

**SECTION – VI**  
**(TECNHICAL SPECIFICATION)**

## **PREAMBLE TO PRICED BILL OF QUANTITIES**

### **Preamble**

1. The Contract is on item rate basis and excludes the definitive engineering and design that shall ultimately define actual quantities of work.
2. The provisional quantities of various items of work like excavation/ filling, foundations, supply and erection of steelwork, and miscellaneous work items such as fire protection wall for transformers, cable trench, walls etc. for the proposed up-gradation works are given in the price-schedule. However, the quantities may vary consequent to actual execution of the work. The payment shall be made for the actual quantities used for various items. Items with quantity 'LOT' will not be eligible for any variation in payment irrespective of the quantities of the constituent sub-items.
3. The Contract Price shall be adjusted for the actual and correct quantities as executed and duly approved by the Employer on the basis of the proposed all inclusive unit rates to arrive at the final Contract Price.
4. Wherever no quantity is given against any item in the Schedule of prices, a rate shall nevertheless be entered against that item. This rate shall be used, in case the item is required to be used during actual execution of the contract.
5. It shall be a condition of this contract that the all-inclusive rates quoted in Schedule of Rates / Prices shall not be varied for reasons of change in respective quantities.
6. Further, it shall also be an important condition of this contract that there shall not be any change in Unit Rates of items consequent to revision of labour rates by the Royal Government of Bhutan.
7. The supply rate against each item shall be an all-inclusive rate, and be inclusive of supply, freight, transport, insurance, etc. The Bidder shall indicate the all-inclusive rate separately for each item. Further, the all-inclusive unit rates shall be on FAS basis inclusive of ex-works price, packing and forwarding charges, railway freight, transport charges to actual work site, storage where necessary, charges for transit insurance, insurance of material/ goods at site.
8. All labour, supervision and inspection costs should be covered in Schedules for erection of substation equipment. The charges/ expenses to be incurred on testing and commissioning of the entire system as a whole shall be excluded in the prices for individual activities.
9. The total price for each activity should cover all costs and expenses required for supply, delivery, storage, erection and maintenance of works

together with all risks, liabilities, contingencies, insurances and obligations imposed and implied by the Contractor.

10. Unit prices of major items and civil works have been included for the purpose of estimation of Contract variations, if any, due to additions and deletions to the scope of works during execution. It shall be noted that such unit rates of constituent sub-items of "LOT" items in the price schedule are not meant for changing the "LOT" prices during actual execution and "LOT" price quoted by the bidder shall govern irrespective of quantity variation for the intended works. The rates of such sub-items can, however, be adopted for on-account payment purposes.
11. All items of work specified in the specifications have not been included in the price-schedule. The items of work not specifically called for in the Schedules are deemed to have been covered under the items called for, to leave the works complete, as per the specifications. The rate quoted by the Contractor shall be deemed to be all inclusive, to cover the smaller items specified / required but not included in the Price-Schedule.
12. In addition to the points stipulated / highlighted in these clauses, all the conditions mentioned in the specifications, pertaining to measurement of quantities and unit rates of scheduled items shall apply.
13. It is deemed that the Bidder has understood the site conditions, environment, transport facilities, soil data etc. while preparing the price schedule and has adequately provided for them in his quoted prices. No claims of extra compensation will be payable for items and situations not foreseen and not incorporated by him in the schedules.
14. The wording under "Description" in the schedules is for subject matter guidance only. The Bidder's price shall include all works as specified in the specifications and drawings and all contractual obligations whether specifically mentioned or not.
15. The Bidder shall, if so desired by the Employer/Engineer, furnish at any stage of the bidding or Contract execution, break-up of prices considered for any or all items covered in various activities.
16. The measurement of quantities shall be on the following basis:

a) **Structural Steel**

The per M.T. rate shall cover, erection of galvanized structural steel including all connections as specified to constitute complete equipment support structure in the final form contemplated in the specifications and drawings. Connecting materials like nuts, bolts, washers, cover-plates etc. shall neither be measured nor be paid separately, but shall be deemed to be included in the weight of above steel members. The rectification to damage to protective zinc

surface by approved paint as specified shall be covered under the quoted rates.

b) **Foundations and Miscellaneous RCC and Other Works: -**

Designs of Foundations and other RC items of work to suit actual soil characteristics shall be provided by the employer to the Contractor for the execution, and shall be paid as per the Unit Rates of individual items like ordinary concrete, steel reinforcement bars, excavation etc, based on the actual quantities.

The rates for excavation shall be deemed to include execution of all items mentioned in the specifications like earth work for casting of foundations, benching, compacting, leveling, de-watering etc., It also includes cost of shoring and shuttering wherever used. The rates for concreting shall together cover cost of all materials for shuttering, casting concrete, curing and also cost of all materials related with the item.

Unit rates for reinforcement shall include supply, cutting, bending, tying, properly placing, providing lap and every other work needed for casting of the concrete, as specified. Similarly the Rates for other items like stone masonry revetment shall be deemed to be all-inclusive.

## **Scope of Works & Technical Specifications**

### **1. Scope of the work**

Construction of 66/33kV Substation and associated works at Jamtshohling, Tashicholing under Samtse Dzongkhag. The works need to be carried out as per the Bill of quantities and the drawings, and the following are the list of works:

1. Site grading works.
2. Construction of 66/33kV equipment foundations.
3. Construction of 66kV gantry tower foundations.
4. Laying of earthing in the 66/33kV switchyard.
5. Construction and electrification of control room building and pump house.
6. Construction of chain link fencing and steel gate for switchyard.
7. Construction of traditional Bhutanese gate with motorized sliding gate.
8. Water supply from intake to substation and internal distribution network.
9. Design, drawing and construction of firefighting system including water tank for entire substation.
10. Road works (Scarifying, laying of asphalt concrete and construction of side drain).
11. Other work as per the Bid document.

### **2. Technical Specification**

The Technical Specifications for various items of work indicated in the BOQ and any extra/substituted /variations in quantities in the various schedules shall conform in all respects to the specifications of the latest BSR and BSB specification – “Specifications for Roads and Building Works – Latest”, unless otherwise specifically indicated and/or the context otherwise means.

Out of the approved brand of BSB, BPC shall select the samples of best quality as felt appropriate and the Contractor shall have no extra claims whatever for the type of samples/brand selected by BPC. Materials that are manufactured in Bhutan shall be used preferably in the construction.

**CHAPTER – 1**  
**(SUBSTATION STRUCTURES)**

# CHAPTER 1

## SUBSTATION STRUCTURES

### 1.0 GENERAL

1.1 The scope of specification covers erection of galvanized steel structures for towers, girders and equipment support structures. Towers, Girders and equipment support structures shall be lattice type shall be fabricated from structural steel conforming to IS 2062 (latest). In case, Equipment support structure are fabricated from GI pipe they shall conform to YST 22 (Kg/mm<sup>2</sup>) or of higher grade as per IS 806.

The scope shall include erection of all types of structures including bolts, nuts, flat washers, hangers, shackles, clamps anticlimbing devices, bird guards, step bolts, inserts in concrete, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, flat washers, fixing plates, ground mounted marshalling boxes (AC/DC Marshalling box & equipment control cabinets), structure mounted marshalling boxes and any other items as required to complete the job.

The connection of all structures to their foundations shall be by base plates and embedded anchor/foundation bolts. All steel structures and anchor/foundation bolts shall be fully galvanized. The weight of the zinc coating shall be at least 0.610 kg/m<sup>2</sup> for anchor bolts / foundation bolts and for structural members. One additional nut shall be provided below the base plate which may be used for the purpose of leveling.

### 2.0 DESIGN REQUIREMENTS FOR STRUCTURES

2.1 For design of steel structures loads such as dead loads, live loads, wind loads etc. shall be based on IS:875,Parts I to V.

2.2 For materials and permissible stresses IS:802,Part-I,Section-2 shall be followed in general. However, additional requirements given in following paragraphs shall be also considered.

2.3 Minimum thickness of galvanized tower member shall be as follows :

<b>Members</b>	<b>Minimum thickness (mm)</b>
Leg members, Ground wire	5
Peak members/Main members	
Other members	4
Redundant members	4

2.4 Maximum slenderness ratios for leg members, other stressed members and

redundant members for compression force shall be as per IS-802.

2.5 Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.

2.6 The minimum bolt diameter shall be 16 mm.

## 2.7 **Step Bolts**

In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. Each tower shall be provided with step bolts not less than 16mm diameter & 175mm long spaced not more than 450mm apart, staggered on faces on one leg extending from about 0.5 metres above ground level to the top of the tower. The step bolt shall conform to IS:10238. Ladders on towers with lighting appliances shall be provided with safety guards.

## 2.8 **Design Criteria**

(a) All structures shall be designed for the worst combination of dead loads, live loads, wind loads as per code IS:875, seismic forces as per code IS:1893 (latest), Importance factor of 1.5, loads due to deviation of conductor, load due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including “snatch” in the case of bundled conductors etc. Short circuit forces shall be calculated considering a fault level of 40.0 kA for 220kV & and 31.5kA for 132kV & 66kV systems. IEC-865 may be followed for evaluation of short circuit forces.

(b) Switchyard gantry structures shall be designed for the two conditions i.e. normal condition and short circuit condition. In both conditions the design of all structures shall be based on the assumption that stringing is done only on one side i.e. all the three (phase) conductors broken on the other side.

For design of foundation, the loads arrived at foundation level from analysis of superstructure shall be multiplied by partial safety of factor by 1.2 under normal & broken wire conditions and by 1.1 under broken wire condition with short circuit forces for switchyard structures which are of lattice type.

(c) Vertical load of half the span of conductors/string and the earth wires on either side of the beam shall be taken into account for the purpose of design. Weight of man with tools shall be considered as 150 kgs. for the design of structures.

(d) Terminal/line take off gantries shall be designed for a minimum conductor tension of 2 metric tonnes per phase for 220 kV and 132kV,

1 tonne per phase for 66 kV or as per requirements whichever is higher. The distance between terminal gantry and dead end tower shall be taken as 200 metres. The design of these terminal gantries shall also be checked considering +/- 30 deg deviation of conductor in both vertical and horizontal planes. For other gantries the structural layout requirements shall be adopted in design.

- (e) The girders shall be connected with lattice columns by bolted joints.
- (f) All Pipe support used for supporting equipments shall be designed for the worst combination of dead loads, erection load. Wind load/seismic forces, short circuit forces and operating forces acting on the equipment and associated bus bars as per IS:806. The material specification shall be as per IS:1161 read in conjunction with IS:806.
- (g) If luminaries are proposed to be fixed on gantries/towers, then the proper loading for the same shall be considered while designing. Also holes for fixing the brackets for luminaries should be provided wherever required.
- (h) Foundation bolts shall be designed for the loads for which the structures are designed.
- (i) Lightning Mast shall be 50m in height (47.5m lattice structure plus 2.5m pipe) or as per requirement during detailed engineering and designed for diagonal wind condition. Lightning masts shall be provided with a structural steel ladder within its base up to a height of 25 metre. The ladder shall be provided with protection rings. Two platforms shall be provided one each at 12.5m and 25.0m height for mounting of lighting fixture. The platforms shall also have protection railing. The details of lighting fixtures would be as per the approved drawings.

### **3.0 DESIGN DRAWINGS, BILL OF MATERIALS AND DOCUMENTS**

- 3.1 The Employer shall furnish design, drawing and BOMs and shop manufacturing drawings for every member to the Purchaser after award of the Contract.
- 3.2 The fabrication drawings to be prepared and furnished by the Employer based on the design approved or standard drawing provided. These fabrication drawings shall indicate complete details of fabrication and erection including all erection splicing details and typical fabrication splicing details, lacing details, weld sizes and lengths. It shall, however, not relieve the Contractor of his responsibility for the safety of the structure and good connections and any loss or damage occurring due to poor storage, defective handling or workmanship shall be borne by the Contractor.

#### **4.0 FABRICATION OF STEEL MEMBERS**

4.1 The fabrication and erection works shall be carried out generally in accordance with IS 802. A reference however may be made to IS 800 in case of non-stipulation of some particular provision in IS 802. All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.

#### **5.0 PROTO-ASSEMBLY**

- (i) The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified camber, if any, is provided. In order to minimize distortion in member the component parts shall be positioned by using the clamps, clips, dogs, jigs and other suitable means and fasteners (bolts and welds) shall be placed in a balanced pattern. If the individual components are to be bolted, paralleled and tapered drifts shall be used to align the part so that the bolts can be accurately positioned.
- (ii) Sample towers, beams and lightning masts and equipment support structures shall be trial assembled in the fabrication shop and shall be inspected and cleared by Contractor based on the approved fabrication drawing before mass fabrication.

Pursuant to above the BOMs along with proto-corrected fabrication drawings and shop manufacturing drawings for every member shall be prepared and submitted by the main vendor to Purchaser as document for information. Such drawings and BOMs, which shall be duly certified by the main vendor for its conformity to the approved design, shall be the basis for Purchaser to carry out inspection.

#### **6.0 BOLTING**

- (i) Every bolt shall be provided with a flat/spring washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.
- (ii) All steel items, bolts, nuts and flat washers shall be hot dip galvanized.
- (iii) 2.0% extra nuts and bolts shall be supplied for erection.

#### **7.0 WELDING**

The work shall be done as per approved fabrication drawings which clearly indicate various details of joints to be welded, type of weld, length and size of weld, whether shop or site weld etc. Symbols for welding on erection and shop drawings shall be according to IS:813. Efforts shall be made to reduce site welding so as to avoid improper joints due to constructional difficulties.

## **8.0 FOUNDATION BOLTS**

- 8.1 Foundation bolts for the towers and equipment supporting structures and elsewhere shall be embedded in first stage concrete while the foundation is cast. The Contractor shall ensure the proper alignment of these bolts to match the holes in the base plate.
- 8.2 The Contractor shall be responsible for the correct alignment and leveling of all steel work on site to ensure that the towers/structures are plumb.
- 8.3 All foundation bolts for lattice structure, pipe structure are to be supplied by the Contractor.
- 8.4 All foundation bolts shall be fully galvanized so as to achieve 0.61 kg. per Sq.m. of Zinc Coating as per specifications.
- 8.5 All foundation bolts shall conform to IS 5624 but the material, however shall be MS conforming to IS:2062.

## **9.0 STABILITY OF STRUCTURE**

The Contractor shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

## **10.0 GROUTING**

The method of grouting the column bases shall be subject to approval of Employer and shall be such as to ensure a complete uniformity of contact over the whole area of the steel base. The Contractor will be fully responsible for the grouting operations.

## **11.0 GALVANISING**

- 11.1 All structural steel works and pipe supports shall be galvanised after fabrication.
- 11.2 Zinc required for galvanizing shall have to be arranged by the manufacturer. Purity of zinc to be used shall be 99.95% as per IS:209.
- 11.3 The Contractor shall be required to make arrangement for frequent inspection by the Purchaser as well as continuous inspection by a resident representative of the Purchaser, if so desired for fabrication work.

## **12.0 TOUCH-UP PAINTING**

The touch up primers and paints shall consist of Red Oxide / Zinc chromate conforming to the requirements of IS:2074 with a pigment to be specified by the Purchaser.

### **13.0 INSPECTION BEFORE DISPATCH**

Each part of the fabricated steel work shall be inspected as per approved quality plans and certified by the Purchaser or his authorized representative as satisfactory before it is dispatched to the erection site. Such certification shall not relieve the Contractor of his responsibility regarding adequacy and completeness of fabrication.

### **14.0 TEST CERTIFICATE**

Copies of all test certificates relating to material procured by the Contractor for the works shall be forwarded to the Purchaser.

### **15.0 ERECTION**

The Contractor should arrange on his own all plant and equipment, welding set, tools and tackles, scaffolding, trestles equipments and all other accessories and ancillaries required for carrying out erection without causing any stresses in the members which may cause deformation and permanent damage.

### **16.0 SAFETY PRECAUTIONS**

The Contractor shall strictly follow at all stages of fabrication, transportation and erection of steel structures, raw materials and other tools and tackles, the stipulations contained in Indian Standard Code for Safety during erection of structural steel work-IS:7205.

**17.0** All tests mentioned in field quality plans have to be carried out and conformity of materials and workmanship shall be ascertained.

**CHAPTER – 2**  
**(SUBSTATION CIVIL WORKS)**

## CHAPTER 2

### SUBSTATION CIVIL WORKS

#### 1. GENERAL

The intent of this specification covers “Design, Engineering, and Construction of all civil works” at sub-station. All civil works shall also satisfy the general technical requirements specified in other Sections of this Specification and as detailed below. They shall be designed to the required service conditions/loads as specified elsewhere in this Specification or implied as per National/ International Standards.

All civil works shall be carried out as per applicable Standards and Codes. All materials shall be of best quality conforming to relevant Indian Standards and Codes. In case of any conflict between Standards/ Code and Technical Specification, the more stringent provision will govern.

The Contractor shall furnish all design, drawings, labour, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for complete performance of the Works in accordance with approved drawings, specifications and direction of Purchaser.

The work shall be carried out according to the design/drawings to be developed by the Contractor and approved by the purchaser based on Tender Drawings Supplied to the Contractor by the Purchaser. For all buildings, structures, foundations etc. necessary layout and details shall be developed by the Contractor keeping in view the functional requirement of the substation facilities and providing enough space and access for operation, use and maintenance based on the input provided by the Purchaser. Certain minimum requirements are indicated in this specification for guidance purposes only. However, the Contractor shall quote according to the complete requirements.

The Contractor shall perform the works to comply with the requirements of this specification and relevant enclosed drawings, and shall assume full responsibility for their satisfactory performance

#### 1.1 Scope of work

The scope of works for all civil, architectural and structural works shall include preparation of designs, supply of all materials to site including insurance and storage, drawings for approval, provision of all labour, qualified supervisory personnel, instruments, tools, erection plant and equipment, fixtures, fittings and all temporary and permanent works necessary, whether or not such items are specifically stated herein for satisfactory completion of the job in all respects in accordance with the specification requirements. It shall be noted that the Contractor will have to complete all these works so that the substation is handed over to the client ‘ready to use’. Specific items of work involved are excavation, site-grading and back-filling, construction of foundations and erections of structural steel supports of switch yard, site development including drains,

roads, fencing and gates, construction of control room and miscellaneous items like water tanks, revetment walls etc.

## **1.2 SITE PREPARATION:**

The contractor shall be responsible for proper grading and levelling of switchyard site as per layout and levels of switchyard finalised during detailed engineering stage. The layout and levels of all structure etc. shall be made by the Contractor at his own cost from the general grids of the plot and benchmarks set by the Contractor and approved by the Purchaser. The Contractor shall give all help in instruments, materials and personnel to the Purchaser for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels. Site levelling including all operations like clearing of site, removal of vegetation, trees, tree stubs etc., slope protection by stone pitching/retaining walls with filter depending on the site location/condition shall be in the scope of the contractor. Bidder shall decide the formation level of the sites as per detailed engineering requirements. However, the level shall be such that it is 300 mm higher than the highest flood level (HFL) of the site.

### **1.2.1 SCOPE**

This clause covers the execution of the work for site preparation, such as clearing of the site, grading and levelling, the supply and compaction of fill material, slope protection by stone pitching/retaining walls with filter depending on the site location/condition, excavation and compaction of backfill for foundation, road construction, drainage, trenches and final topping by stone (broken hard stone).

### **1.2.2 GENERAL**

- (1) The Contractor shall develop the site area to meet the requirement of the intended purpose. The site preparation shall conform to the requirements of relevant sections of this specification or as per stipulations of standard specifications. Necessary protection of slope of switchyard area and approach road shall also be carried out by contractor.
- (2) If fill material is required, the fill material shall be suitable for the above requirement. The fill shall be such a material and the site so designed as to prevent the erosion by wind and water of material from its final compacted position or the in-situ position of undisturbed soil.
- (3) Material unsuitable for founding of foundations shall be removed and replaced by suitable fill material and to be approved by the Purchaser.
- (4) Backfill material around foundations or other works shall be suitable for the purpose for which it is used and compacted to the density described under Compaction. Excavated material not suitable or not required for backfill, shall be disposed off in areas as directed by purchaser up to a maximum lead of 2 km.

### **1.3 EXCAVATION AND BACKFILL**

- (1) Excavation and backfill for foundations shall be in accordance with the relevant code.
- (2) Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, concreting and backfilling.
- (3) When embankments are to be constructed on slopes of 15% or greater, benches or steps with horizontal and vertical faces shall be cut in the original slope prior to placement of embankment material. Vertical faces shall measure not more than 1 m in height.
- (4) Embankments adjacent to abutments, culverts, retaining walls and similar structures shall be constructed by compacting the material in successive uniform horizontal layers not exceeding 15 cm in thickness. (Of loose material before compaction). Each layer shall be compacted as required by means of mechanical tampers approved by the Purchaser. Rocks larger than 10 cm in any direction shall not be placed in embankment adjacent to structures.
- (5) Earth embankments of roadways and site areas adjacent to buildings shall be placed in successive uniform horizontal layers not exceeding 20 cm in thickness in loose stage measurement and compacted to the full width specified. The upper surface of the embankment shall be shaped so as to provide complete drainage of surface water at all times.

The pitching/retaining walls with filter shall be designed and provided for slope protection as per approved drawings. The stone used shall be sound, hard, durable and fairly regular in shape. Stones subjected to marked deterioration by water or weather shall not be used. Suitable measures shall be provided to prevent erosion by seepage of water. Largest stone procurable shall be used as approved by owner for the work. Random rubble masonry (1:5) /RCC retaining walls shall be provided where ever required as per site condition.

### **1.4 COMPACTION**

- (1) The density to which fill materials shall be compacted shall be as per relevant IS and as per direction of Purchaser. All compacted sand filling shall be confined as far as practicable. Backfilled earth shall be compacted to minimum 95% of the Standard Proctor's density at OMC. The subgrade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor's density at OMC. Cohesionless material subgrade shall be compacted to 70% relative density (minimum).
- (2) At all times unfinished construction shall have adequate drainage system. Upon completion of the road's surface course, adjacent shoulders shall be given a final shaping, true alignment and grade.

- (3) Each layer of earth embankment when compacted shall be as close to optimum moisture content as practicable. Embankment material which does not contain sufficient moisture to obtain proper compaction shall be wetted. If the material contains any excess moisture, then it shall be allowed to dry before rolling. The rolling shall begin at the edges overlapping half the width of the roller each time and progress to the center of the road or towards the building as applicable. Rolling will also be required on rock fills. No compaction shall be carried out in rainy weather.

## **1.5 REQUIREMENT FOR FILL MATERIAL UNDER FOUNDATION**

For expansive soils the fill materials and other protections etc. to be used under the foundation is to be got approved by the Purchaser. The thickness of fill material under the foundations shall be such that the maximum pressure from the footing, transferred through the fill material and distributed onto the original undisturbed soil will not exceed the allowable soil bearing pressure of the original undisturbed soil.

## **1.6 ANTIWEED TREATMENT & STONE SPREADING**

### **1.6.1 SCOPE OF WORK**

The Contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings, specification and direction of the Purchaser.

Stone spreading along with cement concrete layer of 100mm thick shall be done in the areas of the switchyard under present scope of work within fenced area. However the 20mm stone aggregate spreading along with cement concrete layer in future areas within fenced area shall also be provided in case step potential without stone layer is not well within safe limits.

### **1.6.2 GENERAL REQUIREMENT**

The material required for site surfacing/stone filling shall be free from all types of organic materials and shall be of standard quality, and as approved by the Purchaser.

**1.6.3** The material to be used for stone filling/site surfacing shall be uncrushed/crushed/broken stone of 20mm nominal size (ungraded single size) conforming to Table 2 of IS:383 – 1970. Hardness, flakiness shall be as required for wearing courses are given below:

- (a) Sieve Analysis limits (Gradation)  
(IS: 383 – Table – 2)

Sieve Size	% passing by weight
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63mm	100
40mm	85-100
20mm	0-20
10mm	0-5

“One Test” shall be conducted for every 500 cu.m.

(b) Hardness

Abrasion value (IS: 2386 Part-IV) – not more than 40%

Impact value (IS: 2386 Part-IV) – not more than 30% and frequency shall be one test per 500 cu.m. with a minimum of one test per source.

(c) Flakiness Index

One test shall be conducted per 500 cu.m. of aggregate as per IS:2386 Part – I and maximum value is 25%.

**1.6.4** After all the structures/equipment are erected, anti-weed treatment shall be applied in the switchyard where ever stone spreading along with cement concrete is to be done and the area shall be thoroughly de-weeded including removal of roots. The recommendation of local agriculture or horticulture department may be sought wherever feasible while choosing the type of chemical to be used. The anti-weed chemical shall be procured from reputed manufacturers. The doses and application of chemical shall be strictly done as per manufacturer’s recommendation. Nevertheless the effectiveness of the chemical shall be demonstrated by the contractor in a test area of 10 m x 10 m (approximately) and shall be sprinkled with water at least once in the afternoon every day after forty eight hours of application of chemical. The treated area shall be monitored over a period of two to three weeks for any growth of weeds by the Engineer – In- Charge. The final approval shall be given by Engineer – In –Charge based on the results.

**1.6.5** Engineer-In-Charge shall decide final formation level so as to ensure that the site appears uniform devoid of undulations. The final formation level shall however be very close to the formation level indicated in the approved drawing.

**1.6.6** After anti weed treatment is complete, the surface of the switchyard area shall be maintained, rolled/compacted to the lines and grades as decided by Engineer-in-charge. The sub grade shall be consolidated by using half ton roller with suitable water sprinkling arrangement to form a smooth and compact surface. The roller shall run over the sub grade till the soil is evenly and densely consolidated and behaves as an elastic mass.

- 1.6.7** In areas that are considered by the Engineer-in-Charge to be too congested with foundations and structures for proper rolling of the site surfacing material by normal rolling equipments, the material shall be compacted by hand, if necessary. Due care shall be exercised so as not to damage any foundation structures or equipment during rolling compaction.
- 1.6.8** The sub grade shall be in moist condition at the time the cement concrete is placed. If necessary, it should be saturated with water for not less than 6 hours but not exceeding 20 hours before placing of cement concrete. If it becomes dry prior to the actual placing of cement concrete, it shall be sprinkled with water and it shall be ensured that no pools of water or soft patches are formed on the surface.
- 1.6.9** Over the prepared sub grade, 100mm thick base layer of cement concrete in 1:5:10 (1 cement :5 fine sand :10 stone aggregate) shall be provided in the area with expansion/construction joints of suitable materials at every 5m interval excluding roads, drains, cable trenches as per detailed engineering drawing. For easy drainage of water, the slope of 1:1000 is to be provided from the ridge to the nearest drain. The ridge shall be suitably located at the centre of the area between the nearest drains. The above slope shall be provided at the top of base layer of cement concrete in 1:5:10. A layer of cement slurry of mix 1:6 (1 cement: 6 fine sand) shall be laid uniformly over cement concrete layer. The cement consumption for cement slurry shall not be less than 150 kg. Per 100 sq. m.
- 1.6.10** A final layer of 150mm thickness of uncrushed/crushed/broken stone of 40mm nominal size (ungraded size) shall be spread uniformly over cement concrete layer after curing is complete.

## **2. SITE DRAINAGE**

Providing rain water drainage system within the switchyard fencing under the present scope including connection at one or more points to the outfall point located outside the substation boundary wall is in the scope of contractor. Invert level of drainage system at outfall point shall be decided in such a way that the water can easily be discharged outside the substation boundary wall. In case outfall point is more than 50M away from boundary wall, only 50 metre drain outside the boundary wall is in the scope of contractor. Outfall point shall be got approved from Engineer- in- charge before commencement of construction. While designing the drainage system following points shall be taken care of:

- (a) The surface of the switchyard shall be sloped to prevent accumulation of water.
- (b) Drain shall be constructed on both sides of roads. In the switchyard maximum spacing between two drains shall not be more than 100 meter. It will be ensured that no area is left un-drained.
- (c) Open surface trapezoidal drains having 300mm bottom width and sides having a maximum slope of 1horizontal: 1.5 vertical with 300mm depth at starting point of drain shall be provided. Any special treatment recommended as per soil investigation report shall also be taken care of.

- (d) Longitudinal slope shall not be less than 1 in 1000.
- (e) Open surface drains shall be constructed with 100mm thick plain cement concrete 1:2:4 (1cement: 2 coarse sand: 4 stone aggregate 20mm nominal size). PCC 1:2:4 shall be laid over 40mm thick layer of PCC 1:4:8 (1 cement: 4coarse sand: 8 stone aggregate 20mm nominal size.)
- (f) The side wall of the drains shall be 25 mm above the gravel level to prevent falling of gravel into drain. Groove of 125 mm width shall be provided at 2000 mm spacing with suitable mild steel grating.
- (g) The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8m/sec respectively. However, minimum non-silting velocity of 0.6m/sec shall be ensured.
- (h) Pipe drains shall be provided in areas of switchyard where movement of crane will be necessary in operating phase of the substation.
- (i) For pipe drains, concrete pipe of class NP2 shall be used. However, for road crossings etc. higher strength pipe of class NP3 shall be provided. For rail crossings, RCC pipes of class NP4 shall be provided. For design of RCC pipes for drains and culverts, IS:456 and IS:783 shall be followed.
- (j) Pipe drains shall be connected through manholes at an interval of max. 30 m.
- (k) If the invert level of outfall point is above the last drain point in the substation boundary, sump of suitable size has to be constructed with in the substation boundary.
- (m) The drainage scheme and associated drawings shall be got approved from the employer before commencement of construction.
- (n) The base and slopes of the existing natural nallah (drain) at the boundary of the site shall be protected with the concrete lining as per the design requirement at site.

### **3. ROADS AND CULVERTS**

- (a) The main approach road including modification of existing road to meet the site conditions, roads for access to equipment and building with in substation are in the scope of bidder. Layout of the roads shall be based on General detail & Arrangement drawing for the substation. Parking areas shall be provided for Site personnel and visitors at convenient locations. Adequate turning space for vehicles shall be provided and bend radii shall be set accordingly. Road to the transformer shall be as short and straight as possible
- (b) The road outside the switchyard shall have 4.0m black topping with 1.0 m wide earthen shoulder on either side of the road. Other roads shall be with 3.5 m black topping and 1.3 m wide earthen shoulder on either side of the road. Protection of cut and embankment slopes of roads as per slope stability requirement shall be made. All roads within the switchyard area shall be RCC.
- (c) All roads shall be designed for 1msa (Cumulative traffic) of traffic as per IRC- 37 (Guidelines for design of flexible pavements).
- (d) IRC specification shall be followed for construction of Roads.
- (e) All the culverts and allied structures (required for road/rail, drain, trench crossings etc.) shall be designed for class AA loading as per IRC standard / IS code and should be checked for Autotransformer / Reactor loading.

#### **4. AUTOTRANSFORMER / REACTOR FOUNDATION, RAIL TRACK/ ROAD CUM RAIL TRACK**

The Contractor shall provide a RCC Rail cum road system integrated with the Autotransformer / Reactor foundation to enable installation and the replacement of any failed unit. The transfer track system shall be suitable to permit the movement of any failed unit fully assembled (including OLTC, bushings) with oil. This system shall enable the removal of any failed unit from its foundation to the nearest road. If trench/drain crossings are required then suitable R.C.C. culverts shall be provided in accordance with I.R.C. standard / relevant IS.

The Contractor shall provide a pylon support system for supporting the firefighting system. Each Autotransformer/Reactor including oil conservator tank and cooler banks etc. shall be placed in a self-sufficient pit surrounded by retaining walls (Pit walls). The clear distance of the retaining wall of the pit from the Autotransformer/Reactor shall be 20% of the Autotransformer/Reactor height or 0.8m whichever is more. The oil collection pit thus formed shall have a void volume equal to 200% volume of total oil in the Autotransformer/Reactor. The minimum height of the retaining walls shall be 15 cm above the finished level of the ground to avoid outside water pouring inside the pit. The bottom of the pit shall have a uniform slope towards the sump pit. While designing the oil collection pit, the movement of the autotransformer must be taken into account.

