project. Wherever directed a mockup or sample installation shall be carried out for approval before proceeding for further installation.

3.5 Plumbing / Sanitary System successful bidder shall prepare coordinated services shop drawings based on the drawings prepared by Electrical, HVAC & Low Voltage bidders to ensure adequate clearances are available for installation of services for each system.

4.0 MATERIALS AND EQUIPMENT

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

5.0 ELECTRICAL INSTALLATION

The electrical work related to Plumbing / Sanitary System services, shall be carried out in full knowledge of, and with the complete coordination of the successful bidder. The electrical installation shall be in total conformity with the control wiring drawings prepared by the successful bidder and approved by the Architect/Consultant/BHEL. All equipment shall be connected and tested in the presence of an authorized representative of the successful bidder.

The Plumbing / Sanitary System shall be commissioned only after the successful bidder has certified in writing that the electrical installation work for Plumbing / Sanitary System services has been thoroughly checked, tested and found to be totally satisfactory and in full conformity with the contract Drawings, Specifications and manufacturers instructions. It is to be clearly understood that the final responsibility for the sufficiency, adequacy and conformity to the contract requirements, of the electrical installation work for Plumbing / Sanitary System services, lies solely with the successful bidder**.**

6.0 BALANCING, TESTING AND COMMISSIONING

Balancing of all water systems and all tests as called for the Specifications shall be carried out by the successful bidder through a specialist group, in accordance with the Specifications and ASPE / ASHRAE Guide lines and Standards. Performance test shall consist of three days of 10 hour each operation of system for each season.
The installation shall be tested again after removal of defects and shall be commissioned only after approval by the BHEL. All tests shall be carried out in the presence of the representatives of the Architect/Consultant and BHEL.

7.0 OPERATING INSTRUCTION & MAINTENANCE MANUAL

Upon completion and commissioning of part Plumbing / Sanitary System the successful bidder shall submit a draft copy of comprehensive operating instructions, maintenance schedule and log sheets for all systems and equipment included in this contract. This shall be supplementary to manufacturer's operating and maintenance manuals. Upon approval of the draft, the successful bidder shall submit four (4) complete bound sets of typewritten operating instructions and maintenance manuals;

one each for retention by Consultant and BHEL and two for BHEL Operating Personnel. These manuals shall also include basis of design, detailed technical data for each piece of equipment as installed, spare parts manual and recommended spares for 4 year period of maintenance of each equipment.

A P P E N D I X – III

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS

PLUMBING

S. No.	Details of Materials / Equipment		Manufacturer's Name
1	Sanitary ware such as EWS, Wash basin, Urinal, Urinal partitions, toilet paper roll holder		1. Hindustan Sanitaryware 2. Parryware 3. CERA (lowest price) 4. Kohler 5. Jaquar 6. American Standard
2	W.C. seat cover		1. Hindustan Sanitaryware 2. Parryware 3. CERA (lowest price) 4. Kohler 5. Jaquar 6. American Standard
3	C.P. brass flush valve for WC and Urinals		1. Jaquar 2. Ess Ess 3.Aquaplus 4. Kohler 5. Grohe
4	C.P. brass fittings such as pillar cocks, stop cocks angular stop cocks, C.P. flexible pipes, C.P. brass waste, C.P. brass cast bottle trap, C.P. brass shower rose, long body bib taps, C.P. brass health faucets, single lever mixing fittings etc.		1. Jaquar 2. Ess Ess 3. Aquaplus 4. Kohler 5. Grohe
5	Automatic hand drier		1. Kopal 2. Blue Circle 3. TOTO 4. Toshi
6	Automatic flushing system for Urinals		1. Jaquar 2. AOS 3.Toshi
7	Stainless Steel Kitchen Sink		1. Neelkanth 2. AMC 3. Cobra
8	Cast Iron Pipes & Fittings, Manhole covers and frames		
	a. As per IS:3989		1. NECO 2. SKF
9	Floor Drain Fixture, Rain Water Outlets & Channel Gratings		1. ACO
10	C.P. Grating for Floor Trap		1. ACO
11	GI Pipes (IS : 1239 and IS : 3589)		1. Tata Steel 2. Jindal (Hissar) 3. Surya Roshni
12	GI pipes fittings		1. Unik 2. Zoloto M 3. Leader
13	CPVC Pipes and Valves		1. Astral

			2. Ashirwad 3. Ajay
14	PVC Pipe		1. Supreme 2. Finolex 3. Prince.
15	RCC Pipe		1. K K 2. Pranali
16	Stoneware Pipes, Gully Traps		1. Perfect Potteries, JABALPUR Approved equivalent ISI marked
17	GM / Forged Brass Valves		1. Zoloto 2. Audco 3. Cim 4.AIP
18	Sluice Valves		1. Kirloskar 2. Zoloto 3. SKS 4. AIP
19	Butterfly Valve		1. KSB 2. Zoloto 3. Audco 4. SKS 5. AIP
20	Check Valve		1. KSB 2. Zoloto 3. Audco 4. SKS 5. AIP
21	Air Release Valve		1. Zoloto 2. Cim
22	Y Strainer		1. Emerald 2. Zoloto
23	Pumps		1. DP Holland 2. Grundfos 3. Wilo
24	Variable Frequency Drives		1. Siemens 2. Danfoss
25	Drinking Water Cooler		1. Blue Star 2. Voltas
26	Couplings		1. Lovejoy
27	Anti Vibration Mounting		1. Dunlop 2. Resistoflex
28	Pressure Gauge		1. Emerald 2. Fiebig 3. HGURU
29	Water Meter (Mechanical Type)		1. Kaycee
30	Level Controller (Water)		1. Active Controls 2. Minilec
31	Level Indicator (Water)		1. Active Controls 2. Minilec
32	Paints		1. Asian Paints 2. Berger 3. ICI 4. Nerolac
33	MH / Water Tank Plastic Steps		1. KGM
34	Water Treatment Plant, R.O., Filters etc.		1. Watcon

			2. Environze 3. Bikon 4. Fontus 5. GMGR 6. WA Corp
35	Water Treatment Vessel		1. Structural 2. Astral
36	Ultra Violet Water Purifier		1. Eureka Forbes 2. Pentair 3. Eurostar 4. Kent
37	Insulation for Hot Water Pipes		1. Armacel – Armaflex (UK) 2. Eurobatex – Union Foam (Italy) 3. K-Flex
38	Flanges		1. Class 150 Table H
39	Pypcoat for Burried Piping		1. IWL / Coaltek
40	Welding Rods		1. Advani
42	CI (LA) Pipes and fittings		1. Electrosteel 2. Kesoram

A P P E N D I X - IV

LIST OF BUREAU OF INDIAN STANDARDS CODES

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices given below as amended upto 30th April, 2003. All equipment and material being supplied by the successful bidder shall meet the requirements of IS, electrical inspectorate and Indian Electricity rules and other Codes / Publications as given below:

1.	**General**	
	SP : 6 (1)	Structural Steel Sections
	IS : 27	Pig Lead
	IS : 554	Dimensions for pipe threads where pressure tight joints are required on the threads.
	IS : 779	Specification for water meters (domestic type).
	IS : 782	Specification for caulking load.
	IS : 800	Code of practice for general construction in steel
	IS : 1172	Code of Basic requirements for water supply drainage and sanitation.
	IS : 1726	Specification for cast iron manhole covers and frames.
	IS : 1742	Code of practice for building drainage.
	IS : 2064	Selection, installation and maintenance of sanitary appliance code of practice.
	IS : 2065	Code of practice for water supply in buildings.
	IS : 2104	Specification for water meter for boxes (domestic type)
	IS : 2379	Colour code for identification of pipe lines.
	IS : 2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
	IS : 2629	Recommended practice for hot dip galvanizing on iron and Steel.
	IS : 3114	Code of practice for laying of cast iron pipe
	IS : 4111 (Part 1)	Code of practice for ancillary structures in sewerage system: Part 1 manholes.
	IS : 4127	Code of practice for laying glazed stoneware pipes.
	IS : 5329	Code of practice for sanitary pipe work above ground for buildings.
	IS : 6159	Recommended practice for design and fabrication of material, prior to galvanizing.
	IS : 7558	Code of practice for domestic hot water installations.
	IS : 8321	Glossary of terms applicable to plumbing work.
	IS : 8419 (Part 1)	Requirements for water filtration equipment: Part 1 Filtration medium sand and gravel.
	IS : 9668	Code of practice for provision and maintenance of water supplies and fire fighting.
	IS : 9912	Coal tar based coating materials and suitable primers for protecting iron and steel pipe lines.
	IS : 10221	Code of practice for coating and wrapping of underground mild steel pipelines.
	IS : 10446	Glossary of terms relating to water supply and sanitation.
	IS : 11149	Rubber Gaskets
	IS : 12183 (Part 1)	Code of practice for plumbing in multi-storeyed buildings:

		Part 1 water supply.
	IS : 12251	Code of practice for drainage of building basements.
	IS : 5572	Code of practice for sanitary pipe work.
	BS : 6700	Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their cartilages.
	BS : 8301	Code of practice for building drainage.
2.	**Pipes and Fittings**	
	IS : 458	Specification for precast concrete pipes (with and without reinforcement)
	IS : 651	Stone ware pipes
	IS : 1239 (Part 1)	Mild steel, tubes, tubulars and other wrought steel fittings: Part 1 Mild Steel tubes.
	IS : 1239 (Part 2)	Mild Steel tubes, tubulars and other wrought steel fittings: Part 2 Mild Steel tubulars and other wrought steel pipe fittings.
	IS : 1536	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
	IS : 1537	Vertically cast iron pressure pipes for water, gas and sewage.
	IS : 1538	Cast Iron fittings for pressure pipes for water, gas and sewage.
	IS : 1729	Sand Cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
	IS : 1879	Malleable cast iron pipe fittings.
	IS : 3989	Centrifugally cast (sun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
	IS : 4346	Specifications for washers for use with fittings for water services.
	IS : 4711	Methods for sampling steel pipes, tubes and fittings.
	IS : 6392	Steel pipe flanges
	IS : 6418	Cast iron and malleable cast iron flanges for general engineering purposes.
	IS : 7181	Specification for horizontally cast iron double flanged pipe for water, gas and sewage.
3.	**Valves**	
	IS : 778	Specification for copper alloy gage, globe and check valves for water works purposes.
	IS : 780	Specification for sluice valves for water works purposes (50 mm to 300 mm size).
	IS : 1703	Specification copper alloy float valves (horizontal plunger type) for water supply fittings.
	IS : 5312 (Part 1)	Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.
	IS : 5312 (Part 2)	Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.
	IS : 12992 (Part 1)	Safety relief valves, spring loaded : Design
	IS : 13095	Butterfly valves for general purposes.
	Quality Tolerance	

	IS : 3025 (Parts 1 to 44)	Method of sampling and test (physical and chemical) for water and waste water.
	IS : 4764	Tolerance limits for sewage effluents discharged into inland surface waters.
	IS : 10500	Drinking Water
5.	**Pumps & Vessels**	
	IS : 1520	Specification for horizontal centrifugal pumps for clear cold fresh water.
	IS : 2002	Steel plates for pressure vessels for intermediate and high temperature service including boilers.
	IS : 5600	Specification for sewage and drainage pumps
	IS : 8034	Specification for submersible pump sets for clear, cold, fresh water.
	IS : 8418	Specification for horizontal centrifugal self priming pumps.

TECHNICAL SPECIFICATIONS

(PLUMBING)

SECTION-01

1. BASIS OF DESIGN

The Plumbing, Sanitary, Drainage System for the project is designed keeping in view the following:

1.1 Requirement of adequate and equal pressure availability of hot and cold water lines in Public Toilets, Kitchen and other identified areas.

1.2 Adequate storage of water in underground raw + overhead treated water tanks.

1.3 Levels of roads / pavements and other services in the area.

1.4 Landscape layout.

The execution of works and materials used shall be as per the latest relevant I.S. specifications.

Wherever reference has been made to Indian Standard or any other specifications, the same shall mean to refer to the latest specification irrespective of any particular edition of such specification being mentioned in the specifications below or BOQ.

2. CONCEPT OF THE SYSTEM

The following services are envisaged for the complex:

2.1 Water Treatment System for meeting the water quality requirement with chemical parameters in acceptable limits as per SP:35(S & T) 1987 which is considered safe for human consumption.

2.2 Flushing water supply through Hydropneumatic system.

2.3 Sewage and Sullage collection system based on IS:1742 and applicable standards for drainage.

2.4 Storm / Rain water drainage system from various levels of the building and disposal to Rain Water Harvesting System / storm water drain.

3. WATER STORAGE & DISTRIBUTION SYSTEM

3.1 **Water Requirement**

The water requirement for the project is proposed to be based on the provisions of IS: 1172 and prevalent practice.

3.2 **Source of Water**

It is expected that part of the daily water requirement for the office shall be through municipal mains supply. The rest will be obtained from bore wells.

3.4 **Appurtenant**

Following components shall be included in the water supply system for efficient functioning:

i. Automatic air vent
ii. Pressure Gauge.

4. SEWAGE, SULLAGE AND STORM WATER

The soil and waste shall be carried down through one pipe drainage system. Independent vent pipe for common soil & water stack is also provided to avoid foul smell entering through trapped gully in WC. Provision of grease trap shall be made for waste water from Kitchen.

4.1**.** **Design Requirement:**

The system is designed considering the following:

a. Termination of vent cowl at terrace level.

b. Provision of adequate slope for horizontal header pipes for achieving self-cleaning velocity in the pipes.

c. Provision of cleanout plug.

SECTION-02
SANITARY FIXTURES & FITTINGS

1. SCOPE

The scope of this section consists of but is not necessarily limited to supply, installation, testing and commissioning of following items:

a. Sanitary appliances and fixtures
b. Chromium plated brass fittings
c. Stainless steel sinks
d. Accessories e.g. towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails, coat hooks etc.
e. Hand driers etc.

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

All exposed pipes within toilets and near appliances/fixtures shall be of chromium plated brass or copper unless otherwise specified.

2. GENERAL REQUIREMENT

Sanitary appliances and fixtures for toilets, chromium plated brass fittings, stainless steel sinks, bathroom accessories like towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails coat hooks, hand driers etc as listed in the relevant items in the BOQ shall be supplied, installed, tested and commissioned by the successful bidder. The rates shall be inclusive of accessories (in such case) required for installation.

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

The sanitary fixtures and fittings shall be installed at the correct assigned position as shown on the drawings and as directed by the Architect / BHEL and shall fully meet with the aesthetic and symmetrical requirements as demanded by the Architect / BHEL

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

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

Fixtures shall be installed by skilled workman with appropriate tools according to the best system practice.
All appliances, fittings and fixtures shall be fixed in a neat workman manner true to level and to heights shown on the drawings and in accordance with the manufacturers

recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulation or terrace shall be made good by the successful bidder at his own cost. Fixtures shall be mounted rigid, plumb and true to alignment.

All materials shall be rustproof; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

Wall flanges shall be provided on all walls, floors, columns etc. wherever supply and disposal pipes pierce through them. These wall caps shall be or chromium plated brass fittings and the receiving pipes and shall be large enough to cover the punctures properly.

Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following:

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

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

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

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

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

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

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

Sizes of sanitary fixtures given in the Specifications or in the BOQ are for identification with reference to the catalogues of make considered. Dimensions of similar models of other makes may very within $\pm$ 10% and the same shall be provided and no claim for extra payment shall be entertained no shall any payment be deducted on this account.

The successful bidder shall fix all plumbing fittings such as water faucets; mixing valves etc. in accordance with manufacturer's instructions and connect to piping system. The successful bidder shall supply all fixing materials such as screws, rawl plugs, unions, collars, compression fittings etc., as required.
Joints / gaps between all sanitary appliances / fixtures and the floor / walls shall be caulked with an approved mildew resistant sealant, having antifungal properties, of colour and shade to match that of the appliances / fixture and the floor / wall to the extent possible.

2.1 Water Closet

Water Closet shall be wash down or siphonic wash down type floor or wall mounted set, as shown in the drawings, designed for low volume flushing from 5-7 litres of water, flushed by means of plastic cistern installed in shaft. Flush pipe / bend shall be connected to the WC by means of a suitable rubber adaptor. Wall hung WC shall be supported by CI floor mounted chair which shall be fixed in a manner as approved by BHEL. Each WC set shall be provided with approved quality of seat, rubber buffers and chromium plated hinges. Seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the WC. Each WC shall be provided with suitable connector connecting the ceramic outlet of WC to CI pipe.

2.2 Urinals

Urinals shall be lipped type half stall with glazed vitreous China of size as called for in the Bill of Quantities. Half stall urinals shall be provided with suitable CP spreader, suitable CP domical waste and CP cast brass bottle trap with pipe and wall flange and shall be fixed to wall by CI brackets, CI wall clips and CP brass screws as recommended by manufacturer complete as directed by the BHEL. Flushing for urinals shall be by means of no hand operation, infrared electric flush valve with complete kit of plumbing, electrical and electronic items, infrared photo cells, solenoid valve transformer and electrical connection. The automatic flush sensor plate shall be flush and press fitted and be of high quality mirror polish finish. Each urinal shall be provided with one flush valve unit. Flush pipes shall be GI pipes concealed in wall chase but with chromium plated bends at inlet and outlet.

Urinal Partitions

Urinal partitions shall be white glazed vitreous china of size specified in the BOQ.
Porcelain partitions shall be fixed at proper heights with CP brass bolts, anchor fasteners and MS clips as recommended by the manufacturer and directed by BHEL.

2.3 Wash Basin

It shall be white glazed vitreous china of size, shape and type specified in the BOQ.
Each basin shall be provided with painted MS angle or CI brackets and clips and the basin securely fixed to wall/counter slab. Placing of basins over the brackets without secure fixing shall not be accepted. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour

as approved by BHEL. The cost of fixing the basin shall be inclusive of supply and installation of brackets as described above.

Each basin shall be provided with suitable CP waste with overflow, pop-up waste or rubber plug and CP brass chain as specified in the BOQ. Each basin shall be provided with hot and cold water mixing fitting or as specified in the BOQ.

2.4 **Sinks**

Sinks shall be stainless shall or any other material as specified in the BOQ. Each sink shall be provided with painted MS or CI brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable painted angle iron brackets or clips as recommended by the manufacturer. Each sink shall be provided with suitable dia CP waste and rubber plug with CP brass chain as given in the BOQ. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by BHEL. Sanitary fittings for sinks shall be deck mounted or wall mounted CP swivel faucets with or without hot and cold water mixing fittings as specified in the BOQ.

2.6 **Toilet Paper Holder**

Toilet paper holder shall be white glazed vitreous china or chrome plated of size, shape and type specified in the BOQ. Porcelain toilet paper holder 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. The latter (chrome) shall be fixed by means of screws/capping having finish similar to the toilet paper holder in wall/temper partitions with raw l plugs or nylon sleeves. When fixed on timber partition, it shall be fixed on a solid wooden base member provided by the BHEL.

2.7 **Towel Rail**

Towel rail shall be chromium plated brass or of stainless steel or powder coated brass of size, shape and type specified in the BOQ. Tower rail shall be fixed with screws/capping having finish similar to the towel rail in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by BHEL.

2.8 **Liquid Soap Dispenser**

Liquid Soap Dispenser shall be wall/counter mounted suitable for dispensing liquid soaps, lotions, detergents. The cover shall lock to body with concealed locking arrangement, opened only be key provided.

3. MOCKUP AND TRIAL ASSEMBLY

The installation of the sanitary fixtures and fittings shall be as per the shop drawings approved by the Architect/Consultant/BHEL. The successful bidder shall have to assemble at least one set of each type of sanitary fixtures and fittings in order to determine precisely the required supply and disposal connections. Relevant instructions from manufacturers shall be followed as applicable. This trial assembly shall be developed to determine the location of puncture holes, holding devices etc.

which will be required for final installation of all sanitary fixtures and fittings. The above assembly shall be subject to final approval by the Architect / BHEL.
The fixtures in the trial assembly can be re-used for final installation without any additional payments for fixing or dismantling of the fixtures.

5. SUPPORTING AND FIXING DEVICES

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

6. FINAL INSTALLATION

The successful bidder shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal/replacement of sanitary fixtures without disturbing the built in piping system. All unions and flanges shall match in appearance with other exposed fittings.
Fixtures shall be mounted rigid, plumb and to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes before making the joints. It shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

7. PROTECTION AGAINST DAMAGE

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

8. MEASUREMENT

8.1. Rate for supply and fixing of sanitary fixtures accessories, CP fittings shall etc. include all items, and operations stated in the respective specifications and BOQ and nothing extra is payable.

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

9. TESTING

All appliances, fixtures and fittings shall be tested before and after installation. Water seals of all appliances shall be tested. The successful bidder shall block the ends of waste and ventilation pipes and shall conduct an air test.

SECTION-03

WATER SUPPLY (COLD & HOT)

1 SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of piping network for water supply for internal & external services as follows:

a Municipal Water supply.

b. Drinking Water Supply.

c. Flushing Water Supply

d. Hot Water Supply.

e. Connection to various mechanical equipments to be supplied and installed by the other specialist bidders.

2 PIPING MATERIALS

The piping system shall consist of Chlorinated Polyvinyl Chloride pipes and fittings approved by BIS and the code is IS : 15778 . The sizes and makes are specified in the BOQ. For any internal works, the pipes and fittings shall be embedded in the wall chase. No unsightly exposed runs shall be permitted. Outside the building the piping shall be installed at least 1.0 m below the finished grade level.