The grating shall be made of MS flat of size 40mmx 5mm placed at 30mm centre to centre and 25mmx5mm MS flat at a spacing of 150mm at right angle to each other. Maximum length of grating shall be 2000mm and width shall not be more than 500mm. The gratings, supported on ISMB 150mm, shall be placed at the formation level and will be covered with 100mm thick layer of broken/crushed/non-crushed stone having size 40mm to 60mm which acts as an extinguisher for flaming oil.

Each oil collection pit shall be drained towards a sump pit within the collection pit whose role is to drain water and oil due to leakage within the collection pit so that collection pit remains dry.

#### **4.1 MATERIALS**

Complete foundation shall be made of reinforced cement concrete and shall be designed as per guidelines for design of foundations given in clause 7 in the specification.

#### **4.2 DRAINAGE**

One 0.5 H.P pump for each pit shall be supplied and installed by the Contractor to evacuate the firefighting & rain water from the sump pit in to the nearest drain.

## **5. FIRE PROTECTION WALLS**

### **5.1 GENERAL**

Fire protection walls shall be provided, if required, in accordance with Tariff Advisory Committee (TAC) recommendations.

### **5.2 FIRE RESISTANCE**

The firewall shall have a minimum fire resistance of 3 hours. The partitions, which are made to reduce the noise level, shall have the same fire resistance. The walls of the building, which are used as firewalls, shall also have a minimum fire resistance of 3 hours.

The firewall shall be designed to protect against the effect of radiant heat and flying debris from an adjacent fire.

### **5.3 DIMENSIONS**

The firewall shall extend 600 mm on each side of the Autotransformer/Reactors and 600 mm above the conservator tank or safety vent.

These dimensions might be reduced in special cases, as per the approval of owner where there is lack of space. A minimum of 2.0meter clearance shall be provided between the equipments e.g. Autotransformer/Reactors and firewalls.

The building walls, which act as firewalls, shall extend at least 1 m above the roof in order to protect it.

### **5.4 MATERIALS**

The firewall will be made of reinforced concrete (M-20 grade) or fire resistant materials to withstand fire as per the system requirements.

## **6. CABLE & PIPE TRENCHES**

- (a) The cable trenches and pre-cast removable RCC cover (with lifting arrangement) shall be constructed using RCC of M20 grade.
- (b) The cable trench walls shall be designed for the following loads.
  - (i) Dead load of 155 kg/m length of cable support + 75 Kg on one tier at the outer edge of tier.
  - (ii) Earth pressure + uniform surcharge pressure of 2T/m<sup>2</sup>.
- (c) Cable trench covers shall be designed for self-weight of top slab + concentrated

load of 150 kg at center of span on each panel.

- (d) Necessary sumps shall be provided and each sump shall be provided with pumps of 5 HP capacity shall be supplied for pumping out water collected in cable trench. Cable trenches shall not be used as storm water drains.
- (e) The top of trenches shall be kept at least 175 mm above the finished ground level. The top of cable trench shall be such that the surface rainwater does not enter the trench. The pre-cast removable RCC slab shall rest on the MS angle of 65 x 65 x 6 mm on both sides and true to shape. The pre-cast R.C.C. slab covers for cable trenches shall also have edge protection angle of size 45 x 45 x 5 mm all around.
- (f) All metal parts inside the trench shall be connected to the earthing system.
- (g) Trench wall shall not foul with the foundation. Suitable clear gap shall be provided.
- (h) The trench bed shall have a slope of 1/500 along the run & 1/250 perpendicular to the run.
- (i) Cable trenches shall be blocked at the ends if required with brick masonry in cement sand mortar 1:6 and plaster with 12mm thick 1:6 cement sand mortar.

## **7. FOUNDATION /RCC CONSTRUCTION**

### **7.1 GENERAL**

- (1) Work covered under this clause of the Specification comprises the design and construction of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, drains, jacking pad, pulling block, control cubicles, bus supports, Autotransformer/Reactors, marshalling kiosks, auxiliary equipment & systems, buildings, tanks or for any other equipment or service and any other foundation required to complete the work. This clause is as well applicable to the other RCC constructions.
- (2) Concrete shall conform to the requirements mentioned in IS: 456 and all the tests shall be conducted as per relevant Indian Standard Codes as mentioned in approved field quality plan. A minimum grade of M20 concrete (1: 1.5: 3 mix) shall be used for all structural/load bearing members as per latest IS 456.
- (3) If the site is sloppy, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes.
- (4) The switchyard foundation's plinths and building plinths shall be minimum 300mm and 500 mm above finished ground level respectively.
- (5) Minimum 75mm thick lean concrete (1:3:6) shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction.

- (6) Concrete made with Portland slag cement shall be carefully cured and special importance shall be given during the placing of concrete and removal of shuttering.
- (7) The design and detailing of foundations shall be done based on the approved soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof. The Spread footings foundation or pile foundation as may be required based on soil/sub-soil conditions and superimposed loads shall be provided.

If pile foundations are adopted, the same shall be cast-in-situ driven/bored or pre-cast or under reamed type as per relevant parts of IS Code 2911. Only RCC piles shall be provided. Suitability of the adopted pile foundations shall be justified by way of full design calculations. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used. Necessary initial load test shall also be carried out by the bidder at their cost to establish the piles design capacity. Only after the design capacity of piles has been established, the Contractor shall take up the job of piling. Routine tests for the piles shall also be conducted. All the work (design & testing) shall be planned in such a way that these shall not cause any delay in project completion.

- (8) For all soils other than Hard Rock, the total depth of foundations below the natural ground level shall not be less than 1.5 m. The corresponding minimum depths for Hard Rock foundations shall be 0.6m.

## **7.2 DESIGN**

- (1) All foundation shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS:456 and minimum grade of concrete shall be M-20. Higher grade of concrete than specified above may be used at the discretion of Contractor without any additional financial implication to the Purchaser.
- (2) Limit state method of design shall be adopted unless specified otherwise in the specification.
- (3) For detailing of reinforcement IS:2502 and SP:34 ,IS 13920 shall be followed. Cold twisted deformed bars (Fe500 N/mm<sup>2</sup>) conforming to IS:1786 or TMT bars as per specifications shall be used as reinforcement. However, in specific areas, mild steel (Grade I) conforming to IS:432 can also be used. Two layers of reinforcement (on inner and outer face) shall be provided for wall & slab sections having thickness of 150 mm and above. Clear cover to reinforcement shall be as per IS:456 (latest).
- (4) RCC water retaining structures like storage tanks, etc. shall be designed as un-cracked section in accordance with IS:3370 (Part I to IV) by working stress method. However, water channels shall be designed as cracked section with limited steel stresses as per IS:3370 (Part I to IV) by working stress method.
- (5) The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and/or superstructure

and other conditions which produces the maximum stresses in the foundation or the foundation component and as per the relevant IS Codes of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.

- (6) Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.
- (7) Necessary protection to the foundation work, if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental/harmful to the concrete foundations.
- (8) RCC columns shall be provided with rigid connection at the base.
- (9) All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factors of safety for these cases shall be taken as mentioned in relevant IS Codes or as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.
- (10) Earth pressure for all underground structures shall be calculated using co-efficient of earth pressure at rest, co-efficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures, earth pressure at rest shall be considered.
- (11) In addition to earth pressure and ground water pressure etc., a surcharge load of  $2T/Sq.m$  shall also be considered for the design of all retaining walls, underground structures including channels, sumps, tanks, trenches, substructure of any underground hollow enclosure etc., for the vehicular traffic in the vicinity of the structure.
- (12) Following conditions shall be considered for the design of water tank in pumps house, channels, sumps, trenches and other underground structures:
  - (a) Full water pressure from inside and no earth pressure & ground water pressure & surcharge pressure from outside (application only to structures which are liable to be filled up with water or any other liquid).
  - (b) Full earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.
  - (c) Design shall also be checked against buoyancy due to the ground water during construction and maintenance stages. Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the superimposed loadings.
- (13) Base slab of any underground enclosure shall also be designed for empty condition during construction and maintenance stages with maximum ground water table (GWT). Minimum factor of safety of 1.5 against buoyancy shall be ensured ignoring the super-imposed loadings.

- (14) Base slab of any underground enclosure like water storage tank shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum GWT. Intermediate dividing piers of such enclosures shall be designed considering water in one pump sump only and the other pumps sump being empty for maintenance.
- (15) The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.
- (16) The foundations of transformer/reactor and circuit breaker shall be of block type foundation. Minimum reinforcement shall be governed by IS:2974 and IS:456.
- (17) The tower and equipment foundations shall be checked for a factor of safety of 1.2 for normal condition and 1.1 for short circuit condition against sliding, overturning and pullout. The same factors shall be used as partial safety factor over loads in limit state design also.

## **8. ADMIXTURES & ADDITIVES**

- (1) Only approved admixtures shall be used in the concrete for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification.
- (2) Admixtures in concrete shall conform to IS:9103. The water proofing cement additives shall conform to IS:2645. Concrete Admixtures/ Additives shall be approved by Purchaser.
- (3) The Contractor may propose and the Purchaser may approve the use of a plaster-reducing set-retarding admixture in some of the concrete. The use of such an admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid to overcoming unusual circumstances and placing conditions.
- (4) The water-reducing set-retarding admixture shall be an approved brand of Ligno-sulphonate type admixture.

The water proofing cement additives shall be used as required/advised by the Purchaser.

## **9. CHAINLINK FENCING, GATE AND BOUNDARY WALL**

### **9.1 General**

Areas requiring boundary walls shall be determined jointly by the contractor and the owner. Fencing and gate shall be provided as per details given below:

## 9.2 Areas requiring Fencing, Boundary wall

Fencing shall be provided for complete switchyard as per drawing. Separate gate shall be provided for men and equipment.

Internal fencing, if required, shall also be provided surrounding the various equipments (if) mounted on ground or a height lower than 2.5m. Necessary gates shall be provided for each area so surrounded.

The minimum requirements of Product materials are as follows:

Chain link fence fabric (without galvanization) in accordance to IS:2721.

- |     |                     |   |   |
|-----|---------------------|---|---|
| (1) | Size of mesh        | : | 50 mm   |
| (2) | Nominal wire size   | : | 3.15mm dia meter  |
| (3) | Width of chain link | : | 2000mm  |
| (4) | Painting            | : | Two or more coats of approved standard<br>make synthetic enamel paint over a coat of standard steel primer. |

## GATE

The gate shall be made of medium duty M.S. angle / pipe conforming to relevant I.S. with welded joints. The main frame (outer frame) of the gate shall be made of 40mm dia pipe and vertical pipes of 15mm dia @ 125mm spacing (maximum) shall be welded with the main frame. Other details shall be as shown in the drawing. The gates shall be fabricated with welded joints to achieve rigid connections. The gate frames shall be painted with one coat of approved steel primer and two coats of synthetic enamel paint. The gates shall be provided with suitable locking arrangement.

The main gate (Bhutanese traditional main gate) shall be 6.0m wide and shall be of double leaf type (as shown in the drawing). Next to the main gate, a men gate (1.25m wide single leaf) shall also be provided. The location of the Bhutanese type main gate shall be finalized jointly by the owner and the contractor.

Steel roller shall be provided with the gate.

## 10. BUILDINGS - GENERAL REQUIREMENTS

### 10.1 GENERAL

The scope includes the design, engineering and construction including anti-termite treatment, plinth protection, DPC of buildings including sanitary, water supply, electrification, false ceiling, false flooring etc. of control room building and fire protection pump house building. The buildings shall be of RCC framed structure of concrete of M20 grade (min).

### **10.1.1 CONTROL ROOM BUILDING**

The floor area requirements given in the tender drawings are tentative and may change at the time of detailed engineering to suit project requirements. The layout of the rooms shall be finalised as per detailed engineering to suit project requirements. The control building shall be one (1) floor and featuring all Bhutanese architectural features.

Minimum headroom of 3 m below soffit of beams/false ceiling shall be considered for rooms. The roof shall have four side sloping roof as indicated in the tender drawing.

An open space of 1 m minimum shall be provided on the periphery of the rows of panel and equipment generally in order to allow easy operator movement and access as well as maintenance.

### **10.1.2 DESIGN**

(a) The buildings shall be designed:

- (1) to the requirements of the Bhutan Building Rules 2002, and the standards quoted therein.
- (2) for the specified climatic & loading conditions.
- (3) to adequately suit the requirements of the equipment and apparatus contained in the buildings and in all respects to be compatible with the intended use and occupancy.
- (4) with a functional and economical space arrangement.
- (5) for a life expectancy of structure, systems and components not less than that of the equipment which is contained in the building, provided regular maintenance is carried out.
- (6) to be aesthetically pleasing blending with the local Bhutanese architecture. Different buildings shall show a uniformity and consistency in architectural design of Bhutan.
- (7) to allow for easy access to equipment and maintenance of the equipment.
- (8) With, wherever required, fire retarding materials for walls, ceilings and doors, which would prevent supporting or spreading of fire.
- (9) with materials preventing dust accumulation.

(b) Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns.

(c) Individual members of the buildings frame shall be designed for the worst

combination of forces such as bending moment, axial force, shear force, torsion etc.

- (d) Permissible stresses for different load combinations shall be taken as per relevant IS Codes.
- (e) All cable vaults shall be located above ground levels i.e. cable vaults shall not be provided as basements in the buildings.
- (f) The building lighting shall be designed in accordance with the requirements of relevant section.

The building auxiliary services like air conditioning and ventilation systems and all other miscellaneous services shall be designed in accordance with the requirements specified in relevant section or elsewhere in this Specification.

One emergency exit shall be provided in control room building.

### **10.1.3 DESIGN LOADS**

The Building structures shall be designed for the most critical combinations of dead loads, super- imposed loads, equipment loads, crane load, wind loads, seismic loads, and temperature loads.

Dead loads shall include the weight of structures complete with finishes, fixtures and partitions and should be taken as per IS: 875.

Super-imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks/hangers and erection, operation and maintenance loads. Equipment loads shall constitute, if applicable, all load of equipments to be supported on the building frame.

For crane loads an impact factor of 30% and lateral crane surge of 10% (lifted weight + trolley) shall be considered in the analysis of frame according to provisions of IS:875. The horizontal surge shall be 5% of the static wheel load.

The wind loads shall be computed for zone of wind velocity 50 m/s as per IS 875, Seismic analysis as per IS 1893, with seismic zone V and importance factor 1.5.

Wind and Seismic forces shall not be considered to act simultaneously.

Floors/slabs shall be designed to carry loads imposed by equipment, cables piping travel of maintenance trucks and equipment and other loads associated with building. Floors shall be designed for live loads as per relevant IS. Cable and piping loads, shall also be considered additionally for floors where these loads are expected.

In addition, beams shall be designed for any incidental point loads to be applied at any point along the beams. The floor loads shall be subject to Purchaser's approval.

For consideration of loads on structures, IS:875, the following minimum superimposed live loads shall, however, be considered for the design.

(a)	Roof		1.5 kN/m <sup>2</sup> 0.75 kN/m <sup>2</sup>	for accessible roofs for in-accessible roofs
(b)	RCC-Floor	(i) (ii)	5 kN/m <sup>2</sup> 10 kN/m <sup>2</sup> (minimum)	for offices For equipment floors or actual requirement, if higher than 10 kN/M <sup>2</sup> . based on equipment component weight and layout plans.
(c)	Stairs & balconies		5 kN/m <sup>2</sup>	
(d)	Toilet Rooms		2 kN/m <sup>2</sup>	
(e)	Chequered plate floor		4 kN/m <sup>2</sup>	
(f)	Walkways		3 kN/m <sup>2</sup>	

Any additional load coming in the structure shall be calculated as per IS: 875.

#### **10.1.4 SUBMISSION**

The following information shall be submitted for review and approval to the Purchaser. Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable:

1. Samples and brands of plumbing and sanitary fixtures.
2. Samples of floor and wall tiles, granite etc.
3. Samples of component fixtures for doors and windows, partition frames including aluminium frames.
4. Sample for fixtures and fittings of internal and external lighting and Air conditioners.

#### **10.1.5 FINISH SCHEDULE**

The finishing schedule is given in subsequent clauses.

#### **10.1.6 Flooring**

Flooring in various rooms of control room building shall be as per detailed schedules given in Table -1

### 10.1.7 WALLS

Control room buildings shall be of framed superstructure. All walls shall be non-load bearing walls. Min. thickness of external walls shall be 230 mm (one brick) with 1:6 cement sand mortar.

### 10.1.8 PLASTERING

All internal walls shall have minimum 15mm thick 1:4 cement sand plaster. The ceiling shall have 6mm thick 1:4 cement sand plaster.

### 10.1.9 FINISHING

All external surfaces shall have 20 mm cement plaster in one coats , under layer 14 mm thick cement plaster 1:5 and finished with a top layer of 6 mm thick cement plaster 1:6 with water proofing compound. The paint shall be antifungal quality of reputed brand suitable for masonry surfaces for high rainfall zone. White cement primer shall be used as per manufacturer's recommendation.

Internal finish Schedule is given in Table - 1 below:

Table -1

Sl No.	Location	Flooring & Skirting 150 mm high	Wall internal	Ceiling	Doors, Windows Ventilators
1.	Control Room PLCC & Relay room	3mm thick epoxy over filler/sealer compound over 75mm thick 1:2:4 concrete sub base	125mm thick, cement plaster	False ceiling & underdeck insulation	Aluminium Jindal or equivalent extruded sections as per IS 733 & 1285 Glazing Flat drawn sheet glass (Min 5.5mm thick) double glazing with 12 mm gap hermetically sealed.
2.	Sub-Station In charge, offi-corridor	Same as control room	Oil bound washable distemper on smooth surface	Same as control room	Same as Control room ces &
4.	Battery Room	Acid Resistant Tiles 25 mm thick	DADO acid resistant tile 2.1M high Acid resistant paint above 2.1 M up to ceiling	Acid resistant paint	Same as control room
5.	Store room	Ironite flooring	125mm thick brick wall Dry Distemper	White wash	Same as control room

6.	Cable vault double sheet ( If required)	IPS flooring	White wash	White wash	Same as control room
7.	Toilet, Janitor room	Anti skid tiles with White cement	Glazed tiles 2.1m high for toilet, for pantry above working platform up to 750 mm	White wash	Teak wood frame flush door shutter with approved brand fixtures best quality  Windows, ventilators aluminium as control room.
9.	Other areas not specified	Epoxy floor	Dry distemper	White wash	

**Note :** Under deck insulation shall be provided in A/C areas. False flooring /ceiling materials shall be provided as required with prior approval of the Employer.

### 10.1.10 ROOF

Roof of the C.R. Building and other buildings shall consist of Cast-in-situ RCC slab, MS trusses and Pre Painted Galvalume (Turquoise Green) roofing sheets, 25g (0.5 mm) including bolts, hooks and nuts 8mm dia. with bitumen and G.I limpet washers filled with white lead for connection, excluding the cost of purlins, rafter and trusses. The eave board shall be MS sheet of 3mm thick and the G.I gutter & down lead pipes including all accessories, fixtures etc., shall be provided. The size of gutter and number of down lead pipes shall be decided during the detailed engineering. The water proofing treatment shall be of following operations:

Applying and grouting a slurry coat of neat cement using 2.75 kg/m<sup>2</sup> of cement admixed with proprietary water proofing compounds conforming to IS: 2645 over the RCC slab including cleaning the surface before treatment for water tank area.

### 10.1.11 GLAZING

Sun film shall be provided for all windows/doors of AC rooms. Thickness of glazing shall be as specified in internal finish schedule elsewhere.

### 10.1.12 FALSE CEILING

Providing and fixing of TRAC-84C ceiling system comprising of 84 mm wide x 12.50 mm deep panels with flange of 23.5mm, made out of 0.5mm thick Alloy AA 3105/3005/5050 chromatised and stove enamelled on both sides in off-white shade. Panels shall be fixed on to rolled formed carriers 32 mm wide x 39 mm deep out of 0.6 mm galvanized steel with cut-outs to hold the panels in a module of 100 mm at maximum 1.6 m centre to centre. Carried to be suspended from roof / truss by 4 mm galvanized steel wire rod hangers or 19 swg industrial GI wire, with special height adjustment suspension clips at regular intervals. Hangers to be fixed by 'J' hooks and nylon inserts. Panels shall be factory cut-to-length up to maximum 5 m to suit site dimensions. Edge profiles / wall angels to be 19 mm x 19 mm,

0.5 mm thick of Aluminium matching the colour of the panels.

The rate includes for all necessary cutting of ceiling for the fixing of complete fixtures as per drawing finalized during detailed engineering.

#### **10.1.13 Underdeck Insulation**

The method of fixing shall consist of slotted M.S. angles of appropriate size (minimum 65x50x2mm) fixed to soffit of RCC roof slab at 600mm centres in both directions by Rawl plugs of adequate strength. The slots shall have 14g G.I. tie wire drawn through them.

50mm thick insulation mat Fibreglass Crown - 100 or equivalent shall, be made out of fibre-glass or approved equivalent conforming to IS: 8183, backed with 34g aluminium foil and 22g x 12mm mesh wire netting. The net shall be stretched tightly across the slotted angles or slotted plates holding it in place by means of wires. The joints of the wire netting shall be butted and tightly laced down with 14g G.I. wire. The system shall be got approved from engineer-in-charge.

#### **10.1.14 DOORS AND WINDOWS**

The details of doors and windows of the control room building shall be as per drawing finalized during detailed engineering and with the relevant IS code. Rolling steel shutters and rolling steel grills shall be provided as per drawing and requirement of buildings. Paints used in the work shall be of best quality specified in specification.

#### **10.1.15 PARTITION**

Partition made of anodised aluminium frame provided with 5.5 mm thick clear glass shall be supplied and installed at locations shown in tender drawings or as required after detailed Engineering.

#### **10.1.16 PLUMBING & SANITATION**

- (i) All plumbing and sanitation shall be executed to comply with the requirements of the appropriate bye-laws, rules and regulations of the Local Authority having jurisdiction over such matters. The Contractor shall arrange for all necessary formalities to be met in regard to inspection, testing, obtaining approval and giving notices etc.
- (ii) Poly-ethylene syntex or equivalent make Roof water tank of adequate capacity depending on the number of users for 24 hours storage shall be provided. Minimum 1 Nos 2000 litres capacity shall be provided.
- (iii) Galvanised MS pipe of medium class conforming to IS:1239 shall be used for internal & external piping work for potable water supply.

- (iv) PVC and HDPE pipes with lead joints conforming to relevant IS shall be used for sanitary works above ground level.
- (v) Each toilet shall have the following minimum fittings.
  - (a) WC (Western type) 390 mm high with toilet paper roll holder and all fittings
  - (b) Urinal (430 x 260 x 350 mm size) with all fittings.
  - (c) Wash basin (550 x 400 mm) with all fittings.
  - (d) Bathroom mirror (600 x 450 x 6 mm thick) hard board backing
  - (e) Towel rail (600 x 20 mm) with brackets
  - (f) Soap holder and liquid soap dispenser.
- (vi) An Eye & face fountain conforming to IS: 1052 shall be provided in the battery room.
- (vii) All sanitary fixtures and fittings shall be of approved quality and type manufactured by well-known manufacturers, such as Jaguar make. All items brought to site must bear identification marks of the type of the Manufacturer.
- (viii) Soil, waste and drain pipes, for underground works shall be stone ware for areas not subject to traffic load. Heavy duty cast iron pipes shall be used otherwise.

**10.1.17** Bidder should include all such items in the BPS which are not specifically mentioned but are essential for the execution of the work. Items which explicitly may not appear in various schedules and are required for successful completion of the building work shall be included in the bid price and shall be provided at no extra cost to owner.

**10.1.18 OTHER BUILDINGS:**

**10.1.19** The tentative dimensions and details of the building are indicated in the tender drawings which may be changed at the time of detailed engineering to suit project requirements.

**10.1.20** Where provided, the DG and FF buildings are preferable to be kept adjacent to each other for convenience of maintenance of equipment. The common wall shall be as per TAC requirements. However, due to space constraints if it becomes inevitable to

construct two separate buildings, no extra claim will be admissible on this account. The DG set being of out-door type, no separate building for DG sets is contemplated.

- 10.1.21** All the equipment foundations and structural members shall be designed as per the relevant clauses of this specification and IS codes. Arrangement shall be made for collection of spilt oil from oil diesel/operated equipment, in the form of drain and sump along the periphery.
- 10.1.22** Diesel storage area shall be adequate to accommodate minimum of 4 standard drums (200 litre each) of diesel oil which could be connected to the pump. Suitable piping arrangement with valves shall be provided. Diesel handling area/room shall be provided with tiles up to 2.1 m level and a wash basin with water line. Pumping arrangement to be provided for diesel oil from the oil storage area up to the diesel tanks of all the diesel engines.
- 10.1.23** A wash basin/sink with water supply shall be provided in the building.
- 10.1.24** Piping shall be provided for conveying oil from the storage tank (common for all diesel/engines) to individual fuel tank of engine.
- 10.1.25** All the external features of the DG cum FF building shall be similar to CR building.
- 10.1.26** Doors and windows shall be provided as indicated in drawings.

## **10.2 BUILDING STORM WATER DRAINAGE FOR ALL BUILDINGS**

The building drain shall be provided for the collection of storm water from the roofs. This water shall be collected in junction boxes and these boxes shall drain to the main drainage system of the station.

PVC rain water down comers conforming relevant Indian standards with water tight lead joints shall be provided to drain off the rain water from the roof. These shall be suitably concealed with masonry work of cement concrete or cladding material. The number and size of down comers shall be governed by IS:1742 and IS:2527.

All drains inside the buildings shall have minimum 40 mm thick grating covers and in areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating.

For all buildings, suitable arrangement for draining out water collected from equipment blowdown, leakages, floor washings firefighting etc. shall be provided for each floor.

### **10.3 MISCELLANEOUS GENERAL REQUIREMENTS**

- 10.3.1** Dense concrete with controlled water cement ratio as per IS-code shall be used for all underground concrete structures such as pump-house, tanks, water retaining structures, cable and pipe trenches etc. for achieving water-tightness.
- 10.3.2** All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 5 mm and minimum width shall be 230 mm.
- 10.3.3** All steel sections and fabricated structures which are required to be transported on sea shall be provided with anti-corrosive paint to take care of sea worthiness.
- 10.3.4** All mild steel parts used in the water retaining structures shall be hot-double dip galvanised. The minimum coating of the zinc shall be 750 gm/sq. m. for galvanised structures and shall comply with IS:2629 and IS:2633. Galvanizing shall be checked and tested in accordance with IS: 2633. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen.
- 10.3.5** A screed concrete layer not less than 100 mm thick and of grade not weaker than M10 conforming to IS: 456-1978 shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structures.
- 10.3.6** Bricks having minimum 50 kg/cm<sup>2</sup> compressive strength can only be used for masonry work. Contractor shall ascertain himself at site regarding the availability of bricks of minimum 50 kg/cm<sup>2</sup> compressive strength before submitting his offer.
- 10.3.7** Doors and windows on external walls of the buildings (other than areas provided, with insulated metal claddings) shall be provided with all requisite Bhutanese Architecture components.
- 10.3.8** Service ladder shall be provided for access to all roofs. RCC fire escape staircase shall be provided in control buildings.

- 10.3.9** Angles 50x50x6 mm (minimum) with lugs shall be provided for edge protection all round cut outs/openings in floor slab, edges of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers, supporting edges of manhole precast cover and any other place where breakage of corners of concrete is expected.
- 10.3.10** Anti-termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc. as per IS: 6313 and other relevant Indian Standards.
- 10.3.11** Hand-railing minimum 900mm high shall be provided around all floor/roof openings, projections/balconies, walk ways, platforms, steel stairs etc. All handrails and ladder pipes shall be 32 mm nominal bore MS pipes (medium class) and shall be galvanised (medium-class as per IS:277). All rungs for ladder shall also be galvanised as per IS: 277 medium class.
- 10.3.12** For RCC stairs, hand railing with 20 mm square MS bars, balustrades with suitable MS flats & aluminium handrails shall be provided.
- 10.3.13** For all civil works covered under this specification, nominal mix by volume batching as per specification is intended. The relationship of grade of concrete and ratio of ingredients shall be as below:

S.No.	Mix	Cement	Sand	Coarse aggregate of 20 mm down grade as per IS 383
1.	M 10	1	3	6
2.	M 15	1	2	4
3.	M 20	1	1.5	3

The material specification, workmanship and acceptance criteria shall be as per relevant clauses of specification and approved Field Quality Plan.

- 10.3.14** The details given in tender drawings shall be considered along with details available in this section of the specification while deciding various components of the building.
- 10.3.15** Items/components of civil works/buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.
- 10.3.16** All items of civil/building works for which bill of quantity has been indicated in BPS (Bid price Schedules) shall be payable on unit rate basis. During actual execution, any variation in such quantities shall be paid based on the unit rate under each item incorporated in Letter of award. In case of compound items, BOQ item description shall be adopted for execution including measurement and payment. The owner has furnished the tentative BOQ for all the unit rate based civil/ building works. Bidder should include all such items in the BPS which are not specifically mentioned but are essential for the execution of the work. Bidders are requested to quote the unit rate as well as the cost of item based on the quantities furnished in the BPS.

## **11. INTERFACING**

The proper coordination & execution of all interfacing civil works activities like fixing of conduits in roofs/walls/floors, fixing of foundation bolts, fixing of lighting fixtures, fixing of supports/embedment, provision of cut outs etc. shall be the sole responsibility of the Contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage etc. is reduced to minimum.

## **12. WATER SUPPLY**

- (i) Tapping of water from the source to the substation area is in the scope of the contractor. The water treatment system including intake structure, sedimentation tank, flocculation tank, storage tank, etc is also in the scope of the contractor and shall be executed as per drawings. Water supply system including all plumbing/erection works, testing and commissioning, all complete, is in the scope of the contractor. The contractor shall carry out the detail survey for the water supply and submit the longitudinal profile of the line. The details of water pressure envisaged along the pipe shall be shown and requirement of pressure break tank shall be indicated supported by appropriate calculations.
- (ii) The contractor shall carry out all the plumbing/erection works required for supply of water in control room building beyond the single point as at (i) above.
- (iii) The contractor shall carry out all the plumbing/erection works required for supply of water to FF pump house beyond the single point as at (i) above.
- (iv) The details of tanks, pipes, fittings, fixtures etc for water supply are given elsewhere in the specification under respective sections.
- (v) Bore wells and pumps for water supply are not envisaged and thus are not in the

scope of contractor.

(vi) A scheme shall be prepared by the contractor indicating the layout and details of water supply which shall be approved by the Purchaser before actual start of work including all other incidental items not shown or specified but as may be required for complete performance of the works.

(vii) The system shall be designed as per relevant IS Codes.

## **12.1 SEWERAGE SYSTEM**

(i) Sewerage system shall be provided for control room building cum administrative building and all other buildings as per the project requirement.

(ii) The Contractor shall construct septic tank and soak pit suitable for 25 users or as per project requirement.

(iii) The system shall be designed as per relevant IS Codes.

## **13. STATUTORY RULES**

**13.1** Contractor shall comply with all the applicable statutory rules pertaining to factories act (as applicable for the Country), Fire Safety Rules of Tariff Advisory Committee, Water Act for pollution control etc.

**13.2** Provisions for fire proof doors, no. of staircases, fire separation wall, plastering on structural members (in fire prone areas) etc. shall be made according to the recommendations of Tariff Advisory Committee.

**13.3** Statutory clearance and norms of Pollution Control Board shall be followed as per relevant acts.

**13.4** Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation to be carried out by the Bidder.

**13.5** Foundation system adopted by Bidder shall ensure that relative settlement and other criteria shall be as per provision in IS: 1904 and other Indian Standards.

**13.6** All water retaining structures designed as un-cracked section shall also be tested for water tightness at full water level in accordance with clause no. 10 of IS:3370 (Part-I).

**13.7** Construction joints shall be as per IS: 456.

**13.8** All underground concrete structures like basements, pumps houses, water retaining structures etc. shall have plasticizer cum water proofing cement additive conforming to IS: 9103. In addition, limit on permeability as given in IS: 2645 shall also be met with. The concrete surface of these structures in contact with earth shall also be provided with

two coat of bituminous painting for water/damp proofing.

In case of water leakage in the above structures, Injection Method shall be applied for repairing the leakage.

**13.9** All building/construction materials shall conform to the best quality if not otherwise mentioned in this specification.

**13.10** All tests as required in the standard field quality plans have to be carried out.

## **14. SUPPLEMENTRY SPECIFICATION FOR CIVIL WORKS**

This part covers the supplementary requirements for civil works of the sub-station.

### **14.1 Roads**

All roads within the substation area shall be of RCC. Road shall be designed based on the relevant standards/codes and considering the vehicular traffic and the substation equipment to be brought in during the execution of work and also during maintenance/replacement of the substation equipment.

Roads outside the substation area shall be bituminous road. Roads inclusive of the construction of sub base, wet mix macadam course and asphalt concrete, provision of kerb-stone as per the drawings attached, shall be built outside of the sub-station, at locations shown by the Engineer / Employer.

The construction shall be such as to satisfy provisions of all applicable IS and IRC codes, the more important ones of which are mentioned below. Additional specifications for items such as Rubble Sub-base, concreting for slab, reinforcement etc. shall be as given elsewhere in this document.

IS:73	Specification for Paving Bitumen
IS:215	Specification for Road Tar
IS: 217	Specification for Cutback Bitumen
IS:454	Specification for Digboi type Cutback Bitumen
IS:460 (Parts 1 to 3)	Specification for Test Sieves
IS: 1077	Specification for common burnt clay building bricks
IS:1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
IS:1195	Specification for Bitumen Mastic Flooring.

IS:1196	Code of Practice for Laying Bitumen Mastic Flooring
IS: 1834	Specification for Hot Applied Sealing Compounds for Joints in Concrete.
IS:2386 (Parts 1 to 8)	Methods of tests for aggregates for concrete.
IS:2720 (Part 5)	Methods of Test for Soils : Part 5 Determination of Liquid and Plastic Limit
IS: 6241	Method of test for determination of stripping value of road aggregates
IRC: 15	Standard specifications and code of practice for construction of Concrete Roads (Second Revision)
IRC: 16	Specification for priming of base course with bituminous primers
IRC: 17	Tentative specification for single coat bituminous surface dressing.
IRC: 19	Standard specification and code of practice for water bound macadam
IRC: 29	Specification for bituminous concrete (Asphalt concrete) for road pavement.
Department of Roads	Specifications for road and bridge works

## 14.2 Construction Sequence

It is the intent of this specification that the water bound macadam road be constructed first. This shall then be opened to traffic, as directed by Employer/ Engineer. After such period of time as decided by Employer/Engineer, preferably when the major construction and/or erection activities within plant limits are over, Contractor shall rectify all defects, wear and tear, etc. and surface the road with bituminous wearing course treatment.

## 14.3 Measurements and Rates

Drawings showing typical cross section of roads are attached herein. These are for guidance in bidding and construction. The cross section, actual width etc. will be decided during execution of the work. Payment shall be on plan area basis and quoted rates shall be all inclusive, satisfying all the specifications as above. The Engineer reserves the right of getting all materials and methods tested as per procedures given in the codes listed above. The quoted Rate shall include the cost of all such testing, preparation of reports etc.

## **15. Construction of CIVIL WORKS**

### **15.1 Excavation**

#### **15.1.1 Drawings**

Based on the contour drawings (which needs to be prepared by the employer) of the sub-station, the employer shall finalize the level showing his scheme for the areas to be excavated/ filled, grade level, sequence of priorities etc., to achieve the most economic arrangement considering excavation, fill, amount of material used for structures, foundations, drainage systems etc. The Contractor shall strictly follow such drawings. The employer shall prepare the most economic scheme, fixing the grade level at his discretion, including stepped gradation at 2 or more levels for the different structures, but the final scheme shall be adopted only after the approval.

#### **15.1.2 Clearing**

The area to be excavated / filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter which shall be disposed off as directed by the Engineer. Where earth fill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter/ materials before fill commences.

Any tree cutting shall be started only after the requisite permission has been obtained by the Contractor from the concerned authorities for each and every tree to be cut.

#### **15.1.3 Precious Objects, Relics, Objects of Antiquity etc.**

All gold, silver, oil, minerals, archaeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the Employer and the Contractor shall duly preserve the same to the satisfaction of the Employer and from time to time deliver the same to such person or persons as the Employer may from time to time authorise or appoint to receive the same.

#### **15.1.4 Classification**

All materials to be excavated shall be classified by the Engineer, into one of the following classes and shall be paid for at the rate tendered for that particular class of material. No distinction shall be made whether the material is dry, moist or wet. The decision of the Engineer regarding the classification of the material shall be final and binding on the Contractor and not be a subject matter of any appeal or arbitration.

Any earthwork will be classified under any of the following categories:

##### **(a) Ordinary And Hard Soils**

These shall include all kinds of soils containing kankar, sand, silt, murrum and/or shingle, gravel, clay, loam, peat, ash, shale, etc., which can generally be excavated by spade, pick axes and shovel, and which is not classified under "Soft and Decomposed Rock" and "Hard Rock" defined below. This shall also include embedded rock boulders not longer

than 1 metre in any one direction and not more than 200 mm in any one of the other two directions.

(b) Soft and Decomposed Rock

This shall include rock, boulders, slag, chalk, slate, hard mica schist, laterite and all other materials which in the opinion of Engineer is rock, but does not need blasting and could be removed with picks, hammer, crow bars, wedges, and pneumatic breaking equipment. The mere fact that the Contractor resorts to blasting for reasons of his own shall not qualify for classification under 'Hard Rock'.

This shall also include excavation in macadam and tarred roads and pavements. This shall also include rock boulders not longer than 1 metre in any direction and not more than 500 mm in any one of the other two directions. Masonry to be dismantled will also be measured under this item.

(c) Hard Rock

This shall include all rock occurring in large continuous masses, which cannot be removed except by chiselling, drilling or blasting for loosening it. Harder varieties of rock with or without veins and secondary minerals which, in the opinion of the Engineer require blasting shall be considered as hard rock. Boulders of rock occurring in such sizes and not classified under (a) and (b) above shall also be classified as hard rock. Concrete work both reinforced and unreinforced to be dismantled will be measured under this item, unless a separate provision is made in the Schedule of Quantities.

### **15.1.5 General**

The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas to avert accident.

The rates quoted shall also include for dumping of excavated materials in regular heaps, bunds, riprap with regular slopes as directed by the Engineer, within the lead specified and levelling the same so as to provide natural drainage. Rock/ soil excavated shall be stacked properly as directed by the Engineer.

All excavation work shall be carried out by mechanical equipment unless, in the opinion of the Engineer, the work involved and time schedule permit manual work.

Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer.

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor in each individual case, for the method he proposes to adopt for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval, however, shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every

precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope. Removal of the slipped earth will not be paid for separately, but shall be deemed to be included in the contract rate of excavation

The Contractor shall ensure that excavations are made to the correct depth and width. If excavations are taken too deep, the excess depth shall be back-filled with lean concrete at the Contractor's expense. If excavations are made too wide, such modifications to the design as the Engineer may require shall be made at the Contractor's expense.

#### **15.1.6 Stripping Loose Rock**

All loose boulders, semi-detached rocks (along with earthy stuff which might move therewith) not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment, or the work, etc., shall be stripped off and removed away from the area of the excavation. The method used shall be such as not to shatter, or render unstable or unsafe the portion which was originally sound and safe.

### **15.2 Fill, Back Filling and Site Grading**

#### **15.2.1 General**

All fill material whether such material is brought from outside borrow areas or from excavation from within the site, will be subject to the Engineer's approval. If any material is rejected by the Engineer, the Contractor shall remove the same forthwith from the site at no extra cost to the Employer. Surplus fill material shall be deposited / disposed off as directed by the Engineer after the fill work is completed.

No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Engineer.

#### **15.2.2 Material**

To the extent available, selected surplus soils from excavated materials shall be used as backfill. Fill material shall be free from clods, salts, sulphates, organic or other foreign material. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murrum or earth to fill up the voids and the mixture used for filling.

If any selected fill material is required to be borrowed, the Contractor shall make arrangements for bringing such material from outside borrow pits. The material and source shall be subject to prior approval of the Engineer. The approved borrow pit area shall be cleared of all bushes, roots of trees, plants, rubbish etc. top soil containing salts/ sulphate and other foreign material shall be removed. The materials so removed shall be disposed off as directed by the Engineer. The Contractor shall make necessary access roads to borrow areas and maintain the same, if such access road does not exist, at his cost.

It shall be Contractor's responsibility to locate suitable borrow areas for borrowing fill material. Such area will be inspected by the Engineer and approved before the Contractor makes arrangements to borrow the fill material. The top soil which may contain vegetation, rubbish, slush, etc. shall not be used. If demanded by the Engineer, the Contractor shall arrange to have trial pits of specified dimensions and numbers dug at locations specified, for the Engineer to examine the nature and type of material likely to be obtained from the borrow area.

The borrowed soil shall be generally granular, and non-cohesive. It shall consist of sand, silty sand, morrum, ordinary soil, gravel and shingle. Dredged material shall also be free from sulphates, salts, organic, foreign and other harmful or objectionable materials. Any material rejected by the Engineer shall be removed from the site immediately.

### **15.2.3 Filling in pits and trenches around foundations of structures, walls etc.**

As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches etc. shall be cleared of all debris, and filled with earth in layers not exceeding 15 cm., each layer being watered, rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of the Engineer. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the Engineer is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and levelled to proper profile as directed by the Engineer or indicated on the drawings.

### **15.2.4 Plinth filling**

Plinth filling shall be carried out with approved material as described hereinbefore in layers not exceeding 15 cm, watered and compacted with mechanical compaction machines. The Engineer may however permit manual compaction by hand tampers in case he is satisfied that mechanical compaction is not possible. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours allowed to dry and then the surface again compacted as specified above to avoid settlements at a later stage. The finished level of the filling shall be trimmed to the level / slope specified.

Where found necessary by the Engineer, compaction of the plinth fill shall be carried out by means of 12 tonne rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. In case of compaction of granular material such as sands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Engineer. As rolling proceeds water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fill.

The thickness of each unconsolidated fill layer can in this case be up to a maximum of 300 mm. The Engineer will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used.

Rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfaction of the Engineer, but in no case less than 10 passes of the roller will be accepted for each layer.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated and filled and consolidated.

At some locations/ areas it may not be possible to use rollers because of space restrictions etc. The Contractor shall then be permitted to use pneumatic tampers, rammers etc. and he shall ensure proper compaction. Alternatively, the Contractor shall ensure necessary compaction by the passage of trucks, carrying the fill material over the deposited fill in such a way that the entire fill area is covered. This will reasonably compact the sand fill and will be accepted by the Engineer. However, the Contractor shall ensure that every layer is thus compacted before the succeeding layers are deposited. Each layer shall not exceed 200 mm in thickness.

#### **15.2.5 Sand filling in plinth and other places**

At places backfilling shall be carried out with local sand if directed by the Engineer. The sand used shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be to the Contractor's account. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until the Engineer has inspected and approved the fill.

#### **15.3 Filling in trenches**

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes.

Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centreline of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of the centreline of the pipe shall be done with selected earth by hand compaction or other approved means in layers not exceeding 15 cm.

In case of excavation of trenches in rock, the filling up to a level 30 cm. above the top of the pipe shall be done with fine materials, such as earth, murrum etc. The filling up of the level of the centreline of the pipe shall be done by hand compaction in layers not exceeding 8 cm. whereas the filling above the centreline of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm. above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

Filling of the trenches shall be carried simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

### **15.3.1 Soil fill**

Approved soil fill consisting of ordinary soil, moraine, soil containing gravel, shingle etc. shall be deposited in layers not exceeding 200 mm. The Contractor should ensure that all clods of earth are broken down to a size not larger than 100 mm.

Where density of fill or use of rollers is not specified the fill shall be carried out as specified in above clauses.

Where specified, the required density of fill shall be obtained by proper compaction.

### **15.4 General Site Grading**

Site grading shall be carried out as indicated in the approved drawings and as directed by the Engineer. Excavation shall be carried out as specified in the specification. Filling and compaction shall be carried out as specified herein unless otherwise indicated below.

If no compaction is called for, the fill may be deposited to the full height in one operation and levelled. If the fill has to be compacted, it shall be placed in layers not exceeding 225 mm and levelled uniformly and compacted as indicated in clause 16.1 before the next layer is deposited.

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor at his cost.

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed. This shall hold good for embankments as well.

The Contractor shall protect the earth fill from being washed away by rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the slip at his cost.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

If specifically permitted by the Engineer, compaction can be obtained by allowing loaded trucks conveying fill or other material to ply over the fill area. Even if such a method is permitted, it will be for the Contractor to demonstrate that the desired/ specified compaction has been obtained. In order that the fill may be reasonably uniform throughout, the material should be dumped in place in approximately uniform layers. Traffic over the fill shall then be so routed to compact the area uniformly throughout.

If so directed by the Engineer, the rock as obtained from excavation may be used for filling and levelling to indicate grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above, has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material

does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

### **15.5 Fill Density**

The compaction, only where so called for, in the schedule of quantities/ items shall comply with the specified (Standard Proctor/ Modified Proctor) density at moisture content differing not more than 4 percent from the optimum moisture content. The Contractor shall demonstrate adequately at his cost, by field and laboratory tests that the specified density has been obtained.

### **15.6 Lead**

Lead for deposition/ disposal of excavated material, shall be as specified in the respective item of work. For the purpose of measurement of lead, the area to be excavated or filled or area on which excavated material is to be deposited/ disposed off shall be divided into suitable blocks and for each of the blocks, the distance between centrelines shall be taken as the lead which shall be measured by the shortest straight line route on the plan and not the actual route taken by the Contractor. No extra compensation is admissible on the grounds that the lead including that for borrowed material had to be transported over marshy or 'katcha' land/ route.

### **15.7 Measurement and Payment**

All excavation shall be measured net. Dimensions for purpose of payment shall be reckoned on the horizontal area of the excavation at the base for foundations of the walls, columns, footings, tanks, rafts or other foundations/ structures to be built, multiplied by the mean depth from the surface of the ground in accordance with the drawings. Extra excavation for working space requirements and excavation in side slopes will not be paid for. The Contractor may make such allowance in his rates to provide for working space and for excavation in side slopes keeping in mind the nature of the soil and safety of excavation. Excavation paid for will be of the exact size of the foundation, undercut being paid for extra as per its volume.

Unless otherwise specified, the unit rates quoted for excavation in different types of material shall also account for a basic lead of 100 metres for disposal as specified or directed. Only leads beyond the basic lead of 100 metres will be considered as extra lead and paid for at the rates quoted in the schedules.

Backfilling as per specification the sides of foundations of columns, footings, structures, walls, tanks, rafts, trenches etc. with excavated material will not be paid for separately. It shall be clearly understood that the rate quoted for excavation including backfilling shall include stacking of excavated material as directed, excavation/ packing of selected stacked material, conveying it to the place of final backfill, compaction etc. as specified. As a rule material to be backfilled shall be stacked temporarily within the basic lead of 100 metres unless otherwise directed by the Engineer. If the Engineer directs/ permits a lead of over 100 metres for such material, the conveyance of the material for the extra distance over the basic lead of 100 metres for backfilling will be paid for.

Payment for fill inside trenches, plinth or similar filling with selected excavated material will be made for only compaction as specified / directed. Cost of all other operations shall be deemed to have been covered in the rate quoted for excavation. Payment for this work will be made based on measurement of plinth/ trench dimensions filled. The plinth ground levels shall be surveyed beforehand for this purpose. If no compaction is specified/ desired such filling will not be separately paid for. In such an event the fill shall be levelled/ finished to the profile as directed at no extra cost.

Backfilling, plinth filling etc. with borrowed earth will be paid for at rates quoted. The quoted rate shall include all operations such as clearing, excavation, lead and transport, fill, compaction etc. as specified. Actual quantity of consolidated filling or actual quantity or excavation in the borrow pits (less such top soil which has been excavated and not used for filling) whichever is less shall be measured and paid for in cubic metres. The lead, lift etc. shall be as indicated in the schedule of quantities. Actual quantity of consolidated sand filling shall be measured and paid in cubic metres.

### **15.8 Close timbering**

It shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 25 cm x 4 cm sections or as directed by Engineer. The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal waling of strong wood at maximum 1.2 metres spacing, strutted with ballies or as directed by Engineer. The length of the ballies struts shall depend on the width of the trench or pit. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical wallings, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

Timber shoring shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench. The type of timbering shall be as approved by Engineer. It shall be the responsibility of Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc., from collapsing.

Timber shoring may be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instructions from Engineer.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded with systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

In the case of open timbering, the entire surface of the side of trench or pit is not required to be covered. The vertical boards of minimum 25 cm x 4 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width. The detailed arrangement, sizes of the timber and the spacing shall be subject to the approval of Engineer. In all other respects, specification for close timbering shall apply to open timbering.

In case of large pits and open excavations, where shoring is required for securing safety of adjoining structures or for any other reasons and where the planking for sides of excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. Load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut.

## **15.9 Dewatering**

All excavations shall be kept free of water. Grading in the vicinity of excavation shall be properly closed to prevent surface water running into excavated areas. Contractor shall remove by pumping or other means approved by Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep all excavations dewatered until the foundation work is completed and backfilled. Sumps made for dewatering must be kept clear of the excavations / trenches required for further work. Method of pumping shall be approved by Engineer; but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction.

Unless separately provided for in the Schedule of quantities, dewatering is deemed to have been included in the unit rates quoted for excavation. If separately provided for, the unit of measurement shall be as indicated in the schedule of quantities.

## **16. BLASTING IN HARD ROCK**

### **16.1 General Requirements**

Unless otherwise stated herein, I.S. specification “IS-4081: Safety code for Blasting and related Drilling Operations” shall be followed. After removal of overburden, if any, excavation shall be continued in rock to such widths, lengths, depths, and profiles as are shown on the drawings or such other lines and grades as may be specified by Engineer. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines specified for the excavation, in the soundest possible condition. The quantity and strength of explosives used, shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Engineer, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structures as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of Engineer at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

Specific permission of Engineer will have to be taken by Contractor for blasting rock and he shall also obtain a valid Blasting License from the authorities concerned. If permission for blasting is refused by Engineer, the rock shall be removed by wedging, pick, barring, heating and quenching or other approved means. All loose or loosened rock in the sides shall be removed by barring, wedging, etc. The unit rates for excavation in hard rock shall include the cost of all these operations.

Contractor shall obtain necessary license for storage of explosives, fuses and detonators issued to him from Employer's stores or from supplier arranged by him, from the authorities dealing with explosives. The fees, if any, required for obtaining such license, shall be borne by Contractor. Contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State and Central Government authorities and statutory bodies / regulations. Explosives shall be kept dry and shall not be exposed to direct rays of sun or be stored in the vicinity of fire, stoves, steam pipes or heated metal, etc. No explosives shall be brought near the work in excess of quantity required for a particular amount of firing to be done; and surplus left after filling the holes shall be removed to the magazine. The magazine shall be built as far as possible from the area to be blasted, Engineer's prior approval shall be taken for the location proposed for the magazine.

In no case shall blasting be allowed closer than 30 metres to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 7 days old. As far as is possible, all blasting shall be completed prior to laying concrete for any foundations or any other purposes. Permission for blasting may be refused, at the discretion of the Engineer, after casting of foundations is started, in which case excavation in hard rock shall be done by other methods.

## **16.2 Specific Requirements**

For blasting operations, the following points shall be observed.

Contractor shall employ a competent and experienced supervisor and licensed blaster in-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

Before any blasting is carried out, Contractor shall intimate Engineer and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

Contractor shall ensure that all workmen and the personnel at site are excluded from an area within 200 m. radius from the firing point, at least 5 minutes before firing time by sounding warning whistle. The area shall also be given a warning by sounding a distinguishing whistle.

The blasting of rock near any existing buildings, equipment or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done with small charges only and where directed by Engineer, a trench shall have to be cut by chiselling prior to the blasting operation, separating the area under blasting from the existing structures.

The firing shall be supervised by a Supervisor and not more than 6 (six) holes at a time shall be set off successively. If the blasts do not tally with the number fired, the misfired holes shall be carefully located after half an hour and when located, shall be exploded by drilling a fresh hole along the misfired hole (but not nearer than 600 mm from it) and by exploding a new charge.

A wooden tamping rod with a flat end shall be used to push cartridges home and metal rod or hammer shall not be permitted. The charges shall be placed firmly into place and

not rammed or pounded. After a hole is filled to the required depth, the balance of the hole shall be filled with stemming which may consist of sand or stone dust or similar inert material.

Contractor shall preferably detonate the explosives electrically.

The explosives shall be exploded by means of a primer which shall be fired by detonating a fuse instantaneous detonator (F.I.D.) or other approved cables. The detonators with F.I.D. shall be connected by special nippers. In dry weather and normal dry excavation, ordinary low explosive gunpowder may be used. In damp rock, high explosive like gelatine with detonator and fuse wire may be used. Underwater or for excavation in rock with substantial accumulated seepage electric detonation shall be used.

Holes for charging explosives shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will be suitable for handling without secondary blasting.

When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an over break limit of 75 mm shall be filled up as instructed by Engineer, with concrete of strength not less than M10. The cost of filling such excess depth shall be borne by Contractor and the excavation carried out beyond the limit specified above will not be paid for. Stopping in rock excavation shall be done by hand trimming.

Contractor shall be responsible for any accident to workmen, public or Employer's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of explosives, or any other Authority duly constituted under the Government of Bhutan Rules.

### **16.3 Measurement**

Volume of rock excavated shall be calculated on the basis of length, breadth and depth of excavation indicated on the drawings. No payment will be made for excavations/over break beyond payment line specified. Where such measurement is not possible as in the case of strata intermixed with soil, excavated rock shall be properly stacked as directed by Engineer and the volume of rock calculated on the basis of stack measurements after making appropriate allowance for voids. The allowance to be made for voids shall be decided by Engineer and this will not be a subject matter of dispute or appeal.

## **17. Line drilling and pre-shearing**

### **17.1 Procedure**

Line drilling and Pre-shearing in rock shall be resorted when so specified or directed by the Engineer. This technique shall be used when the excavation in rock (hard and stratified) has to be carried out to exact lines and levels and when absolutely no over excavation is permissible. It shall also be used where rock blasting is required to be carried out in the close proximity of existing structures, equipment etc.

This technique consists of drilling holes, as close as warranted by the rock conditions and to such depth as may be necessary, along the periphery (or line) of the area within which excavation has to be carried out. This will ensure that when rock inside the area is blasted, over excavation/ over break damage to adjoining property is avoided as the rock shears off along the line of drilled holes.

The diameter, depth and spacing of holes, shall be decided by the Engineer or as specified in the drawings/ schedules. The holes shall be generally be 48 mm in diameter. The Engineer may direct a second line or subsequent lines of holes to be drilled in addition at suitable location/s to facilitate safe excavation.

The layout of the interior blasting holes shall be carefully planned. Only light blasting is permitted in the interior holes which are close to the line drilled holes.

The Contractor shall have to carry out tests to determine the amount of explosives required to ensure an even break at the line drilled holes, so that damage to structure outside line drilled holes as also over breaks are avoided.

After the interior holes are blasted any irregularities in the vertical line drilled face which was line drilled shall be removed and trimmed by wedging, splitting, chiselling and barring.

Excavation shall generally be carried from the centre to the outside.

The Engineer may direct a trench to be cut between adjacent line drilled holes. In such a case, rock between line drilled holes shall be blasted with such pattern of holes as will not cause any damage to any structure close by and also not shatter or render unsuitable any good rock outside the line drilled holes.

Line drilling and pre-shearing will only be permitted in hard rock.

## **18. Setting of stubs**

The stub shall be set correctly in accordance with approved method at the exact location and alignment and in precisely correct levels. Stubs shall be set in the presence of the Engineer's representative available at site for which adequate intimation shall be given to the Engineer by the Contractor.

The placing of the stubs shall be within the tolerances specified below

The difference in elevation between identical parts of any two stubs shall not exceed 1/1000 of the horizontal distance between the stubs, allowance being made for the difference, if any, in the lengths of legs. The actual elevation of any stub shall not differ from the prescribed elevation by more than 6 mm of its correct position.

The difference in horizontal spacing from specified distance between identical parts of any two stubs shall not exceed 1/1000 of the horizontal distance between the stubs.

The Engineer's representatives shall approve setting of stub at each location. The approval shall not, however, absolve the Contractor of his responsibility of correct setting of stubs and casting of foundations, who will be required to rectify the faulty work at his own expenses.

The Engineer reserves the right to uncover the foundations subject to total maximum of 25% locations and if any foundation is found faulty, the Contractor shall be required to uncover all foundations as demanded by the Engineer / Employer and bear all the expenses there of as well as the expenses of rectifying all inadequate or faulty foundations thereby disclosed and putting all these back in order.

## **19. Concrete**

All cement to be used shall be Portland cement meeting the requirements of the relevant Indian Standards (mainly IS 269), from an approved manufacturer. Cement shall be adequately protected from moisture or contamination during transportation and storage at site. Cement in bags shall be limited within a heap of 13 bags in store and 7 bags at site. No cement containing lumps or deleterious matter shall be used.

The reinforced cement concrete used for the foundation shall be of M20 grade (i.e. of 20N/mm<sup>2</sup> cube compression strength at the end of 28 days), with 20mm downgraded stone metal for walls and other members less than 600 mm thickness and 40mm downgraded stone metal for thicker members of the works including pyramid portions. Aggregates shall conform to specifications for coarse and fine aggregates from natural sources for concrete as per IS: 383. The methods used for the preparation of concrete, and all its properties regarding its strength under compression, tension, shears, punching and bending etc., as well as workmanship shall conform to the relevant Indian Standard codes of practice.

The sand used for the concrete shall be composed of hard siliceous materials. It shall be clean and of a sharp angular grit type and free from earthy or organic matter and deleterious salts and screened through a mesh not more than 5mm in the clear.

The aggregates shall be of clean broken hard granite or other stone specified or approved by the Engineer. It shall be of hard, closed-grained quality. It shall also be as far as possible cube like, preferably angular, but not flaky, perfectly clean and free from earth, organic or other deleterious matters. 40mm aggregate shall be of size as will pass through a mesh of 40mm measured in the clear and 20mm aggregate through 20mm square mesh measured in clear. All fine and coarse aggregates shall be obtained from sources approved by the Engineer.

The water used for mixing concrete shall be fresh clean and free from oil, acid and alkali organic materials or other deleterious substances. Salty or brackish water should not be used. Potable water is generally satisfactory.

Though not generally expected, sulphate-resisting cement may be necessary if so indicated during soil investigation. Sulphate resisting Portland cement shall be in accordance with IS standards and shall be obtained from a source approved by the Engineer. The Engineer shall decide the locations where it shall be mandatory for the Contractor to use sulphate-resisting cement. The Contractor shall certify that the proposed cement is of the required quality regarding resistance to corrosion due to sulphates. Methods of testing this quality shall be deemed to have been included in the rates quoted. The use of aluminous cements will not be permitted. For payment purposes, the bidder shall quote for ordinary M20 Concrete and PCC, as listed in the BOQ. If sulphate resistant cement is used, the bidder shall quote an extra per tone of Concrete and PCC; over an above the rates quoted for the corresponding items with ordinary cement

## 19.1 Batching and Mixing of Concrete

It shall be Contractor's responsibility to carry out tests on samples for concrete that the Contractor proposes to employ in foundation concrete. The procedure for testing is outlined in the appropriate clauses under "Inspection and Testing". The test result of the proposed mixture together with data for water cement ratio and slump shall be submitted to the Engineer for approval at least four (4) weeks before the commencement of concreting operation. The trial mix proportions shall be approved if the average compressive strength of a set of 9 specimen tested at 28 days exceeds 21N/mm<sup>2</sup>, with not more than 3 specimen being less than 20N/mm<sup>2</sup>, and no single specimen being less than 17 N/mm<sup>2</sup>.

The Contractor shall be responsible for maintaining the mixture, control and testing of concrete throughout the working period. Neither the mix proportions nor the source of the supply of materials shall be altered without the prior approval of the Engineer. The minimum cement content, the water cement ratio, the slump and all other characteristics of concrete shall be demonstrated to conform to the relevant Indian Standards.

The concrete shall be mixed with an approved concrete mixer. In no case shall hand mixing be allowed. The Contractor shall provide the measuring equipment and shall maintain and operate the equipment as required to accurately determine and control the amount of each separate ingredient entering the concrete. The equipment shall be constantly maintained in first-class workable condition during the working period. The concrete mixing shall be cleaned and inspected at suitable intervals in the presence of the Engineer.

Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional cement to allow for sticking in the drum.

The cost of all concrete testing shall be deemed to be included in the price of the concrete works. In addition, the Engineer shall retain the right to undertake slump tests at any time prior to the placement of concrete and reject any batch of concrete that fails such tests, all at the cost of the contractor.

Mixing shall be continued until there is uniform distribution of material and the mix is uniform in color and consistency but in no case the mixing is done for less than 2 minutes. Normally mixing shall be done close to the foundation. The concrete shall be placed and compacted before setting commences.

The concrete should be mixed as stiff as the requirement of placing the concrete in the forms or moulds with ease and the degree to which the concrete resists segregation. Hence the quantity of water used should not be too much.

Concrete shall not be directly poured from a height more than 1.5m to avoid mix segregation.

Form work shall conform to the provisions of Clause 10 "Form-Work" IS: 456. Proper forms or moulds adequately braced to retain proper shape while concreting should be used for chimney and pyramid or slab portions. The mould should be water tight so that cement cream should not come out leaving only sand and jelly consequently forming of

honeycombing in the concrete. The form boxes shall be cleaned and oiled before these are used for concreting.

The stub shall be free of rust and cleaned thoroughly and painted with cement paste, made of 1 part of cement and  $\frac{3}{4}$  part of water (cement slurry) to a thickness of 1.6mm before the concrete is laid against the stub. The painting with cement slurry shall be done each time to such a height before the cement wash becomes dry.

Concrete shall, in all cases be placed in the presence of the Engineer. No concrete shall be placed until the Engineer has approved the excavated surface, stub setting, and inspection of formwork and completion of all preparation work. Adequate chutes or other approved method shall be employed to place concrete. All concrete shall be consolidated to the maximum practicable density with a concrete vibrator and surface made smooth and free from pockets and honeycomb.

The concrete shall be laid in 150mm layers and consolidated well so that the cement cream works up to the top and no honeycombing are left in the concrete. Concreting is to be done continuously so that the subsequent layers are laid before the final setting of the bottom layer begins.

If fresh concrete is to be laid on old concrete less than a week old, the surface of the old set concrete should be chipped and cleaned thoroughly with wire brush and washed with a layer of thick cement slurry before the new concrete is laid. If, however, the concrete is more than 10 days old, the top layer of the set concrete should be chipped and cleaned thoroughly with wire brush and water and layer of cement mortar (1:2) 12 mm thick shall be laid evenly after giving a coat of cement slurry, as specified above to ensure proper bonding between old and new concrete. If a foundation / chimney or any other concrete member is damaged during the course of the works, it shall be brought to the notice of the Engineer, and rectified as directed by him.

After concreting the chimney portion to the required height, the top surface should be finished smooth, with slight slope towards the outer edge to drain off the rainwater falling on the coping.

In wet locations, the site must be kept completely de-watered both during the placing of the concrete and for 24 hours after completion. There should be no disturbance of concrete by water during this period.

The forms or mould shall not be removed before a lapse of about 24 hours after the completion of concreting. After removal of the forms, the concrete surface, where required shall be repaired with a rich cement and sand mortar in the shortest possible time. For concreting during hot weather adequate provision shall be made to lower concrete temperature which shall not increase beyond 40°C at the time of placement of fresh concrete. All exposed concrete and structure steel within one meter of the ground or high water level, whichever is higher, shall be painted with a black bituminous paint, Flintcote or approved type, before handing over the sub-station to the Employer.