3. Chlorinated Polyvinyl Chloride Pipes & Fittings

The pipes shall be Chlorinated Polyvinyl Chloride pipes and fittings approved by BIS and the code is IS: 15778 . All internal concealed plumbing for water supply shall be CPVC pipes & fittings shall conform to CTS (Copper Tube Size) SDR-11 as per ASTM D2846 5. All pipes and fittings from ½" upto 2" shall come under this category. Medium body CPVC solvent cement conforming to ASTM F493 should be used for joining pipes to fittings.

4. External Plumbing

" All external plumbing for water supply and distribution shall be done with CPVC. The CPVC pipes above 2" for external water supply lines shall conform to ASTM F441 CPVC Schedule 40 & 80 pipe. The fittings above 2" size shall conform to ASTM F438 (Schedule 40 CPVC fittings) or ASTM F 439 (Schedule 80 CPVC fittings). All threaded CPVC fittings shall conform to ASTM F437 (threaded CPVC fittings schedule). A heavy bodied CPVC solvent cement shall be used along with a primer. IPS brand primer and heavy bodied CPVC solvent cement only should be used conforming to ASTM F493. All external CPVC pipes shall be coated with a water based acrylic paint emulsion for enhanced UV protection.

5.

Approximate Number of Joints That can be made with Solvent Cement

	Solvent cement Pack Size			
Pipe Size	118ml	237ml	473ml	946ml
16mm (1/2")	82	164	328	656
20mm (3/4")	55	110	220	440
25mm (1"0	34	68	136	272

Installation procedure

" All parameters pertaining to the installation of CPVC plumbing system such as cutting, joining, support spacing, expansion loops, insulation, type of support, special connections, etc. shall be as per the manufacturer's specifications.

6. Special fittings

" All special fittings and accessories like internally or externally threaded brass adaptors, ball valves, globe valves, unions, diaphragm valves, butterfly valves, etc shall be made of CPVC by any one of our Licensee .

Recommended Support Spacing (Distance between Pipe clamps
Horizontal Support (In Meters)

Pipe Size	Tempreature			
	23oC	38oC	60oC	82oC
16mm (1/2")	1.22	1.22	1.07	0.92
20mm (3/4")	1.53	1.37	1.22	0.92
25mm (1"0	1.68	1.53	1.37	0.92
32mm (1 1/4")	1.83	1.68	1.53	1.22
40mm (1 1/2")	1.98	1.83	1.68	1.22
50mm (2")	2.29	2.14	1.98	1.22

Note: Vertical CPVC piping should be supported at each floor and should have a mid story guide, unless thermal expansion design calls for other provisions

Treatment for external exposed piping :

All external CPVC pipes shall be coated with an acrylic water based paint.

CPVC Solvent Cement Specifications :
" The CPVC solvent cement used for installing CPVC piping systems shall conform to ASTM F493. For pipes from ½" upto 2" pipes and fittings, single step medium bodied CPVC solvent cement should be used. For CPVC pipes and fittings upwards of 2", a primer shall be used followed by a heavy bodied solvent cement conforming to ASTM F493. PVC solvent cement should not be used.

7	32mm (1 1/4")	33	66	132	264
	40mm (1 1/2")	23	46	92	184
	50mm (2")	17	34	68	136

WATER METERS

Water meters of approved make and design shall be supplied for installation at locations as shown. The water meters shall meet with the approval of local supply authorities. Suitable valves and chambers or wall meter box to house the meters shall also be provided along with the meters.

The meters shall conform to Indian Standard IS: 779 and IS: 2373.
Provision shall also be made to lock the water meter. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be a diameter not less than 4mm.

7.1 **Installation of Water Meter and Stop Cock**

The CPVC shall be cut to the required lengths at the position where the meter and stop cock are required to be fixed. Suitable fittings shall be attached to the pipes. The meter and stop cock shall be fixed in a position by means of connecting pipes, jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter installed exactly horizontal or vertical in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken that the factory seal of the meter is not disturbed. Wherever the meter shall be fixed to a newly fitted pipe line, the pipe line shall have to be completely washed before fitting the meter.

8. TESTING

The successful bidder shall notify the Architect three days in advance of any test so that the Architect can witness the tests if he so wishes.

All water supply system shall be tested to hydrostatic pressure test of at least one and a half (1.5) times the maximum pressure but not less than 10Kg/Sq.cm for a period of not less than 8 hours. All leaks and defects in joints revealed during the testing shall be rectified and got approved at site by retest. Piping required subsequent to the above pressure test shall be retested in the same manner.

System may be tested in sections and such sections shall be entirely retested on completion.

The successful bidder shall make sure that proper noiseless circulation of fluid is achieved through the entire piping network of the system concerned. In case of improper circulation, the successful bidder shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and refinishing of floors and walls as required.

In addition to the sectional testing carried out during the construction, successful bidder 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 successful bidder during the defects liability period without any cost.

After commissioning of the water supply system, successful bidder 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.

A test register shall be maintained and all entries shall be signed and dated by successful bidder(s) and BHEL representative.

9. DISINFECTION OF PIPING SYSTEM AND STORAGE TANKS

Before commissioning the water supply system, the successful bidder shall arrange to disinfect the entire system as described in the succeeding paragraph.
The water storage tanks and pipes shall first be filled with water and thoroughly flushed out. The storage tanks shall then be filled with water again and disinfecting chemical containing chlorine added gradually while tanks are being filled to ensure thorough mixing. Sufficient chemical shall be used to give water a dose of 50 parts of chlorine to one million parts of water.
If ordinary bleaching powder is used, the proportions will be 150 gm of powder to 1000 liters of water. The powder shall be mixed with water in the storage tank. If a proprietary brand of chemical is used, the proportions shall be specified by the manufacturer. When the storage tanks is full, the supply shall be stopped and all the taps on the distributing pipes are opened successively working progressively away from the storage tank. Each tap shall be closed when the water discharged begins to smell of chlorine. The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommended proportions. The storage tank and pipe shall then remain charged at least for three hours. Finally the tank and pipes shall be thoroughly flushed out before any water is used for office purpose.
The pipe work shall be thoroughly flushed before supply is restored.

10. STERILIZATION OF MAIN

After the pipe work has been tested and approved, but before it is coupled, it shall be sterilized with a solution of chloride of lime

11. CUTTING CHASES IN MASONARY WALLS

Cold water distribution pipes to fixtures and equipment exposed to view in the bathrooms, kitchens, and sanitary compartments shall be chased into walls or floors or placed in wall cavities. The successful bidder shall be responsible for cutting all notches, chases, and recesses in walls and floors and only a **diamond cutter** shall be used. The maximum size of conduit or pipe permitted to be concealed in floor slabs shall be 32 mm diameter unless otherwise approved by the Architect / BHEL.

The chases upto 7.5 x 7.5 cm shall be made in the walls for housing CPVC pipes etc. These shall be provided in correct positions as shown in the drawings or directed by the Architect/BHEL. Chases shall be made by chiselling out the masonry to proper line and depth. After the pipes etc are fixed in chases, the chases shall be filled with cement mortar 1:2:4 or as may be specified, and made flush with the masonry surface. The concrete surface shall be roughened with wire brush to provide a key for plastering.

Where pipes pass through beams or structural walls, subject to the approval of BHEL, the successful bidder shall ensure that sizes and locations of openings required are formed in when the relevant beams or walls are cast.

12 VALVES

All valves (gate, globe, check, safety) shall be of gun metal suitable for the particular service as specified. All valves shall be of the particular duty and design as specified. Valves shall either be of screwed type or flanged type, as specified, with suitable flanges and non-corrosive bolts and gaskets. Tail pieces as required shall be supplied along with valves. Gate, globe and check valves shall conform to Indian Standard IS:776 and non-return valves and swing check type reflux to IS:5312.
Sluice valves, where specified shall be flanged sluice valves of cast iron body. The spindle, valve seat and wedge nuts shall be gunmetal. They shall generally have non-rising spindle and shall be of the particular duty and design as specified. The valves shall be supplied with suitable flanges, non-corrosive bolts and asbestos fiber gaskets. Sluice valves shall conform to Indian standard IS:780 and IS:2906.

(a **BALL VALVES**
Valves 50mm dia and below 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.

(b Valves above 50mm dia. shall be Butterfly Valves.
Cast iron (IS 210), grade FG 260 butterfly valves conforming to PN 1.0, heavy duty cast iron disc with anti corrosive nickel plating, nitrile seat and stainless steel 410 stem with lever/gear operation and powder coated finish.

Float Valves to be fixed in storage tanks shall consist of cast brass lever arm having copper balls (26 SWG) screwed to the arm integrally. The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers. The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system. Where called for brass valves shall be supplied with brass hexagonal back nuts to secure them to the tanks and a socket to connect to supply pipe. All valves shall be suitable for the working pressure involved.

12.1 **Pressure Gauge**

The pressure gauge shall be constructed of die cast aluminium and stove enamelled. It shall be weather proof with an IP 55 enclosure. It shall be a stainless steel Burden tube type pressure gauge with a scale range from 0 to 16 Kg / cm square and shall be constructed as per IS:3524. Each pressure gauge shall have a siphon tube connection. The shut off arrangement shall be by Ball Valve.

13 WATER FITTINGS

Unless otherwise specified all Gunmetal fittings such as gate, globe, check & safety valves shall be fitted in pipe line in workman like manner. Necessary unions shall be provided on both ends of the valves for easy replacement. The joints between fittings and pipes shall be leak-proof when tested to desired pressure rating. The defective fittings and joints shall be replaced or redone.

14 CONNECTIONS TO VARIOUS MECHANICAL EQUIPMENT SUPPLIED BY OTHER AGENCIES

All inlets, outlets, valves, piping and other incidental work connected with installation of mechanical equipment supplied by other agencies all be carried out by the successful bidder in accordance with the drawings, requirements for proper performance of equipment, manufacturers instructions and the directions of the BHEL/ Architect. The equipments to be supplied by the other agencies consist mainly for Kitchen, Back-of-the-House area and other similar areas. The work of connections to the various equipments shall be effected through proper unions and isolating valves. The work of effecting connections shall be executed in consultation with and according to the requirement of equipment suppliers, under the directions of BHEL/ Architect. The various aspects of connection work shall be executed in a similar way to the work of respective system mentioned elsewhere in these specifications.

15 CONNECTIONS TO RCC WATER TANKS

The successful bidder shall provide all inlets, outlets, washouts, vents, ball cocks, overflows control valves and all such other piping connections including level indicator to water storage tanks as called for. All pipes crossing through RCC work shall have puddle flanges fabricated from MS/GI pipes of required size and length and welded to 6/8 mm thick MS plate. All puddle flanges must be fixed in true alignment and level to ensure further connection in proper order.

Full way gate valves of a approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe. Overflow and vent pipes shall terminate with mosquito proof grating.

The overflow pipe shall be so placed to allow the discharge of water being readily seen. The overflow pipe shall be of size as indicated. A stop valve shall also be provided in the inlet water connection to the tank. The outlet pipes shall be fixed approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning.

16. MEASUREMENTS

The length above ground shall be measured in running meter correct to a cm for the finished work, which shall include pipe and fittings such as coupling , bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, unions. Deductions for length of valves shall be made. Rate quoted shall be inclusive of all fittings, clamps, cutting holes chased and making good the same and all items mentioned in the specifications and Bill of Quantities.

All pipes below ground shall be measured per linear meters (to the nearest cm) and shall be inclusive of all fittings e.g. coupling, tees, bends, elbows, unions, deduction for valves shall be made rate quoted shall be inclusive of all fittings, excavation, back filling and disposal of surplus earth, cutting holes and chase and making good all item mentioned in Bill of Quantities.

17. PIPE PROTECTION (FOR COLD WATER PIPES BURIED IN TRENCHES / GROUND / EARTH)

All buried pipes shall be cleaned and protected against corrosion by applying two layers of 2 mm thick multi-layer anticorrosive polymeric mix tape applied over a coat of primer as per recommendations of the manufacturers and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters. The pipes where laid under floor shall be encased with 100 mm thick jamuna sand all around in addition to protective coating as described above.

18. THRUST BLOCKS

In case of bigger pipes (80 mm dia and above), thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) shall be constructed on all bends as directed by BHEL.

19. MASONRY CHAMBER

i. All masonry chambers for stop cocks, sluice valves and meter etc. shall be built as per supplied drawings.

ii. The excavation for chambers shall be done true to dimension and level indicated on plans or as directed by the BHEL representative.

iii. Concrete shall be of cement concrete 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size.

iv. Brick shall be of class designation 75 in cement mortar 1:5 (1 cement : 5 fine sand)

v. Inside Plastering not less than 12 mm thick shall be done in cement mortar 1:3 (1 cement : 3 fine sand) finished with a floating coat of neat cement.

20. SHIFTING OF EXCAVATED SURPLUS MATERIAL

Successful bidder shall make his own arrangement to shift the surplus excavated material within the site limits as directed by BHEL free of cost within time limit.

21 HOT WATER PIPING INSULATION

MATERIAL

Insulation material for Pipe insulation shall be Closed Cell Elastomeric Nitrile Rubber or closed cell cross linked polyethylene foam. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.038 W/m^{o}K or 0.0313 Kcal / Mhr ^{o}C or 0.212 BTU / (Hr-ft^{2}-^{o}F/inch) at an average temperature of 30^{o}C. The product shall have temperature range of –40 ^{o}C to 105^{o}C. Density of material shall not be less than 0.06 gm/cm^{3}. The insulation shall have fire performance such that it passes minimum CLASS 1 as per BS476 part 7 for surface spread of flame. Water vapour permeability shall not exceed 0.024 perm inch (3 x 10^{-14} Kgs / m.sec.Pa). The material shall have approval from the Chief Fire Officer.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer test certificate for thermal conductivity values. Samples of insulation material from each lot delivered at site may be selected by BHEL and gotten tested for thermal conductivity and density at successful bidder's cost all joints shall be sealed properly with adhesive, which shall provide similar vapour barrier as the original insulating material.

All hot water piping shall be insulated in the manner specified herein. Before applying insulation, all pipes shall be brushed and cleaned. Thermal insulation shall be applied as follows or as specified in drawings or schedule of quantity:

Pipe size (mm)	Thickness of Nitrile rubber insulation
15 mm to 25 mm	9 mm
32 mm to 50 mm	13 mm
65 mm and above	19 mm

<u>Insulation for pipes in wall chase and for pipes in shaft / plant room</u>.

Insulating material in tube form shall be sleeved on the pipes. On existing piping, slit opened tube from insulating material shall be placed over the pipe and adhesive (as recommended by the manufacturer) shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre.
Wherever flat sheets shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. The insulation shall be continuous over the entire run of piping, fittings and valves. All valves, fittings, joints, strainers etc. in hot water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

All insulation work shall be carried out by skilled workmen specially trained in this kind of work. All insulated pipes shall be labeled (HWS / HWR / HWRR) and provided with 300 mm wide band of paint along circumference at every 1200 mm for colour coding. Direction of fluid shall also be marked. All painting shall be as per relevant BIS codes.

Protective Coating Over Insulation

To provide mechanical strength and protection from damage & UV rays all exposed pipe insulated with nitrile rubber as indicated in BOQ shall be covered with fibreglass fabric. The fibreglass fabric shall be applied with one coat of fire proof epoxy or acrylic compound. The coat shall be allowed to cure to non stick state. Subsequently second coat of compound shall be applied to give a tough and smooth finish to the insulated surface.

Measurement Of Insulation

Unless otherwise specified measurement for pipe insulation for the project shall be on the basis of centre line measurements described herewith

Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers shall not be separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including valves, orifice plates and strainers etc. shall be considered strictly by linear measurements along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

SECTION-04

INTERNAL DRAINAGE (SOIL, WASTE, VENT &RAIN WATER PIPES)

1 SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of internal drainage services.

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 BOQ.

2 BASIC PIPING SYSTEM uPVC PIPE AND FITTINGS

All soil and waste water UV stabilized SWR pipes shall conform to IS: 13592 and pipe fittings shall confirm to IS: 14735 have uniform wall thickness for the entire length. These shall be sound and free from surface and other defects. Pipes shall be such that they could be cut.

All rain water and waste pipes from wash basin and sink shall be conforming to IS: 4985. The pipes shall be reasonably round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth and clean, free from grooving and other defects. The end shall be cleanly cut and square with the axis of the pipe the pipe shall be designated by external diameter and shall conform to IS: 4985 Revised in all respects. The dimensions and tolerances of rigid PVC pipes shall be as in Appendix D of Chapter 20. All pipes & fitting running along the basement ceiling in basement shall be CI spun pipes conform to IS:3989. Fittings shall be of required degree with or without access door. All access doors shall be made up with 3mm thick insertion rubber gasket of white lead and tightly bolted to make the fittings air and water tight. The fittings shall be of the same manufacture as the pipes used for soil and waste.
Fittings: Fittings used shall be of the same make as that of PVC pipes, injection molded or made in cast iron and shall conform to Indian Standard wherever available.

2.1 FIXING

Pipe and fitting shall be fixed to walls or in recesses of RCC column wall as shown in drawing by using proper holder bat clamps or special design clamps. The pipe shall be fixed perfectly vertical or in a line as directed. Pipe suspended from roof slabs shall be supported with special designed clamps made out of 6mm thick M.S. flat or angles of suitable size. Suspenders made out of 10mm rounds shall have male threads at one end to fit into inserts with female threads embedded in the slab or RCC work at the time of casting. All branch connections to the main Lines/Stacks shall be made with easy sweep in the direction of flow. All P.V.C. pipes shall have terminal guard at top of the parapet coping.

2.1.1 In case of bends in the bottom most pipes of vertical stacks, these shall be long radius of 135 degree. Inserts suspenders and clamps shall be the suitable sizes required for supporting the pipes and fittings.

2.2 JOINING

2.2.1 The joining is to be done with rubber ring lubricants of approved quality.

Solvent welded joints : Non heat application Method:

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

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

Generous coating of solvent cement shall be evenly applied on the inside of the fitting alround the circumstance for the full length of insertion and on the outside of the pipe end upto the marked line with non synthetic brush of suitable dimension. The pipe shall be pushed into the fitting socket and held for 1 or 2 minutes as otherwise the pipe may come out of the fitting due to the slippery quality of cement and the tapering inside bore of the fitting. The surplus cement on the pipe surfaces shall be wiped out. If the solvent cement has dried up too much or the tapering of the socket is too sleep, jointing will not be proper and pipe will come out of the fitting.

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

2.3 EMBEDDING PIPE IN MASONRY

Pipes shall be embedded in masonry during construction of the building. A hole of size up to 23 x 23 cm of as directed shall be kept in the masonry. The pipes shall be centrally placed in the hold and shall be fixed by filling the space around pipe stacks with cement concrete 1:3:6 (1 cement : 3 coarse sand: 6 graded stone aggregate 20 mm nominal size). Where the wall thickness is 23 cms the cement concrete shall be made flush with the masonry surface on both sides and the surface roughened with wire brushes to receive plaster.

Where the wall thickness of wall is more than 23 cms the other side shall be covered with the same class of brick work

3. PIPES HANGERS, SUPPORTS, CLAMPS ETC.

All vertical pipes shall be fixed by clamps and angle brackets truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).

Horizontal pipes running along ceiling shall be fixed on structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slpe and the clamps adjusted to the proper levels so that the pipes fully rest on them.

Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces.

Clamps shall be of approved design and fabricated from MS flats (which shall be enamel painted after fabrication) of thickness and sizes as per drawings or contractor's shop drawings. Clamps shall be fixed in accordance to manufacturer's details / shop drawings to be submitted by the contractors.

When required to be fixed on RCC columns, walls or beam they shall be fixed with approved type of expansion anchor fasteners (Dash fasteners) of approved design and size according to load.

Structural clamps e.g. trapeze or cluster hangers shall be fabricated by electro-welding from MS structural members e.g. rods, angles, channels flats as per contractors shop drawings shall be enamel painted after fabrication.

4. INSTALLATION OF SOIL, WASTE & VENT PIPES

Soil, waste & vent pipes in shafts under the floors / suspended below slab shall consist of cast iron pipes as described earlier. Waste pipes from bottle trap to floor/urinal traps for wash basin, urinal and sink shall be uPVC pipes and fittings.

All Horizontal pipes running below the slab and along the ceiling shall be fixed on structural adjustable clamps, sturdy hangers of the design as called for in the drawings. The pipes shall be laid in uniform slope and proper levels. All vertical pipes shall be truly vertical fixed by means of stout clamps in two sections, bolted together, built into the walls, wedged and neatly jointed. The branch pipes shall be connected to the stack at the same angle as that of fittings. All connections between soil, waste and ventilating pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts. Where the horizontal run off the pipe is long or where the pipes cross over building expansion joints etc. suitable allowance shall be provided for any movements in the pipes by means of expansion joint etc. such that any such movement does not damage the installation in any way.

5. FLOOR TRAPS

Floor traps where specified shall be siphon type full before P or S type uPVC having a minimum 50 mm deep seal. The trap and waste pipes when buried below ground shall be set and encased in cement concrete blocks firmly supported on firm ground

or when installed on a sunken RCC structural slab. The blocks shall be in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size).
Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30 x 30 cms of the required depth.

6. FLOOR TRAP INLET /HOPPER

Bath room traps and connection shall ensure free and silent flow of discharging water. Where specified, contractor shall provide a special type of floor inlet fitting fixing from uPVC pipe, with one, two or three inlet sockets.

7. CLEANOUT PLUGS

Clean out plug for soil, waste or rain water pipes laid under floors shall be provided near pipe junctions bends, tees, “Ys” and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor level. They shall be threaded and provided with key holes for opening. Cleanout plugs shall be cast brass suitable for the pipe dia.

8. FLOOR TRAP GRATING

Floor and urinal traps shall be provided with 100 – 150 mm square or round stainless steel gratings, with frame and rim of approved design and shape or as specified in the schedule of quantities approved by the Owner’s site representative.