## **19.2 Concreting in Cold Weather.**

When there is danger of freezing, certain minimum temperatures of concrete, as placed, are specified because much of the heat generated during hydration of cement is not

immediately available. The temperature of the concrete shall not be less than 4.5<sup>0</sup>C in moderate weather or 10<sup>0</sup>C when the mean daily temperature drops below 4.5<sup>0</sup>C. To obtain the required temperature for freshly mixed concrete in cold weather, it is necessary to heat mixing water or aggregates, or both, depending on severity of the weather. Heating of the mixing water is the most practicable and efficient procedure. The minimum temperature at which water and the aggregates should enter the mixer, to produce 15<sup>0</sup> C temperature of concrete shall be 6<sup>0</sup>C and 3.5<sup>0</sup>C respectively. Fluctuations in temperature from batch to batch shall be avoided. Very hot water should not be allowed to touch the cement because of the danger of causing quick or “flash” set. If hot water and the coldest portion of the aggregate can be brought together in the mixer first so that the temperature of this mixtures does not exceed about 38<sup>0</sup> C the possibility of flash set will be minimized. The aggregates should be heated uniformly and carefully eliminating all frozen lumps, ice and snow, and avoiding overheating or excessive drying. Average temperatures should not exceed 62<sup>0</sup> C and maximum temperatures should not exceed 100<sup>0</sup> C. Heating of aggregates is preferably accomplished by hot water.

Concrete shall be protected against freezing temperatures for at least 48 hours after being placed when the mean daily temperature is 4.5<sup>0</sup> C or above. When the mean daily temperature is below 4.5<sup>0</sup> C, concrete as placed should have a temperature of not less than 10<sup>0</sup> C and should be maintained at the same temperature for at least 72 hours. Heat of hydration can be gainfully conserved by having insulating formwork covers of timber, clean straw blanket sacking, tarpaulins, plastic sheets etc. in conjunction with air gap up to first 3 days even when ambient temperatures are lower.

For moderately cold weather timber formwork alone are sufficient & preferable to steel formwork. When the concrete is cured by membrane curing no additional protection against freezing is required if the protection at 10<sup>0</sup> C for 72 hours is obtained by means of adequate insulation in contact with the forms or concrete surfaces. If membrane cured concrete is not protected by insulation, the concrete should be protected against freezing temperatures for an additional 72 hours immediately following the 72 hours of protection at 10<sup>0</sup> C. Water cured concrete must be protected against freezing temperatures for 3 days immediately following the 72 hours protection at 10<sup>0</sup> C.

Protection required in cold weather is only as much necessary as to keep the temperature of the concrete from falling below specified temperature during certain initial periods. The most common method of protection is to enclose the structure and surround it with atmosphere warm enough to maintain the required temperatures.

Enclosures should be tight and windproof. Stoves of various types may be used for heating. These are easy to handle, inexpensive and are convenient for small jobs but they have the disadvantages of producing dry heat. Dry heat for protection of concrete in cold weather tends to produce rapid drying because warm air will hold much more moisture than cold air. It is important, therefore, that the concrete be supplied with adequate moisture when dry heat is used.

Because of slower rate of gain of strength during cold weather, the formwork & props have to be kept in place for longer than in usual concreting practice. The appropriate time of removal of formwork may be 5 days for chimney.

### **19.3 Curing**

The concrete after it is 24 hours old shall be cured by keeping concrete wet continuously for a period of 14 days after laying. The pit may be backfilled with selected earth sprinkled with necessary amount of water and well consolidated in layers not exceeding 150mm of consolidated thickness after a minimum period of 24 hours and thereafter both the back-filled earth and chimney top shall be kept wet for the remainder of the prescribed period of 14 days. The uncovered concrete member above the back-filled earth shall be kept wet by providing empty cloth or hessian bags dipped in water fully wrapped around the concrete member for curing and ensuring that the bags are kept wet by frequent pouring of water on them.

### **19.4 Repair and Replacement of Unsatisfactory Concrete:**

Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, holes left by form-holes, etc shall be brought to the notice of the Engineer who may permit the patching of the defective areas or reject the concrete work. Rejected concrete shall be removed and replaced by the Contractor without any additional expense to the Employer. After removing loose materials, the surface shall be prepared and saturated with water for 24 hours before patching is done with 1:1 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as directed by the Engineer.

## **20. Reinforcement**

All materials, activities and methods regarding reinforcing steel shall conform to the relevant I.S. Codes, particularly to IS 432 for mild steel bars and wires, IS 1786 for High Strength bars/TMT bars and wires, and IS 1566 for steel wire fabric. The Contractor shall provide certificates stating origin and process of manufacture of reinforcing steel, and submit test certificates from supplier to the Engineer. At the discretion of the Engineer, samples of reinforcing steel selected by the Engineer shall be tested by the contractor at a local laboratory of the Engineer's choice, to demonstrate the tensile strength of the steel. The cost of such testing shall be deemed to be included in the Scheduled Rates of Items for supply of reinforcement.

The wire shall be 1.25mm in diameter or heavier black annealed iron wire. Preformed clips or attachments shall be of proper design and strength so that reinforcing bars are rigidly supported/held in position, and are not capable of movement during concrete pouring.

Reinforcing steel shall be protected from damage during transportation and during storage. It shall be stacked horizontally with adequate supports to prevent distortion. Bars of different lengths and diameters shall be stacked separately and marked for easy identification.

Reinforcing steel shall be cold bent without any application of heat, by a slow and regular movement. Bending shall be done accurately to dimensions given in the bar bending schedule or foundation drawings in accordance with IS 2502.

Bars having cracks or splits on the bends shall be rejected.

Immediately before placing concrete, it shall be ensured that reinforcing steel is free from dirt, detrimental scale, paint, mortar, oil, or other foreign substances.

Reinforcing steel embedded or partially embedded in the concrete shall remain completely undisturbed for a minimum period of 24 hours, or longer if the Engineer so directs, after a unit of concrete placement has been completed.

Steel shall be placed accurately in accordance with the Drawings. It shall be tied securely at each intersection. Metal or concrete chairs and metal spreaders of approved types shall be used where necessary for support or spacing of steel bars.

Wood supports or spreaders shall not be used.

Splicing of bars except where shown on the Drawings shall not be permitted without the prior written consent of the Engineer. Bar splicing shall be by overlapping, as indicated on the Drawings, and the lap lengths shall not be less than 52 times the diameter of the smaller bar.

## **20.1 Miscellaneous RCC, Masonry and other building Works**

RCC and Masonry walls are envisaged to be built along the boundary of the substation and wherever else required (like between transformers etc. in the substation). These shall be built to the specifications for cement concrete works specified herein before. For dry stone and stone masonry revetment, separate rates shall be quoted per cum. of the wall. These rates shall be inclusive of supply of all materials, items of work involved (like laying etc.) and all costs of workmanship, labor, etc. Excavation and PCC shall be charged separately as per its quoted rate. Specifications for materials and workmanship shall be as given in relevant clauses of this document. RCC or Masonry works other than those mentioned in these specifications are not much expected to be encountered at this point of time. Nevertheless, if these are found necessary at the time of execution of the Contract, the same shall be decided upon by the Engineer. In that case, the unit rates quoted by the Contractor for items required for such works (e.g. the rates for excavation, concrete, reinforcing steel etc.) shall remain binding upon the Contractor.

## **20.2 Grade Slab**

Wherever required within the substation, reinforcement, M20 grade concrete slabs shall be provided on grade, prepared within DRP and PCC in blinding as shown in control building drawing. Reinforcement shall be as per IS 456. Except for the grade slab in the control building all other slab and reinforcement shall be paid as per the quoted rate for concrete and reinforcement. The contractor shall get RCC drawings for slab on grade, approved from engineer. Rubble sub-base, PCC in blinding etc. shall be paid as per quoted rate of the item.

## **21. Water Tanks and RCC Building Works**

Apart from the different codes, design criteria mentioned elsewhere following codes and design criteria also to be followed for design of water tank and RCC buildings.

The minimum cement content in the concrete shall be as per relevant IS code.

For minimum size of structural components and minimum clear cover to reinforcement materials IS:456 shall be followed in general. However, additional requirements given in following paragraphs shall be also considered.

The minimum size of structural components shall be as follows

Slab : 125 mm.

Beam : 230 mm x 230 mm

Column : 230 mm x 230 mm

Wall Thickness : 150 mm

Raft slab : 200 mm

The minimum clear cover to reinforcement shall be as follows

Roof Slab : 25 mm (Top & Bottom).

Raft Slab : 50 mm (Top & Bottom).

Beam : 40 mm (All around)

Column : 40 mm (All around).

Wall : 40 mm.

Permissible Stresses

For liquid retaining structures, all the maximum permissible stresses shall be according to IS 3370.

## **22. RETAINING WALLS**

Retaining walls are expected to be erected along the boundary of the sub-station, or at locations, for instance on slopes, where there are chances of soil erosion due to rainwater, etc. The wall shall consist of broken stone pieces cemented with the help of 1: 5 cement mortar and weep holes and filters. The weep shall be HDPE medium duty pipe minimum of 110mm diameter placed at least 1.5m apart staggered horizontally and vertically with slope of 1 in 100. The revetment walls shall be finally pointed with 1:3 cement mortar. The empty space between revetment and foundation shall be filled by earth. Alternatively, RCC retaining wall shall also be permitted. The design of the revetment and foundation shall be developed by the Contractor and approved by the Engineer.

If RCC or Masonry works are found necessary at the time of execution of the Contract, the same shall be decided upon by the Engineer. In that case, the unit rates quoted by the Contractor for items required for such works (e.g. the rates for excavation, concrete, reinforcing steel etc.) shall remain binding upon the Contractor. For dry stone and stone

masonry revetment, separate rates shall be quoted per cum. of the wall. These rates shall be inclusive of supply of all materials, items of work involved (like excavation, laying etc.) and all costs of workmanship, labour, etc. necessary to complete revetment works.

The various Factors of Safety for stability checks of all types of retaining walls shall be as follows:

Overturning – Dead & Live Load and earth pressure with wind or EQ :	1.5
Overturning - Dead & Live Load and earth pressure with out wind or EQ :	2.0
Sliding -- Dead & Live Load and earth pressure with wind or EQ :	1.5
Sliding -- Dead & Live Load and earth pressure with out wind or EQ :	1.75

All Retaining walls greater than 5.0 m in height shall be RCC walls, with counterforts. Apart from the provisions given in the relevant I S publications for gravity structures, IS 456 shall be used for the design of RC retaining walls, and IS 1905 shall be used for the design of Masonry Walls. Earth Quake load shall be taken as per IS 1893.

The filter medium for all walls shall consist of hand-packed stones, 50 to 75 mm in size, for a width of 600mm immediately behind the wall, from the top of the wall to a level at least 300mm below the lowest weep hole.

## **23. Cable trench**

### **23.1 Conduit and Hand Holes**

The Contractor shall provide the conduit and hand hole for the cable from the main trench to the steel structure or equipment foundation. The hand hole shall be reinforced concrete with galvanized steel chequered plate cover. The size of the hand hole shall be large enough to pull the cable from the conduit to the foundation and minimum size of hand hole shall be 0.50 meter x 0.50 meter. The conduit shall be HDPE drainpipe. The diameter of the Conduit shall be 0.16 meter.

### **23.2 Gravel Pack**

The gravel pack used shall be of size 6 mm to 10 mm well graded. The gravel shall be rounded edges and no sharp corners will be permitted. Gravelling will be done right from the bottom of the hole.

### **23.3 Payment**

Payment for the trench shall be based on quoted rates for individual items like fabricated, galvanized structural steel, excavation, concrete, reinforcement, PCC etc.

### **24. Breaking of Concrete, Brickwork, Blockwork and Stone Masonry**

The Contractor shall demolish any brickwork, blockwork, stone masonry or concrete, either plain or reinforced, as may be required. The waste material shall be removed from the location and dumped at suitable location or transported and disposed off as directed by the Engineer. The Contractor shall observe all precautions by way of necessary propping, strutting, etc. to the satisfaction of the Engineer to ensure that adjacent framework is not damaged. Any damage to the adjacent framework, brickwork or blockwork resulting from negligence of the Contractor thereof shall be made good at the Contractor's cost to the satisfaction of the Engineer. Payment for these items shall be done as per specifications and rates quoted for excavation in soft and hard rock, unless a separate item is included in the Schedule of prices.

### **25. Inspection and Testing**

#### **25.1 General**

Unless the Approved Make / Manufacturer is specifically spelt out in the Specifications, procurement of all items shall be made only after intimation and approval of the source by the Employer / Engineer.

All material supplied by the Contractor, whether as procured (steel, cement, aggregates, reinforcement etc), or in finished form (concrete, galvanized fabricated steel members etc), shall be subject to testing to approval of Engineer / Employer as per the relevant IS code governing that material, at any stage during the execution of the Contract, from procurement up to commissioning and handing over of the plant to the Employer, the cost of which shall be borne by the Contractor.

Apart from the tests specified in the relevant I S Codes, those specified here in below and others mentioned in the Specifications of individual components of the works shall also be performed to the satisfaction of the Engineer, and shall be deemed to be included in the Scheduled Rates of the respective items, unless a separate rate is asked for in the BOQ.

All the contractor's establishments, whether for manufacture or for storage of material, will be inspected by the Engineer during the tenure of the contract. Every facility shall be provided by the Contractor to enable the Engineer to carry out the necessary inspection of the establishment and the cost of all tests during manufacture and preparation of test records shall be deemed to be included in the Scheduled Rate of the item, unless separately provided for in the schedule. The dispatch clearance will be issued to the Contractor by the Employer, on receipt of concurrence from the Engineer. The materials shall be inspected and tested during manufacture by an approved inspection firm or laboratory and be accompanied by appropriate compliance certification as part of the extent of works. The Employer / Engineer may also inspect and test raw and finished materials from time to time at any independent laboratory of

his own choice, independently of the Contractor. All expenses related to such testing including transport of the material to the laboratory, testing charges, inspection / supervision of the tests by the Employers / Engineer shall be reimbursed by the Contractor.

It is the responsibility of the Contractor to advise the Engineer that the materials shall be available for inspection.

The passing of such inspection or test will not, however, prejudice the right of the Engineer to reject at a later date, the Plant and any or all of material, if it does not comply with the Specifications, or give complete satisfaction in service.

Instruments shall be approved and shall, if required by the Engineer, be calibrated by the National Physical Laboratory or such other body as may be approved, at the expense of the Contractor.

Unless otherwise specified in this Contract, selection of test samples, numbers of specimens and acceptance of results shall be in accordance with the terms of the relevant Indian standard, where applicable. Where no terms exist, the Engineer is to instruct details in advance of the inspection and tests in response to the request of the Contractor.

Breakdown test voltages shall be measured by means of a crest or electro-static voltmeter connected to the high voltage side of the transformer, or by an instrument connected to the low voltage side of the transformer supplying the test voltage and calibrated in an approved manner by means of a sphere spark gap. Electrical tests, other than impulse tests, shall be carried out at a frequency of 50 Hz.

The following tests, apart from those specified in the relevant IS codes, shall be carried out at the manufacturer's works:

## **25.2 Structural steel Material Test**

Steel material used for supporting steel structures shall be subjected to tensile load or bend test in accordance with the Indian standards. Test shall be performed by the contractor without any additional cost. The test specimens shall consist of members selected randomly by the Engineer from any of the structures selected by him for the purpose of testing, whether erected or not the engineer reserves the right, if the situation so warrants, to get tested at contractor's expenses 5% by weight of the steel used for support structures.

## **25.3 Concrete Tests**

The Contractor shall carry out tests on sample of concrete from the foundation and other concrete works, as required by the Engineer.

The test specimens shall be cubes of 150 mm side and the mould shall be of metal with inner face accurately machined. Each mould shall be provided with a metal base having a smooth machined surface. The interior surfaces of the mould and base shall be lightly oiled before concrete is placed in the mould.

Test Specimens shall be moulded by placing the fresh concrete in the mould in 50 mm layers, each layer being thoroughly compacted with a steel bar 380 mm long and having a ramming face 25 mm square and weighing 2.8 kg. The concrete may be compacted by vibration, each layer being vibrated by means of an electric or pneumatic hammer or by means of a suitable vibrating table.

Concrete for test specimens shall be taken at the point of deposit. To ensure that the specimens are representative of the concrete in the foundations a number of samples shall be taken from different points. Each sample shall be large enough to make one test specimen and shall be taken from one point in the work.

The test specimens shall be stored at the site at a place free from vibration, under damp sacks for 24 hours, plus 1/2 hour, after which time they should be removed from the moulds, marked and stored in water at a temperature between 10° C and 21° C until the test date. Specimens that are to be sent to a laboratory for testing shall be packed for transit in damp sand, or other suitable damp material, and shall reach the laboratory at least 24 hours before test. On arrival at the laboratory they shall be similarly stored in water until the date of the test.

The test shall be made at the age of the concrete corresponding to that for which the strengths are specified. Compression test shall be made between smooth plane steel plates without end packing and a load shall be applied axially at the rate of approximately 13.8 N/mm<sup>2</sup> per minute. One compression plate of the testing machine shall be provided above seating in the form of a proportion of a sphere, the center of which coincides with the central point of the face of the plate. Test specimens shall be placed in the machine in such a manner that the load is applied to the sides of the specimens as cast.

The results shall be handed in triplicate to the Engineer, as soon as possible after testing.

#### **25.4 Testing of Rock Anchors**

Where rock anchor foundations are used in hard rock, as provided for by the Specification, the Contractor shall type test individual anchors by tensile test loading to failure. The type test shall be considered satisfactory if the foundation fails at or above the design ultimate strength of steel.

Anchor for type testing shall be installed away from permanent foundation anchors but in the same rock. The frequency of type testing shall depend upon the different types of hard rock encountered and the number of type tests performed shall be such as to give confidence in the employment of rock anchor foundations and experience of the type of rock suitable for their use.

The frequency of type testing shall, in the case of dispute, be reasonably determined by the Engineer.

The cost of rock anchor tests shall be included in the Scheduled Price of Hard rock foundation.

## 26. GENERAL BUILDING WORKS

### 26.1 Scope

This specification covers the general requirements for building works comprising brick and stone masonry, flooring, doors, windows, ventilators, wood/aluminium work, water-proofing, plastering, painting and such other related works forming a part of this job, which may be required to be carried out though not specifically mentioned above. The work under this specification shall consist of furnishing of all tools, plants, labour, materials, and everything necessary for carrying out the work.

### 26.2 Applicable Codes and Specifications

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

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

IS:110	Ready mixed paint, brushing, grey filler, for enamels for use over primers.
IS:269	Specification for 33 grade ordinary Portland cement.
IS:280	Specification for mild steel wire for general engineering purposes.
IS:287	Recommendations for maximum permissible moisture content for timber used for different purposes.
IS:337	Varnish, finishing interior.
IS:348	French polish.
IS:383	Specification for coarse and fine aggregates from natural sources for concrete.
IS:412	Expanded metal steel sheets for general purposes.
IS:419	Specification for putty for use on window frames.
IS:428	Distemper, oil emulsion, colour as required.
IS:702	Specification for industrial bitumen.
IS:710	Specification for marine plywood.
IS:712	Specification for building limes.
IS:733	Wrought aluminium and aluminium alloys, bars, rods and sections for general engineering purposes.

IS:777	Specification for glazed earthenware tiles.
IS:1003	Specification for timber panelled and glazed shutters (Part 1)
IS:1003	-DO- (Part 2)
IS:1038	Specification for steel doors, windows and ventilators.
IS:1077	Specification for common burnt clay building bricks.
IS:1081	Code of practice for fixing and glazing of metal (steel & aluminium) doors, windows and ventilators.
IS:1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
IS:1237	Specification for cement concrete flooring tiles.
IS:1322	Bitumen felts for water- proofing and damp proofing.
IS:1346	Code of practice for water-proofing of roofs with bitumen felts.
IS:1361	Specification for steel windows for industrial buildings.
IS:1397	Specification for kraft paper.
IS:1443	Code of practice for laying and finishing of cement concrete flooring tiles.
IS:1477	Code of practice for painting of ferrous metals in buildings (Part 1).
IS:1477	-DO- (Part 2)
IS:1542	Specification for sand for plaster.
IS:1580	Specification for bituminous compounds for water-proofing and caulking purposes.
IS:1597	Code of practice for construction of stone masonry: Part 1 Rubble stone masonry.
IS:1659	Specification for block boards.
IS:1661	Code of practice for application of cement and cement-lime plaster finishes.
IS:1834	Specification for hot applied sealing compound for joint in concrete.

IS:1838	Specification for preformed fillers for expansion joint in concrete pavements and structures (non-extruding and resilient type): Part 1 Bitumen impregnated fibre.
IS:1948	Specification for aluminium doors, windows and ventilators.
IS:1949	Specification for aluminium windows for industrial buildings.
IS:2074	Ready mixed paint, air drying, red oxide-zinc chrome, and priming.
IS:2114	Code of practice for laying in-situ terrazzo floor finish.
IS:2116	Specification for sand for masonry mortars.
IS:2185	Specification for concrete masonry units (Part 1).
IS:2185	-DO- Part 2.
IS:2185	-DO- Part 3.
IS:2202	Specification for wooden flush door shutters (Solid core type): Part 1.
IS:2202	-DO- Part 2.
IS:2212	Code of practice for brickwork.
IS:2250	Code of practice for preparation and use of masonry mortars.
IS:2338	Code of practice for finishing of wood and wood based materials (Part 1).
IS:2338	-DO- (Part 2)
IS:2339	Aluminium paint for general purposes, in dual container.
IS:2395	Code of practice for painting of Concrete, masonry and plaster surfaces (Part 1).
IS:2395	-DO- Part 2
IS:2402	Code of practice for external rendered finishes.
IS:2571	Code of practice for laying in-situ cement concrete flooring.
IS:2572/	Code of practice for construction of hollow concrete block masonry.
IS:2645	Specification of integral cement water-proofing compounds.
IS:2690	Specification for burnt clay flat terracing tiles: Part 1 Machine

	made.
IS:2691	Specification for burnt clay facing bricks.
IS:2750	Specification for steel scaffoldings.
IS:2835	Flat transparent sheet glass.
IS:2932	Specification for enamel, synthetic, exterior type (a) undercoating, (b) finishing.
IS:3036	Code of practice for laying lime concrete for a water-proofed roof finish.
IS:3067	Code of practice of general design details and preparatory work for damp-proofing and water-proofing of buildings.
IS:3068	Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete.
IS:3384	Specification for bitumen primer for use in water-proofing and damp-proofing.
IS:3461	Specification for PVC-asbestos floor tiles.
IS:3462	Specification for unbacked flexible PVC flooring.
IS:3495	Method of test for burnt clay building bricks : Part 1 to 4.
IS:3536	Specification for ready mixed paint, brushing, wood primer, pink.
IS:3564	Specification for door closers (hydraulically regulated.)
IS:3696	Safety code of scaffolds and ladders (Part 1).
IS:3696	-DO- (Part 2).
IS:4020	Methods of test for wooden flush door (Part 1 to 16).
IS:4021	Specification for timber door, window and ventilator frames.
IS:4351	Specification for steel door frames
IS:4443	Code of practice for use of resin type chemical resistant mortars.
IS:4457	Specification for ceramic unglazed vitreous acid resisting tile.
IS:4631	Code of practice for laying epoxy resin floor toppings.
IS:4832	Specification for chemical resistant mortars (Part 2).

IS:4860	Specification for acid resistant bricks.
IS:4948	Specification for welded steel wire fabric for general use.
IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.
IS:5410	Cement paint, colour as required.
IS:5411	Specification for plastic emulsion paint (Part 1).
IS:5411	-DO- (Part 2)
IS:5437	Wired and figured glass.
IS:5491	Code of practice for laying of in-situ granolithic concrete floor topping,
IS:6041	Code of practice for construction of autoclaved cellular concrete block masonry.
IS:6042	Code of practice for construction of light weight concrete block masonry.
IS:6248	Specification for metal rolling shutters and rolling grills.
IS:7193	Specification for glass fibre base coal tar pitch and bitumen felts.
IS:7452	Specification for hot rolled steel sections for doors, windows and ventilators.
IS:8042	Specification for white Portland cement.
IS:8543	Methods of testing plastics (Part 1/Section 1)
IS:8543	Methods of testing plastics (Part 1/Section 2)
IS:8543	Methods of testing plastics (Part 2/Section 1)
IS:8543	Methods of testing plastics (Part 2/Section 2)
IS:8543	Methods of testing plastics (Part 2/Section 3)
IS:8543	Methods of testing plastics (Part 3/Section 1)
IS:8543	Methods of testing plastics (Part 3/Section 2)
IS:8543	Methods of testing plastics (Part 4/Section 1)
IS:8543	Methods of testing plastics (Part 13/Section 1)

IS:9197	Specification for epoxy resin, hardeners and epoxy resin composites for floor topping.
IS:9862	Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting.
IS:12200	Code of practice for provision of water-stops at transverse contraction joints in masonry and concrete dams.

## 27. Brickwork

### 27.1 Materials

Bricks used in the works shall conform to the requirements laid down in IS: 1077. The class of the bricks shall be as specifically indicated in the respective items of work.

The nominal size of the modular brick shall be 200mm x 100mm x 100mm with the permissible tolerances over the actual size of 190mm x 90mm x 90mm as per IS: 1077. The nominal thickness of one brick and half brick walls using modular bricks shall be considered as 200 mm and 100 mm respectively. In the event of use of traditional bricks of nominal size 230mm x 115mm x 75mm with tolerance up to +3 mm in each dimension, one brick and half brick walls shall be considered as 230 mm and 115 mm respectively.

Bricks shall be sound, hard, and homogenous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 5N/sq.mm unless otherwise specified in the item.

The average water absorption shall not be more than 20 percent by weight up to class 12.5 and 15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works.

Sample bricks shall be submitted to the ENGINEER for approval and bricks supplied shall conform to approved samples. If demanded by ENGINEER, brick samples shall be got tested as per IS: 3495 by CONTRACTOR at no extra cost to EMPLOYER. Bricks rejected by ENGINEER shall be removed from the site of works within 24 hours.

Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS: 2250. Mix shall be in the proportion of 1:5 for brickwork of thickness one brick or above and 1:4 for brickwork of thickness half brick or below, unless otherwise specified in the respective items of work. Sand for masonry mortar shall conform to IS: 2116. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by ENGINEER. If so directed by the ENGINEER, sand shall be screened and washed till it satisfies the limits of deleterious materials.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by the ENGINEER. The mortar thus mixed shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. In case, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only up to 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and shall be removed forthwith from the site. Droppings of mortar shall not be re-used under any circumstances.

It is also intended to use locally available bricks and contractor shall get prior approval from the engineer before adoption at site

The CONTRACTOR shall arrange for test on mortar samples if so directed by the ENGINEER.

## **27.2 Workmanship**

Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work. Brick work 200mm/230mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/115mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full size bricks shall be used for the works and cut bricks utilised only to make up required wall length or for bonding. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, at least one face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45°. But in no case the level difference between adjoining walls shall exceed one metre. Brickwork shall not be raised more than one metre per day.

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10mm/15mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering/pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face

of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.

During inclement weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.

Brickwork shall be kept constantly moist on all the faces for at least seven days. The arrangement for curing shall be got approved from the ENGINEER.

Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS:2750 and IS:3696 (Part 1). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the ENGINEER. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/painting.

In the event of usage of traditional bricks of size 230 mmx115mmx75mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/floor or slabs and at the top of the parapet shall be laid with bricks on edge.

All brickwork shall be built tightly against columns, floor slabs or other structural members.

To overcome the possibility of development of cracks in the brick masonry following measures shall be adopted. For resting RCC slabs, the bearing surface of masonry wall shall be finished on top with 12 mm thick cement mortar 1:3 and provided with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.

RCC/steel beams resting on masonry wall shall be provided with plain or reinforced concrete bed blocks of dimensions as indicated in the drawings duly finished on top with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.

Steel wire fabric shall be provided at the junction of brick masonry and concrete as specified elsewhere before taking up plastering work.

The above items shall be measured and paid for separately under the respective items of work.

Bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is taken up for execution. Further, the top most course of half or full brick walls abutting against either a de-shuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

Reinforced cement concrete transoms and mullions of dimensions as indicated in the construction drawings are generally required to be provided in half brick partition walls. Reinforced concrete for transoms and mullions shall be measured and paid for separately under the respective items of work.

Where drawings indicate that structural steel sections are to be encased in brickwork, the brick masonry shall be built closely against the steel section, ensuring a minimum of 20mm thick cement-sand 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.

CONTRACTOR shall note that the unit rates quoted for the masonry work shall be deemed to include for the installation of miscellaneous inserts such as pipe sleeves, bolts, steel sections with anchors etc. and providing pockets, leaving openings, cutting chases etc. in accordance with the construction drawings. Miscellaneous inserts shall be either supplied FREE by the EMPLOYER or to be furnished by the CONTRACTOR. Any of the miscellaneous inserts which are required to be fabricated and supplied by the CONTRACTOR and cement concrete to be provided in the pockets for the hold fasts of door/window frames etc. shall however, be measured and paid separately under the respective items of work.

Facing bricks of the type specified conforming to IS:2691 shall be laid in the positions indicated on the drawings and all facing brickwork shall be well bonded to the backing bricks/RCC surfaces. The level of execution of the facing brick work shall at any time be lower by at least 600 mm below the level of the backing brickwork.

Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of painting to be carried out shall be as specified in the item of work. The pattern of laying the bricks shall be as specifically indicated in the drawings.

For facing brickwork, double scaffolding shall be used.

Faced works shall be kept clean and free from damage, discoloration etc., at all times.

### **27.3 Measurement**

Measurement shall be in cu.m correct to two places of decimal for brickwork of thickness one brick i.e. 200mm/230mm and above. Measurement shall be in sq.m correct to two places decimal for facing brickwork and brickwork of thickness half brick i.e. 100mm/115mm and below. Measurement shall be for the quantities as actually executed duly deducting for openings, lintels, transoms/mullions etc. All concrete works shall be measured and paid for separately under the respective items of work.

## **28. Un-coursed Random Rubble Masonry, in Foundation. Plinth and Superstructure**

### **28.1 Materials**

Stones for the works shall be of the specified variety which are hard, durable, and fine grained and uniform in colour (for superstructure work) free from veins, flaws and other defects. Quality and work shall conform to the requirements specified in IS: 1597 (Part-1). The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS: 1124. The CONTRACTOR shall supply sample stones to the ENGINEER for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.

Cement-sand mortar for stone masonry works shall be in the proportion of 1:6 unless otherwise specified in the respective items of work. Materials and preparation of mortar shall be as specified in clauses 27.1

### **28.2 Workmanship**

For all works below ground level the masonry shall be random rubble un-coursed with ordinary quarry dressed stones for the hearting and selected quarry dressed stones for the facing.

For all works above ground level and in superstructure the masonry shall be random rubble un-coursed, well bonded, faced with hammer dressed stones with squared quoins at corners. The bushings on the face shall not be more than 40 mm on an exposed face and on the face to be plastered it shall not project by more than 12 mm nor shall it have depressions more than 10 mm from the average wall surface.

Face stones shall extend back sufficiently and band well with the masonry. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourths the thickness of wall nor less than 150 mm. The height of stone may be up to a maximum of 300 mm. Face stones or hearting stones shall not be less than 150 mm in any direction.

Chips and spalls shall be used wherever necessary to avoid thick mortar joints and to ensure that no hollow spaces are left in the masonry. The use of chips and spalls in the hearting shall not exceed 20 percent of the quantity of stone masonry. Spalls & chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.

The maximum thickness of joints shall not exceed 20 mm. All joints shall be completely filled with mortar. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool during the progress of the work while the mortar is still green.

Through or bond stones shall be provided in walls up to 600 mm thick and in case of walls above 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous lime stone and sand stone, etc.) the bond stone shall

extend about two-thirds into the wall and a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. Each bond stone or a set of bond stones shall be provided for every 0.5 sq.m of wall surface.