9. CUTTING AND MAKING GOOD

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

10. TESTING

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

Soil and waste pipes shall be tested in sections after installation, by filling up the stack with water. All openings and connections shall be suitably plugged as approved by the Project Manager. The total head in the stack shall be 4.5 m at the highest point of the section under test. The period of test shall be minimum for 30 minutes or as directed by the Project Manager. If any leakage is visible, the defective part of the work shall be cut out and made good.

On completion of the work the entire installation shall be tested by smoke testing machine. The test shall be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging the outlets with bellow plugs. Apply dense smoke keeping the top of stack open and observe for leakages. Rectify or replace defective sections.

After the installation is fully complete, it should be tested by flushing the toilets, running at least 20% of all taps simultaneously and ensuring that the entire system is self draining, has no leakages, blockages etc. Rectify and replace where required. A test register shall be maintained and all entries shall be signed and dated by the Contractor and the Project Manager or his representative.

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

SECTION-05 EXTERNAL DRAINAGE

(SEWAGE & STORM WATER DISPOSAL)

1 SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of external drainage & sewage disposal services.

1.1 General Scheme

The successful bidder shall install a drainage system to effectively collect; drain and dispose all soil and waste water from various parts of the buildings, appurtenances and equipment. The piping system shall finally terminate and discharge into the Sewage sump and finally discharge by pumping to Municipal Sewer line. The piping work mainly consists of laying of Salt glazed stoneware pipes, reinforced cement concrete pipes and cast iron soil pipes as called for on the drawings. All piping shall be installed at depth greater than 80 cm below finished ground level. The disposal system shall include construction of gully traps, manholes, intercepting chambers as indicated. The piping system shall be vented suitably at the starting point of all branch drains, main drains, the highest/lowest point of drain and at intervals as shown. All ventilating arrangements shall be unobstructive and concealed. The work shall be executed strictly in accordance with IS: 1742. The sewage system shall be subject to smoke test for its soundness as directed by BHEL. Wherever the sewerage pipes run above water supply lines, same shall be completely encased in cement concrete 1:2:4 all round with the prior approval of BHEL.

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

a. Sewer lines including earth work for excavation, disposal, back filling and compaction, pipe lines, manholes, drop connections and connections to the municipal or existing sewer.

b. Storm water drainage, earth works for excavation, disposal, backfilling and compaction, pipe lines, manholes, catch basins and connections to the existing municipal storm water drain or connected as indicated by BHEL.

General Requirements

All materials shall be new and of quality conforming to specifications and subject to the approval of the BHEL representative. Wherever particular makes are mentioned, the choice of selection shall remain with the Architect / Consultant / BHEL.

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

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

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

Location of all manholes, etc shall be got confirmed by BHEL before the actual execution of work at site. 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 BHEL in writing.

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

2. TRENCHING FOR PIPES AND DRAINS

2.1 General

All the material shall be new of best quality conforming to specifications and subject to the approval of the Architects. Drainage lines shall be laid to the required gradients and profiles. All drainage work shall be done in accordance with the local municipal by-laws.

Successful bidder shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority. Location of all manholes, catch basins etc. shall be finalized and shown in approved shop drawings before the actual execution of work at site. All work shall be executed as directed by BHEL

2.2 Alignment & Grade

The sewer and storm water drainage pipes shall be carefully laid to levels and gradients shown in the plans and sections but subject to modifications as shall be ordered by the Architects from time to time to meet the requirements of the works. Great care shall be taken to prevent sand etc. from entering the pipes. The pipes between two manholes shall be laid truly in straight lines without vertical or horizontal undulations. The body of the pipes shall rest on an even bed in the trench for its length and places shall be excavated to receive collar for the purpose of jointing. No deviations from the lines, depths of cuttings or gradients as called for on the drawings shall be permitted without the written approval of the Architect/BHEL. All pipes shall be laid at least 60cms below the finished ground level or as called for on the drawings.

2.3 Setting out Trenches

The successful bidder shall set out all trenches, manholes, chambers and such other works to true grades and alignments as called for. He shall provide the necessary instruments for setting out and verification for the same. All trenches shall be laid to true grade and in straight lines and as shown on the drawings. The trenches shall be laid to proper levels by the assistance of boning rods and sight rails which shall be fixed at intervals not exceeding 10 meters or as directed by BHEL.

2.4 Trench Excavation

The trenches for the pipes shall be excavated (in all types of soil) with bottoms formed to level and gradients as shown on the drawings or as directed by BHEL. In soft and filled in ground, BHEL may require the trenches to be excavated to a greater depth than the shown on the drawings and to fill up such additional excavation with concrete (1:4:8) consolidated to bring the excavation to the required levels as shown on the drawings.

All excavations shall be properly protected where necessary by suitable timbering, piling and sheeting as approved by BHEL. All timbering and sheeting when withdrawn shall be done gradually to avoid falls. All cavities are adequately filled and consolidated. No blasting shall be allowed without prior approval in writing from the Architect/BHEL. It shall be carried out under thorough and competent supervision, with the written permission of the appropriate authorities taking full precautions connected with the blasting operations. All excavated earth shall be kept clear of the trenches to a distance equal to 75 cms.

2.5 Timbering of Sewer and Trenches

The successful bidder shall at all times support efficiently and effectively the sides of all the trenches and other excavations by suitable timbering, piling and sheeting and they shall be close timbered in loose or sandy strata and below the surface of the sub soil water level.

All timbering, sheeting and piling with their wallings 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 take place.

The successful bidder shall be held responsible and shall be accountable for the sufficiency of all timbering, bracings, sheeting and piling used and also for, all damage to persons and property resulting from improper quality strength placing, maintaining or removing of the same.

2.6 Shoring of Buildings

The successful bidder 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.

2.7 Obstruction Road

The successful bidder 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 successful bidder shall obtain the consent of BHEL in writing before closing any road to vehicular traffic and the foot walks must be clear at all times.

2.8 Protection of Pipes etc.

All pipes, water mains, cables etc. met in the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the cables, the removal of which shall be arranged by the successful bidder with the written consent from BHEL.

2.9 Trench Back Filling

Refilling of the trenches shall not be commenced until the length of pipes therein has been tested and approved. All timbering which may be withdrawn safely shall be removed as filling proceeds. Where the pipes are unprotected by concrete hunching, selected fine material shall be carefully hand-packed around the lower half of the pipes so as to buttress them to the sides of the trench.

The refilling shall then be continued to 150mm over the top of the pipe using selected fine hand packed material, watered and rammed on both sides of the pipes with a wooden hammer. The process of filling and tamping shall proceed evenly in layers not exceeding 150mm thickness, each layer being watered and consolidated so as to maintain an equal pressure on both sides of the pipe line. In gardens and fields the top solid and turf if any, shall be carefully replaced.

2.10 Successful Bidder **to restore settlement and Damages**

The successful bidder shall at his own costs and expenses, make good promptly during the whole period for the works in hand if any settlement occurs in the surfaces of roads, beams, footpaths, gardens, open spaces etc. in the public or private areas caused by his trenches or by his other excavations and he shall be liable for any accident caused thereby. He shall also, at his own expense and charges, repair (and make good) any damage done to building and other property. If in the opinion of BHEL he fails to make good such works with all practicable dispatch, BHEL shall be at his liberty to get the work done by other means and the expenses thereof shall be paid by the successful bidder or deducted from any money that may be or become due to him or recovered from him by any other manner according to the laws of land.

The successful bidder 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, surplus soil shall be immediately removed, the surface shall be properly restored and roadways and sides shall be left clear.

2.11 **Removal of Water from Sewer, Trench etc.**

The successful bidder shall at all times during the progress of work keep the excavations free from water which shall be disposed 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 road or streets, nor cause any interference with the use of the same by the public.

If any excavation is carried out at any point or points to a greater width of the specified cross section of the sewer with its cover, the full width of the trench shall be filled with concrete by the successful bidder at his own expense and charges to the requirements of BHEL.

2.12 **Removal of Filth**

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

2.13 **Width of Trench**

BHEL shall have power by giving an order in writing to the successful bidder to increase the maximum width/depth for excavation and backfilling in trenches for various classes of sewer, manholes and other works in certain length to be specifically laid down by him, where on account of bad ground on other unusual conditions, he considers that such increased width/depths are necessary in view of the site conditions.

3 PIPING MATERIAL

3.1 RCC pipes

All pipes shall be centrifugally spun RCC pipes NP2. 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 successful bidder shall produce, prior to use on site, a certificate to that effect from the manufacturer.

The pipes shall be with or without reinforcement as required and of the class as specified. These shall conform to IS: 458-1971.

All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

Laying

RCC spun pipes shall be laid on cement concrete bed of 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 and 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 boning rods, etc. Cradles or concrete bed may be omitted, if directed by BHEL.

Jointing

Semi flexible type collar joint.

Hemp rope soaked in neat cement wash shall be passed round the joint and inserted in it by means of caulking tool. More skein of yarn shall be added and rammed home. Cement mortar with one part of cement and two part of sand and with minimum water content but on no account soft or sloppy, shall be carefully inserted, punched and caulked into the collar and more cement mortar added until the space of the collar has been filled completely with tightly caulked mortar. Provision of rubber sealing ring in the collar joint shall also be made. The joint shall then be finished off neatly outside the socket at an angle of 45 deg.

Curing:

The joint shall be cured for at least seven days. Refilling at joints will be permitted only on satisfactory completion of curing period.

Cement Concrete for Pipe Supports:

a. Unless otherwise directed by BHEL cement concrete for bed, all round or in haunches shall be in the mix 1:4:8(1cement : 4 coarse sand :8 graded stone aggregate 40 mm nominal size):

Description	Upto 1.4 m Depth (5')	Upto 3 m Depth (10')	Beyond 3 m Depth (10')
Pipes in open ground (no sub soil water)	all round	in haunches	all round
RCC/C.I pipes in sub soil water	all round	in haunches	in haunches
RCC/C.I pipes (in all Conditions)	all round	in haunches	in haunches
RCC/C.I pipes under Road or building	all round	all round	all round

b. RCC pipes or CI pipes may be supported on brick masonry or precast RCC or in situ cradles. Cradles shall be as shown on the drawings.

c. Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings.

Measurement:

a. Excavation

Measurement for excavation of pipes trenches shall be made per linear meter.

b. Trenches shall be measurement 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 upto 1.5 metre or as given in the Bill of Quantities.

Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the Bill of Quantities and above the rate for depth upto 1.5 m.

c. RCC pipes shall be measured for length of the pipe line per linear meter.

i. Length between manholes shall be recorded from inside of one manhole to inside of other manhole.
ii. Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole.

3.2 **Cast Iron Class (LA) Pipe:**

All drainage line passing under building, floors and roads with heavy traffic shall be Cast Iron Class (LA) Pipe.

Cast Iron Class (LA) pipe shall be such that they could be cut, drilled or machined. Pipe centrifugally cast in unlined water cooled moulds shall be heat treated in order to achieve the necessary mechanical properties and to relieve casting stresses; provide that the specified mechanical properties are satisfied.

Material

Cast iron pipe shall be centrifugally spun cast iron pipes and conforming to IS:1536-1976.

Fittings

Fittings shall be used for Cast Iron Class (LA) Pipes shall conform to IS:1538-1976. Whenever possible junction from branch pipe shall be made by Wyes.

Laying

Fittings used for C.I drainage pipe shall conform to IS:1538-1976. Whenever possible junction from branches pipes shall be made by a Wyes.

All cast iron pipes and fittings shall be jointed with best quality soft pig lead (conforming to IS 782-1966) which shall be free from impurities. In wet trenches joints shall be made from lead wool. Nothing extra will be paid for lead wool joints. Depth of pig lead and weight for joints shall be as given in table below:

Lead caulked Joints with Pig Lead

The approximate depth and weights of Pig Lead for various diameters of C I pipes and specials shall be as follows:

Nominal Size of Pipe mm	**Lead per joint Kg**	**Depth of Lead Joint mm**
80	1.8	45
100	2.2	45
125	2.6	45
150	3.4	50
200	5.0	50
250	6.1	50

The spigot of pipe of fittings shall be centred in the adjoining socket by caulking. Sufficient turns of tarred gasket shall be given to leave a depth of 45 mm when the gasket has been caulked tightly home. Joining ring shall be placed round the barrel and against the face of the socket. Molten pig lead shall then be poured to fill the remainder of the socket. This shall then be done in one pouring. The lead shall then be solidly caulked with suitable tools and hammers weighting not less than 2 Kgs.

Measurement:

a. Excavation

Measurement for excavation of pipes trenches shall be made per linear meter.

b. Trenches shall be measurement 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 upto 1.5 metre or as given in the Bill of Quantities.

Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the Bill of Quantities and above the rate for depth upto 1.5 m.

c. C.I class (LA) pipes shall be measured for the length of the pipe line per linear meter i.e:

i. Length between manholes shall be recorded from inside of one manhole or inside of other manhole.

ii. Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole.

3.3 Salt Glazed Stoneware Pipes

Stoneware pipes shall be new and of First Class quality salt glazed and free from rough texture inside and outside and straight. All pipes shall comply with IS: 651 and have the manufacturers name marked on them.

Laying of Salt Glazed Stoneware 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 site. Each pipe shall be lightly struck 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 shall be segregated, marked in a conspicuous manner and their use in the works prevented by expeditiously removing them from the work site.

The pipes shall be laid with sockets leading uphill and shall 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 pipes laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried to low it shall be made up with cement concrete 1:4:8 (1 cement: 4 coarse sand: 8 stone aggregate 20mm nominal size) at the successful bidder's cost and charges

Jointing of Salt Glazed Stoneware 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 (1cement: 1 clear sharp washed sand). When the socket is filled, a fillet shall be of 45 degrees with the barrel of that 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 the inside of the joint with a suitable scarper of "badger". The newly made joints shall be protected until set, from the sun, drying winds, rain or dust. Sackling or other materials which can be kept damp shall be used. The joints shall be exposed and space left all around the pipes for inspection BHEL. 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.

S.W. Gully Trap

Gully trap shall be stoneware conforming to IS:651. These shall be sound and free from visible defects such as fire cracks, or hair cracks. The glaze of the traps shall be free from cracks. They shall give a sharp clear note when struck with light hammer. There shall be no broken blisters. Each gully trap shall have one CI grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a water tight CI cover with frame inside dimensions 300 x 300mm the cover weighing not less than 4.5 kg and the frame not less than 2.7kg. The grating cover and frame shall be of good casting and shall have truly square machined seating faces.

Fixing of S.W. Gully Trap

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

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

Measurements

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

4. CONSTRUCTION OF MANHOLE

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

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

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

Above the horizontal diameter, the sides of channel shall be extended vertically to the same level as the crown of the outgoing pipe and the top edge shall be suitably rounded off. The branch channels shall also be similarly constructed with respect to the benching but at their junction with the main channel an appropriate fall suitably rounded off in the direction of flow in the main channel shall be given. All manholes / sumps shall be provided with poly propylene coated steel reinforced foot rest. The polyproplene shall confirm to ASTM D-4101 specification, injection moulded around 12 mm dia IS-1786 grade FE-415 steel reinforcing bar. These rungs shall be set at 30cms interval in two vertical runs at 380mm apart horizontally. The top rung shall be 450mm below the manhole cover. Unless otherwise mentioned, manholes shall be constructed to the requirements of Indian Standard IS: 4111 (Part I). All manholes shall be constructed so as to be water tight under test. All angles shall be rounded to a 75mm radius with cement plaster 20mm thick. The benching at the side shall be carried out in such a manner so as to provide no lodgment for any splashing in case of accidental flooding. Manhole cover with frame shall be of cast iron of an approved make. The covers and frame shall generally be double seal as specified in the Bill of Quantities.

4.1 Measurements

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

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

i. Bed concrete
ii. Brick work.
iii. Plastering (inside & outside)
iv. R C C top slab, benching and channeling including drop connections.
v. Supply and fix foot rests.
vi. Keeping holes and embedding pipes for all the connections.
vii. Excavation, refilling, necessary de-watering and disposing off surplus soil to a place as directed by BHEL.

viii. Curing.
ix Cost of angle frame and embedding the frame in concrete bed.
x Testing.
xi De-watering of chambers.

4.2. **Drop Connection**

Drop connection shall be provided between branch sewer and main sewer in the main sewer itself in steep ground when the difference in invert level of two exceeds 60 cms of the required sizes. Drop connections from gully traps to main sewer in rectangular shall be made inside the manholes and shall have CI special types door bend on to top and heel rest bend at bottom connected by a CI pipe. The pipe shall be supported by holder bat clamps at 180 cms intervals with atleast one clamp for each drop connection. All joints shall be lead caulked joints 25mm deep.

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

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

4.3 **Making Connections**

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

6. TESTING

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

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 shall roll down the invert of the pipe and emerge at the lower end.

ii. means of a mirror at one end a lamp at the other end. If the pipe is straight the full circle of light will be seen otherwise obstructions or deviations will be apparent.

iii. The successful bidder shall give a smoke test to the drain and sewer at his own expense and charges, if directed by the BHEL representative.

v. A test register shall be maintained which shall be signed and dated by successful bidder and BHEL representative.

8. PIPE COLOUR CODE:

S.No.	Pipe Lines	Ground / Base Colour	First Colour Band	Second Colour 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	Hot Water	Sea Green	Light Grey	
4	Drainage	Black		
	Colour Code to Conform to IS:2379:1990			

PART-4 TECHNICAL SPECIFICATIONS
SECTION-4 CCTV ACCESS CONTROL

SECTION -1

SECURITY SURVELLIANCE (CCTV)

1. The Closed Circuit Television System is intended for comprehensive round the clock surveillance of the all entries, Service areas and perimeter of complex.

2. All closed Circuit Television system equipment covered in this specification shall comply with PAL standards.

3. The CCTV system shall be suited to the surveillance requirements and shall provide excellent performance through highly reliable equipments.

4. The system shall provide clear and sharp picture on monitors in all lighting conditions at any time of the day or night with minimum illumination level as specified.

5. All cameras shall be linked to monitors in the security control room through programmable video distribution / switching units, which shall enable operator to switch on any of the camera on any monitor. Pictures from various cameras locations shall be displayed on monitor in a programmed sequence and in short selectable time intervals with facility of automatic / manual selection.

6. The security and surveillance system shall be designed so as to enable recording of events for reviewing at a later date.

7. The DVRs have to be integrated with the existing Lenel Video Management Software installed in the server at BHEL House. The Pictures / Videos from various camera locations shall be accessible through PCs anywhere in the building (connected to the server) with the help of user login provided for the system.

SECTION – 2

ACCESS CONTROL SYSTEM

1.1 General:-

1.1.1 The access control and security management system shall be monitored and managed by the client / server (with Lenel make on-guard security management software), already installed in BHEL House.

1.1.2 The Dual Interface Module has to be integrated with the existing Lenel based Intelligent system controller (LNL-2220). Therefore the dual interface modules should be compatible with the existing Intelligent system controller installed in BHEL House.

1.1.3 The access control system for various areas of the Building is based on Smart Card Readers at specific locations.

1.1.4 The Security System shall provide the User with a facility to monitor remotely the entry to the building to observe and log the flow of both staff and visitors to the building. The design of the system shall be modular.

All component equipment items shall be readily removable from their normally installed location for the purposes of maintenance and adjustments. It shall be possible to replace critical components quickly and easily with spares held at the site.

1.2 Smart Card Reader

Using the 13.56 MHz technology platform, featuring crisp architectural styling, the reader has an elegantly curved faceplate. The high intensity, three color light bar provides clear, visual feedback even in direct sunlight. Selectable, distinct tone sequences indicate status conditions.

- Complies with the ISO 15693 standard for contact less smart card technology
- Typical Maximum Read Range: 2”-3”
- 2Kbits (256Bytes)
- UL certifed Polycarbonate
- Current Requirement: 80/300 mA @ 12 VDC
- Operating Temperature : -31º to 150º F (-35º to 65º C)

1.3 EM Lock

- Voltage Input : 12 VDC / 24 VDC (per Magnet)
- Holding Force : (Up to 600 lbs for Single Leaf)
- Holding Force : (Up to 1200 lbs for Double leaf)
- Operating Temperature : 0~55° C (32~131° F)
- Operating Humidity : 0~95% (non condensing)
- UL Listed

LIST OF APPROVED MAKES FOR BHEL OFFICE, NEW DLEHI

ACCESS CONTROL SYSTEM

S. No.	Items	List of Makes
1.	Dual Reader Interface module	Lenel
2.	Smart Card Reader	HID / Honeywell / GE / Schneider
3.	Electromagnetic Locks	BEL / Trimec / IR / Sprint / Faradays
4.	Panic Bar	Von-Duprin / Monarch / SB / Briton
5.	Copper Conductor Control Cable	Bonton / Lapp Cable / Fusion Polymer / RR Kabel / L&T
6.	Communication Cable / Signal Cable	Lapp Cable / Fusion Polymer / BELDON
7.	M.S. Conduit	BEC / VPL india
8.	GI Pipes	Tata / Prakash Surya / Jindal Hissar
9.	DWC Pipes	REX / Durex

Note: For any item not covered in the above list, the successful bidder shall get the sample approved from the consultant and BHEL before the commencement of supply. For items listed above, the successful bidder will indicate the proposed make out of the above and obtain the prior approval of BHEL before arranging the procurement.

LIST OF MAKES – CCTV

S. No.	Items	List of Makes
1)	DVR	Lenel
2)	Camera	Bosch / Pelco / Honeywell / GE
3)	LCD Monitor	IBM / Dell / HP/Samsung/ Sony
4)	Copper Conductor Control Cable	Bonton / Lapp Cable / Fusion Polymer / RR Kabel / L&T
5)	Communication Cable / Signal Cable	Lapp Cable / Fusion Polymer / BELDON
6)	M.S. Conduit	BEC / VPL India
7)	GI Pipes	Tata / Prakash Surya / Jindal Hissar
8)	DWC Pipes	REX / Durex

Note: For any item not covered in the above list, the successful bidder shall get the sample approved from the consultant and BHEL before the commencement of supply. For items listed above, the successful bidder will indicate the proposed make out of the above and obtain the prior approval of BHEL before arranging the procurement.