All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly. However if any part of the masonry is required to be left behind, the wall shall be raked back (and not saw toothed) at an angle not exceeding 45°. Masonry work shall not be raised by more than one metre per day.

Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days for proper curing of the joints.

Type of scaffolding to be used shall be as specified in clause 27.2

Installation of miscellaneous inserts in the masonry shall be as specified in clause 27.2.

### **28.3 Measurement**

Measurement shall be in cu.m correct to two places of decimal. The quantities measured and paid for, shall be those as actually executed after making necessary deductions for openings, lintels etc.

## **29. Coursed Rubble Masonry (First Sort) for Superstructure**

### **29.1 Materials**

The material specification for the work shall be as per Clause 28.1

### **29.2 Workmanship**

All courses shall be laid truly horizontal and shall be of the same height in any course. The height of course shall not be less than 150 mm and not more than 300 mm. The width of stone shall not be less than its height.

Face stones shall tail into the work for not less than their height and at least 1/3rd the number of stones, shall tail into the work for a length not less than twice their height but not more than three-fourths the thickness of the wall whichever is smaller. These should be laid as headers and stretchers alternately to break joints by at least 75 mm.

The face stones shall be squared on all joints and beds; the bed joints being hammer or chisel dressed true and square for at least 80 mm back from the face and the side joints for at least 40 mm. The face of the stone shall be hammer dressed so that the bushing shall not be more than 40 mm on an exposed face and 10 mm on a face to be plastered. No portion of the dressed surface shall show a depth of gap more than 6 mm from a straight edge placed on it. The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joints.

No spalls or pinnings shall be allowed on the face. All bed joints shall be horizontal and side joints shall be vertical and no joints shall be more than 10 mm in thickness. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool, during the progress of the work while the mortar is still green.

Hearting shall consist of flat bedded stones carefully laid on their proper beds and solidly bedded in mortar. The use of chips shall be restricted to the filling of interstices between the adjacent stones, in hearting and these shall not exceed 10 percent of the quantity of the stone masonry. Care shall be taken so that no hollow spaces are left anywhere in the masonry.

The requirement regarding through or bond stones shall be as specified in clause 28.2 with the further stipulation that these shall be provided at 1.5 m to 1.8 m apart clear in every course but staggered at alternate courses.

The quoins which shall be of the same height as the course in which they occur, shall not be less than 450 mm in any direction. Quoin stones shall be laid as stretchers and headers alternately. They shall be laid square on their beds, which shall be rough chisel dressed to a depth of at least 100 mm from the face. These stones shall have a minimum uniform chisel drafts of 25mm width at four edges, all the edges being in the same plane.

Type of scaffolding to be used shall be as per clause 27.2.

Requirements of execution of the work and curing shall be as stipulated in clause 28.2

Installation of miscellaneous inserts in the masonry shall be as specified in clause 27.2

### **29.3 Measurement**

Measurement shall be in cu.m correct to two places of decimal. The quantities measured and paid for, shall be those as actually executed after making necessary deductions for openings, lintels etc.

## **30. Concrete Masonry Block**

### **30.1 Materials**

Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS: 2185 (Part 1).

Masonry units of hollow and solid light-weight concrete blocks shall conform to the requirements of IS: 2185 (Part 2).

Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS: 2185 (Part 3).

The height of the concrete masonry units shall not exceed either its length or six times its width.

The nominal dimensions of concrete block shall be as under.

Length 400,500 or 600 mm.

Height 100 or 200 mm.

Width 100 to 300 mm in 50 mm increments

Half blocks shall be in lengths of 200, 250 or 300 mm to correspond to the full length blocks. Actual dimensions shall be 10 mm short of the nominal dimensions.

The maximum variation in the length of the units shall not be more than + 5mm and maximum variation in height or width of the units shall not be more than + 3mm.

Concrete blocks shall be either hollow blocks with open or closed cavities or solid blocks.

Concrete blocks shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall be as specified. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shall be square. The bedding surfaces shall be at right angles to the faces of the block.

The concrete mix for the hollow and solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume i.e. (1:6).

Concrete blocks shall be of approved manufacture, which satisfy the limitations in the values of water absorption, drying shrinkage and moisture movement, as specified for the type of block as per relevant IS code. CONTRACTOR shall furnish the test certificates and also supply the samples, for the approval of ENGINEER.

### **30.2 Workmanship**

The type of the concrete block, thickness and grade based on the compressive strength for use in load bearing and/or non-load bearing walls shall be as specified in the respective items of work. The minimum nominal thickness of non-load bearing internal walls shall be 100 mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.

The workmanship, shall generally conform to the requirements of IS: 2572 for concrete block masonry, IS: 6042 for light weight concrete block masonry and IS: 6041 for autoclaved cellular concrete block masonry works.

From considerations of durability, generally concrete block masonry shall be used in superstructure works above the damp-proof course level.

Concrete blocks shall be embedded with a mortar which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works unless otherwise specified in the respective items of work. Preparation of mortar shall be as specified in clause 27.1.

The thickness of both horizontal and vertical joints shall be 10 mm. The first course shall be laid with greater care, ensuring that it is properly aligned, levelled and plumb since this will facilitate in laying succeeding courses to obtain a straight and truly vertical wall. For the horizontal (bedding) joint, mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of 10 mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or on the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity. Mortar while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10 mm as each course is laid to ensure good bond for the plaster.

Dimensional stability of hollow concrete blocks greatly affected by variations of moisture content in the units. Only well dried blocks should be used for the construction. Blocks with moisture content more than 25% of maximum water absorption permissible shall not be used. The blocks should not be wetted before or during laying in the walls. Blocks should be laid dry except slightly moistening their surface on which mortar is to be applied to obviate absorption of water from the mortar.

As per the design requirements and to effectively control cracks in the masonry, RCC bond beam/studs, joint reinforcement shall be provided at locations as per details indicated in the construction drawings. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS:280 or welded wire fabric/high strength deformed bar as per the drawings.

For jambs of doors, windows and openings, solid concrete blocks shall be provided. If hollow units are used, the hollows shall be filled with concrete of mix 1:3:6. Hold fasts of doors/windows should be arranged so that they occur at block course level.

At intersection of walls, the courses shall be laid up at the same time with a true masonry bond between at least 50% of the concrete blocks. The sequence for construction of partition walls and treatment at the top of load bearing walls for the RCC slab shall be as detailed under clause 27.2 for the brick work.

Curing of the mortar joints shall be carried out for at least 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet.

Double scaffolding as per clause 27.2 shall be adopted for execution of block masonry work.

Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in multiples of half-length and full height of units respectively, adapting modular co-ordination for walls, opening locations for doors, windows etc.

Concrete blocks shall be stored at site suitably to avoid any contact with moisture from the ground and covered to protect against wetting.

### **30.3 Measurement**

Measurement shall be in cu.m. correct up to two places of decimal for walls of thickness 200 mm and above. Measurement shall be in sq.m correct up to two places of decimal for walls of 100mm/150mm in thickness. Measurement shall be for the quantities as actually executed duly deducting for openings, and concrete works. Concrete and reinforcement will be measured and paid separately. The rate quoted shall be for the type of masonry blocks specified in the respective items of work which shall include for the specific sequential operations as stipulated in the construction drawings.

## **31. Damp - Proof Course**

### **31.1 Materials and Workmanship**

Where specified, all the walls in a building shall be provided with damp-proof course to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other openings. Damp-proof course shall consist of 50 mm thick cement concrete of 1:2:4 nominal mix with approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10 mm downgraded coarse aggregates.

The surface of brick/stone masonry work shall be levelled and prepared before laying the cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak through and is also not disturbed during compaction. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster.

Damp-proof course shall be cured properly for at least seven days after which it shall be allowed to dry for taking up further work.

### **31.2 Measurement**

Measurement of damp-proof course shall be in sq.m. correct to two places of decimal as actually executed. No separate payment will be made for formwork.

## **32. Miscellaneous Inserts, Bolts etc.**

All the miscellaneous inserts such as bolts, pipes, plate embedments etc. shall be accurately installed in the building works at the correct locations and levels, all as detailed in the construction drawings. CONTRACTOR shall prepare and use templates for this purpose, if so directed by the ENGINEER. In the event, any of the inserts are improperly installed, CONTRACTOR shall make necessary arrangements to remove and re-install at the correct locations/levels, all as directed by the ENGINEER without any extra cost to the EMPLOYER.

### **32.1 Measurement**

Miscellaneous inserts, supplied by the CONTRACTOR shall be measured and paid for as per the respective items of work.

## **33. Wood Work in Doors and Windows**

### **33.1 Materials**

Timber to be used shall be first class Teak wood as per IS: 4021. Timber shall be of the best quality and well-seasoned by a suitable process before being planed to the required sizes. The maximum permissible moisture content shall be from 10 to 16 percent for timber 50mm and above in thickness and 9 to 14 percent of timber less than 50mm in thickness for different regions of the country as stipulated In IS: 287. Timber shall be close grained, of uniform colour and free from decay, fungal growth, boxed heart, pitch pockets or streaks an the exposed edges, borer holes, splits and cracks.

Flush door shutters of the solid core type with plywood face panels shall conform to IS: 2202 (Part 1) and with particle board/hard board face panels shall conform to IS: 2202 (Part 2).

Transparent sheet glass shall conform to the requirements of IS: 2835. Wired and figured glass shall be as per IS: 5437.

Builder's hardware of fittings and fixtures shall be of the best quality from approved manufacturers.

### **33.2 Workmanship**

The workmanship and finish of wood work in doors, windows, ventilators and partitions shall be of a very high order. CONTRACTOR shall ensure that work is executed in a professional manner by skilled carpenters for good appearance, efficient and smooth operation of the shutters.

All works shall be executed as per the detailed drawings and/or as directed by the ENGINEER. All members of the door, window, and ventilator shall be straight without any warp or bow and shall have smooth well planed faces. The right angle shall be checked from the inside surfaces of the respective members of the frame. Frames shall have mortice and Tenon joints which shall be treated with an approved adhesive and provided with metal or wood pins. The vertical members of the door frame shall project 50 mm below the finished floor level. The finished dimension of frames shall be rebated on the solid for keying with the plaster and for receiving the shutters. The depth of rebate for housing the shutter shall be 15 mm. The size of the frames shall be as specified in the respective items of work. The workmanship shall generally conform to the requirements specified in IS: 4021.

The face of the frames abutting the masonry or concrete shall be provided with a coat of coal tar.

Three hold fasts using 25 mm x 6 mm mild steel flats 225 long with split ends shall be fixed on each side of door and window frames, one at the centre and the other two at 300 mm from the top and bottom of the frame. For window and ventilator frames less than 1 m in height, two hold fasts on each side shall be fixed at quarter points.

Timber panelled shutters for doors shall be constructed in the form of framework of stiles and rails with panel insertion. The panels shall be fixed by either providing grooves in the stiles and rails or by beading. Glazing bars shall be as detailed in the drawings. The stiles and rails shall be joined by mortice and Tenon joints at right angles. All members of the shutter shall be straight without any warp or bow and shall have smooth, well planed faces at right angles to each other. The right angle for the shutter shall be checked by measuring the diagonals and the difference shall not be more than + 3 mm. Timber panels made from more than one piece shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. The workmanship shall, generally conform to the requirements specified in IS: 1003 (Parts 1 & 2). The thickness of the shutter, width/thickness of the stiles/rails/panel type shall be as indicated in the bid drawings/item of work.

Details of the wooden flush door shutters, solid core type with specific requirement of the thickness, core, face panels, viewing glazed panel, Venetian louver opening, teak wood lipping etc. shall be as indicated in the respective items of work.

Glazing of door, window, ventilator and partitions shall be with either flat transparent sheet glass, wired or figured glass. Transparent sheet glass shall be of 'B' quality as per IS: 2835. The thickness and type of glazing to be provided shall be as specified in the item of work.

The material of the fittings and fixtures of approved brand and samples shall be as specified in the item of work. The number, size and type of the fittings and fixtures shall be as indicated in the bid drawings/item of work.

Wood work shall not be provided with the finishes of painting, galvanising etc. unless it has been approved by the ENGINEER. The type of finish and the number of coats shall be as stipulated in the respective items of work. Preparation of the wood surface and application of the finishes shall be in accordance with clause 33.

The framework of the partitions with mullions and transoms shall be with the sections of dimensions as per the item at work. Panels of double/single glazing/ plywood shall be fixed as per details indicated in the drawings. Partitions shall be fixed rigidly between the floor and structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction drawings.

Any carpentry work which show defects due to inadequate seasoning of the timber or bad workmanship shall be removed and replaced by CONTRACTOR with work as per specification requirements, at no extra cost to the EMPLOYER.

### **33.3 Measurement**

Measurement for doors, windows, ventilators architraves and partitions shall be in sq.m correct to two places of decimal. Measurement shall be from out to out of the frames.

Rate quoted shall be for all the works including glazing, painting, builder's hardware of fittings and fixtures as specifically described in the respective items of work.

### **34. Aluminum Doors, Windows, Ventilators & Partitions**

#### **34.1 Materials**

Aluminium alloy used in the. Manufacture of extruded sections for the fabrication of doors, windows, and ventilators shall conform to designation HE9-WP of IS: 733.

Transparent sheet glass shall conform to the requirements of IS: 2835. Wired and figured glass shall be as per IS: 5437.

Builder's hardware of fittings & fixtures shall be of the best quality from approved manufacturers.

#### **34.2 Workmanship**

All aluminium doors, windows, ventilators and partitions shall be of the type as specified in the respective items of work and of sizes as indicated in the drawings. The doors, windows, ventilators shall conform to the requirements of IS: 1948. Aluminium windows, shall conform to IS: 1949, if so specified.

All aluminium units shall be supplied with anodised finish. The minimum anodic film thickness shall be 0.015 mm.

Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the units shall be with the extruded sections, cut to correct lengths, mitred and welded at the corners to a true right angle conforming to the requirements of IS: 1948. Tolerance in overall dimensions shall be within + 1.5mm. The frames and shutters shall be free from warp or buckle and shall be square and truly plane. Punching of holes, slots and other provisions to install fittings or fixtures later shall be made at the correct locations, as per the requirements.

Aluminium swing type doors, aluminium sliding windows, partitions shall be as described in the item of work and/or bid drawings which indicates generally the arrangement along with the overall size of the various components and weight per running metre of the extruded sections to be adopted.

IS:1948 and IS:1949 referred to incorporates the sizes, shapes, thicknesses and weight per running metre of extruded sections for the various components of the units. However, new sizes, shapes, thicknesses with modifications to suit snap-fit glazing clips etc. are continuously being added by various leading manufacturers of extruded sections, which are available in the market. As such, the sections of the various components of the unit proposed by the CONTRACTOR, will be reviewed by the ENGINEER and will be accepted only if they are equal to or marginally more than that specified in the codes/drawings.

The framework of the partitions with mullions and transoms shall be with anodised aluminium box sections of dimensions as per the item of work. Anodised Aluminium box sections shall be in-filled with timber of class 3 (silver oak or any other equivalent)

as per IS: 4021. Panels of double/single glazing/plywood shall be fixed as per details indicated in the drawing. Partitions shall be fixed rigidly between the floor and the structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction drawings.

Doors, windows and ventilators shall be fixed into the prepared openings. They shall not be 'built-in' as the masonry work proceeds, to avoid distortion and damage of the units. The dimensions of the masonry opening shall have 10mm clearance all-round the overall dimensions of the frame for this purpose. Any support of scaffolding members on the frames/glazing bars is prohibited.

Glazing of the units shall be either with flat transparent glass or wired/figured glass of the thickness as specified in the item of work. All glass panels shall have properly squared corner and straight edges. Glazing shall be provided on the outside of the frames.

Fixing of the glazing shall be either with spring glazing clips and putty conforming to IS:419 or with metal beads. Pre-formed PVC or rubber gasket shall be provided for fixing the beads with concealed screws. The type of fixing the glazing shall be as indicated in the item of work and/or in drawings.

The material of the Builders hardware of fittings and fixtures of chromium plated steel, cast brass, brass copper oxidised or anodised aluminium shall be as specified in the item of work. The number, size and type of fittings and fixtures shall be as in the bid drawings/item of work.

Installation of the units with fixing lugs, screws, mastic caulking compound at the specified locations shall generally conform to the requirements of IS:1081.

Necessary holes etc required for fixing shall be made by the CONTRACTOR and made good after installation. Workmanship expected is of a high order for efficient and smooth operation of the units.

Glazing beads shall be of the snap-fit type suitable for the thickness of glazing proposed as indicated in the item of work. A layer of clear transparent lacquer shall be applied on aluminium sections to protect them from damage during installation. This lacquer coating shall be removed after the installation is completed.

### **34.3 Measurement**

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be from out to out of the frames. Rate quoted shall be for the works including glazing, Builder's hardware of fittings and fixtures as specifically described in the respective items of work.

## **35. Steel Rolling Shutters**

### **35.1 Materials and Workmanship**

Rolling shutters shall be of an approved manufacture, conforming to the requirements specified in IS: 6248.

The type of rolling shutter viz. self-coiling type (manual) for clear areas up to 12 sq.m, gear operated type (mechanical) for clear areas up to 35 sq.m and electrically operated type for areas up to 50 sq.m shall be as specified in the respective items of work. Mechanical type of rolling shutters shall be suitable for operation from both inside and outside with the crank handle or chain gear operating mechanism duly considering the size of wall/column. Electrical type of rolling shutter shall also be provided with a facility for emergency mechanical operation.

Rolling shutters shall be supplied duly considering the type, specified clear width/height of the opening and the location of fixing as indicated in the drawings.

Shutters shall be built-up of interlocking laths 75mm width between rolling centres formed from cold rolled steel strips. The thickness of the steel strip shall not be less than 0.90 mm for shutters up to 3.50m width and not less than 1.20 mm for shutters above 3.50 m width. Each lath section shall be continuous single piece without any welded joint.

The guide channels out of mild steel sheets of thickness not less than 3.15 mm shall be of either rolled, pressed or built up construction. The channel shall be of size as stipulated in IS: 6248 for various clear width of the shutters.

Hood covers shall be of mild steel sheets not less than 0.90mm thick and of approved shape.

Rolling shutters shall be provided with a central hasp and staple safety device in addition to one pair of lever locks and sliding locks at the ends.

All component parts of the steel rolling shutter (excepting springs and insides of guide channels) shall be provided with one coat of zinc chrome primer conforming to IS: 2074 at the shop before supply. These surfaces shall be given an additional coat of primer after erection at the site along with the number of coats and type of finish paint as specified in the respective Items of work. Painting shall be carried out as per clause 33.31.

In case of galvanised rolling shutter, the lath sections, guides, lock plate, bracket plates, suspension shaft and the hood cover shall be hot dip galvanised with a zinc coating containing not less than 97.5 percent pure zinc. The weight of the zinc coating per sq.m shall be as specified in the item of work.

Guide channels shall be installed truly plumb at the specified location. Bracket plate shall be rigidly fixed with necessary bolts and holdfasts. Workmanship of erection shall ensure strength and rigidity of rolling shutter for trouble free and smooth operation.

### **35.2 Measurement**

Measurement shall be in sq.m correct to two places of decimal of the clear area of the opening. Quoted rate shall be inclusive of painting as specified in the item of work.

## **36. Rubble Sub-Base**

### **36.1 Materials**

Stones used for rubble packing under floors on grade, foundations etc., shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects. Stones shall generally conform to the requirements stipulated in IS: 1597 (Part-I).

Stones shall be as regular as can be obtained from quarries. Stones shall be of height equal to the thickness of the packing proposed with a tolerance of + 10mm. Stones shall not have a base area less than 250 sq.cm nor more than 500 sq.cm, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of the ENGINEER.

### **36.2 Workmanship**

Stones shall be hand packed carefully and laid with their largest base downwards resting flat on the prepared sub-grade and with their height equal to the thickness of the packing. Stones shall be laid breaking joints and in close contact with each other. All interstices between the stones shall be wedged-in by small stones of suitable size, well driven in by crow bars and hammers to ensure tight packing and complete filling-in of the interstices. The wedging shall be carried out simultaneously with the placing in position of rubble packing and shall not lag behind. After this, any interstices between the smaller wedged stones shall be infilled with clean hard sand by brooming so as to fill the joints completely.

The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

### **36.3 Measurement**

Measurement shall be in sq.m correct to two places of decimal for the specified compacted thickness of rubble sub-base.

## **37. Base Concrete**

The thickness and grade of concrete and reinforcement shall be as specified in the item of work.

Before placing the blinding concrete of 1:4:8 mix, 50/75mm thick as per the item of work, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

### **37.1 Measurement**

Measurement shall be in sq.m correct to two places of decimal. This work could be either separate or combined along with the floor finish as indicated in the respective items of work.

## **38. Glazed Tile Finish**

### **38.1 Materials**

Glazed earthenware tiles shall conform to the requirements of IS: 777. Tiles shall be of the best quality from an approved manufacturer. The tiles shall be flat, true to shape and free from flaws such as crazing, blisters, pinholes, specks or welts. Edges and underside of the tiles shall be free from glaze and shall have ribs or indentations for a better anchorage with the bedding mortar. Dimensional tolerances shall be as specified in IS: 777.

### **38.2 Workmanship**

The size, thickness, colour, with or without designs etc. of the tiles for flooring/dado/skirting shall be as specified in the respective items of work. The total thickness of glazed tile finish including the bedding mortar shall be 20 mm in flooring/dado/skirting. The minimum thickness of bedding mortar shall be 12mm for flooring and 10mm for dado/skirting work.

The bedding mortar shall consist of 1 part of cement to 3 parts of sand mixed with just sufficient water to obtain proper consistency for laying. Sand for the mortar shall conform to IS: 2116 and shall have minimum fineness modules of 1.5.

Tiles shall be soaked in water for about 10 minutes just before laying. Where full size tiles cannot be fixed, tiles shall be cut to the required size using special cutting device and the edges rubbed smooth to ensure straight and true joints.

Coloured tiles with or without designs shall be uniform and shall be preferably procured from the same batch of manufacture to avoid any differences in the shade.

Tiles for the flooring shall be laid over hardened concrete base. The surface of the concrete base shall be cleaned of all loose materials, mortar droppings etc well wetted without allowing any water pools on the surface. The bedding mortar shall then be laid evenly over the surface, tamped to the desired level and allowed to harden for a day. The top surface shall be left rough to provide a good band for the tiles. For skirting and dado work, the backing mortar shall be roughened using a wire brush.

Neat cement slurry using 3.3 kg cement per one sq.m of floor area shall be spread over the hardened mortar bed over such an area as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. For skirting and dado work, the back of the tiles shall be smeared with cement slurry for setting on the backing mortar. Fixing of tiles shall be done from the bottom of the wall upwards. The joints shall be in perfect straight lines and as thin as possible but shall not be more than 1 mm wide. The surface shall be checked frequently to ensure correct level/required slope.

Floor tiles near the walls shall enter skirting/dado to a minimum depth of 10mm. Tiles shall not sound hollow when tapped.

All the joints shall be cleaned of grey cement with wire brush to a depth of at least 3mm and all dust, loose mortar etc. shall be removed. White cement with or without pigment shall then be used for flush pointing the joints. Curing shall then be carried out for a minimum period of 7 days for the bedding and joints to set properly. The surface shall then be cleaned using a suitable detergent, fully washed and wiped dry.

Specials consisting of caves, internal and external angles, cornices, beads and their corner pieces shall be of thickness not less than the tiles with which they are used.

### **38.3 Measurement**

Measurement for floor tiling and dado shall be in sq.m correct to two places of decimal. Actual quantity of tiling work as laid shall be measured for payment as per the respective items of work after making deductions for openings etc. Measurement for skirting shall be in running metres correct to two places of decimal for the specified height as per the item of work.

## **39. In-Situ Cement Concrete Floor Topping**

### **39.1 Materials**

The mix proportion for the in-situ concrete floor topping shall be 1:2½:3½ (one part cement: two and half parts sand: three and half parts coarse aggregates) by volume unless otherwise specified in the item of work.

The aggregates shall conform for the requirements of IS: 383.

Coarse aggregates shall have high hardness surface texture and shall consist of crushed rock of granite, basalt, trap or quartzite. The aggregate crushing value shall not exceed 30 percent. The grading of the aggregates of size 12.5mm and below shall be as per IS: 2571.

Grading of the sand shall be within the limits indicated in IS: 2571.

### **39.2 Workmanship**

The thickness of the floor topping shall be as specified in the item of work. The minimum thickness of the floor topping shall be 25mm.

Preparation of base concrete/structural slab before laying the topping shall be as per clause 37. The surface shall be rough to provide adequate bond for the topping.

Mixing of concrete shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the ENGINEER. The concrete shall be as stiff as possible and the amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and compacting. The mix shall be used in the work within 30 minutes of the addition of water for its preparation.

Floor finish shall be laid in suitable panels to reduce the risk of cracking. No dimension of a panel shall exceed 2 meters and the length of a panel shall not exceed one and a half

times its breadth. Topping shall be laid in alternate panels, the intermediate panels being cast after a gap of at least one day. Construction joints shall be plain vertical butt joints.

Screed strips shall be fixed dividing the area into suitable panels. Immediately before depositing the concrete topping, neat cement slurry at 2.75 kg/sq.m of area shall be thoroughly brushed into the prepared surface. Topping shall then be laid, very thoroughly tamped, struck off level and floated with wooden float. The surface shall then be tested with a straight edge and mason's spirit level to detect any inequalities from that specified in the drawings and these shall be made good immediately.

Finishing of the surface by trowelling shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled 3 times at intervals so as to produce a smooth uniform and hard surface. Immediately after laying, the first trowelling just sufficient to give a level surface shall be carried out avoiding excessive trowelling at this stage. The surface shall be re-trowelled after sometime to close any pores and to scrap off excess water or laitance, which shall not be trowelled back into the topping. Final trowelling shall be done well before the concrete has become too hard but at a time when considerable pressure is required to make any impression on the surface. Sprinkling of dry cement or cement-sand mixture for absorbing moisture shall not be permitted.

Immediately after the surface is finished, it shall be protected suitably from rapid drying due to wind/ sunlight. After the surface has hardened sufficiently to prevent any damage to it, the topping shall be kept continuously moist for a minimum period of 10 days.

It is preferable to lay the topping on hardened base concrete, as against being laid monolithically with a lesser thickness, since proper levels and slopes with close surface tolerance, is achievable in practice, owing to its greater thickness. Further, as this would be laid after all other building operations are over, there will be no risk of any damages or discoloration to the floor finish which are difficult to repair satisfactorily.

### **39.3 Measurement**

Measurement shall be in sq.m correct up to two places of decimal.

## **40. Acid Resisting Brick/Tiling Work**

### **40.1 Materials**

The ceramic unglazed vitreous acid resisting tiles shall conform to the requirements of IS: 4457. Acid resistant bricks shall conform to the requirements of IS: 4860.

The finished tile/brick when fractured shall appear fine grained in texture, dense and homogeneous. Tile/brick shall be sound, true to shape, flat, free from flaws and any manufacturing defects affecting their utility. Tolerance in the dimensions shall be within the limits specified in the respective IS.

The tiles/bricks shall be bedded and jointed using chemical resistant mortar of the resin type conforming to IS: 4832 (Part II). Method of usage shall generally be as per the requirements of IS: 4443.

## **40.2 Workmanship**

The size and thickness of tiles/size and class of bricks for use in the flooring/skirting/dado shall be as specified in the respective items of work.

The resin shall have viscosity for readily mixing with the filler by manual methods. The filler shall have graded particles which permit joint thickness of 1.5 mm.

The base concrete surface shall be free from dirt and thoroughly dried. The surface shall be applied with a coat of bitumen primer conforming to IS: 3384. The primed surface shall then be applied with a uniform coat of bitumen conforming to IS: 1530. Tiles or bricks shall be laid directly without the application of bitumen, if epoxy or polyester resin is used for the mortar.

Just adequate quantity of mortar which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for bedding and jointing. Rigid PVC/Stainless steel/chromium plated tools shall be used for mixing and laying.

For laying the floor 6 to 8 mm thick mortar shall be spread on the back of the tile/brick. Two adjacent sides of the tile/brick shall be smeared with 4 to 6 mm thick mortar. Tile/brick shall be pressed into the bed and pushed against the floor and with the adjacent tile/ brick, until the joint in each case is 2 to 3 mm thick. Excess mortar shall then be trimmed off and allowed to harden fully. Similar procedure shall be adopted for the work on walls by pressing the tile/brick against the prepared wall surfaces and only one course shall be laid at a time until the initial setting period. The mortar joints shall be cured for a minimum period of 72 hours with 20 to 25% hydrochloric acid or 30 to 40% sulphuric acid. After acid curing, the joints shall be washed with water and allowed to thoroughly dry. The joints shall then be filled with mortar to make them smooth and plane. Acid curing is not required to be carried out if epoxy or polyester resin is used for the mortar.

Resin mortars are normally self-curing. The area tiled shall not be put to use before 48 hours in case epoxy, polyester and furane type of resin is used for the mortar. If phenolic or cashew nut shell liquid resin is used for the mortar, the area tiled shall not be put to use for 7 to 28 days respectively, without heat treatment. This period shall be 2 to 6 days respectively if heat treatment is given with infrared lamp.

## **40.3 Measurement**

Measurement shall be in sq.m correct to two places of decimal for flooring/dado. Measurement shall be in running metres correct to two places of decimal for skirting of height as specified in the item of work.

## **41. Preformed Fillers and Joint Sealing Compound**

### **41.1 Materials**

Preformed filler for expansion/isolation joints shall be non-extruding and resilient type of bitumen impregnated fibres conforming to IS: 1838 (Part I).

Bitumen coat to concrete/masonry surfaces for fixing the preformed bitumen filler strip shall conform to IS: 702. Bitumen primer shall conform to IS: 3384.

Sealing compound for filling the joints above the preformed bitumen filler shall conform to Grade 'A' as per IS: 1834.

#### **41.2 Workmanship**

The thickness of the preformed bitumen filler shall be as specified in the respective items of work. CONTRACTOR shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces/thicknesses of strips to make up the specified size shall not be permitted.

The concrete/masonry surface shall be cleaned free from dust and any loose particles. When the surface is dry, one coat of industrial blown type bitumen of grade 85/25 conforming to IS: 702 shall be applied hot by brushing at the rate of 1.20 kg/sq.m. When the bitumen is still hot, the preformed bitumen filler shall be pressed and held in position till it completely adheres. The surface of the filler against which further concreting/masonry work is to be done shall similarly be applied with one coat of hot bitumen at the rate of 1.20 kg/sq.m. Sealing compound shall be heated to a pouring consistency for enabling it to run molten in a uniform manner into the joint. Before pouring the sealing compound, the vertical faces of the concrete joint shall be applied hot with a coat of bitumen primer conforming to IS: 3384 in order to improve the adhesive quality of the sealing compound.

Expansion joints between beams/slabs shall be provided with 100mm wide x 4mm thick mild steel plate at the soffit of RCC beams/slabs to support and prevent the preformed joint filler from dislodging. This plate shall be welded to an edge angle of ISA 50 x 50 x 6mm provided at the bottom corner, adjacent to the expansion joint of one of the beams/slabs, by intermittent fillet welding. Steel surfaces shall be provided with 2 coats of red oxide zinc chrome primer and 3 coats of synthetic enamel paint finish.

#### **41.3 Measurement**

Measurement for the preformed joint filler shall be in sq.m correct to two places of decimal for the specified thickness as per the items of work. Measurement for applying the bitumen coat to concrete/masonry surfaces shall be in sq.m correct to two places of decimal. Measurement for the joint sealing compound shall be in running metres correct to two places of decimal for the specified width and thickness as per the items of work. Measurement for the mild steel corner angle and plate shall be by weight as per the item of work.

### **42. Cement Plastering Work**

#### **42.1 Materials**

The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand) unless otherwise specified under the respective item of work. Cement and sand shall be mixed thoroughly in dry condition and then water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS. The quality and grading of sand for plastering shall conform to IS: 1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the ENGINEER. If so desired by the ENGINEER sand shall be screened and washed to meet the specification requirements. The mortar thus mixed shall be used

as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required to restore consistency but this will be permitted only up to 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

## **42.2 Workmanship**

Preparation of surfaces and application of plaster finishes shall generally confirm to the requirements specified in IS: 1661 and IS: 2402.

Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/window panels, pipes, conduits etc. are completed.

All joints in masonry shall be raked as the work proceeds to a depth of 10mm/20mm for brick/stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry surface to be rendered shall be washed with clean-water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet but only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

Interior plain faced plaster - This plaster shall be laid in a single coat of 15 mm thickness. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface. Interior plaster shall be carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by the ENGINEER. Rate quoted for plaster work shall be deemed to include for plastering of all these surfaces.

Plain Faced Ceiling plaster - This plaster shall be applied in a single coat of 6mm thickness. Application of mortar shall be as stipulated for interior plain faced plaster.

Exterior plain faced plaster - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14mm thick. The rendering coat shall be applied as stipulated for interior plain faced plaster except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for at least two days and then allowed to dry. The second coat or finishing coat shall be 6 mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for at least 7 days.

Interior plain faced plaster 20mm thick if specified for uneven faces of brick walls or for random/coursed rubble masonry walls shall be executed in 2 coats similar to the procedure stipulated for exterior plain faced plaster.

Exterior Sand Faced Plaster - This plaster shall be applied in 2 coats. The first coat shall be 14mm thick and the second coat shall be 6mm thick. These coats shall be applied as stipulated for exterior plain faced plaster. However, only approved quality white sand shall be used for the second coat and for the finishing work. Sand for the finishing work shall be coarse and of even size and shall be dashed against the surface and sponged. The mortar proportions for the first and second coats shall be as specified in the respective items of work.

Wherever more than 20mm thick plaster has been specified, which is intended for purposes of providing beading, bands, etc. this work shall be carried out in two or three coats as directed by the ENGINEER duly satisfying the requirements of curing each coat (rendering/floating) for a minimum period of 2 days and curing the finished work for at least 7 days.

In the case of pebble faced finish plaster, pebbles of approved size and quality shall be dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by the ENGINEER.

Where specified in the drawings, rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition. Battens shall be carefully removed after the initial set of plaster and the broken edges and corners made good. All grooves shall be uniform in width and depth and shall be true to the lines and levels as per the drawings.

Curing of plaster shall be started as soon as the applied plaster has hardened sufficiently so as not to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.

When the specification items of work calls for waterproofing plaster the CONTRACTOR shall provide the waterproofing compound as specified while preparing the cement mortar. Payment for water-proofing compound will be made separately if it is not included as a combined item of work. Where lath plastering is specified, it shall be paid for at the same rate as for plaster work except that separate payment for metal lath will be made.

For external plaster, the plastering operations shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/windows etc. Ceiling plaster shall be completed first before commencing wall plastering.

Double scaffolding to be used shall be as specified in clause 27.2

The finished plaster surface shall not show any deviation more than 4mm when checked with a straight edge of 2m length placed against the surface.

To overcome the possibility of development of cracks in the plastering work following measures shall be adapted.

Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.

Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/thermal movement. This steel item shall be measured and paid for separately.

Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

### **42.3 Measurement**

Measurement for plastering work shall be in sq.m correct to two places of decimal. Unless a separate item is provided for grooves, mouldings, etc., these works are deemed to be included in the unit rates quoted for plastering work. The quantity of work to be paid for under these items shall be calculated by taking the projected surface of the areas plastered after making necessary deductions for openings for doors, windows, fan openings etc. The actual plaster work carried out on jambs/sills of windows, openings, etc. shall be measured for payment.

## **43. Cement Pointing**

### **43.1 Materials**

The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to three parts of fine sand) unless otherwise specified in the respective items of work. Sand shall conform to IS: 1542 and shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by ENGINEER and if so directed it shall be washed/screened to meet specification requirements.

### **43.2 Workmanship**

Where pointing of joints in masonry work is specified on drawings/respective items of work, the joints shall be raked at least 15mm/20mm deep in brick/stone masonry respectively as the work proceeds when the mortar is still green.

Any dust/dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be specified in the respective items of work. No false joints shall be allowed.

The work shall be kept moist for at least 7 days after the pointing is completed. Whenever coloured pointing is to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the ENGINEER.

### **43.3 Measurement**

The quantity of work to be paid for under this Item shall be measured in sq.m correct to two places of decimal by taking the projected surface of the area pointed after making necessary deductions for openings, etc.

#### **44. Water-Proofing Admixture**

Water-proofing admixture shall conform to the requirements of IS: 2645 and shall be of approved manufacture. The admixture shall not contain calcium chloride. The quantity of the admixture to be used for the works and method of mixing etc. shall be as per manufacturer's instructions and as directed by the Engineer. Payment shall be made for the actual quantity of such admixture used unless it is already covered in the rate for the relevant item of work.

#### **45. Painting of Concrete Masonry & Plastered Surfaces**

##### **45.1 Materials**

Oil bound distemper shall conform to IS: 428. The primer shall be alkali resistant primer of the same manufacture as that of the distemper.

Cement paint shall conform to IS: 5410. The primer shall be a thinned coat of cement paint.

Acrylic emulsion paint shall be of an approved manufacture.

Plastic emulsion paint shall conform to IS: 5411.

Lead free acid, alkali and chlorine resisting paint shall conform to IS: 9862.

White wash shall be made from good quality fat lime conforming to IS: 712. It shall be slaked at site and mixed with water in the proportion of 5 litres of water to 1 kg of un-slaked lime stirred well to make a thin cream. This shall be allowed to stand for a minimum period of one day and strained through a clean coarse cloth. Four kg of gum dissolved in hot water shall be added to each cu.m of cream. 1.30 kg of sodium chloride dissolved in hot water shall then be added per 10 kg of lime used for the white wash to be ready for application.

Colour wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by the ENGINEER.

All the materials shall be of the best quality from an approved manufacturer. CONTRACTOR shall obtain prior approval of the ENGINEER for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

##### **45.2 Workmanship**

CONTRACTOR shall obtain the approval of the ENGINEER regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting.

Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub-strata.

The surfaces to be treated shall be prepared by thoroughly brushing them free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil, grease and efflorescence. Efflorescence shall be removed only by dry brushing of the growth.

Cracks shall be filled with Gypsum. Workmanship of painting shall generally conform to IS: 2395.

Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.

#### **45.3 White Wash**

The prepared surfaces shall be wetted and the finish applied by brushing. The operation for each coat shall consist of a stroke of the brush first given horizontally from the right and the other from the left and similarly, the subsequent stroke from bottom upwards and the other from top downwards, before the first coat dries. Each coat shall be allowed to dry before the next coat is applied. Minimum of 3 coats shall be applied unless otherwise specified in the item of work. The dry surface shall present a uniform finish without any brush marks.

#### **45.4 Colour Wash**

Colour wash shall be applied in the same way as for white wash. A minimum of 3 coats shall be applied unless otherwise specified in the item of work. The surface shall present a smooth and uniform finish without any streaks. The finished dry surface shall not show any signs of peeling/powdery and come off readily on the hand when rubbed.

#### **45.5 Cement Paint**

The prepared surfaces shall be wetted to control surface suction and to provide moisture to aid in proper curing of the paint. Cement paint shall be applied with a brush with stiff bristles. The primer coat shall be a thinned coat of cement paint. The quantity of thinner shall be as per manufacturer's instructions. The coats shall be vigorously scrubbed to work the paint into any voids for providing a continuous paint film free from pinholes for effective water-proofing in addition to decoration. Cement paint shall be brushed in uniform thickness and the covering capacity for two coats on plastered surfaces shall be 3 to 4 kg/sq.m. A minimum of 3 coats of the same colour shall be applied unless otherwise specified in the item of work. At least 24 hours shall be left after the first coat to become sufficiently hard before the second coat is applied. The painted surfaces shall be thoroughly cured by sprinkling with water using a fog spray at least 2 to 3 times a day. Curing shall commence after about 12 hours when the paint hardens. Curing shall be continued for at least 2 days after the application of final coat. The operations for brushing each coat shall be as detailed in 47.7

#### **45.6 Oil Bound Distemper**

The prepared surfaces shall be dry and provided with one coat of alkali resistant primer by brushing. The surface shall be finished uniformly without leaving any brush marks and allowed to dry for at least 48 hours. A minimum of two coats of oil bound distemper shall be applied unless otherwise specified in the item of work. The first coat shall be of a lighter tint. At least 24 hours shall be left after the first coat to become completely dry before the application of the second coat. Broad, stiff, double bristled distemper brushes shall be used for the work. The operations for brushing each coat shall be as detailed in.

#### **45.7 Plastic Emulsion Paint**

The prepared surface shall be dry and provided with one coat of primer which shall be a thinned coat of emulsion paint. The quantity of thinner shall be as per manufacturer's instructions. The paint shall be laid evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly in a direction at right angles. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off constitutes one coat. The next coat shall be applied only after the first coat has dried and sufficiently become hard which normally takes about 2 to 3 hours. A minimum of 2 finishing coats of the same colour shall be applied unless otherwise specified in the item of work. Paint may also be applied using rollers. The surface on finishing shall present a flat velvety smooth finish and uniform in shade without any patches.

#### **45.8 Acrylic Emulsion Paint**

Acrylic emulsion paint shall be applied in the same way as for plastic emulsion paint. A minimum of 2 finishing coats over one coat of primer shall be provided unless otherwise specified in the item of work.

#### **45.9 Acid, Aikali Resisting Paint**

A minimum of 2 coats of acid/alkali resisting paint shall be applied over the prepared dry surfaces by brushing. Primer coat shall be as per manufacturer's instructions.

#### **45.10 Measurement**

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the areas as executed duly deducting for any openings etc. Rate quoted shall take into account the provision of necessary enabling works such as scaffolding, painter's cradle etc.

### **46. Painting & Polishing of Wood Work**

#### **46.1 Materials**

Wood primer shall conform to IS:3536.

Filler shall conform to IS:110.

Varnish shall conform to IS:337.

French polish shall conform to IS:348.

Synthetic enamel paint shall conform to IS:2932.

All the materials shall be of the best quality from an approved manufacturer. CONTRACTOR shall obtain prior approval of the ENGINEER for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

## **46.2 Workmanship**

The type of finish to be provided for woodwork of either painting or polishing, the number of coats, etc. shall be as specified in the respective items of work.

Primer and finish paint shall be compatible with each other to avoid, cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

Painting shall be either by brushing or spraying. CONTRACTOR shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirements of IS: 2338 (Part I).

All the wood surfaces to be painted shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothed with abrasive paper using it across the grains and dusted off. Wood primer coat shall then be applied uniformly by brushing. The number of primer coats shall be as specified in the item of work. Any slight irregularities of the surface shall then be made up by applying an optimum coat of filler conforming to IS: 110 and rubbed down with an abrasive paper for obtaining a smooth surface for the undercoat of synthetic enamel paint conforming to IS: 2932. Paint shall be applied by brushing evenly and smoothly by means of crossing and laying off in the direction of the grain of wood. After drying, the coat shall be carefully rubbed down using very fine grade of sand paper and wiped clean before the next coat is applied. At least 24 hours shall elapse between the applications of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the ENGINEER. A minimum of 2 finishing coats over one coat of primer shall be provided unless otherwise specified in the item of work.

All the wood surfaces to be provided with clear finishes shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothed with abrasive paper using it in the direction of the grains and dusted off.

Any slight irregularities of the surface shall be made up by applying an optimum coat of transparent liquid filler and rubbed down with an abrasive paper for obtaining a smooth surface. All dust and dirt shall be thoroughly removed. Over this prepared surface, varnish conforming to IS: 337 shall be applied by brushing. Varnish should not be retouched once it has begun to set. Staining if required shall be provided as directed by the ENGINEER. When two coats of varnish is specified, the first coat should be a hard-drying undercoat or flattening varnish which shall be allowed to dry hard before applying the finishing coat. The number of coats to be applied shall be as per the item of work. For works where clear finish of French polish is specified the prepared surfaces of wood shall be applied with the polish using a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on surface in a series of overlapping circles to give an even finish over the entire area. The surface shall be allowed to dry before applying the next coat. Finishing shall be carried out using a fresh clean cloth over the pad, slight dampening with methylated spirit and rubbing lightly and quickly in circular motions. The finished surface shall have a uniform texture and high gloss. A minimum of 2 finishing coats over one coat of primer shall be provided unless otherwise specified in the item of work

## **46.3 Measurement**

Measurement shall be in sq.m correct to two place of decimal. Measurement shall be for the projected area between out to out of frames and no multiplying factor is allowed on

any account. Rate shall be inclusive of enabling works such as scaffolding, etc. Measurement and payment is applicable only if a separate item is specified and not if it is already made as part of a combined item.

## **47. Painting of Steel Work**

### **47.1 Materials**

Red oxide - zinc chrome primer shall conform to IS: 2074.

Synthetic enamel paint shall conform to IS: 2932.

Aluminium paint shall conform to IS: 2339.

All the materials shall be of the best quality from an approved manufacturer. CONTRACTOR shall obtain prior approval of the ENGINEER for the brand of manufacture and the colour/shade. All the materials shall be brought to the site in sealed containers.

### **47.2 Workmanship**

Painting work shall be carried out only on thoroughly dry surfaces. Painting shall be applied either by brushing or by spraying. CONTRACTOR shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirement of IS: 1477 (Part 2).

The type of paint, number of coats etc. shall be as specified in the respective items of work.

Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The methods to be adopted using solvents, wire brushing, power tool cleaning etc., shall be as per IS: 1477 (Part-1) and as indicated in the item of work.

It is essential to ensure that immediately after preparation of the surfaces, the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without holidays. After the first coat becomes hard dry, a second coat of primer shall be applied by brushing to obtain a film free from 'holidays'. After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of synthetic enamel paint of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

The first finishing coat of paint shall be applied by brushing and allowed to hard dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing.

At least 24 hours shall elapse between the applications of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the ENGINEER.

### **47.3 Measurement**

Measurement shall be as per clause 47.7.

## **48. Flashing**

### **48.1 Materials**

Anodised aluminium sheets shall be 1.00mm thick with anodic film thickness of 0.025 mm.

Galvanised mild steel sheets shall be 1.00mm thick with zinc coating of 800 gms/sq.m.

Bitumen felt shall be either Hessian base self-finished bitumen felt Type-3 Grade I conforming to IS: 1322 or glass fibre base self-finished felt Type-2 Grade I conforming to IS: 7193.

### **48.2 Workmanship**

The type of the flashing and method of fixing shall be as specified in the respective items of work.

Flashing shall be of the correct shape and size as indicated in the construction drawings and they shall be properly fixed to ensure their effectiveness.

Flashing shall be of long lengths so as to provide minimum number of joints. The minimum overlap at joints shall be 100mm. Fixing of the flashing shall be either by bolting with bitumen washers or by tucking into the groove 75 mm wide X 65 mm deep in masonry/concrete along with cement mortar 1:4 filleting as indicated in the drawings. Curing of the mortar shall be carried out for a minimum period of 4 days.

Bitumen felt flashing of the type as specified shall be provided with 2 coats of bituminous paint at the rate of 0.10 litre/sq.m after the installation.

### **48.3 Measurement**

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the actual area of the flashing material provided and the rate shall include for all the incidental works of bending to shape and fixing details as per the construction drawings.

## **49. G. I. Roof & Side Sheeting and Accessories**

### **49.1 Scope**

This specification covers the general requirements for supply, delivery and erection of all sheeting for roofing and side cladding including all accessories and fixtures necessary to provide weather exposed surfaces of roof and building walls for industrial, residential and commercial types of buildings, complete with openings for doors, windows, roof lights, ventilators, pipes, etc.

## **49.2 Applicable Codes and Specifications**

The following specifications, standards and codes, including all official amendments and revisions and other specifications referred to therein shall be considered as a part of this specification. In all cases the latest issue/edition/revision shall apply. In case of discrepancy between this specification and those referred to herein, this specification shall govern.

- (a) Specification for Pre painted galvalume sheets.
- (b) Specification for hook bolts for PPGL sheet roofing.
- (c) Specification for washers for PPGL sheet roofing.

## **49.3 Materials**

Roof sheets shall be pre painted galvalume conforming to relevant IS.

The sheets shall be 0.5mm thick, as specified and shall be of approved quality and manufacture as approved by Engineer.

The sheets shall be free from cracks, pitting, blisters, split edges, twists, laminations, scales and other surface defects. Sheets shall be clearly sheared and be free from twist or buckle and shall have uniform corrugations, true in depth and pitch parallel to the sides of the sheet. The sheets supplied shall show no sign of rust or white powdery deposits on the surface.

### **49.3.1 Storage of Materials**

Sheets shall be stacked to a height of not more than one metre on firm and level ground, with timber or other packing beneath them.

Contractor shall exercise great care in handling the sheets and accessories. Damaged materials shall not be stacked with sound materials. All damaged or rejected materials shall be removed from site immediately.

### **49.3.2 Laying**

The sheets shall be laid on the purlins/other roof members and side girts as indicated on the drawings or as instructed by Engineer.

The maximum spacing of purlins shall as per drawings.

Before the actual laying of sheets is started, the purlin spacing and the length of the sheets shall be checked to ensure proper laps and the specified overhang at the eaves. The end lap of the sheets shall always fall over a purlin/ side girt.

The bearing surface of all purlins/other roof members and side /girts shall be in one plane so that the sheets being fixed shall not be required to be forced down to rest on the purlins/side girts. The finished roof shall present a uniform slope and lines of

corrugations shall be straight and true and the completed work shall present a neat and uniform appearance and be leak proof. For side sheeting, corrugations shall be vertical and in one plane.

The sheets shall be laid with a minimum lap of 150 mm at the ends and 2 ridges of corrugations at each side. In the case of roofs with a pitch flatter than 22 degrees or in the case of very exposed situations. Minimum end laps shall be 200 mm. The side laps shall be laid on the side facing away from the prevailing monsoon winds. The minimum lap of sheets with ridges, hips and valleys shall be 200 mm measured at right angles to the line of ridge, hip or valley respectively. The free overhang of the sheets at the eaves shall not exceed 300 mm.

The sheets shall be cut to suit the dimensions or shape of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge and chiselled to give a smooth and straight finish. The corrugated galvanised sheets shall not generally be built into gables and parapets. They shall be bent up along their side edges close to the wall and the junction shall be protected by suitable flashing or by a projecting drip course covering the junction by at least 75 mm.

Where slopes of roofs are less than 22 degrees, sheets shall be joined together at the side laps by galvanised iron seam bolts and nuts of size 25 mm x 6 mm, each bolt with a bitumen and G.I. limpet washer or with a G.I limpet washer filled with white lead. The seam bolts shall be placed zig- zag over the two overlapping corrugations at a spacing not exceeding 600mm along each of the staggered rows.

All laps in G.I sheets shall be painted with one coat of zinc rich primer and two coats of approved paint before fixing in place.

#### **49.4 Fixing**

Sheets shall be secured to the purlins and other roof members by means of 8mm diameter galvanised iron J or L hook bolts and nuts with bitumen and G.I. limpet washer or with a G.I. Limpet washer filled with white lead, as directed by Engineer. The grip of the hook bolt on the side of the purlin shall not be less than 25 mm. Each hook bolt shall have a bitumen washer and a galvanised iron washer placed over the sheet before the nut is screwed down from above. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and spacing shall not exceed 300mm. Bitumen washer 35 mm in dia. and 1.5 mm thick shall be of approved manufacture. Each nut shall be screwed lightly at first. After 10 or more sheets are laid. The nuts shall be tightened to ensure a leak proof roof. The bolts shall be sufficiently long so that after fixing they project at least 12 mm above the top of their nuts.

Where sheets are laid on tubular purlins, the fixing bolt shall be designed to encompass at least half the tube circumference and precautions should be taken to prevent its rotation.

Holes for hook bolts etc. shall be drilled and not punched in the ridges of the corrugations in the exact positions to suit the purlins while the sheets are on the ground. The diameter of holes shall be 1.5 mm more than the diameter of the fixing

bolts, while the holes in the washers shall be of the exact diameter of the whole bolts or the seam bolts. No hole shall be nearer than 40 mm to any edge of a sheet or an accessory. Sheets with holes drilled wrongly shall be rejected.

Direct fixing of sheets to drilled steel frame work or by stud welding or fixing by coach screws shall not be permitted.

#### **49.5 General**

All work shall proceed in a diligent and systematic manner.

Contractor shall not allow access to any person other than workmen employed for laying and fixing sheeting while the above work is in progress. If, however, it is not possible to keep the area clear, suitable safety measures shall be taken by Contractor during the progress of the work.

Contractor shall use roof ladders or planks while laying and fixing the sheets, to avoid damage to sheets and to provide security to the workmen.

Contractor shall arrange any staging or other temporary structures required for the purpose of installing the roof and side sheeting at his own cost.

At no time shall the sheets or accessories be laid and left unfixed. Temporary fixing/supporting shall not be acceptable. In case of any loss or damage due to infringement of these conditions by contractor, the same shall be made good by contractor at no extra cost to Employer.

#### **49.6 Galvanised Iron Accessories**

##### **49.6.1 Ridges and hips.**

Ridges and hips of galvanised roofs shall be covered with ridge and hip sections of pre painted plain G.I sheets with a minimum 200 mm lap on either side over the C.G.I sheets. The end laps at the ridges and hips and between ridges and hips shall also be not less than 200 mm. The ridges and hips shall be of 600 mm overall width made from plain G.I sheets, 0.6 mm or 0.8 mm thick, bent to shape and fixed as shown on the drawings.

Ridges and hips shall be fixed to the purlins below with the same 8 mm dia. G.I. hook bolts and nuts and bitumen and G.I limpet washers which fix the sheets to the purlins. At least one of the fixing bolts shall pass through the end laps of ridges and hips, on either side. If this is not possible extra hook bolts shall be provided.

The end laps of ridges and hips shall be joined together by G.I seam bolts 25 x 6 mm size each with a bitumen and G.I limpet washer. There shall be at least two such bolts in each end lap.

The edges of the ridges and hips shall be straight from end to end and their surfaces shall be plane and parallel to the general plane of the roof. The ridges and hips shall fit in squarely on the sheets and shall be leak proof.

#### **49.7 Valleys and Flashings**

Valleys shall be 900 mm wide overall made from pre painted G.I. sheet 1.6 mm thick bent to shape and fixed as shown on the drawings or as directed by engineer. Laps with C.G.I. sheets shall not be less than 250mm on either side. The end laps of valleys shall also not be less than 250 mm.

Flashing shall be of 1.25 mm thick or 1.00 mm thick plain G.I sheet having 400 mm overall width, bent to shape and fixed as shown on the drawings. They shall lap not less than 150 mm over the roofing sheets. The end laps between flashing pieces shall not be less than 250 mm.

Laying and fixing shall be as for Ridges and Hips.

#### **49.8 Eaves and Valley Gutters**

Gutters shall be fabricated from PVC as specified.

Eaves or valley gutters shall be of the shapes and section as shown on the drawings or as directed by the Engineer. The overall width of the sheets referred to therein shall mean the peripheral width of the gutter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12 mm. And beaten to from a rounded edge. The ends of the sheets at junctions of pieces shall be hooked into each other and beaten flush to avoid leakage.

Gutters shall be laid with a minimum fall of 1 in 120. Gutters shall be true to line and slope and shall be supported on and fixed to M.S. flat iron / PVC brackets bent to shape. Where the brackets are to be fixed to the purlins, the brackets shall consist of 50 mm x 3 mm flats bent to shape with one end turned at right angle and fixed to face of purlin with 10 mm dia. bolt, nut & washer. The requisite slope in the gutters shall be given in the line of brackets. The brackets shall be placed at a spacing of not more than 1.2 m. The gutters shall be fixed to the brackets with 2 No. 6 mm dia G.I. bolts and nuts, each fitted with a pair of G.I and bitumen washers. The connecting bolts shall be above the water line of the gutters.

For connections to down take pipes, Contractor shall fabricate a proper drop end or funnel- shaped connecting piece, stop ends, etc. and flat iron brackets and bolts and nuts required for fixing the later to the roof members.

#### **49.9 Measurement & Payment**

The measurement shall be taken for the finished work in superficial area on the flat in the plane of the roof/side measured in sq.m. without allowance for laps and corrugations and payment shall be effected based on the rates quoted by contractor after making necessary deductions for openings.

The laps between the sheets both at the ends and at the sides, shall not be measured. However, the overlaps of the sheets over valley gutters, ridge, hip and flashing pieces shall be included in the measurement.

No deduction shall be made for opening less than 0.4 sq.m in area and nothing extra shall be paid for forming such openings. For openings exceeding 0.4 sq.m in area deductions shall be made in measurements for the full opening payment shall be made separately for labour involved for making these openings, with the cutting required being measured in meters. Cutting across corrugations shall be measured flat and not girthed. No additions shall be made for laps cut through.

Roofs with curved sheets shall be measured and paid for separately. Measurement shall be taken on the flat and not girthed. The breadth of the roof shall be measured along the trough of the curved sheets.

If separate rates are called for accessories in the schedule of Quantities these shall be measured and paid for separately or else the rate quoted for roof / side sheeting shall be deemed to include for all accessories. Where called for separately the accessories shall be measured for the finished work taken along the centre line. The measured length of the finished work shall include the length over accessories and the rate for the same shall include the cost of accessories. Laps shall not be measured.

The rate shall include the cost of all materials and labour involved in all the operations described in these specifications and as may be necessary for the work. The materials shall include sheets, accessories, galvanised iron J or L hook bolts, and nuts, G.I seam bolts and nuts, bituminous and G.I limpet washers, brackets etc.

The rate quoted shall also include providing any staging or any temporary structure required for the purpose of installing the roof and side sheeting.

**CHAPTER – 3**  
**(LIGHTING SYSTEM)**

## CHAPTER 3

### LIGHTING SYSTEM

#### 1.0 LIGHTING SYSTEM

1.1 The scope of work comprises supply, installation, testing and commissioning of various lighting fixtures complete with lamps, supports and accessories, ceiling fans complete with electronic regulators, exhaust fans for toilets and pantry & accessories, lighting panels with distribution boxes, galvanised rigid steel conduits, lighting wires, G.I. Earth wire, receptacles, tag block & telephone socket, switchboards, switches, junction boxes, pull out boxes complete with accessories. The lighting system shall be with LEDs only. The types indicated herein, though correspond to conventional system, the equivalent LED system shall be supplied.

#### 1.2 SYSTEM DESCRIPTION

The lighting system shall comprise of the following:

##### 1.2.1 AC Normal Lighting

AC lights will be connected to AC lighting panels. All the lights connected to the AC lighting system in different areas will be connected to the main lighting distribution boards.

##### 1.2.2 AC Emergency Lighting

This system will be available in control room building & fire fighting pump house. AC lighting load will be connected to this system which will be normally 'ON'. The lighting panels of this system will be connected to the Emergency lighting board which is fed from diesel generator during the emergency. 50% of lighting fixtures shall be connected on AC emergency lighting.

##### 1.2.3 D.C. Emergency lighting

A few DC emergency lighting fixtures operated on the DC system will be provided in the strategic locations including staircase, corridors, electrical rooms, Battery charger room, 33 kV switchgear room & LT switchgear room in control room building and Fire fighting pump house so that the operating personnel can safely find their way even during emergency of a total AC failure. These lights will be normally 'OFF' and will be switched 'ON' automatically when under voltage occurs in the AC main lighting distribution board. GLS lamp down lighters in false ceiling area and Bulkhead fixtures in non false ceiling area to be used.

##### 1.2.4 Portable Fixtures

Three numbers of battery operated, portable fixtures will be provided in the

Control room building and one number shall be provided in DG Set Building Cum Fire fighting pump house.

These fixtures will be provided at important locations in the above-mentioned areas.

1.4 Ceiling fans (1400 mm sweep, AC 230 volts) shall be provided in DG Set building, fire fighting pump house and non AC rooms in the control room building. Wall mounted fans shall be provided in the conference room, shift manager and substation in charge rooms in control room building. Exhaust fans shall be provided in toilets and pantry.

1.5 The following specific areas are included in the scope of lighting:

- (i) Control Room Building.
- (ii) Fire fighting pump house.

1.7 Each cable and conduit run shall be tagged with number that appear in the cable and conduit schedules. Cables and conduits shall be tagged at their entrance and/or exit from any piece of equipment, junction or pull box, floor opening etc.

2.0 **DESCRIPTION OF ITEMS**

The Contractor shall supply and install the following equipment and accessories in accordance with the specification.

2.1 **LIGHTING PANELS**

2.1.1 **INDOOR**

415 V indoor AC lighting panel ,63 A 3 phase 4 wire bus and one number 63-amp TPN MCB with 300ma 63 A RCCB. Flush mounted with per phase isolation and indication lamps din mounted. The DB will be flush mounted.

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 ACP-1            Indoor            18 nos outgoing 16-32 Amps SPMCP.  
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2.2 110V DC indoor type change over board and 110V DC 32A two wire bus and one 32A contractor backed up by 32A double pole MCB as incomer. The panel shall have local push button controls. Following are the various types of panels required with control timer.

Type	Description	Details of outgoing feeders)
DCP	Indoor	6 nos.-16A DP MCB unit.

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2.3

**Sub-Lighting Panels**

Type	Description
SLP	4 pole 32A Isolator suitable for 415V, 50 cycles AC Supply with LILO facility using 8 nos terminal blocks suitable for cable up to 16 mm sq cable. Enclosure shall be suitable for outdoor use with IP-55 degree of protection as per IS:13947 (Part-1).

2.4

**Lighting Fixtures and Receptacles****Lighting Fixtures**

Type	Description
FI	2x36W fluorescent lamps in industrial reflector type fixture, complete with accessories and suitable for pendent mounting, similar to Philips Cat. No. TKC 24/236/Bajaj Cat. No. : BJIV-236 /Crompton Greaves Cat No. 1VE 1224 HSB
IF	Incandescent GLS lamp in recessed down light having high purity aluminium reflector electrochemically brightened and anodized. Stainless steel leaf springs and pressure die cast ceiling similar to Philips Cat.No. DN-622 Crompton greaves cat DDLV 10-BC.
SFI	Weather proof integral Floor Lighting with housing made of corrosion resistant die cast aluminium painted black. Grey powder coated outside suitable for 150W SON-T lamp complete with all accessories and suitable for termination with conduits/flexible Cat. No. F69045 (C). Similar to Philips Cat. No. SWF230/150/Bajaj Cat.No.BGEMF-150WSV Crompton Greaves Cat No. FAD 11151H.
PF	1x11 W CFL Lamp emergency light with Battery operated portable fixture with built in chargeable Batteries and battery charger suitable for a lighting period of six hours similar to ALPHA DELUX of M/s DELTA FLASH LITE/MICRO LITE OF M/s MICRO /BPL MAKE.
FB	9W CFL lamp in Bulkhead fixtures with Cast Aluminium alloy body, suitable for column, wall,

and ceiling mounting finished stove enamelled silver grey outside white inside, to be supplied complete ( with front cover, wire guard, tropicalised, gasket and lamp holder taped 3/4" E.T. for conduit entry) similar to Philips Cat.No.FXC 101/Bajaj Cat.No. BJBE-19/Crompton Greaves-

- FF 2x36W fluorescent lamp with mirror optics in recessed mounting type decorative fluorescent fitting consisting of white stove enamelled sheet steel housing with accessories and reflector of aluminium sheet steel duty electro-chemically brightened and anodised fitted with aluminium lamellae painted white similar to Philips Cat.No. TBS-285/236 and Bajaj Cat.No. BJLM-236/Crompton Greaves Cat. No. CRFA 24 HSB.
- FL 2x36W fluorescent lamps in decorative lighting fixture with widespread mirror optics suitable for pendent mounting with twin tube complete with all accessories: similar to Philips cat-No. TCS-306/236 and Bajaj Cat. No. BJSM-236/Crompton Greaves Cat No. CSB W 1124 HSB.
- IB 60/100w GLS lamp in Bulkhead fixtures with Cast Aluminium alloy body, suitable for column, wall, and ceiling mounting finished stove enamelled silver grey outside white inside, to be supplied complete ( with front glass, wire guard, tropicalised, gasket and E.S. Porcelain, lamp holder taped 3/4" E.T. for conduit entry) similar to Philips Cat.No. NXC 101/ /Crompton Greaves IBH1220/BC.
- BL 2X9 Or 1x18 watt CFL bollard light for landscape lighting having FRP/LLDPE housing similar to Philips FGC202 / Crompton Greaves Cat No CFBL1129.
- DLR 2x18 watt CFL Down light for recess mounting lighting having similar to Philips FBH225/2X18 /Crompton Greaves Cat No DDLH218TG.
- DSM 1X13 WATT surface mounted CFL similar to Art Light Make Cat NO RL 3146.
- HL 2X 18 CFL Decorative hanging down Light similar to cat no Art light RL 3166/HL.
- CL 1X 18 WATT Decorative ceiling mounted luminaire similar to Philips Dixie Cat FL 343/118.