PART-4 TECHNICAL SPECIFICATIONS
SECTION-5 FIRE DETECTION & ALARM SYSTEM NETWORK

A. INTELLIGENT ADDRESSABLE FIRE ALARM SYSTEM

1. BASIS OF DESIGN

An Intelligent Fire Alarm System (IFAS) shall be provided to effect total control over the life safety services required in the building. The IFAS shall be of the digital, distributed processing, real time, multitasking, multi-user and multi-location type.

The IFAS provided shall be able to tie-up the following Mechanical, Electrical & Low Voltage Services into an integrated system.

a. Air Conditioning System

b. Staircase pressurization fans, Lift shafts and lift lobbies pressurization fans

c. Integration with Public address system – Voice Evacuation

d. Lifts

e. Pressurization Fans

f. Smoke evacuation system and Fire Dampers

The system shall be provided with Addressable and Analog fire alarm initiating, annunciating and control devices.

The addressable and intelligent system shall be such that smoke sensors, beam detectors, thermal sensors, manual call points etc., can be identified with point address. The system shall be capable of:

a. Setting smoke sensor sensitivity remotely (from the Fire Work Station Panel) to either high sensitivity manually or on a pre-programmed sequence e.g. occupied/unoccupied period. The FAS shall be able to recognize normal and alarm conditions, below normal sensor values that reveal trouble condition, and above normal values that indicate either a pre-alarm condition or the need of maintenance.

b. Being adjusted by the operator who shall be able to adjust alarm and pre-alarm thresholds and other parameters for the smoke sensors.

c. Providing a maintenance/pre-alert alarm capability at smoke sensors to prevent the detectors from indicating a false alarm due to dust, dirt etc.

d. Providing alarm verification of individual smoke sensors.

e. Providing local numeric point address and Indicating display of device and current condition of the point. Local annunciation shall not interfere with annunciation from the Fire Control System.

f. Providing outputs that are addressable, i.e. outputs shall have point address. The operator shall be able to command such points manually or assign the points to Logical Point Groups (Software Zones) for pre-programmed operation.

In the event of a fire alarm, but not in a fault condition, the following action shall be performed automatically.

a. The System Alarm Indication on the main fire alarm control panel shall flash.

b. A local piezo-electric sounder in the control panel shall be sounded.

c. The LCD display on the main fire alarm control panel shall indicate all information associated with Fire Alarm condition including the type of alarm point and its location within the premises.

d. History storage equipment shall log the information associated with the Fire Alarm Control Panel condition, along with the time and date of occurrence.

e. All system output programs assigned via control-by-event programs that are to be activated by a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

f. All lifts initiated through the systems will automatically be returned to Ground Floor.

g. Air Conditioning System on affected floors shall automatically be switched OFF and simultaneously respective fire dampers shall also be closed.

h. Shall give output for staircase pressurization fans to put on.

i. Shall give output for toilet exhaust fans on affected floors to put off.

j. Provide signal for public address system for playing pre-recorded alarm massage.

2. FIRE ALARM CONTROL PANEL (FACP)

2.1 The distributed Intelligent Fire Alarm Control Panel (FACP) shall function as fully stand-alone panel as well as providing a communication interface to the central station. FACP shall have its own microprocessor, software and memory and should be listed under UL. In the event of failure of the central or communication breakdown between the central station and the FACP, the FACP shall automatically operate on stand-alone mode without sacrificing any functions.

2.2 The memory data for panel configuration and operation shall reside in non-volatile memory (EEPROM). The card containing the memory shall have battery back-up for upto 100 hours on the board itself, if required.

2.3 FACPs shall supervise detection circuits and shall generate an alarm in case of abnormal condition.

2.4 FACPs shall provide general purpose inputs for monitoring such functions as low battery or AC power failure. FACPs shall provide tamper protection and commandable outputs, which can operate relays or logic level devices. Output commands shall take any of, but not limited to, maintained command, Momentary Command, Alarm Follow, or Alarm latch as required. Any relay in the FACP which is intended to be removable shall be supervised against removal.

2.5 Smoke detectors shall be powered using the FACP-based smoke detection circuits. FACPs shall provide for resetting smoke detectors, fault-isolation and sensor loop operation. It shall be possible to mix different fire devices within the same FACP to optimize field wiring.

2.6 FACPs shall provide indication for communication with the central console and alarm/trouble conditions in each sensor loops.

2.7 FACPs shall provide monitoring and control of one floor or area or for multiple floors or areas. FACPs shall meet the following requirements to assure the integrity and reliability of the system.

a. The FACP shall be UL listed independently as a fire alarm control panel.

b. FACP electronics shall be contained in an enclosure made of minimum 16 gauge steel. Access to FACP switches and electronics shall be by key-lock. Usage of no other tools should be required. Visual indicators of FSP status for each zone shall be visible without opening the key-locked cover.

2.8 All hardware and software to allow the FACP configuration and operation to be changed shall be provided. Memory data shall be contained in non-volatile memory (EPROM).

2.9 Alarm verification with field-adjustable time from 0 to 60 seconds for individual smoke detector shall be provided. During the alarm verification, the panel shall retard the alarm until the end of the period. If the alarm is only a transient smoke alarm, the panel shall automatically reset the alarm. Only a verified alarm shall initiate the alarm sequence for the software zone (Logical Point Group) or point. Final time setting shall be as per approval of the fire authorities.

2.10 Display at the FACP shall be provided to indicate point in alarm or trouble. In such systems, means for manually scanning the points in trouble shall be provided and a trouble and alarm LED shall be used to indicate that there are points in alarm/trouble. The alarm/trouble LED shall only extinguish when all alarm/troubles are cleared from the loop.

2.11 It shall be possible to command test, reset and alarm silence from both the FACP and the central console.

2.12 FACP switches shall allow authorized personnel to accomplish the following, independent of the central console :

a. Initiate a general alarm condition.

b. Silence the local audible alarm.

c. It shall be possible to acknowledge (Silence the local FACP audible without silencing the alarm indicating devices (hooters).

d. Reset all zones (Logical Point Group) / points, after all initiating devices have returned to normal.

e. Perform a complete operational test of the microprocessor and memory with a visual indication with each board.

f. Test all panel LEDs for proper operation without causing a change in the condition of any zone (Logical Point Group)

g. Walk Test

2.13 Software zones/loops shall be circuited and protected by Fault Isolation Modules such that in the event of a zone/loop short-circuit, not more than twenty (20) devices shall be left non-functional.

2.14 Intelligent Smoke and thermal sensors shall be located as shown and shall report sensed levels in analog form.

2.15 Monitor modules shall be provided to monitor and address contact-type input devices. The monitor module shall be supervised by FACP.

2.16 The FACP shall process the true continuous analog signal from the sensors. In addition, the FACP shall further process all analog values for pre-alarm limits to prompt the operator for early maintenance. If a sensor value increases to an above normal level or a pre-alarm limit for an extended duration, the FACP shall communicate maintenance pre-alarm.

a. Any time sensor value transitions beyond the secondary and higher limit value, an alarm initiation and report shall be issued.

b. Limits and sensor values shall be displayed, modifiable, and reported in decimal values.

c. The FACP shall have Drift Compensation facility to compensate for environment. The FACP shall have the ability to recalibrate Pre-alarm and Alarm limits if required, after comparing each sensor's operating characteristics with the set sensitivity. This should be carried out at least once in every 24 hours. FACP should annunciate trouble conditions when sensor(s) is beyond compensation range (excessively dirty sensor).

d. The FACP should be UL listed approved to provide the sensitivity measurement and documentation required by NFPA72E.

2.17 FACP shall be backed up by UPS power (By BHEL) and shall also be connected to central DG Power available in the building.

2.18 FACP shall be provided with following features :

Charger Rate Control

Control-by-Time	Non-Alarm Module Reporting
Day/Night Sensitivity	Periodic Detector Test
Device Blink Control	Remote Page
Drift Compensation	Trouble Reminder
NFPA 72 Sensitivity Test	Verification Counters
System Status Reports	Walk Test
Security Monitor Points	Maintenance Alert
Alarm Verification	System Configuration Report
Printer Interface	System Point Report
Event Historical log	Programmable Automatic Timed and Manual Signal Silence
Programmable Manual Signal	Control-By-Event with Boolean Logic Silence Inhibit Timer and Timer Control

2.19 FACP shall have real-time clock to prevent loss of time and date in case of failure of power supplies.

2.20 The display on FACP shall provide indication for AC Power, System Alarm, System Trouble/Security Alarm, Display Trouble and Signal Silence.

2.21 Minimum two different password levels will be provided to prevent unauthorized System control or programming.

2.22 Operator control switches for Signal Silence, lamp Test, Reset, System Test and Acknowledgement shall be provided.

2.23 The FACP should be truly field programmable with QWERTY keypad. This would mean that in the event of change of any logic, detector / zone sequence alteration, the operator can initiate the FACP panel to reconfigure the above parameters.

2.24 The FACP should have a degraded mode of operation. In the event of the CPU failure the field devices (detectors & modules) should be able to take a decision degrade mode to ensure reliability even during failure.

2.25 Power supply unit of FACP shall have following characters :

a. The main power supply shall be 230 VAC±10%, 50 Hz±1% and shall in turn provide all necessary power of the FACP.

b. It shall provide a battery charger for 24 hours for standby power using dual-rate charging technique for fast battery recharge.

c. It shall provide a very low frequency sweep earth fault detect circuit, capable of detecting earth faults on sensitive addressable modules.

d. It shall provide indication for battery voltage and charging current.

2.26 For ease of service, all wiring terminal blocks shall be plug-in type and shall have sufficient capacity for 18 to 12 AWG wire termination. Fixed terminal blocks shall not be acceptable.

2.27 INTERACTIVE FIRE FIGHTERS' DISPLAY PERFORMANCE

The network will interface and report the individually monitored system's alarm status via a user-friendly Screen 19 inch Graphical User Interface (GUI) based software.

The software shall operate under Microsoft® Windows® XP Embedded platform as manufactured by Microsoft Corporation.

The GUI based software must be capable of graphically representing the facility being monitored with floor plans and icons depicting the actual locations of the fire alarm device locations.

The software shall use a 1280 pixel x 1024 pixel GUI display capable of showing a large primary floor plan display, a site plan representative of an aerial view of the facility, the first active fire alarm on the system.

The software shall permit automatic navigation to the screen containing an icon that represents the first fire alarm device in alarm in the event of an off-normal condition.

The fire alarm device icon shall be visible only when it is in an alarm (or active) condition.

The software shall display the activated smoke detectors in a time sequence to track smoke progression.

The software shall allow the importation of externally developed floor plans in Windows Metafile (WMF), JPEG (JPG), Graphics Interchange Format (GIF) and Bitmap (BMP) format.

The software shall provide an intuitive and easy way to navigate to different screens representing floors and areas within a facility.

The system shall provide for continuous monitoring of all fire alarm conditions regardless of the current activity displayed on the screen.

The software shall display "YOU ARE HERE" along with icons representing standard building objects (stairs, elevators, etc) to be shown on the floor plan.

The software shall allow icons that represent hazardous materials stored in a facility.

The software shall provide a screen that displays preprogrammed building contact information.

The software shall provide a screen that displays building occupancy and other general building information.

The software shall allow a site plan to be imported that shows an aerial view of the facility.

The Software shall provide a facility for sending alarm text from configured points to alphanumeric pagers, Digital mobile phones with text message (SMS) support Email SNMP message.

The software shall display all active fire, supervisory, and security events within an event list.

The entire unit including cabinet shall be UL listed.

3. DETECTORS & ADDRESSABLE DEVICES

3.1 GENERAL FEATURES COMMON TO ALL DETECTORS

a. Compatibility: All automatic fire detectors shall be inter-changeable without requiring different mounting bases or alterations in the signal panel.

b. Sensitivity: On average 30 mgs of burned material per cu.m. (as measured in a 1 cu.m. chamber or 0.5% obs/ft) shall release an alarm sensitivity which shall be adjustable according to the use of the space.

c. Power Consumption: Each detector shall use the minimum of power, for economic circuits, so that it shall have capacity to connect at least 250 devices (125 detectors+125 devices) in one loop.

d. Built-in-response indicator: Each detector shall incorporate indicator “LED” at the detector which shall blink during normal condition and light up on actuation of the detector to locate the detector which is operated. The detector shall not be affected by the failure of the response indicator lamp.

e. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.

e. Maintenance: All detectors shall be fitted either with plug-in system or bayonet type connections only, from the maintenance and compatibility point of view.

f. Construction: The detector shall be vibration and shock proof. When disassembling for cleaning purposes, its components must not be damaged by static over voltage.

g. Atmospheric and Thermal Disturbance: The detector shall so designed as to be practically immune to environmental criteria such as air currents, humidity, temperature fluctuations and pressure and shall not trigger false alarm, due to the above conditions.

h. Continuous Operation: An alarm release shall not effect a detector’s functioning. After resetting the alarm, the detector shall resume operation without any readjustment.

i. Adaptability to ambient conditions: Detectors shall be designed for adaptability to humid locations. No performance deterioration shall be acceptable.

3.2 ADDRESSABLE PHOTOELECTRIC SMOKE DETECTORS

Smoke detectors shall be intelligent and addressable devices, and shall connect with two wires to one of the Fire Alarm Control Panel loops. Minimum to 128 intelligent detectors should connect to one loop. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog value for smoke density. The detectors shall be ceiling mounted type and shall include a twist-lock base.

The detectors shall provide a magnetic test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test shall be activated remotely on command from the control panel.

The detector shall continuously monitor any changes in sensitivity due to environment affect of dust smoke temperature changing and humidity.
The detectors shall compensate for dust accumulation and other slow environmental changes which may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.

The area covered by each smoke detector shall be as per IS-2189.

3.3 BEAM DETECTOR

Addressable Beam detectors shall be consist of a Single unit transmitter and receiver with reflector plate capable of being powered together installed where the height exceeds 10 meters or single unit containing Transmitter and receiver. Beam Detectors are microprocessor based devices consisting of a separate transmitter and receiver suitable to protect a linear distance of 75 m in length and spaced 15 m apart. Sensitivity selectable at 55% total obscurations. It shall be with built-in automatic gain control compensate for the gradual deterioration of signal strength from dust accumulation, component ageing and temperature fluctuations. The conventional beam detectors with monitor module are not accepted.

3.4 ADDRESSABLE MULTI CRITERIA DETECTOR

The intelligent multi criteria detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.

The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).

The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the

characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

An output connection shall be provided in the base to connect an external remote alarm LED.

3.5 ADDRESSABLE MANUAL STATIONS

Addressable manual stations shall be provided to connect to the Fire Alarm Control Panel loops. Minimum 125 addressable manual stations may be connected to one loop.

The manual stations shall on command from the Control Panel send data to the panel representing the state of the manual station.

Stations shall be suitable for surface mounting as shown on the plans, or semi-flush mounting, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor unless otherwise specified by applicable building codes.

3.6 ADDRESSABLE MONITOR MODULE

The monitor module shall provide address-setting and shall also store an internal identifying code which the Fire Alarm Control Panel shall use to identify the type of device. Modules using binary jumpers are not acceptable. An indication shall be provided which shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

3.7 RESPONSE INDICATOR

In addition to built-in response indicator in each detector. Secondary response indicator of LED type shall be provided outside the rooms wherever asked for by the Architect/ BHEL, for indication of fire through detector in the room. The design & colour shall be as per Architect/ BHEL ‘s approval.

3.8 CONTROL MODULE

The control module shall provide address-setting and shall also store an internal identifying code which the control panel shall use to identify the type of device. Modules which use binary jumpers are not acceptable. An indication shall be provided which shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel.

3.9 ADDRESSABLE HOOTERS

All field hooters should preferably be addressable and software configurable. All hooters should be able to provide at least a minimum of 3 different tones, which should be user configurable. The minimum decibel level of each hooter should be 90dB. All hooters should be UL listed.

3.10 PROGRAMMABLE ELECTRONIC EXIT POINT DIRECTIONAL SOUNDERS:

Electronic sounders shall operate on 24 VDC nominal in compliance with Directional sounder definition given in NFPA 72.

Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dB measured at 10 feet from the device.

Shall be flush or surface mounted as shown on plans.

Shall produce broad band directional sound to guide occupants to safe exists even in complete darkness.

Strobe lights shall meet the requirements of the UL be fully synchronized, and shall meet the following criteria:

The maximum pulse duration shall be 2/10 of one second. Strobe intensity shall meet the requirements of UL. The flash rate shall meet the requirements of UL. Field Wiring Terminal Blocks

For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for 12 AWG or 4 sq mm wire. Terminal blocks that are permanently fixed are not acceptable.

3.11 NETWORK FACP PANEL (NFP)

A network control annunciator shall be provided to display all system intelligent points. The NFP shall be capable of displaying all information for all points on the network.

The NFP shall include a minimum of 480 characters, backlit by a long life, solid state LCD display.
Each remote panel in the installed system shall include remote Control and Display Annunciators. These annunciators shall have integral qwerty keypad in membrane style, tactile push-button control switches for the control of system functions, and LEDs with programmable (software-controlled) flash rates and slide-in labels for annunciation of system events.

- The Remote Control Display Annunciators shall provide the system with individual zone and / or device annunciation.

- The Remote Control Display Annunciators shall provide the system with individual zone and / or device annunciation with zone and / or device disable.

- The Remote Control Display Annunciators shall provide the system with individual alarm and trouble annunciation per zone and / or device with zone and / or device disable. The Remote Control Display Annunciators shall provide the system with groups of three switches that have software controlled interlock to allow only one of the switches to be active at any time. The switch triads shall be used for all of the manual zone/floor paging operations in the protected premises.

- The Remote Control and Display Annunciators shall be provided to provide the system with groups of three switches that have software controlled interlock to allow only one of the switches to be active at any time. The switch triads shall be used for all of the fan and damper controls in the protected premises.

4. FUNCTIONAL REQUIREMENTS

4.1 INTELLIGENT SYSTEM DEVICES

a. Each device shall be assigned a unique address via electronic addressing. Address selection via rotary switch are also acceptable.

b. Devices shall receive power and communication from the same pair of conductors.

4.2 SENSORS

a. All fire sensors shall mount on a common base to facilitate the changing of sensor type if building conditions change.

b. Each sensor shall contain an LED which shall blink each time the sensor is scanned by the FACP. If the FACP determines that the sensor is in alarm, the FACP shall command the sensor LED to get latched on.

c. Each sensor shall be capable of being tested for alarm via command from the FACP.

d. Each sensor shall respond to FACP scan for information with its type identification to preclude inadvertent substitution of another sensor type. The FACP shall continue operation with the detector installed but shall initiate a mismatch (trouble) condition until the proper detector is insta lled.

e. Each sensor shall respond to FACP scan for information with an analog representation of measured fire-related phenomenon (smoke density, particles of combustion, temperature). Systems which only monitor the presence of conventional detector in an addressable base shall not be acceptable.

4.3 INPUT DEVICES

a. The input device shall provide an addressable input for N.O. or N.C. contact devices such as manual stations etc.

b. The input device shall provide a supervised initiating circuit. An open-circuit fault shall annunciate at the FACP (subsequent alarms shall be reported).

c. The device shall contain an LED which will blink upon being scanned by the FACP. Upon determination of an alarm condition, the LED shall be latched on.

4.4 AUTOMATIC FUNCTIONS AT FACP

The alarms shall be displayed at the FACP on an LCD display. The display shall indicate the device in alarm by ID number, the appropriate alarm state, and the current time and date. It shall also display a point description of minimum 32 characters and, the respective analog value. The display shall also contain a minimum 40 characters alarm message. It shall be possible to see the number of acknowledged alarms, number of current fire alarms, number of trouble conditions and number of other miscellaneous alarms in the system. The FACP printer shall print out same information displayed on the LCD display. The LCD display and printer shall be powered directly from the panel.

4.5 MANUAL FUNCTIONS AT FACP

i. At any given time, operator shall have the following manual capabilities at FACP by means of switches located behind a key-locked cover:

   a. Initiate an alarm summary display on the FACP LCD display. This display shall step through all currently active alarms in the system.

   b. Initiate a summary printout of all currently active alarms on the FACP printer.

   c. Initiate an “all-point summary” printout on the FACP printer recording the status of each system point (initiating circuits, indicating circuits etc.)

   d. If the alarm is ignored by an operator then the history of the same to be available.

ii. At any time, the operator shall have following manual capabilities at the FACP under password control; Operator privileges and ID numbers of upto four digits shall be assignable by the main operator or by a designated alternate. Actions taken by operators shall automatically be printed on the FACP printer with operator initials, time and date.

   a. Commands output points to different mode. Such commands shall be printed with selected descriptors ON/OFF/AUTO, OPEN/CLOSE, DAY/NIGHT etc. In addition, command shall be used to ISOLATE or DISCONNECT points. When isolated, alarms and troubles shall be received but not acted upon.

   b. Modify system parameters. Alphanumeric key pad shall be provided for operators to modify the following parameters :

      - Change sensor alarm and pre-alarm threshold
      - Update date and time
      - Change point descriptors
      - Change action message
      - Disable a point
      - Change sensor verification time
      - Change password
      - Activate/deactivate indicating output control point
      - Control-by-event programs on line

c. Select a system status report for printing on the printer from the control station. The following real time reports shall be provided:
- All point log
- Alarm summary
- Trouble summary
- Status summary
- Sensitivity log
- Disabled points log
- Isolated points log
- Disconnected points log
- Logical group points log

The sensitivity log shall print the analog value of each addressable analog sensor.

d. Select printing of a trend sensitivity log which when enabled, shall print minimum last 24 analog values for every addressable analog sensor taken at predetermined intervals. Systems which limit the number of addressable analog sensors which can be trended are not acceptable.

e. Select a sequence of programmed commands which can be automatically executed, in sequence, via a single command.

f. Perform a walk-test function such that an operation can be periodically checked out for all initiating devices on a zone. In walk test mode, all initiators on the selected zone shall automatically be isolated. As each device is placed into an alarm or trouble condition, the FACP shall print the condition and automatically reset the device. No audible signals shall be initiated from the zone to prevent disruption of building occupants. If a zone is inadvertently left in the walk-test mode, it shall automatically reset to normal after a five-minute idle time is exceeded.

4.6 **SYSTEM SUPERVISION**

a. In the normal supervisory condition, only the “POWER” ON, and “RUN” conditions, shall be illuminated. The LCD display shall display “System Normal” and the current time and date.

b. The LCD display shall indicate the loss of power condition and the printer shall record the same. Following restoration of normal AC power, the trouble indicators shall be automatically reset and the printer shall record the ‘return to normal condition’.

c. The LCD display shall indicate the loop in trouble and the printer shall record same.

d. The LCD display shall indicate trouble and the printer shall record same. Operation of a momentary “Silence” switch shall silence the audible trouble signal but the visual “Trouble” LEDs shall remain ON until the malfunction has been corrected and the system has reset. The FACP printer shall record this action.

4.7 PROGRAMMING OF FACP

The LCD display and printer programming shall be accomplished on site by means of QWERTY keypad inbuilt in panel. Modules requiring off-site programming are not acceptable. LCD shall initiate test of all addressable sensors in the system.

Programming functions shall include alarm/trouble type assignment, point descriptor assignment, alarm message assignment etc. Data file for the LCD display and a printer shall be stored in EEPROM.

4.8 OTHER DEVICES

Fault-isolation of fire zones (Logical Point Group) / circuit modules shall be provided to enable part of a fault-tolerant loop to continue operating when a short occurs in the loop.

4.9 FIRE ALARM SYSTEM (FAS) SOFTWARE

The status of each detector shall be monitored by the FAS.

Using the FAS, the operator shall be able to adjust the sensitivity of any detector.

Using the FAS, the operator shall be able to define the entire database for the file system. Fire system which are not field programmable shall not be accepted.

The FAS operator shall be able to acknowledge alarms or trouble messages at the FAS.

It shall be necessary for all alarm or trouble conditions to be acknowledge at the fire system central panel.

FAS software shall be of upload/download type as well as with graphic facilities. The

successful bidder shall list out the graphic facilities being provided by him.

All devices & detectors shall be visible on building plans superimposed in FAS software.

FIRE CONTROL SEQUENCES

Upon activation of a fire alarm device:

FACP will display the exact address & alarm in the panel.

The Central Control Station shall switch OFF the AHUs of the affected floor fire damper and toilet exhaust fans while the AHUs on the other floors shall remain operational so as to keep the area under positive pressure.

Staircase pressurization fans shall be operated through the fire alarm system.

Appropriate fire messages shall start to broadcast automatically (synthesized voice) after time delay through PA system.

The lifts and escalators alarms shall also be tied to the Fire Alarm System. The Fire Alarm System shall function as follows:

In the event of a fire, a signal will be provided by the Fire Alarm System to return all lifts to ground floor.

Should an emergency alarm originate from an individual lift, an audible alarm shall sound at both Fire Control Stations.

When an alarm is detected

- All include annunciating devices on the floor one above and one below shall sound.
- Stairwell pressurization fans shall be started.
- The air handling unit for the floor shall be stopped.
- The air handling unit on the floor above and the floor below shall be started, (unless those floors are also in alarm).
- Smoke extraction.

If the alarm has not been acknowledged at the central panel within one minute, all audible annunciating devices on the floor above and the floor below shall sound.

It the alarm has not been acknowledged at the central panel within three minutes, all audible annunciating devices on the building shall sound.

It shall be possible to accomplish the following, independent of the central console:

a. Initiate a general alarm condition.

b. Silence the local audible.

c. Silence the alarm signals. It shall be possible to acknowledge (silence) the local FACP audible without silencing the alarm indicating devices (hooters).

d. Reset all zones, after all initiating devices have returned to normal.

e. Perform a complete operational test of the microprocessor and memory with a visual indication of satisfactory communication with each board.

f. Test all panel LED's for proper operation without causing a change in the condition of any zone.

g. Print reports of all points based on Historical data.

h. Read the status of each point based on LCD display and print the status information.

i. Change passwords.

j. Disable points/zones.

k. Change sensitivity of sensors.

l. Perform a walk test and generate walk test report.

5. ASPIRATING SMOKE DETECTION SYSTEM FOR HIGH CEILING AREA

5.1 SCOPE OF WORK

5.1.1. The successful bidder shall also make provision in the Aspirating Smoke Detectors to trip AHU and to shut fire dampers in the event of fire through the relay contacts.

5.2 CODES AND STANDARDS

The entire installation shall be installed to comply one or more of the following codes and standards:

NFPA Standards, US

British Standards, BS 5839 part:1

5.3 APPROVALS

All the equipments shall be designed, tested, approved, and/or listed by: LPCB

UL (Underwriters Laboratories Inc.), US

5.4 DESIGN REQUIREMENTS

5.4.1 It shall have a display featuring LEDs and Reset/Isolate button. The system shall be configured by a programmer that is either integral to the system, portable or PC based.

5.4.2 The system shall allow programming of:

a) Multiple Smoke Threshold Alarm Levels.

b) Time Delays.

c) Faults including airflow, detector, power, filter block and network as well as an indication of the urgency of the fault.

d) Configurable relay outputs for remote indication of alarm and fault conditions.

5.4.4 It shall consist of an air sampling pipe network to transport air to the detection system, supported by calculations from a FM approved computer-based design modeling tool. Maximum transport time shall not exceed 90 seconds, and designed within the certification requirements of relevant approvals as per Clause 5.3.

5.4.5 Optional equipment may include intelligent remote displays and/or a high level interface with the building fire alarm system and a dedicated System Management graphics package.

5.4.6 Performance Requirements

a) Shall provide very early smoke detection and provide multiple output levels corresponding to Alert, Action, and Fire 1 & 2. These levels shall be programmable and shall be able to set sensitivities ranging from 0.005 – 20% obscuration / meter.

b) Shall report any fault on the unit by using configurable fault output relays or via the graphics Software.

c) Shall monitor for filter contamination automatically.

d) Shall incorporate a flow sensor in each pipe and provide staged airflow faults.

e) Shall have a clean air supply to maintain Laser chamber clean all the time.

5.5 MATERIALS AND EQUIPMENTS

5.5.1 Both Light Scattering and Particle Counting shall be utilized in the device as follows:

The Laser detection Chamber shall be of the mass Light Scattering type and capable of detecting a wide range of smoke particle types of varying size. A particle counting method shall be employed for the purposes of:

a) Preventing large particles from affecting the true smoke reading.

b) Monitoring contamination of the filter (dust & dirt etc.) to notify automatically when maintenance is required.

5.5.2. The Laser Detection Chamber shall incorporate a separate secondary clean air feed from the filter; providing clean air barriers across critical detector optics to eliminate internal detector contamination.

5.5.3 The detector shall not use adaptive algorithms to adjust the sensitivity from the set during commissioning. A learning tool shall be provided to ensure the best selection of appropriate alarm thresholds during the commissioning process.

5.6 DETECTOR ASSEMBLY

5.6.1 The Detector, Filter, Aspirator and Relay Outputs shall be housed in a mounting box and shall be arranged in such a way that air is drawn continuously from the fire risk area by the Aspirator and a sample passed through the Dual Stage Filter and then to the detector.

5.6.2 The detector shall be LASER-based and shall have an obscuration sensitivity range of 0.005 – 20% obscuration per meter.

5.6.3 The detector shall have four independent field programmable smoke alarm thresholds across its sensitivity range and also capable of detecting oxygen etc. if required by addition of modules.

5.6.4 The Detector shall also incorporate facilities to transmit the following faults

a) Detector
b) Airflow
c) Filter
d) System
e) Zone
f) Network
g) Power
h) Urgent and Minor faults. Minor faults shall be considered as servicing or maintenance signals. Urgent fault shall indicate that the unit may not be able to detect.

5.6.5 The detector shall have four pipe inlets which must contain a flow sensor. Both Minor and Urgent flow faults shall be reported.

5.6.6 The filter must be a two-stage disposable filter cartridge. The first stage shall be capable of filtering particles in excess of 20 microns from the air sample. The second stage shall be ultra-fine, removing more than 99% of contaminant particles of 0.3 microns or larger, to provide a clean air barrier around the detector's optics to prevent contamination and increase service life.

5.6.7 The aspirator shall be a purpose-designed rotary vane air pump. It shall be capable of allowing/ supporting for a single pipe run / multiple sampling pipe runs with a transport time of less than 90 seconds.

5.6.8 The Assembly must contain relays for fire alarm and fault conditions. The relays shall be software programmable (latching or non-latching). The relays must be rated at 2A at

30V DC. Remote relays shall be offered as an option and either configured to replicate those on the detector or programmed differently.

5.6.9 The Assembly shall have built-in event and smoke logging. It shall store smoke levels, alarm conditions, operator actions and faults. The date and time of each event shall be recorded. Each detector (Zone) shall be capable of storing up to minimum 18,000 events.

5.7 DISPLAYS ON THE DETECTOR ASSEMBLY

5.7.1 The detector shall have a LED / LCD / Bar graph display for the multiple alarm threshold levels indicated and faults such as detector fault, airflow fault and indication to Isolate and Reset.

5.8 PROGRAMMERS

5.8.1. When required, a Programmer module may be located within the detector, a remote mounting box, or in a portable hand-held unit.

5.8.2. Each Programmer at a minimum shall support the following features:

a) Programming of any device on the system.

b) Viewing of the status of any device in the system.

c) Adjustment of the alarm thresholds of a nominated detector.

d) Setting of Day/night, weekend and holiday sensitivity threshold settings.

e) Initiation of AutoLearn, to automatically configure the detectors alarms threshold settings to suit the current environment.

f) Multi-level password control.

g) To Program latching or non-latching relay operation.

h) To Program energizing or de-energizing relays.

i) To Program high and low flow settings for airflow supervision.

j) To Program aspirator speed control.

k) To Program maintenance intervals.

l) Facilities for referencing with time dilution compensation.

m) Testing of relays assigned to a specific zone to aid commissioning.

5.9 NETWORK

5.9.1. The devices in the smoke detection system shall be capable of communicating with each other via twisted pair RS485 cable. The network shall be able to support up to 250 devices (detectors, displays units and programmers), of which at least 100 detectors can be supported if required.

5.9.2. The network shall be capable of being configured in a fault tolerant loop for both short circuit and open circuit. Any communication faults shall be reported unambiguously and shall be clearly attributable to an individual device or wire link in the fault messages.

5.9.3. PC based configuration tools shall be available to configure and manage the network of detectors.

5.9.4 Digital Communication Port shall comply with EIA RS485 Protocol.

5.10 SYSTEM MANAGER GRAPHIC SOFTWARE FOR COMPLETE MONITORING AND CONTROL OF VERY EARLY WARNING SMOKE DETECTION SYSTEM:

The software package shall centrally monitor and configure very early warning smoke detection and fire protection systems in multiple local or remote locations.

The software package shall be compatible with smoke detection and fire protection systems that are approved by global approvals bodies and meet all local codes, standards and regulations.

The software shall consist of monitoring and configuration components:

- The configuration component shall allow users to configure all detectors remotely by using a connected PC.
- The monitoring component shall allow users to monitor individual detectors, multiple detectors connected via a HLI or multiple HLIs.

5.10.1 System Description

5.10.1.1 Access and Usability

The software shall support local and remote password-based access control:

- Three local password-protected levels of software access: designer, user and administrator.
- Multiple user accounts with unique user-ID and password based access control.
- Remote password-management of remote fire networks
- The software shall have a user-friendly graphics user interface.
- The software shall support cut and paste functionality for common tasks.
- The software shall provide support for multiple languages including English
- The software shall support translations of messages from one supported language to another.
- The software shall support disk space monitoring.

5.10.1.2 **Monitoring Functionality**

The software shall have the capacity to monitor multiple connections:

- The software shall enable one or more workstations to monitor and configure multiple detector systems in multiple buildings and multiple sites.
- The software shall provide an event list that provides a single integrated view of all events (faults/troubles and alarms) across multiple sites.
- The software shall prioritize all events presented in the event list according to logical precedence rules.
- The software shall allow management of all events from the event list including acknowledgement of events and resetting of devices.
- The software shall allow colors to be assigned to different event types.
- The software shall allow printing of event lists.

The software shall be able to provide an all-in-one monitoring solution:

- Using standard RS232 ports (or Ethernet) on existing and future monitoring and control systems, PCs using the software shall connect to and interpret status change data transmitted from the ports and provide graphic annunciation, control, history logging and reporting as specified herein.
- Network systems that cannot interface to Network systems or systems requiring the use of a “dry contact” or “voltage monitoring” interfaces to connect to Network shall not be accepted.

The software shall be able to connect to multiple remote sites via IP-based LAN or WAN using virtual serial port emulation.

The software shall communicate with one or more N*etwork*-compliant detectors via a high level interface (HLI) natively using the Network protocol without the necessity for using protocol translation or other communications equipment. The software shall be able to monitor up to 250 devices. The software shall be compatible with 4 alarm levels:

- **Alert** (Alarm Level 1) – may be used to activate a visual and audible alarm in the fire risk area.
- **Action** (Alarm Level 2) – may be used to activate the electrical/electronic equipment shutdown relay and activate visual and audible alarms in the Security Office or other appropriate location.

- **Fire 1** (Alarm Level 3) – may be used to activate an alarm condition in the Fire Alarm Control Panel to call the Fire Brigade and activate all warning systems.

- **Fire 2** (Alarm Level 4) – may be used to activate a suppression system and/or other suitable countermeasures (e.g. evacuation action or shutdown of systems).

The software shall allow importation of .wav files for event notification.

The software shall have a text-to-speech option to allow natural language annunciation of all faults and alarms:

- The text-to-speech component of the software shall use Nuance's RealSpeak speech engine.

- The text-to-speech functionality shall be available in a number of different languages.

The software shall support sophisticated floor plan development and management functionality:

- The software shall enable floor plan drawings to be used in the software to graphically notify users where a smoke event is occurring in their monitored system.

- The software shall allow development of multiple levels of interconnected floor plans.

- The software shall allow importation of AutoCAD, jpg, bmp and other common image files

- The software shall include software to allow designers to create and manipulate CAD images for incorporation in meaningful context-sensitive multi-level floor plans.

The software shall allow for multiple device smoke trending on a single graph.

The software shall support printing on a printer such as a line printer that supports Unicode.

The software shall support sophisticated event log management functionality:

- Event logs from all networked detectors shall be able to be retrieved and viewed.

- Event logs for each monitored site and/or combined event logs for multiple sites.

- Event logs shall be able to be archived and sorted.

- Total event integration, consolidation and archiving across multiple networks shall be provided. All system, network and device events shall be stored in an ODBC-compliant database.

A remote notification facility shall enable the use of email (or SMS) to provide immediate and up-to-date information the system's operational status irrespective of location.

The software shall enable presentation of unique customised corporate response procedures upon occurrence of specific events in defined parts of the facility

5.10.1.3 **Configuration Functionality**

The software shall allow configuration of all models of detectors:

- Full remote programming of all detector functions.
- Saving of detector configurations for safe storage.
- The software shall allow creation of off-line configurations for all such detectors and allow a merging and comparison with off-line configuration with on-line configurations.

5.11 SAMPLING PIPE

5.11.1 The sampling pipe shall be smooth bore with an internal diameter between 15-25 mm. normally; pipe with an outside diameter of 25mm and internal diameter of 21mm should be used.

5.11.2 The pipe material should be suitable for the environment in which it is installed, or should be the material as required by the specifying body.

5.11.3 All joints in the sampling pipe must be air tight and made by using solvent cement, except at entry to the detector.

5.11.4 The pipe shall be identified as Aspirating Smoke Detector Pipe along its entire length at regular intervals not exceeding the manufacturer's recommendation or that of local codes and standards.

5.11.5 All pipes should be supported at not less than 1.5m centres, or that of the local codes or standards.

5.11.6 The far end of each trunk or branch pipe shall be fitted an end cap and drilled with a hole appropriately sized to achieve the performance as specified and as calculated by the system design.

5.12 SAMPLING HOLES

5.12.1 Sampling Holes of 2mm, or otherwise appropriately sized holes, shall not be separated by more than the maximum distance allowable for conventional detectors as specified in the local codes & standards. Intervals may vary according to calculations.

5.12.2 Each sampling point shall be identified in accordance with Codes or Standards.

5.12.3 Consideration shall be given to the manufacturer's recommendations and standards in relation to the number of Sampling Points and the distance of the Sampling Points from the ceiling and roof structure and forced ventilation systems.

5.13 INSTALLATION

5.13.1 The Successful bidder shall install the system in accordance with the manufacturer's recommendation.

5.13.2 Where false ceilings are available, the sampling pipe shall be installed above the ceiling, and Capillary Sampling Points shall be installed on the ceiling and connected by means of a capillary tube.

5.13.3 The minimum internal diameter of the Capillary tube shall be 5mm, the maximum length of the capillary tube shall be 2m unless the manufacturer in consultation with BHEL has specified otherwise.

5.13.4 The Capillary tube shall terminate at a ceiling Sampling Point specifically approved by BHEL. The performance characteristics of the sampling points shall be taken into account during the system design.

5.13.5 Air Sampling Piping network shall be laid as per the approved pipe layout. Pipe work calculations shall be submitted with the proposed pipe layout design for approval.

5.14 TESTING

5.14.1 Commissioning Test

5.14.1.1 Commissioning of the entire installation shall be done in the presence of a representative of BHEL.

5.14.1.2 All necessary instrumentation, equipment, materials and labour shall be provided by the Successful bidder.

5.14.1.3 The Successful bidder shall record all tests and system calibrations and a copy of these results shall be retained on site in the system Log Book.

5.14.2 Functional Test

5.14.2.1 Introduce Smoke into the Detector Assembly to provide a basic functional test.

5.14.2.2 Introduce smoke to the least favourable Sampling Point in each Sampling Pipe. Transport time is not to exceed 90 Sec's.

LIST OF APPROVED MAKES OF MATERIALS FOR

FIRE ALARM & DETECTION WORK

1.	Copper conductor PVC Insulated wires & Cables including telephone cables.	1. Skytone 2. RR Kabel 3. Finolex 4. Polycab 5. Lapp Cable 6. Bonton 7. Havells
2.	Addressable Multicriteria Smoke/ Laser / OT blue / Heat Detectors with base	1. Edwards 2. Simplex 3. Notifier
3.	Fault Isolator with base	1. Edwards 2. Simplex 3. Notifier

4.	Response Indicator	1. Edwards 2. Simplex 3. Notifier
5.	Addressable Manual Call points	1. Edwards 2. Simplex 3. Notifier
6.	Addressable Control Module	1. Edwards 2. Simplex 3. Notifier
7.	Addressable Monitor Module	1. Edwards 2. Simplex 3. Notifier

8.	Sounder/ Hooter cum Strobe	1. Edwards 2. Simplex 3. Notifier
9.	Fire Alarm Control Panel	1. Edwards 2. Simplex 3. Notifier
10.	PA System Panel	1. Edwards 2. Simplex 3. Notifier
11.	Telephone Jack / Hand Set	1. Edwards 2. Simplex 3. Notifier

12.	Software	1. Edwards 2. Simplex 3. Notifier
13.	Speaker	1. Edwards 2. Simplex 3. Notifier
14.	Fire survival cable,	1. Bonton 2. Fr Tec
15.	Maintenance free batteries	1. Exide 2. Standard 3. Amron

16.	M.S. Conduit	1. B.E.C. 2. VPL India
17.	PC	1. DELL 2. IBM 3. HP
18.	Laser Jet Printer	1. HP 2. Cannon

NOTES:

1. The Successful bidder shall get the samples of all the items, approved from BHEL before commencing the supply.

SECTION-IV

TECHNICAL SPECIFICATION FOR AIR-CONDITIONING WORK

The installation of the VRV/VRF system should be undertaken through OEM certified agencies only.

1. SCOPE OF WORK

1.1 The supply at site of all main equipments and items associated with air-conditioning & ventilation system detailed under these technical specifications.

1.2 To execute all incidental work at site including all material supply at site required in the technical specifications. Nature of such works will be sheet metal duct/grill work, refrigerant piping work for VRF/VRV etc. all electrical work connected with HVAC such as cables, control panel, electric panels etc., erection at site for all manufactured items at works and also items fabricated at site.

1.3 Routine testing, pressure testing of fabricated components, commissioning of complete plant at site.

1.4 Performance testing at works of various equipments manufactured at works.

1.5 Performance testing at the site of complete HVAC system as per various technical requirements.

2. SYSTEM DESIGN:

A. DESIGN PARAMETERS:

To air-condition the proposed building following design parameters have been assumed:

a) Outside conditions:

i) Summer

DB	105.0 °F
WB	74.84 °F

ii) Monsoon

DB	92.0 °F
WB	82.4 °F

iii) Winter

DB	44.78 °F
WB	43.34 °F

iv) Lighting load : As indicated in heat load calculation summary sheets.

v) Occupancy : As indicated in heat load calculation summary sheets.

b) Inside conditions: As indicated in heat load calculation summary sheets.