2.5

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**RECEPTACLES**

RO 15A, 240V, Outdoor Receptacle 2 pole, 3- pin type  
R1 5/15A, 240V, Indoor Receptacle 3-pin type.  
RP 63A, 415V, Interlocked switch socket, outdoor receptacle.

2.6

**SWITCH BOARDS**

Modular type switches, 5/15 Amp. Receptacles.

2.7

**CONDUITS AND ACCESSORIES**

Galvanised Rigid Steel Conduits of 19mm/25mm/32mm/40mm dia.

2.8

**JUNCTION BOXES** with 5 Nos. of terminal blocks.

2.9

**CEILING FANS**-1400 mm Sweep with Electronic regulator.

3.0

**LIGHTING FIXTURES AND ACCESSORIES**

3.1

**General**

All lighting fixtures and accessories shall be designed for continuous operation under atmospheric conditions existing at site, without reduction in the life or without any deterioration of materials, internal wiring.

3.2

**Temperature Rise**

All lighting fixtures and accessories shall be designed to have a low temperature rise according to the relevant Indian Standards. The design ambient temperature shall be taken as 50 deg C.

3.3

**Supply Voltage**

3.3.1

Lighting fixtures and accessories meant for 240V A.C. operation shall be suitable for operation on 240V A.C. 50Hz, supply voltage variation of  $\pm 10\%$ , frequency variation of  $\pm 5\%$  and combined voltage and frequency variation of  $\pm 10\%$ .

3.3.2

Lighting fixture and accessories meant for 110V DC operation shall be suitable for operation on 110V DC with variation between 190 to 240 Volts.

3.4

**Lighting Fixtures**

The lighting fixtures shall be Philips or Bajaj or Crompton Greaves make only except for fixtures type 'DSM' & 'HL' for which make has been specified elsewhere in this section. The different types of lighting fixtures

are also indicated elsewhere in this Section.

- 3.4.1 All fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection.
- 3.4.2 All lighting fixtures shall be complete with fluorescent tubes / incandescent lamps/mercury vapour/sodium vapour lamps as specified and shall be suitably wired up.
- 3.4.3 All fluorescent lamp fixture shall be complete with all accessories like ballasts, power factor improvement capacitors, lamps, starters, holders etc.
- 3.4.4 High beam fixtures shall be suitable for pendant mounting and flood lights shall have suitable base plate / frame for mounting on steel structural member. Hook mounted high beam fixtures are not acceptable.
- 3.4.5 Each lighting fixture shall be provided with an earthing terminal suitable for connection to 16 SWG GI earthing conductors.
- 3.4.6. All light reflecting surfaces shall have optimum light reflecting co-efficient such as to ensure the overall light output as specified by the manufacturer.
- 3.4.7 Height of fixtures should be such that it is easy to replace the lamps with normal ladder/stool. In case the ceiling height is very high, the fixtures may be placed on the walls for ground lighting.

### 3.5 **ACCESSORIES**

#### 3.5.1 **Reflectors**

The reflectors shall be manufactured from sheet steel or aluminium as applicable. They shall be securely fixed to the captive type.

#### 3.5.2 **Lamp holders and Starter Holders**

- (a) Lamp holders/starter holders for fluorescent tubes shall be of the spring loaded, low contact resistance, bi-pin rotor type, resistant to wear and suitable for operation at the specified temperature, without deterioration in insulation value, contact resistance or retention of the lamp/starter. They shall hold the lamp/starter in position under normal condition of shock and vibration.
- (b) Lamp holders/starter for incandescent lamps and HPMV/HPSV lamps shall be of screwed type, manufactured in accordance with relevant standard and designed to give long and satisfactory service.

#### 3.5.3 **Ballasts**

- (a) The Ballasts shall be designed, manufactured and supplied in

accordance with relevant standard and function satisfactorily under site condition specified. The ballasts shall be designed to have a long service life and low power loss.

- (b) Ballasts shall be mounted using self locking anti-vibration fixing and shall be easy to remove without dismantling the fixtures. They shall be totally enclosed units.
- (c) The ballasts shall be of the inductive, heavy duty type, filled with thermosetting insulating moisture repellent polyester compound filled under pressure or vacuum. The ballast wiring shall be of copper wire. They shall be free from hum. Ballasts which produce humming sound shall be replaced free of cost by the Contractor. Ballasts for high pressure mercury vapour/ HPSV lamps shall be provided with suitable tapplings to set the voltage within the range specified. End connections and taps shall be brought out in a suitable terminal block, rigidly fixed to the ballast enclosure.
- (d) Separate ballast for each lamp shall be provided in case of multi-lamp fixtures.

#### 3.5.4 **Starters**

Starters shall have bimetal electrodes and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamps and without the use of any tool. Starters shall have brass contacts and radio interference suppressing capacitor.

#### 3.5.5 **Capacitors**

- (a) The capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.
- (b) The capacitors shall be suitable for operation at supply voltage as specified and shall have a value of capacitance so as to correct the power factors of its corresponding lamp circuit to the extent of 0.90 lag.
- (c) The capacitors shall be hermetically sealed in a metal enclosure.

### 3.6 **Lamps**

3.6.1 General Lighting Services (GLS) lamps shall be provided with screwed caps and shall be of 'clear' type unless otherwise specified.

3.6.2 The fluorescent lamps shall be 'Day-light-colour' type unless otherwise specified and shall also be provided with features to avoid blackening of lamps ends. The Bidder should clearly state these features in the bid.

3.7 The Bidder shall furnish typical wiring diagram for Fluorescent, HPMV & HPSV fitting including all accessories. The diagram shall include technical

details of accessories i.e. starters, chokes, capacitors etc.

3.8 Flexible conduits if required, for any fixture shall be deemed to be included in Contractor's scope.

#### 4.0 **RECEPTACLES**

- (a) All receptacles shall be of cast steel/aluminium, heavy duty type, suitable for fixing on wall/column and complete with individual switch.
- (b) In general the receptacles to be installed are of the following types:
  - (i) **Type RO-15A**, 240V, 2 pole, 3 pin type with third pin grounded, metal clad with gasket having cable gland entry suitable for 2Cx6 sq.mm. PVC/aluminium armoured cable and a metallic cover tied to it with a metallic chain and suitable for installation in moist location and or outdoor. The switch shall be of rotary type. Receptacles shall be housed in an enclosure made out of 2 mm thick GI sheet with hinged doors with padlocking arrangements. Door shall be lined with good quality gasketing. This shall conform to IP-55.
  - (ii) **Type RI**-The 5/15 amp 6 pin receptacles with switches will be of Modular type with flush type switches and electroplated metal enclosures of approved make.
  - (iii) **Type RP** - 63A, 415V, 3 phase, 4 pin interlocked plug and switch with earthing contacts. Other requirements shall be same as type RO. The receptacle shall be suitable for 3.5C x 35/3.5Cx70 sq.mm. Aluminium conductor cable entry and shall also be suitable for loop-in and loop out connection of cables of identical size. Receptacle shall be suitable for outdoor application. Receptacles shall be housed in a box made out of 2mm thick G.I. sheet, with hinged door with padlocking arrangement. Door shall be lined with good quality gasketing. This shall conform to IP-55.

#### 5.0 **SWITCH AND SWITCHBOARD**

- (a) All Switch board/boxes, 6/16 Amp Receptacles and electronic fan regulators located in office/building areas shall be modular flush mounted type or brick wall with only the switch knob projecting outside.
- (b) Switch boards/boxes shall have conduit knock outs on all the sides. Adequate provision shall be made for ventilation of these boxes.
- (c) The exact number of switches including regulator for fans and

layout of the same in the switchboard shall be to suit the requirement during installation.

- (d) The maximum number of luminaires, controlled by one no 6 amp switch would 4 nos. For DC fixtures there will be no switch and the same shall be directly controlled from DC LP.
- (e) The luminaires shall be wired in such a fashion that luminaires on each phase are evenly distributed all over the room.

## 6.0 CONDUITS & CONDUIT ACCESSORIES

- 6.1 The conduits shall conform to IS:9537. All conduits shall be seamed by welding, shall be of heavy gauge and shall be hot dip galvanised.
- 6.2 Flexible conduits wherever required shall be made with bright, cold rolled annealed and electro-galvanised mild steel strips.
- 6.3 All conduits accessories shall conform to relevant IS and shall be hot dip galvanised.

## 7.0 JUNCTION BOXES

- 7.1 The junction boxes shall be concealed type for indoor lighting and suitable for mounting on columns, lighting poles, structures etc., for outdoor lighting.
- 7.2 Junction boxes shall be of square/rectangular type of 1.6 mm sheet steel with minimum 6 mm thick pressure diecast aluminium material LM-6 and shall have bolted cover with good quality gasket lining.
- 7.3 The junction box and cover shall be hot dip galvanised.
- 7.4. The junction boxes shall be complete with conduit knockouts/threaded nuts and provided with terminal strips .The junction boxes shall be suitable for termination of conduit/glands of dia 20 mm, 25 mm, 32 mm, 40 mm on all sides. The junction boxes shall be provided with 4 way terminals suitable for two numbers 10 sq. mm. wire & for street lighting/switchyard lighting suitable for 2 numbers 4C x 16 Sq.mm Al. cable.
- 7.5 The junction boxes shall have the following indelible markings:
  - (i) Circuit Nos. on the top.
  - (ii) Circuit Nos. with ferrules (inside) as per drawings.
  - (iii) DANGER sign in case of 415 volt junction box.
- 7.6 The junction boxes shall be weather proof type with gaskets conforming to IP 55 as per IS:13947 (Part I) . The conduit connections shall also be properly sealed to prevent entry of water.

## 8.0 **TERMINAL BLOCKS**

8.1 Each terminal shall be suitable for terminating up to 2 Nos. 10 sq.mm. Stranded Aluminium Conductors without any damage to the conductors or any looseness of connections. Terminal strips provided in street - lighting poles shall be suitable for terminating up to 2 nos. 4C x 16 sq. mm aluminium cables.

## 9.0 **PULL OUT BOXES**

9.1. The pull out boxes shall be concealed type for indoor lighting and suitable for mounting on column, structures etc., for outdoor lighting. The supply of bolts, nuts and screws required for the erection shall be included in the installation rates.

9.2 The pull out boxes shall be circular of cast iron or 16 SWG sheet steel and shall have cover with good quality gasket lining.

9.3 The pull out boxes and cover shall be hot dip galvanised.

9.4 The pull out boxes shall be completed with conduit knock outs/threaded hubs and provided at approximately 3 meters intervals in a conduit run.

## 10.0 **LIGHTING PANELS (L.P.)**

10.1 Each panel shall be provided with one incoming triple pole MCB with neutral link and outgoing miniature circuit breakers as per clause 2.0. The panels shall conform to IS-8623.

### 10.2 **Constructional Features**

10.2.1 Panels shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be of thickness not less than 2.00 mm (cold rolled) or 2.5 mm (hot rolled) smoothly finished, levelled and free from flaws. Stiffeners shall be provided wherever necessary. The indoor lighting panels will be ready made DB of minimum 20 SWG sheet thickness.

10.2.2 The panels shall be of single front construction, front hinged and front connected, suitable for either floor mounting on channels, sills or on walls/columns by suitable M.S. brackets.

10.2.3 Panels shall have a dead front assembly provided with hinged door(s) and out door panels will be with padlocking arrangement with single key supplied in duplicate.

10.2.4 All out door panels, removable covers, doors and plates shall be gasket all around with neoprene gaskets.

10.2.5 The panels shall be suitable for cable/conduit entry from the top and bottom. Suitable removable cable gland-plate shall be provided on the top

and bottom of panels. Necessary number of double compression cable gland shall be supplied, fitted on to this gland plate. The glands shall be screwed on top and made of tinned brass.

10.2.6 The panels shall be so constructed as to permit free access to connection of terminals and easy replacement of parts.

10.2.7 Each panel shall have a caution notice fixed on it.

10.2.8 Each panel will be provided with directory holder in which printed and laminated as built circuit directory would be kept

10.2.9 Each Outdoor lighting panel shall be provided with one no. 'ON' indicating lamp for each phase along with fuses. For indoor lighting panels din mounted phase indication lamps will be provided, mounted alongside of the MCB.

### 10.3 **Main Bus Bars**

10.3.1 Bus bars shall be of aluminium alloy conforming to IS:5082 and shall have adequate cross-section to carry the rated continuous and withstand short circuit currents. Maximum operating temperature of the bus bars shall not exceed 85 deg. C. The bus bars shall be able to withstand a fault level of 9 kA for 1 sec. for AC panels and 4 kA for 1 sec. for DC panels. The Indoor lighting panels shall have copper bus bar.

### 10.4 **Residual Current Circuit Breakers (RCCB)**

10.4.1 For indoor panels, 63A, 4pole, 300 ma conforming to IS 12640 will be provided along with the incomer.

### 10.5 **Miniature Circuit Breaker (MCB)**

(a) The miniature circuit breakers shall be suitable for manual closing, opening, automatic tripping under overload and short circuit. The MCBs shall also be trip free.

(b) Single pole as well as three pole versions shall be furnished as required in the Schedule of Lighting Panels.

(c) The MCBs and panel MCCB together shall be rated for full fault level. In case the MCB rating is less than the specified fault level the bidder shall co-ordinate these breaker characteristics with the back up MCCB in such a way that if fault current is higher than breaker rating, the MCCB should blow earlier than the breaker. If the fault current is less than MCB breaking capacity, MCB shall operate first and not the incomer MCCB.

(d) The MCBs shall be suitable for housing in the lighting panels and shall be suitable for connection with stranded copper wire

connection at both the incoming and outgoing side by copper lugs or for bus bar connection on the incoming side.

- (e) The terminals of the MCBs and the 'open', 'close' and 'trip' conditions shall be clearly and indelibly marked.
- (f) The contractor shall check and co-ordinate the ratings of MCBs with respect to starting characteristics of discharge lamps. The vendor has to furnish overload and short circuit curve of MCB as well as starting characteristics curves of lamps for Employer's approval.
- (g) The MCB shall generally conform to IS:8828.

#### 10.6 **Contactors**

Contactors shall be of the full voltage, direct-on line air break, single throw, electro-magnetic type. They shall be provided with at least 2-'NC' and 2-'NO' auxiliary contacts. Contactor shall be provided with the three element, positive acting, ambient temperature compensated time lagged, hand reset type thermal overload relay with adjustable settings to suit the rated current. Hand reset button shall be flush with the front of the cabinet and suitable for resetting with starter compartment door closed. The Contactor shall be suitable for switching on Tungsten filament lamp also. The bidder shall check the adequacy of the Contactors rating wire with respect to lighting load.

#### 10.7 **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 integral escutcheon plates engraved with their functions. Push buttons shall be of reputed make.

#### 10.8 **Labels**

- (a) The lighting panels shall be provided on the front with panel designation labels on a 3 mm thick plastic plate of approved type. The letter shall be black engraved on white back ground.
- (b) All incoming and outgoing circuits shall be provided with labels. Labels shall be made of non-rusting metal or 3 ply lamicold. Labels shall have white letters on black or dark blue background.

#### 10.9 **Earthing Terminals**

Panels shall be provided with two separate and distinct earthing terminals suitable to receive the earthing conductors of size 50x6 G.S. Flat.

10.10 Type test reports for following tests on all lighting panels shall be submitted for approval as per clause 9.2 of section: GTR.

- (i) Wiring continuity test.
- (ii) High voltage (2.5 kV for 1 minute) and insulation test.
- (iii) Operational test.
- (iv) Degree of protection (not less than IP-55 test on outdoor Lighting Panels and IP-52 test on indoor Lighting Panels as per IS 13947 (Part I)).
- (v) Heat run test.

#### 11.0 **Emergency Portable Lighting Fixtures**

- 11.1 The portable fixtures shall have a built in battery rated for six hours, battery chargers and solid state inverters. These shall be of approved make.
- 11.2 The portable fixtures shall be of a single unit, completely tropicalised and suitable for prolonged use with no maintenance.
- 11.3 The portable fixtures shall be supplied and necessary supporting brackets of galvanised steel suitable for wall/column mounting shall also be supplied.
- 11.4 The portable fixture shall come up automatically in the event of failure of normal supply.

#### 12.0 **LIGHTING POLES** Not applicable

#### 13.0 **CEILING & WALL MOUNTED FANS AND REGULATORS**

- 13.1 The contractor shall supply and install 1400 mm sweep ceiling fans complete with electronic regulator and switch, suspension rod, canopy and accessories. The wall mounted fans shall be of 300 mm sweep
- 13.2 The contractor shall supply and install the switch, electronic regulator and board for mounting switch and electronic regulator for ceiling fans.
- 13.3 Winding of the fans and regulators shall be insulated with Class-E insulating material. Winding shall be of copper wire.
- 13.4 Electronic regulator with smooth control shall be provided.
- 13.5 Fans and electronic regulators shall be of Alstom / Crompton Greaves / Bajaj Electricals / Usha Electricals make.

#### 14.0 **LIGHTING WIRES**

- 14.1 The wiring used for lighting shall be as per approved makes.
- 14.2 The wires shall be of 1100 V grade, PVC insulated product of reputed manufacturers.

- 14.3 The conductor sizes for wires used for point wiring beyond lighting panels shall be single core 4 sq. mm., 6 sq.mm and 10 sq.mm stranded aluminium wires and 2.5 sq.mm, 4 sq.mm, 6 sq.mm and 1.5 sq.mm stranded copper wire.
- 14.4 The wires used for connection of a lighting fixture from a nearest junction box or for loop-in loop-out connection between two fluorescent fixtures shall be single core copper stranded conductor, 1100V grade flexible PVC insulated cords, unsheathed, conforming to IS:694 with nominal conductor cross sectional areas of 2.5 sq. mm.
- 14.5 The wires shall be colour coded as follows:
- Red for R - Phase
  - Yellow for Y - Phase
  - Blue for B - Phase
  - Black for Neutral
  - White for DC (Positive)
  - Grey for DC (Negative)

#### 15.0 **PAINTING OF SHOP MADE ITEMS**

- 15.1 All sheet steel work shall be phosphate in accordance with the following procedure and in accordance with IS:6005 'Code of Practice for Phosphating Iron and Steel'.
- 15.2 Oil grease and dirt shall be thoroughly removed by emulsion cleaning.
- 15.3 Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
- 15.4 After phosphating through rinsing shall be carried out with clean water, followed by final rinsing with diluted dichromate solution and oven drying.
- 15.5 The phosphate coating shall be sealed by the application of two coats of ready mixed stoving type metal primer (comprising of red oxide and Zinc chromate in a synthetic medium). The first coat may be 'flash dried' while the second coat shall be stoved.
- 15.6 After application of the primer, two coats of finishing synthetic enamel paint shall be applied with each coat followed by stoving. The second finishing coat for the external of panels shall be applied after completion of tests. The panels can also be powder coated instead of painting after surface treatment as given above.
- 15.7 Both outside and inside of lighting panel, sheet metal fabricated junction boxes etc. and outside of lighting fixtures shall be finished in light grey (IS-5 shade 631). Inside of lighting fixtures shall be finished in white. The colour of indoor lighting panels should match with colour of wall.

- 15.8 Each coat of primer and finishing paint shall be of slightly different shade so as to enable inspection of the painting.
- 15.9 The final finished thickness of paint film on steel shall not be less than 100 microns and shall not be more than 150 microns. The final thickness of powder coating will not be less than 50 microns. For indoor lighting panels the painting will be as per approved manufacturer's specification.
- 15.10 Finished painted appearance on equipment shall present on aesthetically pleasing appearance, free from dents and uneven surfaces.
- 16.0 **LIGHTING SYSTEM INSTALLATION WORKS**
- 16.1 **General**
- 16.1.1 In accordance with the specified installation instructions as shown on manufacturer's drawings or as directed by Employer, Contractor shall unload, erect, install, test and put into commercial use all the electrical equipment included in the contract. Equipment shall be installed in a neat, workmanship manner so that it is level, Plumb Square and properly aligned and oriented. Tolerances shall be as established in manufacturers drawing or as stipulated by Purchaser.
- 16.1.2 All apparatus, connections and cabling shall be designed so as to minimise risk of fire or any damage which will be caused in the event of fire.
- 16.2 **Conduit System**
- 16.2.1 Contractor shall supply, store and install conduits required for the lighting installation as specified. All accessories/fittings required for making the installation complete, including but not limited to pull out boxes (as specified in specification ordinary and inspection tees and elbow, check nuts, male and female bushings (brass or galvanised steel), caps, square headed make plugs, nipples, gland sealing fittings, pull boxes, conduits terminal boxes, glands, gaskets and box covers, saddle terminal boxes, and all steel supporting work shall be supplied by the Contractor. The conduit fittings shall be of the same material as conduits. The contractor shall also supply 20 mm HDPE conduit 6kg/sq cm and accessories for telephone wiring.
- 16.2.2 All unarmoured cables shall run within the conduits from lighting panels to lighting fixtures, receptacles. etc.
- 16.2.3 Size of conduit shall be suitably selected by the Contractor.
- 16.2.4 Conduit support shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.
- 16.2.5 Conduit supports shall be clamped on the approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn, shall

be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs. Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.

- 16.2.6 Where conduits are along with cable trays they shall be clamped to supporting steel at an interval of 600 mm.
- 16.2.7 For directly embedding in soil, the conduits shall be coated with an asphalt-base compound. Concrete pier or anchor shall be provided wherever necessary to support the conduit rigidly and to hold it in place.
- 16.2.8 For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.
- 16.2.9 Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.
- 16.2.10 Conduits joints and connections shall be made through water-tight and rust proof by application of a thread compound which insulates the joints. White lead is suitable for application on embedded conduit and red lead for exposed conduit.
- 16.2.11 The entire metallic conduit system, shall be embedded, electrically continuous and thoroughly grounded. Where slip joints are used, suitable bounding shall be provided around the joint to ensure a continuous ground circuit.
- 16.2.12 Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduit ends shall be plugged or capped to prevent entry of foreign material.

### 16.3 **Wiring**

- 16.3.1 Wiring shall be generally carried out by PVC insulated wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawings of wires is permissible.
- 16.3.2 Wires shall not be pulled through more than two equivalent 90 deg. bends in a single conduit run. Where required, suitable junction boxes shall be used.
- 16.3.3 Wiring shall be spliced only at junction boxes with approved type terminal strip.
- 16.3.4 For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.
- 16.3.5 For vertical run of wires in conduit, wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/junction box.

16.3.6 Maximum two wires can be terminated to each way of terminal connections.

16.3.7 Separate neutral wires are to be provided for each circuit.

16.3.8 AC and DC wiring should not run through the same conduit.

16.4 **Lighting Panels**

16.4.1 The lighting panels shall be erected at the locations to be finalised during detailed engineering.

16.4.2 Suitable foundations/supporting structures for all outdoor type lighting panels shall be provided by the Contractor.

16.5 **Foundation & civil works**

Not applicable

**CHAPTER – 4**  
**(AIR CONDITIONING SYSTEM)**

## CHAPTER 4

### AIR CONDITIONING AND VENTILATION SYSTEM PACKAGE

#### 1.00.00 GENERAL

1.01.00 This specification covers supply, installation, testing and commissioning and handing over to Employer of Air conditioning system for the control room building.

Air conditioning units for control room building shall be set to maintain the following inside conditions.

DBT  $24.4^{\circ}\text{C} \pm 2^{\circ}\text{C}$

1.02.00 The following areas shall be air conditioned:

- (i) Control room .
- (ii) Conference Room.
- (iii) Operator's room.
- (iv) Electronics test lab.
- (v) Transit Rooms.
- (vi) Any other areas in the Control Building except for the stair case, pantry, toilet, 33kV & 11 kV switchgear, LT switchgear and Battery / Charger rooms.

1.03.00 Air conditioning requirement of rooms indicated at clause no.1.02.00 shall be met using split AC units. High wall type split AC units of 2TR capacity each with high wall type indoor evaporator unit shall be used for all rooms.

#### 1.04.00 Scope

The scope of the equipment to be furnished and services to be provided under the contract are outlined hereinafter and the same is to be read in conjunction with the provision contained in other sections/ clauses. The scope of the work under the contract shall be deemed to include all such items, which although are not specifically mentioned in the bid documents and/or in Bidder's proposal, but are required to make the equipment/system complete for its safe, efficient, reliable and trouble free operation.

1.04.01. Adequate nos. of high wall type split AC units of 2TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor and high wall type indoor evaporator unit with cordless remote controller.

1.04.02 Copper refrigerant piping complete with insulation between the indoor and remote outdoor condensers as required.

1.04.03 PVC drain piping from the indoor units up to the nearest drain point.

1.04.04 Power and control cabling between the indoor unit and outdoor unit and earthing.

1.04.05 MS Brackets for outdoor condensing units, condensers as required.

## 2.00.00 **Specification for Split AC units.**

- 2.01.00 The split AC units will be complete with indoor evaporator unit, outdoor condensing units and cordless remote control units.
- 2.02.00 Outdoor unit shall comprise of hermetically sealed reciprocating/ rotary compressors mounted on vibration isolators, propeller type axial flow fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.
- 2.03.00 The indoor units shall be high wall type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by special motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi function cordless remote control unit with special features like programmable timer, sleep mode and soft dry mode etc.
- 2.04.00 The Split AC units shall be of Carrier, Voltas, Blue Star, Hitachi, Daikin, LG, National, O' General or Samsung make.

## 3.00.00 **Ventilation System**

Exhaust fans of propeller type/ axial type shall be provided for the rooms which are not air conditioned complete with suitable drive motors, DOL starters, rain protection cowl with screen, grouting bolts etc. Fan for battery room shall be bifurcated type, spark proof construction. These shall be fed from a local distribution board.

Sl. No.	Location	Capacity (M <sup>3</sup> /hr.)	Static Pr. (mmWg)
(1)	33 kV & 11 kV switchgear room	3000	10
(2)	Battery room	3000	10
(3)	DCDB room	2000	10
(4)	MCC room	2000	10
(5)	Records room	1500	5
(6)	Stores	1500	5
(7)	Toilets	1000	5
(8)	Pantry	500	5

- 3.00.01 Anchor bolts, sleeves, Inserts, Foundation Plates, Lifting Lug, Eye Bolts etc. required.
- 3.00.02 (i) Grouting, dressing and final finishing of foundations etc.  
(ii) Making good of opening in wall, floor and roof slabs.
- 3.00.03 Supply and erection of cables
- 3.00.04 Supply and installation of various conduits, pipes, junction boxes required for erection of the cables.
- 3.00.05 Special maintenance tools and tackles.

**CHAPTER – 5**  
**(CCTV SYSTEM)**

# **CHAPTER 5**

## **CCTV SYSTEM**

### **General**

The substation is intended to be monitored from the Control Room through the CCTV. It is intended to provide remote visual monitoring system for monitoring and surveillance of switchyard and substation area through CCTV systems.

### **1.0 Scope**

The scope of the work shall include supply, installation, testing and commissioning of Visual monitoring system with remote monitoring station located at suitable locations in the substation. The number of cameras shall be so selected that complete outdoor switchyard including the substation boundary and main gate and 33 kV switchgear room can be visually monitored. Further, the system shall have provision for visual monitoring from one additional location in future. (Hardware/ software for future remote location not included in the scope of this specification).

The system shall comprise components of robust design to give satisfactory performance in an Electro magnetically hostile environment of extra high voltage switchyard. The technical requirement of various components is given below.

### **1.1 Technical requirements**

#### **(a) Cameras**

The colour cameras shall have PAN, TILT, ZOOM facilities so that it can be focused to the required location from the remote station through a controller. It should have sufficient range/Resolution for viewing with high degree of clarity and shall have the following features.

- (i) The camera shall be able to PAN through 360 degrees.
- (ii) Tilting angle shall be 180 degrees.
- (iii) It shall be possible to define at least 12 preset locations so that the camera gets automatically focused on selection of the location for viewing a predefined location.
- (iv) The camera shall have interface to communicate with Digital Video Recorder.
- (v) The camera shall be housed in a weather proof housing for protecting it from rain, dust etc and shall conform to at least to IP 55.
- (vi) The camera shall be suitable for viewing even under low illumination level up to 5 LUX.
- (vii) The equipment should generally conform to Electro magnetic compatibility requirements for out door equipment in EHV switchyards. The required EMC levels are 4 kV (level IV of IEC 61000) for fast Transient and 2.5 kV (level III of IEC 61000) for HF disturbances. Type test reports to establish compliance with this requirement shall be submitted during detailed engineering.

- (viii) The resolution of camera and the monitor of PC based Digital Video Recorder should be so as to give the required resolution.

**(b) PC Based Digital Video Recorder system.**

PC based Digital Video Recorder (DVR): DVR shall comprise of a PC station with Monitor, key board, mouse and modem and camera controller with software for performing the following functions.

- (i) Storing data for at least one week after which first records shall be over written by the latest. The records shall consist of visual data of complete travel of Isolator contacts from open to close position or vice versa.
- (ii) Panning, tilting, zooming and focusing of cameras.
- (iii) Receiving data from and controlling at least 16 cameras.
- (iv) Panning, zooming, tilting, playing back recorded data.
- (v) Communicating with the camera and remote monitoring station (through normal land telephone line to be provided by the owner).
- (vi) It shall be possible to define locations for all the cameras and focus the camera to pre defined locations as well as to any other selected location.

**(c) Remote monitoring station:**

It shall be a PC based station with a colour monitor (minimum 42”), modem, controller, key board, mouse etc. All equipments for remote monitoring station are in the scope of this specification. It shall have necessary hardware and software to access all data in DVR and control the camera through fibre optical communication channel. It shall be possible to display four pictures simultaneously on the screen with provision for selecting any one of them for viewing any one of them on full screen.

**(d) Mounting**

The cameras shall be mounted on the existing gantry structures at suitable locations to get a proper view of the entire yard and equipment. Any mounting arrangement for cameras and Modems for communication are in the scope of the bidder. It may however be noted that no separate structures for mounting of cameras are intended.

**(e) HF Cable**

1.1 kV Double screened HF cable with low loss (5 dB. per km or less) shall be used for communication between Cameras and DVR system.

**CHAPTER – 6**  
**(FIRE PROTECTION SYSTEM)**

## **CHAPTER 6**

### **FIRE PROTECTION SYSTEM**

#### **1.00.00 INTENT OF SPECIFICATION**

This section covers the design and performance requirements of the following types of fire protection systems:

- (a) Hydrant System.
- (b) Fire Detection System.
- (c) Portable Fire Extinguishers.

1.00.01 It is not the intent to completely specify all details of design and construction. Nevertheless, the system design and equipment shall conform in all respects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Owner. The system design shall also conform to TAC/ NFPA norms.

1.00.02 The scope of work include complete earthwork (i.e. excavation, backfilling etc.) for the entire buried piping for the system, valve pits and pipe supports for buried, entrenched and overground piping.

1.00.03 The equipment offered shall comply with the relevant Indian Standards. The equipment conforming to any other approved international standards shall meet the requirement called for in the latest revision of relevant Indian Standard or shall be superior.

1.00.04 Ambient temperature for design of all equipment shall be considered as 40°C.

1.00.05 The piping and instruments diagram for Hydrant system for the substations and the detailed layout and piping drawing shall be prepared by the Contractor based on reference drawings such as road, drainage, cable trench, switch yard layout, etc.