Selection of Equipment:

The equipment selection is based on the heat load calculation summary sheet:

HEAT LOAD SUMMARY								
BASIS OF DESIGN				DESIGN DATA SUMMARY				
S. NO.	CONDITIONED SPACE	ACTUAL AIR CONDITIONED AREA	HEIGHT	SUMMER LOAD	MONSOON LOAD	SUMMER DEHUMIDIFIED CFM	MONSOON DEHUMIDIFIED CFM	REQUIRED FRESH AIR QTY
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
		S.FT	FT.	TR	TR	CFM	CFM	CFM
1	**Basement Floor**							
1.1	Bank	100	8.0	0.59	0.70	182	132	63
1.2	Bank reception	75	8.0	0.70	0.83	243	206	63
1.3	Health Club	730	8.0	4.22	5.35	1373	1223	420
1.4	Library	1074	8.0	5.11	6.91	1329	1118	672
1.5	Lunch Room	4100	8.0	30.98	40.88	7576	5671	4305
1.6	Printer	199	8.0	1.70	1.89	685	611	105
1.7	Stationary	710	8.0	2.47	2.67	878	690	210
1.8	Table Tannic	592	8.0	2.98	3.84	766	572	420
1.9	Travel-1	58	8.0	0.52	0.67	146	131	63
1.10	Travel-2	80	8.0	0.57	0.70	175	150	63
1.11	VIP Lunch Room	1735	8.0	14.49	19.31	3880	3365	1848
1.12	Union Room	217	8.0	1.44	2.12	331	341	210
1.13	Maintenance Staff	150	8.0	1.61	2.28	423	429	210
1.14	Corridor	571	11.5	1.15	1.73	353	450	126
1.15	Stationary-1	370	8.0	0.86	0.83	312	223	63
1.16	Public Record Office	2040	8.0	6.09	6.00	2265	1764	420
	Sub Total	**12801.0**		**75.5**	**96.7**	**20917.3**	**17077.5**	**9261.0**
2	**Ground Floor**							
2.1	8 PAX	182	8.0	1.49	1.91	443	387	168
2.2	8 PAX-2	180	8.0	1.56	1.99	481	430	168
2.3	10 PAX-1	202	8.0	2.41	2.96	843	788	210
2.4	10 PAX-2	200	8.0	2.02	2.56	637	577	210
2.5	12 PAX-1	232	8.0	2.13	2.70	613	494	252
2.6	12 PAX-2	220	8.0	2.15	2.76	619	3	252

2.7	Audio Visual Room	138	8.0	1.34	1.39	624	581	42
2.8	Cons-1	75	8.0	0.48	0.57	167	145	42
2.9	Cons-2	90	8.0	0.60	0.69	229	210	42
2.10	Cons-3	60	8.0	0.45	0.58	154	149	42
2.11	Lab	60	8.0	0.40	0.53	128	124	42
2.12	Dispatch	194	8.0	1.30	1.40	556	505	63
2.13	Exhibition Space	420	8.0	4.23	5.78	1035	879	588
2.14	GM	295	8.0	1.56	1.83	570	500	126
2.15	NUR	56	8.0	0.32	0.36	124	112	21
2.16	Office	183	8.0	0.91	1.02	353	308	63
2.17	Phar	60	8.0	0.40	0.51	128	116	42
2.18	Security Office	409	8.0	2.28	2.65	818	699	189
2.19	Security Office	328	8.0	2.28	2.66	819	707	189
2.20	Waiting	247	8.0	0.85	1.05	276	246	84
2.21	Waiting lounge	199	8.0	1.48	1.77	481	392	147
2.22	Waiting lounge	205	8.0	1.35	1.71	414	362	147
2.23	Workstation	1661	8.0	9.74	10.98	3946	3629	588
2.24	Attrium	3217	8.0	14.26	15.65	5588	1620	840
2.25	Board Room	875	8.0	5.96	7.62	1819	1620	651
	Sub Total	**9988.0**		**61.9**	**73.6**	**21866.7**	**15581.9**	**5208.0**
3	**First Floor**							
3.1	12 PAX	619	8.0	4.44	4.88	1831	1796	252
3.2	18 PAX	1071	8.0	6.49	7.19	2660	2622	378
3.3	AGM-4	159	8.0	1.00	1.14	354	290	84
3.4	AGM-1	157	8.0	0.99	1.17	352	337	84
3.5	AGM-2,3	155	8.0	1.0	1.1	334	316	84.0
		155	8.0	1.0	1.1	334	316	84.0
3.6	AGM-6,8	172	8.0	1.01	1.20	364	350	84
		172	8.0	1.01	1.20	364	350	84
3.7	AGM-5,7	172	8.0	1.31	1.49	519	523	84
		172	8.0	1.31	1.49	519	523	84
3.8	AGM-9	157	8.0	0.99	1.16	352	327	84
3.9	Antee	171	8.0	1.41	1.51	574	488	84
3.10	Antee-2	171	8.0	1.01	1.26	321	279	105
3.11	Antee Room	353	8.0	2.59	3.08	942	928	210
3.12	Attandent	48	8.0	0.54	0.79	116	118	84
3.13	Attandent-2	76	8.0	0.77	0.97	234	218	84
3.14	Attandent Room	67	8.0	0.72	1.02	164	165	105
3.15	CMD Room	890	8.0	5.54	6.31	2025	1632	441
3.16	Conference Room 16 PAX	412	8.0	3.24	4.12	945	934	357
3.17	Corridor-1	1850	11.5	4.84	5.72	1701	1411	420
3.18	Corridor-2	1345	11.5	4.07	4.97	1510	1592	315
3.19	DGM-2 (LOW HT)	261	8.0	2.07	2.47	707	661	189

3.20	DGM(LOW HEIGHT)	264	8.0	2.65	2.94	1015	930	189
3.21	DGM (ED 3,2)	135	8.0	0.89	1.04	342	302	63
3.22	Dinning Area							
3.23	Director Finence	590	8.0	3.64	3.91	1453	1210	231
3.24	Director(Power)	592	8.0	3.25	3.75	1248	1128	231
3.25	ED-1	291	8.0	1.82	2.00	704	646	126
3.26	ED-2	291	8.0	1.82	2.04	707	668	126
3.27	GM	269	8.0	1.41	1.59	529	492	105
3.28	GM-2	284	8.0	1.53	1.80	593	612	105
3.29	GM-3	284	8.0	1.30	1.57	473	482	105
3.30	GM-4	280	8.0	1.34	1.61	493	504	105
3.31	Meeting-1,2	132	8.0	0.98	1.36	262	274	126
		132	8.0	0.98	1.36	262	274	126
3.32	Meeting Room	251	8.0	1.73	2.32	465	492	210
3.33	Meeting Room 15 PAX	280	8.0	2.74	3.50	803	747	315
3.34	Meeting Room 16 PAX	406	8.0	3.60	4.49	1171	1053	357
3.35	PS-1,2	160	8.0	0.67	0.86	224	242	63
		160	8.0	0.67	0.86	224	242	63
3.36	Staff	170	8.0	1.02	1.10	455	462	42
3.37	Waiting	550	8.0	2.55	3.12	831	718	252
3.38	Waiting Room+PS 1,2,3,4 +lobby	1170	8.0	5.11	6.15	1845	1853	420
3.39	Waiting lounge	554	8.0	2.21	2.82	740	777	210
3.40	Corridor-3	890	11.5	2.81	3.30	1099	1139	189
	Sub Total	**16940.0**		**92.0**	**108.9**	**33163.2**	**31423.8**	**7539.0**
4	**Second Floor**							
4.1	AGM-6	192	8.0	1.20	1.33	463	431	84
4.2	AGM-2	146	8.0	1.17	1.27	446	344	84
	AGM-3	146	8.0	0.95	1.10	333	258	84
4.3	AGM-4	160	8.0	1.17	1.29	444	402	84
	AGM-5	160	8.0	1.18	1.30	454	412	84
	AGM-6	192	8.0	1.20	1.33	463	431	84
4.4	AGM-7,8,9	166	8.0	0.82	1.07	264	279	84
	AGM-7,8,9	166	8.0	0.82	1.07	264	279	84
	AGM-7,8,9	166	8.0	0.82	1.07	264	279	84
4.5	AGM-10	166	8.0	0.82	1.03	264	225	84
4.6	AGM-11	166	8.0	0.83	1.07	266	281	84
4.7	AGM-12	166	8.0	0.83	1.07	266	281	84
4.8	AGM-13	192	8.0	1.30	1.55	518	552	84
4.9	Antee Room	157	8.0	1.51	1.64	584	521	105
4.10	Antee Room-2	157	8.0	1.45	1.71	551	563	105
4.11	Att and PS-1,2,3	497	8.0	2.64	3.22	846	736	252
4.12	Att and PSI	497	8.0	2.64	3.21	879	735	252

4.13	Attandent Room	132	8.0	1.64	2.16	435	395	210
4.14	Conference	377	8.0	3.08	3.71	1027	950	294
4.15	Conference hall							
4.16	Corridor-1	1889	11.5	4.72	6.09	1638	1814	420
4.17	Corridor-2	1435	11.5	3.71	4.45	1277	1062	336
4.18	CVO	556	8.0	2.70	2.99	1083	1046	168
4.19	DGM-1	296	8.0	3.86	3.77	1699	1497	168
4.20	DGM-2	290	8.0	2.48	2.66	969	858	168
4.21	DGM-3	292	8.0	2.52	2.69	988	875	168
4.22	Director Visiting	560	8.0	2.35	2.32	1029	804	105
4.23	Director (E R &D)	608	8.0	2.33	2.34	1019	923	105
4.24	Director (E,R &D)	610	8.0	2.70	2.80	1213	1193	105
4.25	ED-1	335	8.0	1.92	2.10	755	702	126
4.26	ED-2	335	8.0	1.91	2.11	751	706	126
4.27	GM-1	290	8.0	1.11	1.43	371	400	105
4.28	GM-2	320	8.0	1.30	1.50	471	387	105
4.29	GM-3	310	8.0	1.29	1.56	465	477	105
4.30	GM-4	323	8.0	1.03	1.30	375	409	84
4.31	GM-5	323	8.0	1.12	1.45	378	413	105
4.32	GM-6	293	8.0	1.09	1.42	364	395	105
4.33	Meeting 10 PAX	175	8.0	1.62	2.24	428	445	210
4.34	Meeting Room	175	8.0	1.62	2.24	425	442	210
4.35	Meeting Room-2	377	8.0	2.95	3.62	918	898	294
4.36	Printing+PS	437	8.0	1.85	2.12	764	796	105
4.37	Printer	92	8.0	1.06	1.18	473	511	42
4.38	PS-1	75	8.0	0.51	0.62	185	187	42
4.39	PS-1& 2	140	8.0	0.77	1.02	236	250	84
		140	8.0	0.77	1.02	236	250	84
4.40	Server Room	95	8.0	4.00	4.09	2027	2191	42
4.41	Staff	300	8.0	1.74	1.91	703	680	105
4.42	Workstation	652	8.0	4.44	4.76	1875	1810	231
4.43	Work Station-2	602	8.0	3.99	4.51	1681	1751	210
4.44	Working Station	1127	8.0	6.12	6.93	2463	2470	378
4.45	WorkStation	1136	8.0	6.40	7.19	2611	2622	378
4.46	Corridor-3	1050	11.5	3.67	4.01	1555	1362	189
4.47	Meeting Room	324	8.0	2.38	3.33	616	570	315
4.48	**Sub Total**	**19963.0**		**108.1**	**125.0**	**41073.2**	**39548.7**	**7833.0**
	Third Floor							
5	AGM-1	165	8.0	1.10	1.25	412	379	84
5.1	AGM-2	168	8.0	0.87	1.11	286	298	84
5.2	AGM-3	166	8.0	0.85	1.09	276	290	84
5.3	AGM-1	165	8.0	1.10	1.25	396	379	84
5.4	Attendant Room	88.0	8.0	1.5	2.0	366	332	210
5.5	Corridor	1010	11.5	3.05	3.49	1142	951	231

5.6	DGM	250	8.0	3.43	3.49	1426	1252	189
5.7	GM-1	318	8.0	1.21	1.52	423	452	105
5.8	Meeting Room 15 PAX	307.00	8.0	2.19	3.14	516	538	315
5.9	Meeting Room -1,2	168.00	8.0	1.49	2.11	358	371	210
		168.00	8.0	1.51	2.11	367	379	210
5.10	Office	164.00	8.0	1.51	1.57	624	567	84
5.11	Working Area	963	8.0	5.96	6.90	2337	2365	399
5.12	Working Hall-24 PAX	1523	8.0	7.69	8.86	3037	3075	504
5.13	Working Station-2	958	8.0	5.91	6.70	2354	2338	378
5.14	Corridor-3	910	11.5	2.83	3.10	1111	904	189
	Sub Total	**7491.0**		**42.2**	**49.7**	**15432.2**	**14868.9**	**3360.0**
	Fourth Floor							
6	AGM-1	151	8.0	1.40	1.47	566	509	84
6.1	AGM-2	150	8.0	1.85	2.17	634	575	168
6.2	AGM-3	147	8.0	1.08	1.22	398	362	84
6.3	AGM-4	166	8.0	1.08	1.23	400	368	84
6.4	AGM-5	164.0	8.0	1.1	1.2	406	375	84
6.5	AGM-6	146	8.0	1.24	1.47	482	511	84
6.6	AGM-7-12	162	8.0	0.71	0.90	248	263	63
		162	8.0	0.71	0.90	248	263	63
		162	8.0	0.71	0.90	248	263	63
		162	8.0	0.71	0.90	248	263	63
		162	8.0	0.71	0.90	248	263	63
		162	8.0	0.71	0.90	248	263	63
6.7	Attendant Room	137	8.0	1.79	2.36	472	430	231
6.8	Corridor	1506	11.5	3.89	4.95	1414	1582	315
6.9	DGM	292	8.0	2.32	2.58	883	807	168
6.10	DGM-1	296	8.0	3.18	3.26	1337	1201	168
6.11	DGM-2	300	8.0	2.30	2.56	871	796	168
6.12	ED-1	336	8.0	1.95	2.12	773	715	126
6.13	ED-2	333	8.0	1.95	2.14	773	726	126
6.14	GM-1,2,3	307	8.0	1.22	1.55	433	469	105
		307	8.0	1.22	1.55	433	469	105
		307	8.0	1.22	1.55	433	469	105
6.15	Meeting Room	323	8.0	2.28	3.23	563	591	315
6.16	Meeting Room-2,3	174	8.0	1.56	2.17	395	405	210
		174	8.0	1.56	2.17	395	405	210
6.17	PS-1,2	140	8.0	0.73	0.99	216	232	84
		140	8.0	0.73	0.99	216	232	84
6.18	Staff	1130	8.0	6.92	7.70	2931	2997	357
6.19	Staff-18 Nos	1146	8.0	5.46	5.89	2417	2461	231

6.20	Staff-18 Nos	1126	8.0	6.23	7.02	2522	2521	378
6.21	Corridor-3	910	11.5	2.83	3.10	1111	904	189
	Sub Total	**11280.0**		**61.4**	**72.1**	**22964.6**	**22688.8**	**4641.0**
	Fifth Floor							
7	AGM-1	151	8.0	1.49	1.55	619	552	84
7.1	AGM-2	150	8.0	1.95	2.25	686	617	168
7.2	AGM-3	147	8.0	1.17	1.29	449	404	84
7.3	AGM-4	166	8.0	1.19	1.31	457	415	84
7.4	AGM-5	164.0	8.0	1.2	1.3	463	421	84
7.5	AGM-6	146	8.0	1.33	1.54	532	551	84
7.6	AGM-7-12	162	8.0	0.82	0.98	303	308	63
		162	8.0	0.82	0.98	303	308	63
		162	8.0	0.82	0.98	303	308	63
		162	8.0	0.82	0.98	303	308	63
		162	8.0	0.82	0.98	303	308	63
		162	8.0	0.82	0.98	303	308	63
7.7	Attendent Room	137	8.0	1.88	2.43	519	468	231
7.8	Corridor	1506.00	11.5	4.87	5.68	1931	2005	315
7.9	DGM	292.00	8.0	2.51	2.72	983	889	168
7.10	DGM-1	296.00	8.0	3.37	3.40	1439	1285	168
7.11	DGM-2	300	8.0	2.49	2.70	975	881	168
7.12	ED-1	336	8.0	2.17	2.28	888	809	126
7.13	ED-2	333	8.0	2.17	2.30	888	820	126
7.14	GM-1,2,3	307	8.0	1.42	1.70	538	555	105
		307	8.0	1.42	1.70	538	555	105
		307	8.0	1.42	1.70	538	555	105
7.15	Meeting Room-1	323	8.0	2.49	3.39	674	681	315
7.16	Meeting Room-2,3	174	8.0	1.67	2.26	455	454	210
		174	8.0	1.67	2.26	455	454	210
7.17	PS-1,2	140	8.0	0.82	1.06	264	271	84
		140	8.0	0.82	1.06	264	271	84
7.18	Staff	1130	8.0	7.66	8.25	3318	3314	357
7.19	Staff-18 Nos	1146	8.0	6.21	6.44	2810	2783	231
7.20	Staff-18 Nos	1126.00	8.0	6.95	7.57	2900	2838	378
7.21	Corridor-3	910.00	11.5	3.42	3.77	1423	1409	189
	Sub Total	**11280.0**		**68.7**	**77.8**	**26827.6**	**26105.9**	**4641.0**
	Grand Total	**89743.0**		**509.8**	**603.8**	**182245.0**	**167295.4**	**42483.0**
	ODU Selection			**816.0**	**HP**			

3. SYSTEM DESCRIPTION:

It is proposed to install a VRV/VRF for air conditioning the building.

3.1 EQUIPMENT

It is proposed to install cassette unit in cabins and ductable unit in common area and basement. The winter heating systems are provided through heat pump which is a part of VRV / VRF unit.

3.2 VENTILATION SYSTEM

Fresh air shall be provided with following number of air changes/hour for ventilation:

Toilets Exhaust– 50 CFM / WC

4. ROOF INSULATION

All exposed roofs of the areas to be air-conditioned shall be thermally insulated.

5 WORKS

These works shall be done by the contractor within the quoted rates of the contractor for each item.

Making opening in walls/floors/ceilings for taking out duct/cables / pipings, etc., and fitting them properly.

Making openings in walls/floors/ceilings for grouting supports for duct/cables/piping work and grouting of supports.

Making necessary frames in walls/ceilings for fixing of grilles/diffusers etc.

Designing and providing foundation for equipment like Outdoor unit, fresh air unit and Ventilation Fans etc. floating type foundation block (RCC pads) directly resting on finished RCC floor/slab over neoprene rubber pads is to be considered by the contractor.

6. DRAWINGS

The drawings forming part of these specifications provide a feasible scheme for locating the equipment. The contractor may re-arrange the equipment for improving the layout and meeting the site conditions. All such changes shall however be subject to the Engineer In Charge approval. These drawings are not meant to be working drawings, which shall be prepared by the contractor as required.

7. PERFORMANCE GUARANTEE

7.1 The contractor shall guarantee that the air conditioning plant shall maintain the designed inside Temperature within ±2° F tolerance and shall not exceed the specified limit at any point in the given area.

7.2 The contractor shall guarantee that the capacity of various components as well as the whole system shall not be less than the specified capacity.

7.3 The contractor shall ensure that the system shall be free of vibrations and disturbing sounds.

7.4 The contractor shall guarantee the consumption of power within the designed limits on hourly basis.

8. NOISE LEVEL

Air conditioning equipment and materials (like motors, compressors etc.) shall be selected, designed and installed in such a manner that the inside noise criterion for all conditioned spaces shall be in the range of NC-30 to NC-35. Thus the noise level in conditioned occupied space due to all air conditioning equipment shall not exceed 52 DB at 150 Hz when measured at any point in the occupied spaces less than 1.5 meter from any supply air register or 60 cm from any return air grille.

The outdoor noise criterion for out door units, at a distance of 50 meters from the unit shall be NC-45. Therefore, noise level in open areas 50 meters away from ODU in any direction shall not exceed 60 DB.

9. SHOP DRAWINGS

9.1 The contractor shall prepare and supply the following drawings (4 sets) to the Consultants within 20 days from the date of award of work

Duct Layout for all floors

Piping layout for all floors

Outdoor Equipment Layout

Mounting Arrangement Drawing for all equipments on the terrace.

Fixing details for indoor units.

Single Line diagram for refrigerant circulation system

Single Line diagram for electrical distribution system

Fabrication Drawings for all electrical panels

Control wiring details

9.2 The contractor shall re-submit 4 sets of all the drawings to the Consultants within 10 days from date of receiving comments if any from the Consultants after incorporating the comments.

10.0 PAINTING WORK

The painting should be carried out as required and as per the instruction of the Engineer in Charge. The procedure and the standard colour codes are as follows:

1) Cleaning the surface

2) Apply a primer coat of red oxide

3) Applying two coats of enamel paint of APPROVED colour code after applying cement primer for plastered surface.

4) Standard colour code.

c) Hot gas line	PO Red
f) Copper line	Golden paint
g) Gauge panel	Siemens Gray
h) All supports/stands	Black
i) Gas equiliser line	Yellow
j) Ducting Concealed Black rust proof Exposed to grilles insulated/ insulated duct Black Exposed	Fiesta blue
k) Electric panel's	Steel gray

SECTION – 2 - VRF / VRV SYSTEM

1 General

1.1 The scope of this section comprises the design, supply, erection, testing and commissioning of inverter technology based VRV / VRF type system of air conditioning conforming to these specification and in accordance with the requirements of Drawing and BOQ. The prices quoted shall include all the equipment ancillary material as specified and all such items whatsoever and which may be required to fulfill the intent and purpose as laid down in the specification and the approved drawings. The contractor shall calculate equipment capacity based upon design parameters specified for the system design & verify all the quantities and sizes of refrigerant pipe, fitting, cables, control cable, pipes, insulation, indoor units, out door units etc. before installation to avoid any shortfall or surplus. The tenderer shall also include all necessary civil work and MS frame work for installation of outdoor and indoor units in VRV / VRF based air conditioning system. The cost quoted by tenderer shall also include the refrigerant gas R-410a & its charging for proper & specified functioning of air conditioning system.

1.2 Civil work/ MS frame work for indoor and outdoor units related to VRV/ VRF equipments, all cuttings should be properly finished as per existing surroundings. The installation of outdoor unit on the terrace of building should be checked up structurally & their mounting should be structurally safe for the outdoor unit to ensure safety and stability after installation.

1.3 The scope in the tender schedule also covers detailed designing of complete air-conditioning system on inverter technology based VRV / VRF air conditioning with air cooled outdoor units system capable of cooling and heating (reverse cycle) as per individual or season requirement suitable for operation on 415 V, 3 Phase, 50 Hz AC electric supply.

1.4 The outdoor units shall have both cooling & heat pump mode, consisting of one / multiple outdoor units with single circuit of refrigerant piping and multiple in door units of various types. Each indoor unit should have capability to cool or heat as per seasonal weather changes. This shall also include complete capacity calculation for indoor and outdoor units complete with CAD drawing, designing & layout of following.

i. Outdoor units.

ii. Indoor units.

iii. Refrigerant piping

iv. Power & Control Cables between Outdoor units & Indoor units.

v. Management system for HVAC.

1.5 While designing the system care should be taken to select outdoor units of suitable capacity based on design data provided & to economize on available floor area for installation of outdoor units as well as optimum utilization of outdoor units. The indoor units should be designed based upon the heat load calculations for individual rooms/ areas to be air-conditioned and over capacities should be avoided. The design should also specifically take care of disposal of condensate drain water so that there is no leakage of condensate water inside the room as well in the route of condensate

water pipe line. The layout of refrigerant piping is to be designed in such a way so that it should not disturb the aesthetic of the building/ room, inadvertent damage in the route of pipe should not occur in future & optimum length of pipe line for efficient air conditioning. After completion of the work four set of 'as erected/ Commissioned drawing' of activities listed above shall be submitted.

2 Design Data

2.1 The work of air-conditioning outdoor and indoor units as specified in schedule of work is required to be carried out at proposed Bharat Heavy Electricals Ltd Bhel House, Siri Fort, New Delhi. The firm shall ensure that the design inside condition shall be achieved in all cases except if the design conditions exceeded and if at any design stage need for higher capacity outdoor HP is required, necessary approval shall be accorded based on design analysis and discussions on the subject. In case of any deviation from the parameters specified, the technical issues involved shall be brought to the notice of Engineer-in-charge for seeking necessary approvals to achieve these parameters. Engineer-in-charge, however, reserves to right to permit any deviations from the parameters as specified.
Note: 1 HP unit = 0.80 TR (Approximately)

3 The firm should comply with the parameters as specified in the terms & conditions.

3.1 The tenderer shall obtain before quoting/ the consent of OEM and furnish the same along with the bid document. This consent shall also cover aspects of desired assistance in the field of design, development, testing, execution, completion & maintenance/ maintenance spares of the air-conditioning system.

3.2 Notwithstanding the technical details as specified in the tender, the manufacturers may offer/ indicate systems and necessary design & features applicable for the offered products at the tendering stage.

4 <u>OUTDOOR UNIT</u>

(i) For testing and evaluation consideration, JIS B8616 or equivalent standard shall be applicable.

(ii) The outdoor unit shall be factory assembled, weather proof casing (Material of construction of casing shall be vendor's standard design), constructed from heavy gauge GI sheets steel panels and coated with baked enamel finish. The outdoor unit shall be completely factory wired, tested with all necessary controls & filled with first charge of refrigerant before delivering at site.

(iii) The inverter technology based VRV/ VRF equipment should be capable of refrigerant piping between indoor units and outdoor unit which shall be Extendable upto 150m with maximum height difference between outdoor & indoor unit of 50m & level difference between two indoor units shall be maximum upto 15m.

- The tender will, however, be at liberty to supply outdoor units in ratings as specified above or higher.

(i) The outdoor unit shall be factory tested and filled with first charge of refrigerant R 410a before delivering at site.

(ii) It should also be provided with duty cycling for inverter capable of changing

the rotating speed of inverter controller to follow variation in cooling & heating loads & switching starting sequence for better stability and prolonged equipment life. The firm shall submit the copy of proof in support of standard mentioned by the manufacturer in the tender for their Out door unit.

(iii) Each outdoor unit shall be provided with suitable amps. 400/440 Volts AC supply MCCB 25 KA in water proof box as incomer and suitable capacity of MCCB & internal wiring in the outdoor unit.

(iv) **NOTE:** Bidder can offer from their standard product feature nearer to the range indicated.

(v) The outdoor unit shall be suitable for mix match connection of types of indoor units.

(vi) It should be provided with duty cycling for switching the starting sequence of multiple outdoor units.

(vii) The outdoor unit shall be modular in design and should be allowed for side by side installation.

(viii) The unit shall be provided with its own microprocessor control panel.

(ix) The outdoor units should have anti corrosion paint free plate for easy mounting of unit.

(x) The machine must have a sub cool feature to use coil surface more effectively through proper circuit/ bridge so that it prevents the flushing of refrigerant from long piping due to this effect thereby achieving energy savings.

(xi) The outdoor unit should be fitted with low noise level and should not be more than 67db (A) at normal operation when measured at 1.5m distance from ground level.

(xii) The outdoor unit should be fitted with low noise aero spiral design fan with aero fitting grill for spiral discharge airflow to reduce pressure loss and should be fixed with DC/AC fan motor for better efficiency.

(xiii) The outdoor units are connected to multiple indoor units of various types as such the combined operating loads of indoor units may touch 120 to 125% of the nominal capacity. The outdoor unit shall be able to perform at the combined loads demands as indicated above.

(xiv) In case trouble occurs in indoor unit(s), the continuous operation of system should be possible.

(xv) The body of indoor unit shall be as per manufacturer's standard specifications.

5 REFRIGERANT CIRCUIT

The refrigerant circuit shall include liquid and gas shut-off valves and a solenoid valves at condenser end.

The equipment must have inbuilt refrigerant stabilization control for proper refrigerant distribution.

All necessary safety devices shall be provided to ensure the safe operation of the system.

6 HEAT EXCHANGER (Condenser of outdoor unit)

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coil.

The aluminum fins shall be covered by anti-corrosion resin film/paint/treatment.

The unit should be with bye-pass/ e-pass heat exchanger to optimize the path of heat exchanger and for better efficiency of condenser.

The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical discharge. Each fan shall have a safety guard.

7 SAFETY DEVICES

All necessary safety devices shall be provided to ensure safe operation of the system. Following safety devices shall be part of outdoor unit:- high pressure switch, fuse, fan drive overload protector, fusible plug, crankcase heater, over load relay, overload protection for inverter.

The outdoor roof mounted units shall be provided in such a fashion that these do not affect the overall aesthetics and ambience of the building. If required these units shall be suitably camouflaged to give good aesthetic look. These provisions, however, shall be discussed, if required, at a later date and the prices for the same shall be worked out separately as extra item.

Noise levels for outdoor units shall not be more than 67 db (measured at a point 1 meter in front of the unit at a height of 1.5 meters.

8 INDOOR UNITS

All indoor units as specified shall have in general; noise levels less than 46 db. For critical applications noise levels below these limits may, however, be specified during design stage.

i. Each unit shall have electronic control valve to control refrigerant flow rate respond to load variation of the room.

ii. The address of the indoor unit shall be set automatically in case of individual and group control.

iii. In case of centralized control system, it shall be possible to set the address of individual indoor unit through a liquid crystal remote controller.

iv. 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 support from housing.

v. The cooling coil shall be made out of seamless copper tubes and have continuous aluminium 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 coil shall be factory tested at 21 kg/sq.m air pressure under water.

vi. Indoor unit shall have cleanable type filter fixed to an integrally moulded/ moulded plastic frame. The filter shall be slide in and neatly insertable type. It shall be possible to clean the filters either with compressed air or water.

vii. Each unit shall have computerized control for maintaining designed room temperature. Each unit shall be provided with microprocessor thermostat for cooling/ heating.

viii. Each indoor high wall unit shall be with corded/ cordless remote controller as standard features. Corded/ cordless remote shall have standard features as per standard design of manufacturers.

9 HIGH WALL INDOOR TVPE UNIT

The unit shall be high wall mounted type. The unit shall include pre-filters, fan section and DX- coil section. The housing of the unit shall be powder coated/ heat treated galvanized steel. The body shall be light in weight and shall be able to suspend from four comers. The fan shall be aerodynamically designed diffuser turbo fan type.

Unit shall have an external attractive panel for supply and return air.

10 CENTRALIZED TYPE REMOTE CONTROLLER (PUSH BUTTON TYPE)

A multifunctional compact centralized controller shall be provided with the system. These controllers shall be capable of controlling all the indoor and outdoor units.

It shall be able to control the indoor units with the following functions:

i) Starting/ stopping of Air Conditioners as a zone or group or individual unit.

ii) Temperature setting for each indoor unit or zone.

iii) Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.

iv) Monitoring of operation status such as operation mode and temperature setting of individual indoor units, maintenance information and trouble shooting information.

v) Display of air conditioner operation history.

vi) Daily management automation through yearly schedule function with possibility of various schedules.

The controller shall have wide screen user friendly and can be wired by a non-polar 2-wire transmission cable to a distance of 1 K.M away from indoor unit. The cables shall be as per prevailing practice adopted by the manufacturers but shall have minimum rating of 3 core, 1.5 sq. mm shielded cables suitable for outdoor application. Cordless/corded remote having star and feature as per standard design of manufacturer is acceptable.

11 Y –JOINT REF NET SEPARATION

Supply & installation of the Y-Joint/ Ref-net separation refrigeration pipe joints and headers in the appropriate orientation to enable correct distribution of refrigerant. The Distribution Joints should be factory insulated with pre-formed sections of Expanded Polystyrene/Equivalent.

12 REFRIEGERANT PIPING:

i. Refrigerant piping for the air-conditioning system shall be upto 19 mm dia of soft seamless copper tubes and, for & above 19.1 mm dia the pipe material shall be of hard seamless copper tubes with pipes material being hard drawn copper pipe. Forged copper fittings shall be used for the refrigerant piping. The refrigerant piping arrangements shall be in accordance with good engineering practices as applicable to the air-conditioning industry, and shall include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits except Y joint/separation tubes.

ii. Before jointing any copper pipe or fittings, its internals shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently it shall be thoroughly blown out using nitrogen gas.

iii. After completion of installation of the refrigerant piping, the refrigerant piping system shall be pressure tested using nitrogen gas at a suitable pressure as specified by OEM (Original Equipment Manufacturer). Pressure shall be maintained in the system for 48 hours. The system shall then be evacuated to vacuum of not less than 700 mm Hg and held for 24 hours.

iv. The supplier of air-conditioning system shall choose sizes as designed and erect proper interconnections of the complete refrigerant circuit. The thickness of copper piping shall not be less than 22 SWG for pipes upto 19 mm and 16 SWG for larger dia.

v. The suction line pipe size and the liquid line pipe sizes shall be selected according to the manufacturer's specified diameter. All refrigerant pipes shall be properly supported and anchored to the building/structure using steel hangers, fasteners, brackets and supports which shall be fixed to the building/structure by means of inserts or expansion shields or anchor fasteners of adequate size and number to support the load imposed thereon.

vi. The refrigerant piping should be laid in such a way that it should not distort the interior of the room, wherever the refrigerant pipe has to be laid across the room, it should be laid in a concealed manner by making appropriate boxing arrangement with minimum 15 mm thick Gypsum Board matching with the interior of the room. All associated minor Civil Engineering works (like chasing on wall, ceiling & re-plastering & repainting etc.) related with the above items are included in the scope of work. The above scope does not include false ceiling wherever required.

vii. To protect Nitrile rubber insulation of outdoor installed copper piping from degradation due to ultra violet rays and atmospheric condition, it shall be covered with polyshield coating of at least two coats of resin and hardener (poly bond make or equivalent). Fibre glass tape shall be helically wound with adequate overlap & coated with two coats of resin with hardener to give smooth & plain finish.

viii. Piping work shall be recessed in wall/floor wherever required as per direction of Engineer-in-charge without any extra cost.

12.1 Drain piping: duly insulated

The drain pipe connection of each fan coil unit to the main header should be 25 mm dia/32 mm dia as required. The header pipe should be of 40 mm dia/32 mm dia as required. The drain-pipe should be heavy duty PVC pipe lSI marked and conforming to relevant IS complete with fitting as required whereas the connection of the fan coil unit to the PVC pipe should be with flexible braided pipe. The drain piping should be insulated with 9 mm thick tubular nitrile rubber Elastomeric insulation.

For proper drainage of condensate U trap shall be provided in the drain piping wherever required. All pipe supports shall be prefabricated and pre-painted slotted angle supports, properly installed with clamps. The condensate drain pipe arrangement for disposal of condensate water be made in such a way that there should not be any leakages of condensate water inside rooms as well in the route of drain water pipe line & water should be discharged at the location jointly decided with Engineer-in-Charge of work. All associated Civil Engineering works as per requirement at site in above connection like making chase in the wall & restoring it original shape by re-plastering & repainting, etc. are included in the scope of work. The arrangement of drain-pipe shall be made in such a way that it should not affect the aesthetic of the building as well as is maintenance friendly & easily accessible.

All the GI drain piping shall be insulated with 9mm thick tubular nitrile elastomeric rubber insulation.

12.2 Various Sizes Pvc Insulated Copper Conductor Wiring Cables

PVC insulated multi stranded sheathed copper conductor wiring cable for working voltage upto & including 1100 Volts, lSI marked conforming to IS 694/1990 (Latest Version).

Wiring of installation shall be in conformity with IS 732/1989 (Latest Version), IS 4648/1968
(Latest Version).

13 RIGID PVC CONDUIT PIPE

Laying conduit shall be in conformity with IS: 732/1989 (Latest Version), IS 4648/1968 (Latest Version).

Fitting for rigid non-metallic conduit shall conform to IS 3419/1989 (Latest Version) and accessories shall conform to relevant IS.

SECTION – 3 – DUCT WORK AND OUTLETS

A. PRE-INSULATED DUCT WORK

1. PRE-INSULATED GLASS WOOL DUCT WORK FOR THERMAL/ ACOUSTIC APPLICATION

1.1 Duct thermal

Pre-insulated duct board shall be made of high density of rigid resin bonded fire safe glass wool with both side factory laminated aluminum foil, outer facing foil is having - Reinforced aluminum + Kraft+ glass veil and inner facing foil - Aluminum + Kraft + glass veil. The 'R' Value should be as per ECBC code.

1.2 Joint System: Duct boards should have exclusive design with male / female edges, in order to provide greater strength for joints, easy installation and shall reduce the number of cutting operation & exceptional inside finish.

Tools and Accessories for Installation of Duct Boards shall be followed as per recommendation of manufacturer's manual.

1.3 Duct Support: Duct board shall be installed, using support as per CPWD specification for the work. Maximum distance between hangers / support shall not exceed for horizontal ducts as:

- 900 mm inner dimension maximum distance of hanger 2.4 m
- 900-1500 mm inner dimension maximum distance of hanger 1.8mm
- Above 1500 mm inner dimension maximum distance of hanger 1.2 m

2. INSPECTION AND TESTING

Duct dimensions shall be checked based on the duct dimension / layout drawings duly approved by the Architects / Consultants.

The ducts, branches elbows etc. shall be inspected and the joints and connection shall be checked properly before these are assembled in position. After assembly the system shall be checked for tightness of male/ female joints to avoid the leakage Climaver Al. tape of 75mm thickness shall be applied on each male / female joint to avoid the leakage of air.

Full sized standard dimension sheet as specified are to be used and any patched or made-up pieces of duct work are liable to be rejected. Joints between male/ female connections shall be fitted properly and Al. tape of 75 mm thickness shall be applied on joints.

Test points shall be provide at the discharge of each air handling unit and at each individual zone of the duct work system. Test points shall consist of 25mm diameter sockets fitted with sealing plugs which can be removed for the fitting of measuring devices. Test points shall be insulated as for the duct work and shall be provided with identification labels.

Rectangular risers should be free supported by angles or channels secured to the sides of the duct flanges with bolts or sheet metal screws or blind rivets. The supporting angle or channel should be freely resting over the slab cut-out. Riser support intervals should be limited to one storey height.

To ensure the air tightness, all ducts shall be checked with Leak Test after completion of duct fabrication but before installation of duct system.

3. GRILLES

3.1 The supply and return air grilles shall be fabricated from aluminum extruded sections. The supply air grilles shall have fix bar. The horizontal louvers shall be of extruded section, fixed type. The return air grille shall have single horizontal extended section fixed louvers. The grilles may or may not be with an outer frame.

3.2 The aluminum grilles shall have opposed blade dampers of black anodized extruded aluminum sections, which shall be key operated from the grille face wherever required.

3.3 The adjustable grille louvers shall be fabricated from extruded aluminum sections. The damper blades shall be of black anodized extruded aluminum sections and shaped to form air tight joints. Grills longer than 450mm shall have intermediate supports for the horizontal louvers. The grilles shall generally be to the design of Tuttle & Baley Grilles and Registers.

4. DIFFUSERS

4.1 The ceiling type round or square diffusers shall be of extruded aluminum sections with flush or step down face, as specified with fixed pattern and round neck.

4.2 The diffusers shall be die formed for proper air diffusion.

4.3 All supply diffusers shall be provided with extruded aluminum dampers, with knurled knobs for adjustment from the bottom.

5. LINEAR SLOT DIFFUSERS

5.1 The linear slot diffusers shall be fabricated from the extruded aluminum sections.

5.2 The diffusion blades shall be die formed, flush mounted type with single or double direction air flow.

5.3 The frame also of extruded aluminum sections shall hold the louvers tightly in fixed position.

5.4 The dampers as described under grilles shall be provided wherever specified.

6 DAMPERS

6.1 At the junction of each branch duct with main duct and split of main duct, volume dampers must be provided.

6.2 Dampers shall be heavier gauge and shall be rigid in construction to the passage of air.

6.3 The volume dampers shall be of an approved type, lever operated and complete with locking devices which will permit the dampers to be adjusted and locked in any positions.

6.4 The dampers shall be of splitter, butterfly or louver type. The damper blade shall not be less than 1.25mm (18 Gauge), reinforced with 25mm angles 3mm thick along any unsupported side longer than 250mm. Angles shall not interfere with the operation of dampers, nor cause any turbulence.

6.5 Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings, dampers and frames shall be constructed of 1.5mm steel and blades shall not be over 225mm wide. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8mm thickness with fine mesh spacing.

6.6 Wherever required for system balancing, provide a volume balancing opposed blade damper with quadrant and thumb screw lock. Provide damper rod and damper block with upset screws.

6.7 After completion of the duct work, dampers are to be adjusted and set to deliver the required amounts of air as specified on the drawings.

7. ACCESS PANEL

7.1 A hinged and gasket access panel shall be provided on duct work before each reheat coil and at each control device that may be located inside the duct work.

8. UVGI System

8.1 OUTWARDLY PROJECTING 4/5 LAMP UV AIR PURIFIER

1. Description: UV Bio Wall, Induct Air Purifier or equivalent.

2. An individual Array that will provide a barrier wall of germicidal UV energy that will treat 100% of the air that passes through it.

3. An Array will consist of 4/5 outwardly projecting UV lamps to be used in an air duct supporting a longitudinal (parallel) airflow.

4. The overall diameter of the Array will not exceed 4.25 inches (18.4cm).

5. The lamp assemblies will be positioned that a cylindrical Array of UV assemblies is obtained.

6. An aluminum convex deflector element mounted to the support, so that the airflow is directed over the UV lamp assemblies.

7. The cone diameter shall not exceed 3.5 inches (8.75cm)

8. The wire sets connecting the Array to the ballast box that are inside the duct shall be constructed of suitable gauge UL 1716 Teflon wire.

9. The aluminum ballast box shall consist of one ballast for each lamp, a resettable hour accumulating counter that will show the accumulated hours for each lamp, an LED “Lamp On” indicator for each lamp, an audible buzzer to indicate a “Lamp Out” condition. A dry contact will be included to remotely monitor a lamp out condition and a second dry contact to be able to remotely turn on and turn off the Array.

8.2 ELECTRICAL ELEMENTS

8.2.1 The ballasts shall be instant start, solid state electronic type, 120 VAC or 277VAC, 50-60Hz. high power factor, outdoor rated.

Electrical requirements if 120 VAC:

- 24 inch Array: 120VAC 50-60Hz, 3.5 amps, 360 watts
- 30 inch Array: 120VAC 50-60Hz, 4 amps, 400 watts
- 40 inch Array: 120VAC, 50-60Hz, 5 amps, 500 watts.
- 50 inch Array: 120VAC, 50-60Hz, 6 amps, 600 watts
- 60 inch Array: 120VAC, 50-60Hz, 7.5 amps, 750 watts.

8.2.2 INSTALLATION

8.2.2.1 The one piece anodized aluminum Array will contain a plurality (5) of reflectors, having a generally parabolic inner surface and a UV lamp mounted to each reflector so that the generally parabolic reflector inner surface reflects all the UV radiation emitted by the UV lamps in a radial direction.

8.2.2.2 The Array can be positioned either in the return side of the duct, or in the supply side of the duct.

8.2.2.3 The inside of the duct where the Array will be installed, must be lined with aluminum to reflect the UV intensity back into the duct. The aluminum must have a minimum coefficient of reflection of 85%.

8.3 UV LAMP

8.3.1 The Array will be available with UV lamp lengths of 24 inches, 30 inches, 40 inches, 50 inches, or 60 inches.

8.3.2 The high intensity UVC lamps will be of the low-pressure 19mm. (3.0 Torr) mercury laden argon-neon type with an internal Alumina coating to reduce solarization.

8.3.3 The UVC lamps are pure fused quartz, type 219 shell, properly doped with Titanium Oxide in order to filter out 99.99% of the 185 nm wavelength.

8.4 PERFORMANCE

8.4.1 The UV intensity for each individual lamp shall not be less than

- 270 microwatts per/cm^2 at 36 inches for the 24 inch lamps
- 290 microwatts per/cm^2 at 36 inches for the 30 inch lamps
- 500 microwatts per/cm^2 at 36 inches for the 40 inch lamps
- 580 microwatts per/cm^2 at 36 inches for the 50 inch lamps
- 640 microwatts per/cm^2 at 36 inches for the 60 inch lamps.

8.4.2 WARRANTY

The UV Air Purifier shall carry 17,000 hours of lamp warranty and 15 years of warranty on ballast box (electronic).

8.4.3 Certification :- The purifier must be CSA or UL Certified.

SECTION – 4 – VENTILATION SYSTEM

1. General

The ventilation fans, blowers and air washer shall be complete in all respects and shall generally comply with the specifications given below:

2. Axial flow fans

2.1 The Axial Fan Blades shall be of Cast Aluminium of aerofoil design for high efficiency and high static pressure. The blades shall be joined together on cast aluminium hub.

2.2 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.

2.3 The fan assembly shall be statically and dynamically balanced.

2.4 The fan motor shall be totally enclosed Fan cooled type.

2.5 It shall have painted G.I. wire mesh on both sides.

3. INLINE FANS

3.1 SCOPE

The scope of work comprises of supply, erection, testing and commissioning of inline fans conforming to these specifications and in accordance with the Schedule of Quantities and drawings, as per relevant IS Codes, as per approval of Consultant and/or Engineer-In-charge.

3.2 TYPE

Fans shall be single inlet single width (SISW) type / Double Inlet Double Width (DIDW). Fan shall have directly driven forward curved centrifugal impeller, running in a metal scroll balanced to give quite and vibration free operation. Fan motor assembly shall be statically and dynamically balanced.

The fan shall be assembled in such a manner that the motor and impeller can be easily removed and reinstalled after servicing. The noise level of the fan should not exceed 40 DB.

3.3 MATERIAL

Fans casing shall be manufactured from galvanized steel sheets 2.0 mm thick and painted with two coats of rust proof primer and two coats of synthetic enamel paint.

All other metal parts shall be hot dip galvanized.

3.4 MOTOR

The fan motor shall be equipped with motor with speed regulator giving volume control from 0 to 100% of output.

Motors shall be with class 'F' insulation wired to an externally mounted weather proof terminal box.

Motor name plate horsepower shall exceed brake horsepower by minimum of 10%. Motor shall be designed especially for quiet operation and motor speed shall not exceed 1440 RPM.

Motor should be painted with two coats of rust proof primer and two coats of synthetic enamel paint.

3.5 INSTALLATION

Fan shall have rigid supports and fitted to both ends of the casing.

Wherever the fans are to be suspended from ceiling or mounted on the wall, the contractor shall include supply and fixing of all the material that may be required to complete the installation in all respect.

Fan inlet and outlet connections shall be by means of flexible canvas connections having flexibility and slackness as per relevant IS Codes.

3.6 TESTING

Fan after installation shall be tested for capacities, power consumption, noise level and vibration and results shall confirm to the approved data furnished by the contractor.

4. Centrifugal blowers

4.1 The centrifugal blowers shall be double/single inlet, double/single width, non-overloading type, of suitable construction. The blower performance must be rated in accordance with approved test codes and procedures. The centrifugal fans should conform to IS-4894-1987 (Revised to Date).

4.2 The blower housing comprising of scroll & side plates shall be accurately cut be of heavy gauge all welded sectional construction and reinforced with angle bracings. Outlets shall be flanged to assure proper duct connections. Inlet cones shall be spun venturi type, or curved vane type, to ensure smooth air entry. The base frame shall be of angle iron in bolted/welded construction.

4.3 Impeller shall be fabricated from sheet steel with backward curved, properly designed. Blades, with heavy C.I. Hub and shall be both dynamically and statically balanced, to a close tolerance for quiet and vibration free performance.

4.4 Shaft shall be of hot rolled steel or forged steel, sized adequately, but in no case of less than 40 mm diameter and shall be accurately ground and polished to a close tolerance.

4.5 Bearings shall be self aligning, heavy duty ball or tapered roller type with integral dust and grease seals.

4.6 After assembly, the complete fan shall be painted with rust proof primer and two coats of synthetic enamel paint.

4.7 Fan having wheel diameter of 1220 mm or more, shall be supplied with split, bolted housing for convenience of handling and installation.

4.8 **Blower drive assembly**

4.8.1 Drive assembly for each blower shall consist of blower pulley, motor pulley, a set of 'V' belts, belt guards, and belt tension adjusting device.

4.8.2 Pulleys shall be selected to provide the required speed. They shall be multi-groove type, with section and grooves selected to transmit 33% more load than the required power and shall be statically balanced.

4.8.3 The belt guards shall be of M.S. Sheet with angle iron reinforcements and expanded metal screen.

4.9 **Motors and starters**

4.9.1 The motor for each blower shall be squirrel cage high efficiency (efficiency -1) induction type and conform to specifications as given under section on control panel, motors and switchgear. The motor H.P. Shall be atleast 20% more than the limit load of fan and of minimum rating as given under 'Schedule of Equipments'. The Motors shall be as per IS-325-1996 (Revised to date) with F-Class of Insulation.

4.10 **Accessories**

All necessary accessories shall be provided for proper operation and shall also include **(As part of Unit Price):**

4.10.1 Dunlop cushy foot vibration isolators for the blowers.
4.10.2 Double canvass connections at the outlet of each fan.
4.10.3 Nuts, bolts, shims etc. as required for the grouting of the equipment.
4.10.4.1 Slide rails for mounting the motor and belt adjustments.

4.10.5 Bird Screens in the Inlet.
4.10.6 Louvers for Fresh Air and exhaust openings.
4.10.7 Detachable and washable fresh air filters at the inlet.

SECTION – 5 – FRESH AIR SECTION

1. Single Skin Fresh Fan Section

1.1 Single skin fan section housing shall be fabricated of 16G pre-coated or powder coated galvanized steel sheet from out side. All corner supporting frames shall be of extruded Aluminium section. It shall have suitable size of inlet & outlet.

1.2 The centrifugal fan (DIDW) & motor shall be mounted on the common base of Aluminium, inside the housing including anti-vibration. Blower should conform the specification under item No. 4 of Section – 4 (Ventilation System).

1.3 The fan outlet shall be connected to the casing with the help of fire retardant flexible canvass.

1.4 The fan shall be complete with motor, belt pulley with all accessories.

1.5 The opening for access doors and gaps between sections shall be provided with the neoprene rubber T gasket fixed in the extruded sections.

1.6 In case of exhaust, the fan outlet shall have Louvers with bird screen.

1.7 In case of lift well & lift lobby pressurization, the fan inlet shall have fresh air louvers with bird screen.

1.8 Each unit shall be provided with a factory assembled filter section containing washable synthetic type air filters having anodized aluminum frame. The media shall be supported with HDP mesh on one side and aluminum mesh on other side. Filter banks shall be easily accessible and designed for easy withdrawal and renewal of filter cells. Filter framework shall be fully sealed and constructed from aluminum alloy. Filter banks face velocities shall not exceed 170 mtr/ minute.

SECTION – 6 – INSULATION

1. General

The Insulation of water piping, air handling units, ducting, chillers etc., shall be carried out as per specifications given below:

2. Materials

The materials to be used for insulation shall be as follows, unless some other material is specifically mentioned elsewhere. The detailed specifications of the materials are listed under respective sub heads.

2.1	Pipe Insulation	:	Cross Link Polyethylene
2.2	Drain Pipe Insulation	:	Closed Cell Cross Linked Polyethylene (XLPE)
2.3	Duct Insulation	:	Insulated duct
2.4	Acoustic Treatment	:	Resin Bonded glass wool
2.5	Equipment Insulation	:	Closed Cell Nitrile Rubber

3. Drain Pipe Insulation

3.1 The material for insulation of drain pipes shall be pipe section of closed cell cross linked polyethylene insulation having a 'K' valve of 0.027 W/mK at a mean temperature of 10°C and a minimum density of 55 Kg/cub m.

3.2 The thickness of insulation shall be a section of 15 mm thick.

4. Acoustic Treatment

4.1 The material for acoustic treatment of ducts shall be 25 mm thick resin bonded glass wool, as described earlier, conforming to I.S. 8183 of 1976. The density of glass wool shall be 32 kg/cub.m and the material shall be in the form of rolls of uniform density. The 'k' value at 10°C shall not be less than 0.03 W/mK. Facing shall be provided with perforated aluminum sheet held with G.I. stick pins and washers.

4.2 Equipment Insulation

4.2.1 All the complete shell insulated as per manufactures standard practice.

5. Duct Acoustic

Pre-insulated duct board shall be made of high density of rigid resin bonded fire safe glass wool with both side factory laminated aluminum foil, outer facing foil is having - Reinforced aluminum + Kraft + glass veil and inner facing - Black glass textile.
Density of above both pre insulated glass wool duct board shall be 75-80Kg/m^3 and at the edge of panels shall have density of 150Kg/m^3. size of panels for duct construction as below.

Thickness(mm)	Length(m)	Width(m)
25	3	1.19

The thermal conductivity of duct board shall not be exceeding 0.033 W/m K at 10 deg C means temperature and thermal resistance should be more than 0.6 m^2K/W. Glass wool duct panels shall be tested as per EN 13403 Vapour permeance of duct panels should be approximate value: 0.013 g/m2. day mm Hg (outer facing) Mechanical stiffness: R5 rigidity, according to EN 13403 (European Standard for non metallic ducts) this rigidity is the maximum level of the ones established by this standard.

Duct board should withstand pressure under 800 Pa with no evidence of fissures or swelling (test according to EN 13403).

Fire test: Panels shall be tested as Euroclass: Euro class C-s1, d0

- s1: null smoke emission
- d0: non flaming droplets / particles.

6. DRAIN PIPING INSULATION

Cross linked closed cell preformed sections of polyethylene insulation of 9 mm (as per details indicated above) having a low stable k value of 0.027 – 0.029 k.cal/hr.m.^{o}C (at 0^{o}C - 23^{o}C) with minimum density of 32kg/cum, Fire-Retardant and of Fire Rating Class-1 in self-extinguishing and non-dripping having good ozone resistance and non-fiber erosion and should be CFC free finally finished with 0.63 mm thick aluminium sheet cladding.

7. MEASUREMENT OF INSULATION

Unless otherwise specified measurement for duct and pipe insulation for the project shall be as per CPWD specification for HVAC Work.

8. INSTALLATION

8.1 The duct surface shall first be cleaned from inside.

8.2 The insulation boards shall be wrapped in RP tissue paper.

8.3 The insulation shall then be covered with 0.5mm perforated aluminum sheets.

8.4 The sheet and the insulation shall be secured to the duct by means of cadmium-plated bolts, nuts and washers. The ends should be completely sealed off, so that no insulation material is exposed.

SECTION – 7

ELECTRICAL INSTALLATIONS

Refer to Technical specifications of Electrical Works

SECTION – 8

MODE OF MEASUREMENTS

1. UNIT PRICES IN THE SCHEDULE OF QUANTITIES

1.1 The item description in the schedule of quantities is in the form of a condensed resume. The unit price shall be held to include everything necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum total of all the individual item prices shall represent the total price of the installation ready to be handed over.

1.2 The unit price of the various items shall include the following:

1.2.1 All equipment, machinery, apparatus and materials required as well as the cost of any tests which EIC may request in addition to the tests generally required to prove quality and performance of equipment.

1.2.2 All the labour required to supply and install the complete installation in accordance with the specifications/drawings.

1.2.3 Use of any tools, equipment, machinery, lifting tackle, scaffolding, ladders etc. required by the contractor to carry out his work.

1.2.4 All the necessary measures to prevent the transmission of vibration.

1.2.5 The necessary material to isolate equipment foundations from the building structure, wherever necessary.

1.2.6 Storage and insurance of all equipment apparatus and materials.

1.3 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 make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

1.3.1 The contractor's unit price shall also include all taxes, duties, octrois, works contract tax etc as applicable.

2. MEASUREMENTS OF SHEET METAL DUCTS, GRILLES/ DIFFUSERS ETC.

2.1 SHEET METAL DUCTS

2.1.1 All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars, vanes & other fittings. Gaskets, nuts, bolts, vibration reducing pads are included in the basic duct items of the BOQ./ or as per IS code.

2.1.2 The unit of measurements shall be the finished sheet metal surfaces area in meters squares. No extra shall be allowed for laps and wastage.

2.1.3 All the guide vanes, deflectors in duct elbows, branches, grille collars quadrant dampers etc. shall be measured for actual sheet metal surface and paid for at the same rate as duct of same thickness.

2.1.4 The unit duct price shall include all the duct hangers and supports, exposing of concrete reinforcement for supports and making good of the same as well as any materials and labour required to complete the duct frame.

2.2 GRILLES/DIFFUSERS

All grilles/diffusers shall be measured as follows.

2.2.1 All measurements of grilles/diffusers shall be the actual outlet size excluding the outer flanges.

2.2.2 The square or rectangular grills/diffusers shall be measured in sq.m.

2.2.3 All round diffusers shall be measured by their diameters in cm.

2.2.4 All linear diffusers shall be measured as per actual length in metres.

3. MEASUREMENTS OF PIPING, FITTINGS, VALVES, FABRICATED ITEMS

3.1 PIPE

3.1.1 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, reducers, elbows etc. Deduction shall be made for valves in the line.

3.1.2 The rate quoted shall be inclusive of cutting holes, exposing reinforcement in wall and ceiling and floors and making good the same and inclusive of all items as specified in specification and schedule of quantities.

3.1.3 Rates quoted shall be inclusive of providing and fixing pads wherever specified or required by the Engineer in charge.

3.1.4 Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowance being made for providing the same.

3.1.5 The length of the pipe for the purpose of payment will be taken through the centerline of the pipe and all fittings (e.g. tees, bends, reducers, elbows, etc.) as through the fittings are also resumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above for the fittings.

3.3 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 BOQ or as required at site by Engineer in Charge.

4. INSULATION

4.1 The measurement for piping, and ducts shall be made over the bare uninsulated surface area of the metal.

4.2 PIPES, DUCTS

4.2.1 PIPES

The measurements for insulation of piping shall be made in linear metres through all valves, flanges, and fittings. Pipes/bends shall be measured along the center line radius between tangent points. If the outer radius is R1 and the inner radius is R2. The center line radius shall be measure as (R1+R2)/2. Measurement of all fittings shall be measure with the running metre of pipe line as if they are also pipe lengths. Nothing extra over the above shall be payable for insulation over fittings in pipe line/routings. Fittings that connect two or more different sizes of pipe shall be measured as part of the larger size.

4.2.2 DUCTS

The measurements for insulation of ducts shall be made in actual square metres of bare uninsulated duct surface through all dampers, flanges and fittings. In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for the dampers, 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.

4.3 ACCESSORIES INSULATION

4.3.2 In case of curved or irregular surfaces, measurements shall be taken along the curves.

4.3.3 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.

4.4 ROOF AND WALL INSULATION & ACOUSTIC TREATMENT

4.4.1 The unit of measurement for all underdeck roof insulation, wall insulation, wall/roof acoustic panel shall be the uninsulated area of walls, roofs, to be treated, in square meters.

4.4.2 The insulation, acoustic panels shall include cost of battens, supports, adhesives, vapour proofing, finished tiles/boards/sheets as well as additional labour and material required for completing the work.

APPENDIX – II

TECHNICAL DATA TO BE FURNISHED BY THE TENDERER FOR THE VRF/ VRV SYSTEM

Tenderers are required to separately fill the Data for each rating of the equipment offered.

S. No.	System Offered	VRF or VRV (Strike off one of them)
1.0	**OUTDOOR UNITS (ODU)**	
1.1	Make and model number of the compressor	
1.2	Applicable codes and standards for manufacture of ODU	
1.3	Normal rating of the Outdoor unit	
1.4	Actual rating of the ODU	
1.5	Number of compressors in each outdoor unit	
1.6	Type of compressor	
1.7	Type of modulation	
1.8	Capacity of each compressor	
1.9	Power consumption per TR at rated capacity of the ODU	
1.10	Total power consumption of rated capacity of the ODU	
1.11	Total Power consumption at actual capacity	
1.12	Motor rating of each compressor	
1.13	AC or DC motor	
1.14	Type of starter for the compressor motor	
1.15	Whether the motor starters are integral to the ODU	
1.16	Type of refrigerant	
1.17	Quantity of refrigerant in the circuit	
1.18	Noise level of the ODU at one meter from the ODU	
1.19	Energy Efficiency Ratio of the offered ODU	
1.20	Type of oil recovery system	

1.21	Range Capacity	
1.22	Number of inverters where applicable for the ODU	
1.23	External static pressure	
1.24	Construction of the ODU	
1.24.1	Modular/ fabricated	
1.24.2	Casing material	
1.24.3	Frame work material	
1.24.4	Painting/ coating	
1.24.5	Method of vibration isolation	
2.0	**INDOOR UNITS (IDU)**	
2.1	Make and model number of the IDU	
2.2	Material of construction	
2.3	Type of indoor unit	
2.4	Type of mounting of the indoor unit	
2.5	Power consumption of each indoor unit at full load	
2.6	Air flow through the indoor unit	

APPENDIX – III

AIR-COOLED CONDENSER DETAILS:

Description	Unit	Tech .Details
Number of circuit's	--	
CONDENSER COIL:		
Make	--	
Type	--	
Face area	m2	
Air Volume	Cfm	
Rows deep	Nos.	
Fins per Inch	Nos.	
Tube Material / Size / Thick	-- / mm / mm	
Fin Material / Size / Thick	-- / mm / mm	
CONDENSER FAN:		
Make	--	
Type of Fan	--	
Fan Material	--	
Type of Drive	--	
No of Fan / Condenser	Nos.	
Impeller Diameter	Mm	
Power supply	V / Ph / Hz	
Motor Rated KW	KW	
Full Load Amps (FLA)	amps.	
Motor rpm	Rpm	
Motor class of insulation	--	
Motor protection	--	
DIMENSION AND WEIGHT:		
Casing Material	--	
Width	Mm	
Depth	Mm	
Height	Mm	
Weight	Kg	

2. INLINE FAN

2.1 Manufacturer
2.2 Model No.
2.3 Type of fan
2.4 Overall dimension (mm)
2.5 Air quantity CFM
2.6 Static pressure (mm wc)
2.7 Speed RPM
2.8 Motor Horse Power
2.9 Method of Starting
2.10 Class of insulation

APPENDIX – VI

LIST OF DRAWINGS

S. No.	Description	Drawing No.
1.	AC Layout (Basement Floor Plan)	AC-01
2.	AC Layout (Ground Floor Plan)	AC-02
3.	AC Layout (First Floor Plan)	AC-03
4.	AC Layout (Second Floor Plan)	AC-04
5.	AC Layout (Third Floor Plan)	AC-05
6.	AC Layout (Fourth & Fifth Floor Plan)	AC-06
7.	AC Layout (Fifth Floor Plan)	AC-07
8.	HVAC Layout (Terrace Floor Plan)	AC-08

APPENDIX – VII

LIST OF APPROVED MAKES OF MATERIALS FOR HVAC WORK

FOR BHEL OFFICE, NEW DELHI

S. NO.	ITEMS	ACCEPTABLE MAKES
1.	Variable Refrigerant Flow Unit (VRF)	Daikin / Mitsubhishi / Hitachi / O General / Toshiba
2.	Propeller Fan	Alstom/ Crompton/ Ventaxia / Flaktwood
3.	Axial Flow Fan	Nicotra / Kruger / FlaktWood / System Air
4.	Inline Fan	Caryaire/ Nuaire / Kanalflakt/ Flaktwood
5.	Control	Honeywell / Johnson / Danfoss / Siemens
6.	Grilles/Diffusers and VCD	Caryaire / Conair / Air master
7.	Slot Diffuser	Caryaire / Conair / Air master
8.	Volume control damper	Caryaire / Air flow / Conair/ Air master
9.	Pre-Insulated duct work	UP Twiga / ALPHA
10.	Fibre Glass	UP-Twiga / Owens Corning / Llyod
11.	Closed-cell polyethylene Insulation	Paramount / Armacell / Supreme
12.	Copper Pipes	Rajco / Mandev

13.	Control Cables	Bonton / Finolex / Havells / Lapp Cable / Relison / Skytone
14.	Power Cables	Bonton / Finolex / Havells / Lapp Cable / Relison / Skytone
15.	Push Buttons	Siemens / Cutler Hammer/ L&T
16.	Auxiliary Relays/ Contactors	Siemens / L&T / BCH / GE
17.	Line Type Fuse	G.E. / L & T / Siemens
18.	Timer	Siemens / L&T / Cutler Hammer / GE
19.	Indicating Lamps	Siemens / L & T / Vaishno
20.	Selector Switches	Siemens / L & T / Kaycee
21.	G.I. sheets	Tata / Nippon / SAIL

Note: For any item not covered in the above list, the contractor shall get the samples approved from the authorized representative of BHEL/CONSULTANTS before the supply is made.