1.00.06 Various equipment under the fire protection system should be supplied from the list of approved vendors/suppliers/makes provided in this specification or any other makes the Employer may approve during detail engineering.

#### **2.00.00 DESIGN AND CONSTRUCTION**

##### **2.01.00 Hydrant System**

Hydrant system of fire protection essentially consists of a large network of pipe, both under ground and over ground which feeds pressurised water to a number of hydrant valves, indoor as well as outdoor. These hydrant

valves are located at strategic locations near buildings and Transformers. Hose pipes of suitable length and fitted with standard accessories like branch pipes, nozzles etc., are kept in Hose boxes. In case of emergency, these hoses are coupled to the respective hydrant valves through instantaneous couplings and jet of water is directed on the equipment on fire. Hydrant protection shall be provided for the following in the sub-station.

- (a) Control room building.
- (b) L.T. Transformer area.
- (c) Fire Fighting pump House.
- (d) Stores.
- (e) Transformers.

2.01.01 A warning plate shall be placed near the hydrant points for the transformers and the pump in substation to clearly indicate that water shall be sprayed only after ensuring that the power to the transformer which is on fire is switched off and there are no live parts within 20metres of distance from the personnel using the hydrant.

#### 2.02.00 **Fire Detection System**

2.02.01 Suitable fire detection system using smoke detectors and/or heat detectors shall be provided for the entire control room building, including corridor and toilets. Fire detectors shall be located at strategic locations in various rooms of the building. The operation of any of the fire detectors/ manual call point should result in the following;

- (1) A visual signal exhibited in the annunciation panels indicating the area where the fire is detected.
- (2) An audible alarm sounded in the panel.
- (3) An external audible alarm sounded in the building, location of which shall be decided during detailed engineering.
- (4) If the zone comprises of more than one room, a visual signal shall be exhibited on the outer wall of each room.

2.02.02 Each zone shall be provided with two zone cards in the panel so that system will remain healthy even if one of the cards becomes defective.

2.02.03 Fire detectors shall be provided on ceiling as well as on false ceiling in conference room, on false ceiling in control room and relay room and on ceiling in all other areas. Coverage area of each smoke detector shall not be more than 80 m<sup>2</sup> and that of heat detectors shall not be more than 40 m<sup>2</sup>. Addressable type smoke detectors shall be provided in all areas. If a detector is concealed, a remote visual indication of its operation shall be provided. Manual call points (Break glass Alarm Stations) shall be

provided at strategic locations in the control room building. All cabling shall be done through concealed conduits.

2.04.00 Portable and Wheel/ Trolley mounted Fire Extinguishers.

2.04.01 Portable Fire Extinguishers

Adequate number of portable fire extinguishers of pressurised water, dry chemical powder, and Carbon dioxide type shall be provided in suitable locations in control room building and DG set cum FF building. These extinguishers will be used during the early phases of fire to prevent its spread and costly damage.

The design, construction & testing of pressurised water type, dry chemical powder type and Carbon dioxide type portable fire extinguishers shall meet the requirements as per clause 10.00.00.

2.05.00 Water Supply System

2.05.01 Water for hydrant system shall be supplied by one electrical motor driven pump with another pump, driven by diesel engine, shall be used as stand-by. Two nos. water storage R.C.C. tanks of adequate capacity shall be provided. Water for hydrant system shall be supplied by pump of appropriate capacity at 56 MWC discharge pressure. The tank shall be provided with all accessories such as drain, overflow and filling connection with float valve etc. The pump shall work on positive suction. Annunciations of the hydrant system shall be provided in fire water pump house and repeated in the control room.

The outdoor piping for the system in general shall be laid above ground on concrete pedestals with proper clamping. However, at road/rail crossings, in front/access of buildings, places where movement of cranes/vehicles is expected and at any other place where above ground piping is not advisable, the pipes shall be laid underground as per Cl.no.7.04.05. Such locations shall be finalised during detailed engineering.

The whole system will be kept pressurised by providing combination of air vessel and jockey pumps. The capacity of air vessel shall not be less than 3m<sup>3</sup>. Minor leakage will be met by Jockey pump. One additional jockey pump shall be provided as standby. The pumps and air vessel with all auxiliary equipment will be located in firewater pump house.

Operation of all the pumps shall be automatic and pumps shall be brought into operation at preset pressure. Fire pumps shall only be stopped manually. Manual start/stop provision shall be provided in local control panel.

2.05.02 The design and construction of horizontal centrifugal pumps along with drives and accessories shall be in line with the guidelines of Tariff Advisory Committee of India.

2.05.03 The technical specification of the diesel engine driven fire pump and electric motor driven fire pumps shall meet requirements as set in Data Sheet. The general design of the fire fighting pump sets shall meet the requirements under clauses no.5.00.00 for Horizontal centrifugal pumps and 12.00.00 for Electrical motors.

2.05.04 Each pump shall be provided with a nameplate indicating suction lift/delivery head, capacity and number of revolutions per minute.

2.05.05 Design, construction, erection, testing and trial operation of piping, valves, strainers, hydrant valves, hoses, nozzles, branch pipes, hose boxes, expansion joints etc. shall conform to the requirements of clause no. 7.00.00.

## 2.06.00 **Instrumentation and Control System**

2.06.01 All instruments like pressure indicators, differential pressure indicators, pressure switches, level indicators, level switches, temperature indicators, alarms and all other instruments and panels as indicated in the specification and drawings and those needed for safe and efficient operation of the whole system shall be furnished according to the requirements of clause 11.00.00.

### 2.06.02 **Control Panel**

Power feeder for motors will be from switchgear board located in control building but control supply for all local control panels, annunciation panels, battery charger units, space heaters etc. shall be fed from the AC and DC distribution boards located in pump house. These AC & DC distribution boards will be fed from the switchgears and DCDBs located in control building.

#### (a) Panel for motor driven fire water Pump

The panel shall be provided with:

- |     |  |       |
|-----|--|-------|
| (1) | TPN switch                                   | 1 No. |
| (2) | Auto/manual switch                           | 1 No. |
| (3) | Start/Stop Push buttons with indication lamp | 1 Set |
| (4) | DOL starter with thermal O/L relay           | 1 Set |
| (5) | Indicating lamp showing power ON             | 1 Set |

- |     |                                       |       |
|-----|---------------------------------------|-------|
| (6) | Indication lamp with drive<br>ON/OF   | 1 Set |
| (7) | Indication lamp showing<br>Motor Trip | 1 No. |

Main power cable from breaker feeder of main switchboard shall be terminated in this panel and another cable shall emanate from this panel which shall be terminated at motor terminals.

- |     |                                |      |
|-----|--------------------------------|------|
| (b) | Panel for Two nos. Jockey Pump | 1No. |
|-----|--------------------------------|------|

The panel shall be provided with the following :

- |     |   |                                   |
|-----|---|-----------------------------------|
| (1) | Fuse-switch unit for Jockey pumps   | 1 Set for each<br>pump            |
| (2) | Auto/manual switch for<br>Jockey Pumps  | 1 No. each                        |
| (3) | Selector switch for<br>selecting either jockey pump   | 1 No.                             |
| (4) | D.O.L. starter with overload<br>relay self-resetting type,<br>for all the drives.                                   | 1 No. each                        |
| (5) | Start/stop push button for<br>Jockey Pump with indication<br>lamp with pad-locking<br>arrangements in stop position | 1 Set for each<br>jockey pump     |
| (6) | Indication lamp for trip<br>indication  | 1 No. each for<br>all the drives. |

- |     |  |       |
|-----|--|-------|
| (c) | Panel for 2 Nos. battery charger<br>& Diesel Engine driven fire water pump | 1 No. |
|-----|--|-------|

The panel shall be provided with the following :

- |     |   |       |
|-----|---|-------|
| (1) | Auto/Manual switch for<br>Diesel Engine driven pump | 1 No. |
| (2) | Start/Stop push buttons<br>with indication lamp     | 1 Set |

- (3) Indicating lamp showing drive ON/OFF 1 Set
- (4) D.C. Voltmeter/Ammeter in the battery charger circuit
- (5) Battery charger will be as per specification described
- (6) Selector switch for selecting either of battery chargers for the battery sets.
- (7) Selector switch for selecting either set of batteries for Diesel engine starting.
- (8) Selector switch for boost charging/Trickle charging of battery set.

2.06.03 **Annunciation Panels**

(a) **Location: Fire Water Pump House**

- (i) Indicating lamps showing power supply "ON" and status indication lamps for each motor.
- (ii) Annunciation windows complete with buttons. Details are as follows:

Sl.No.	Description	Number
(1)	Electric motor driven fire water pump running	1
(2)	Electric motor driven fire water pump fails to start	1
(3)	Diesel engine driven fire water pump running.	1
(4)	Diesel engine driven water pump fails to start	1
(5)	Jockey pump-1 running	1
(6)	Jockey pump-1 fails to start	1

(7)	Jockey pump-2 running	1
(8)	Jockey pump-2 fails to start	1
(9)	Fire fighting System in operation/ Header pressure low	1
(10)	Fire in smoke detection system zone	1
(11)	Water storage tank water level low	2
(12)	High speed diesel tank level low	1
(13)	Spare	10

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(b) **Location Control Room**

- (i) Indication lamp showing power supply 'ON'
- (ii) Following annunciations shall be provided.

Sl.No.	Description	Number
(1)	Diesel engine driven fire water pump in operation	1
(2)	Motor driven fire water pump in operation	1
(3)	Fire fighting Water storage tank level Low	2
(4)	Fire/Fault	1+1(duplicate) For each zone as applicable
(5)	Spares	10

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- (c) Each annunciation panel shall be provided with a hooter.
- (d) Indication for fault in respective areas shall also be provided. Each annunciation window shall exhibit 'FIRE' and 'FAULT' conditions

separately.

2.06.04 The control and interlock system for the fire protection system shall meet the following requirements:

(1) **Electric Motor Driven Fire water Pump**

Pump should start automatically Hydrant system header pressure low. Pump should be stopped manually only. Pump should also be started manually if required from local control panel.

(2) **Diesel Engine Driven Standby Pump**

The pump should automatically start under any of the following conditions:

- (a) Header pressure low.
- (b) Electric motor operated fire water pump fails to start.
  - Pump should be stopped manually only.
  - Pump should also be started manually if required from the local control panel.
  - The battery set which is connected for starting of Diesel engine shall not be subjected to boost charge.

3. **Jockey Pump**

Jockey pump shall start automatically when water pressure in header falls below the set value. Jockey pump shall stop automatically when the pressure is restored to its normal value.

Manual starting/stopping shall be possible from the local control panel.

3.00.00 **SHOP AND SITE TESTS**

3.01.00 **Shop Tests**

3.01.01 Shop tests of all major equipment centrifugal pumps, diesel engines, electrical drive motors, piping, valves and specialties, pressure and storage vessels, MCC, electrical panels, controls, instrumentation etc. shall be conducted as specified in various clauses and as per applicable standards/codes.

3.01.02 Shop tests shall include all tests to be carried out at Contractor's works, works of his sub-contractor and at works where raw materials supplied for manufacture of equipment are fabricated. The tests to be carried out shall

include but not be limited to the tests described as follows:

- (a) Materials analysis and testing.
- (b) Hydrostatic pressure test of all pressure parts, piping, etc.
- (c) Dimensional and visual check.
- (d) Balancing test of rotating components.
- (e) Determination of performance characteristics of pumps, compressors, diesel engines, electrical drive motors, etc.
- (f) Response characteristics of smoke detectors.
- (g) Temperature rating test on Heat detectors.
- (h) Flow rate and operational test on Flow control valves.
- (i) Operational test of alarm valve (water-motor gang).
- (j) Calibration tests on instruments and tests on control panel.
- (k) Destruction/burst tests on 2% or minimum one (1) no. of hoses and portable type fire extinguishers for each type as applicable. Any fraction number shall be counted as next higher integer.
- (l) Performance test on fire extinguishers as required in the code.

3.01.03 In the absence of any Code/Standard, equipment shall be tested as per mutually agreed procedure between the supplier and the Employer.

3.01.04 A comprehensive visual and functional check for panels would be conducted and will include a thorough check up of panel dimensions, material of construction, panel finish, compliance with tubing and wiring specifications, quality of workmanship, proper tagging & locations of instruments/accessories. The wiring check shall be complete point to point ring out and check for agreement with installation drawings and equipment vendor prints of the complete system and an inspection of all field connection terminals and levelling.

3.01.05 All test certificates and reports shall be submitted to the Employer for approval.

3.01.06 The Employer's representative shall be given full access to all tests. The manufacturer shall inform the Employer allowing adequate time so that, if the Employer so desires, his representatives can witness the test.

3.02.00 **Site Tests**

3.02.01 **General**

- (a) All piping and valves, after installation will be tested hydraulically at pressure of 1.5 times that of the maximum attainable pressure in the system to check against leak tightness.
- (b) All manually operated valves/gates shall be operated throughout 100% of the travel and these should function without any trouble whatsoever, to the satisfaction of the Employer.
- (c) All pumps shall be run with the specified fluid from shut off condition to valve wide open condition. Head developed will be checked from the discharge pressure gauge reading. During the test, the pumps and drives shall run smoothly without any undue vibration, leakage through gland, temperature rise in the bearing parts, noise, flow pulsation etc.
- (d) All pressure vessels should be tested hydraulically at the specified test pressure, singly or in the system.
- (e) Painting shall be checked by dry type thickness gauges.
- (f) Visual check on all structural components, welding, painting etc. and if doubt arises, these will be tested again.
- (g) All test instruments and equipment shall be furnished by the Contractor to the satisfaction of the Employer.
- (h) Automatic starting of all the fire pumps by operating the test valves.
- (i) Automatic operation of the Jockey pump.
- (j) Operation of the automatic flow control valve by operating the test valve and remote operating of the solenoid valve.
- (k) Operation of entire annunciation system.

3.02.02 After erection at site, the complete hydrant system shall be subject to tests to show satisfactory performance for which detailed procedure shall be submitted for Employer's approval. It shall be in line with standard Performance Guarantee Test procedure enclosed at Appendix – 1.

3.02.03 All the detectors installed shall be tested for actuation by bringing a suitable source of heat/smoke near the detector and creating a stream of hot air/ smoke over the detector. The exact procedure of this test shall be detailed out by the Employer to the successful Bidder.

4.00.00        **SPARE PARTS**

The Contractor shall indicate in his scope of supply all the mandatory spares in the relevant schedules. The list of mandatory spares is indicated in 'Section - Projects'.

5.00.00        **HORIZONTAL CENTRIFUGAL PUMPS**

This clause covers the design, performance, manufacturing, construction features and testing of horizontal centrifugal pumps used for the purpose of fire fighting.

5.01.00        The materials of the various components shall conform to the applicable IS/BS/ASTM/DIN Standards.

5.01.01        In case of any contradiction with the aforesaid standards and the stipulations as per the technical specification as specified hereinafter, the stipulations of the technical specification shall prevail. In case of contradiction between this specification and "horizontal centrifugal pump data specification sheets" enclosed, stipulations of the data specification sheets will prevail.

5.02.00        **General Performance Requirements**

5.02.01        The pump set shall be suitable for continuous operation at any point within the "Range of operation".

5.02.02        Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum being at shut off.

5.02.03        Pumps shall be capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of rated head. Range of operation shall be 20% of rated flow to 150% of rated flow.

5.02.04        The pump-motor set shall be designed in such a way that there is no damage due to the reverse flow through the pump which may occur due to any mal-operation of the system.

5.02.05        **Drive Rating**

The drive rating shall not be less than the maximum power requirement at any point within the "Range of Operation" specified where the supply frequency is 51.5 Hz (and the motor is running at 103% of its rated speed).

During starting under reverse flow condition, the motor shall be capable of bringing the pump to rated speed at normal direction with 90% rated voltage at motor terminals.

5.02.07        Pump set along with its drive shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall generally be guided by Hydraulic Institute Standards.

5.02.08        The Contractor under this specification shall assume full responsibility in the operation of the pump and drive as one unit.

- 5.03.00      **Design & Construction**
- 5.03.01      Pump casing may be axially or radially split. The casing shall be designed to withstand the maximum pressure developed by the pump at the pumping temperature.
- 5.03.02      Pump casing shall be provided with adequate number of vent and priming connections with valves, unless the pump is made self-venting & priming. Casing drain, as required, shall be provided complete with drain valves.
- 5.03.03      Under certain conditions, the pump casing nozzles will be subjected to reactions from external piping. Pump design must ensure that the nozzles are capable of withstanding external reactions not less than those specified in API-610.
- 5.03.04      Pump shall preferably be of such construction that it is possible to service the internals of the pump without disturbing suction and discharge piping connections.
- 5.03.05      **Impeller**
- The impeller shall be secured to the shaft and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft impellers shall be secured to the shaft by an additional locknut or cap screw. All screwed fasteners shall tighten in the direction of normal rotation.
- 5.03.06      **Wearing Rings**
- Replaceable type wearing rings shall be furnished to prevent damage to impeller and casing. Suitable method of locking the wearing ring shall be used.
- 5.03.07      **Shaft**
- Shaft size selected shall take into consideration the critical speed, which shall be at least 20% away from the operating speed. The critical speed shall also be atleast 10% away from runaway speed.
- 5.03.08      **Shaft Sleeves**
- Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing or seal and plate so as to distinguish between the leakage between shaft & shaft sleeve and that past the seals/gland.
- 5.03.09      Shaft sleeves shall be securely fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.
- 5.03.10      **Bearings**
- Bearings and hydraulic devices (if provided for balancing axial thrust) of adequate design shall be furnished for taking the entire pump load arising from all probable conditions of continuous operation throughout its "Range of Operation" and also at the shut-off condition. The bearing shall be designed on the basis of 20,000 working hours minimum for the load

corresponding to the duty point.

Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.

5.03.11 **Stuffing Boxes**

Stuffing box design shall permit replacement of packing without removing any part other than the gland. Stuffing boxes shall be sealed/cooled by the fluid being pumped and necessary piping, fittings, valves, instruments, etc. shall form an integral part of the pump assembly.

5.03.12 **Shaft Couplings**

All shafts shall be connected with adequately sized flexible couplings of suitable design. Necessary guards shall be provided for the couplings.

5.03.13 **Base Plates & Sole Plate**

A common base plate mounting both for the pump and drive shall be furnished.

The base plate shall be of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the pumping unit so mounted as to minimise misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust etc. Suitable drain taps and drip lip shall be provided.

5.03.14 **Balancing**

All rotating components shall be statically and dynamically balanced at shop.

5.03.15 All the components of pumps of identical parameters supplied under this specification shall be interchangeable.

5.03.16 **Prime Mover**

The design and construction of the electric drive motor shall be as specified in clause 12.00.00.

5.04.00 **Tests and Inspection**

5.04.01 The manufacturer shall conduct all tests required to ensure that the equipment furnished conform to the requirements of this specification and are in compliance with the requirements of applicable Codes and Standards. The particulars of the proposed tests and the procedures for the tests shall be submitted to the Employer/Engineer for approval before conducting the tests.

5.04.02 Where stage inspection is to be witnessed by Employer, in addition to above, the Bidder shall submit to the Employer/Engineer at the beginning of the contract, the detailed PERT-Chart showing the manufacturing programme and indicating the period where Employer or his authorised inspecting agency are required at the shop.

5.04.03 **Material of Construction**

All materials used for pump construction shall be of tested quality.

Materials shall be tested as per the relevant standards and test certificates shall be made available to the Employer/Engineer.

- 5.04.04 Where stage inspection is to be witnessed by Employer, all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication, by Employer's Inspector who shall stamp the material. In case mill test certificates for the material are not available, the Contractor shall carry out physical and chemical tests at his own cost from a testing agency approved by the Employer, as per the requirements of specified material standard. The samples for physical and chemical tests shall be drawn up in presence of Employer's inspector who shall also witness the tests.
- 5.04.05 Shaft shall be subjected to 100% ultrasonic test and machined portion of the impeller shall be subject to 100% DP test. On finished shaft DP test will also be carried out.
- 5.04.06 **Hydraulic test at shop**
- All pressure parts shall be subjected to hydraulic testing at a pressure of 150% of maximum pressure generated by the pump at rated speed or 200% of total dynamic head whichever is higher, for a period not less than one (1) hour.
- 5.04.07 **Performance test at shop**
- Pumps shall be subjected to routine tests to determine the performance of the pumps. These tests shall be conducted in presence of Employer/Engineer's representative as per the requirements of the Hydraulic Institute Standards/ASME Power Test Code PTC 8.2/BS-599/I.S.S., latest edition. Routine tests shall be done on all the pumps.
- 5.04.08 Performance tests shall be conducted to cover the entire range of operation of the pumps. These shall be carried out to span 150% of rated capacity upto pump shut-off condition. A minimum of five combinations of head and capacity are to be achieved during testing to establish the performance curves, including the design capacity point and the two extremities of the Range of operation specified.
- 5.04.09 Tests shall preferably be conducted alongwith the actual drives being supplied.
- 5.04.10 The Bidders shall submit in his proposal the facilities available at his works to conduct performance testing. If because of limitations of available facilities, a reduced speed test or model test has to be resorted to establish pump performance, the same has to be highlighted in the offer.
- 5.04.11 In case of model testing, the stipulations of latest edition of Hydraulic Institute Standards shall be binding. Prototype or model tests, however, shall be conducted with the suction condition identical to the field conditions i.e. sigma values of prototype and model is to be kept same.
- 5.04.12 Prior to conducting model testing, calculations establishing model parameters, sizes and test procedure will be submitted to Employer/Engineer for approval.
- 5.04.13 All rotating components of the pumps shall be subjected to static and dynamic balancing tests.
- 5.04.14 After installation, pumps offered may be subjected to testing at field also

by Employer. If the performances at field are not found to meet the requirement, then the equipment shall be rectified by the Contractor without any extra cost. Prior to performance testing, the procedure for such tests will be mutually agreed between Employer and Contractor. The Contractor shall furnish all necessary instruments, accessories and personnel for site testing. Prior to testing, the calibration curves of all instruments and permissible tolerance limit of instruments shall be mutually agreed upon.

5.04.15 If desired by the Employer, the Contractor shall conduct necessary model test for establishing optimum sump dimensions/flow correcting devices in existing sump, to suit the pump offered.

5.04.16 The Employer or his authorised representative shall have full access to all tests. Prior to performance tests, the Contractor shall intimate the Employer allowing adequate time so that if the Employer so desires, his representative can witness the test.

5.04.17 Report and test certificates of the above tests shall be submitted to the Employer/Engineer for approval.

## 6.00.00 **DIESEL ENGINES**

This Clause covers the design, performance, manufacturing construction features and testing of compression ignition diesel engines, used primarily for driving centrifugal pumps, used for the purpose of fire fighting.

### 6.01.00 **Design and Construction**

#### **General**

6.01.01 The diesel engine shall be of multicylinder type four-stroke cycle with mechanical (airless) injection, cold starting type.

6.01.02 The continuous engine brake horse power rating (after accounting for all auxiliary power consumption) at the site conditions shall be atleast 20% greater than the requirement at the duty point of pump at rated RPM and in no case, less than the maximum power requirement at any condition of operation of pump.

6.01.03 Reference conditions for rated output of engine shall be as per IS:10000, part II or ISO:3046, part I.

6.01.04 The engine shall be designed with regard to ease of maintenance, repair, cleaning and inspection.

6.01.05 All parts subjected to substantial temperature changes shall be designed and supported to permit free expansion and contraction without resulting in leakage, harmful distortion or misalignment.

### 6.01.06 **Starting**

The engine shall be capable of both automatic and manual start. The normal mode of starting is automatic but in the event of failure of automatic start or at the discretion of the operator, the engine can be started manually from the LCP.

Since the fire pumping unit driven by the diesel engine is not required to run continuously for long periods and the operation will not be frequent,

special features shall be built into the engine to allow it to start within a very short period against full load even if it has remained idle for a considerable period.

6.01.07 If provision for manual start (cranking) is provided, all controls/mechanisms, which have to be operated during the starting process, shall be within easy reach of the operator.

6.01.08 Automatic cranking shall be effected by a D.C. motor having high starting torque to overcome full engine compression. Starting power will be supplied from either of the two (2) sets of storage batteries. The automatic starting arrangement shall include a 'Repeat Start' feature. The battery capacity shall be adequate for 10 (ten) consecutive starts without recharging with a cold engine under full compression.

6.01.09 The batteries shall be used exclusively for starting the diesel engine and be kept fully charged all the time in position. Arrangement for both trickle and booster charge shall be provided.

Diesel engine shall be provided with two (2) battery charger units of air-cooled design. The charger unit shall be capable of charging one (1) set of battery at a time. Provision shall, however, be made so that any one of the charger units can be utilised for charging either of the two (2) batteries.

6.01.10 For detail design of battery and battery charger, sub- section Electrical may be referred to.

#### 6.01.11 **Governing System**

The engine shall be fitted with a speed control device, which will control the speed under all conditions of load.

6.01.12 The governor shall offer following features

(a) Engine should be provided with an adjustable governor capable of regulating engine speed within 5% of its rated speed under any condition of load between shut-off and maximum load conditions of the pumps. The governor shall be set to maintain rated pump speed at maximum pump load.

(b) Engine shall be provided with an over speed shut- down device. It shall be arranged to shut-down the engine at a speed approximately 20% above rated engine speed and for manual reset, such that the automatic engine controller will continue to show an over speed signal until the device is manually reset to normal operating position (Vol.II, NFPA, 1978).

6.01.13 The governor shall be suitable for operation without external power supply.

#### 6.01.14 **Fuel System**

The diesel engine will run on High Speed Diesel.

6.01.15 The engine shall be provided with fuel oil tank having adequate capacity to hold sufficient fuel oil for a minimum of six (6) hours of full load run. The fuel oil tank shall preferably be mounted near the engine. No fuel oil tank will be provided by the Employer.

- 6.01.16 The fuel oil tank shall be of welded steel constructed to relevant standards for mild steel drums. The outlet of the tank shall be above the inlet of fuel injection pump of the diesel engine to ensure adequate pressure at suction of injection pump.
- 6.01.17 The fuel oil tank shall be designed in such a way that the sludge and sediment settles down to the tank bottom and is not carried to the injection pump. A small sump shall be provided and fitted with drain plug to take out sludge/sediment and to drain oil. Adequate hand holes (greater than 80 mm size) shall be provided to facilitate maintenance.
- 6.01.18 Pipeline carrying fuel oil shall be gradually sloped from the tank to the injection pump. Any valve in the fuel feed pipe between the fuel tank and the engine shall be placed adjacent to the tank and it shall be locked in the open position. A filter shall be incorporated in this pipeline, in addition to other filters in the fuel oil system. Pipe joints shall not be soldered and plastic tubing shall not be used. Reinforced flexible pipes may also be used.
- 6.01.19 The complete fuel oil system shall be designed to avoid any air pocket in any part of the pipe work, fuel pump, sprayers/injectors, filter system etc. No air relief cock is permitted. However, where air relief is essential, plugs may be used.
- 6.01.20 A manual fuel pump shall be provided for priming and releasing of air from the fuel pipelines.
- 6.01.21 **Lubricating Oil System**
- Automatic pressure lubrication shall be provided by a pump driven by the crank shaft, taking suction from a sump and delivering pressurised oil through cooler and fine mesh filters to a main supply header fitted in the bed plate casing. High pressure oil shall be supplied to the main and big end bearings, cam-shaft bearings, cam-shaft chain and gear drives, governor, auxiliary drive gears etc. Valve gear shall be lubricated at reduced pressure through a reducing valve and the cams by an oil bath.
- 6.01.22 **Cooling Water System**
- Direct cooling or heat exchanger type cooling system shall be employed for the diesel engine. Water shall be tapped from the fire pump discharge. This water shall be led through duplex strainer, pressure breakdown orifice and then after passing through the engine, the water at the outlet shall be taken directly to the sump through an elevated funnel.
- 6.02.00 **Testing & Inspection**
- 6.02.01 The manufacturer shall conduct all tests required, to ensure that the equipment furnished conforms to the requirement of this sub-section and in compliance with requirements of applicable codes. The particulars of the proposed tests and the procedure for the tests shall be submitted to the Employer for approval before conducting the tests.
- 6.02.02 At manufacturer's works, tests shall be carried out during and after completion of manufacture of different component/parts and the assembly as applicable. Following tests shall be conducted.
- 6.02.03 Material analysis and testing.
- 6.02.04 Hydrostatic pressure testing of all pressure parts.

- 6.02.05 Static and dynamic balance tests of rotating parts at applicable over-speed and determination of vibration level.
- 6.02.06 MPI/DPT on machined parts of piston and cylinder.
- 6.02.07 Ultrasonic testing of crankshaft and connecting rod after heat treatment.
- 6.02.08 Dimensional check of close tolerance components like piston, cylinder bore etc.
- 6.02.09 Calibration tests of all fuel pumps, injectors, standard orifices, nozzles, instruments etc.
- 6.02.10 Overspeed test of the assembly at 120% of rated speed.
- 6.02.11 Power run test.
- 6.02.12 Performance test of the diesel engine to determine its torque, power and specific fuel consumption as function of shaft speed. Performance test of the engine shall be carried for 12 hours out of which 1 hour at full load and one hour at 110% overload.
- 6.02.13 Measurement of vibration & noise
- (i) Measurement of vibration
- The vibration shall be measured during full load test as well as during the overload test and limit shall be 100 microns.
- (ii) Measurement of noise level
- The equivalent 'A' weighted sound level measured at a distance of 1.5 M above floor level in elevation and 1.0 M horizontally from the base of the equipment, expressed in dB to a reference of 0.0002 microbar shall not exceed 93 dBA.
- 6.02.14 Adjustment of speed governor as per BS:5514.
- 6.02.15 Diesel engine shall be subjected to routine tests as per IS:10000/BS:5514.
- 7.00.00 **PIPING, VALVES AND SPECIALITIES**
- This clause covers the design, manufacture, shop testing, erection, testing and commissioning of piping, valves and specialities.
- 7.02.00 **Scope**
- The piping system which shall include but not be limited to the following :
- 7.02.01 Plain run of piping, bends, elbows, tees, branches, laterals, crosses, reducing unions, couplings, caps, expansion joints, flanges, blank flanges, thrust blocks, anchors, hangers, supports, saddles, shoes, vibration dampeners, sampling connections, hume pipes etc.
- 7.02.02 Gaskets, ring joints, backing rings, jointing material etc. as required. Also all welding electrodes and welding consumables including special ones, if any.

- 7.02.03 Instrument tapping connections, stubs etc.
- 7.02.04 Gate and globe valves to start/stop and regulate flow and swing check valves for one directional flow.
- 7.02.05 Basket strainers.
- 7.02.06 Bolts, nuts, fasteners as required for interconnecting piping, valves and fittings as well as for terminal points. For pipe connections into Owner's R.C.C. works, Bidder will furnish all inserts.
- 7.02.07 Painting, anti-corrosive coatings etc. inside and outside pipes and equipment.  
  
Adequate number of air release valves shall be provided at the highest points in the piping system to vent any trapped air in the system.

7.03.00 **Design**

7.03.01 Material of construction of various pipes shall be as follows :

(a) **Buried Pipes**

Mild steel black pipes as per IS:1239, Part-I medium grade (for pipes of sizes 150 NB and below) or IS:3589, Fe 410 grade (for pipes of sizes 200 NB and above) suitably lagged on the outside to prevent soil corrosion, as specified elsewhere.

(b) **Overground Pipes normally full of water**

Mild steel black pipes as per IS:1239, Part-I medium grade (for pipes for sizes 150 NB and below) or IS:3589, Fe 410 grade (for pipes of sizes 200 NB and above).

7.03.02 All fittings to be used in connection with steel pipe lines upto a size of 80 mm shall be as per IS:1239. Part-II Mild steel tubulars and other wrought steel pipe fittings, Heavy grade. Fittings with sizes above 80 mm upto 150 mm shall be fabricated from IS:1239 Heavy grade pipes or steel plates having thickness not less than those of IS:1239 Part-I Heavy grade pipes. Fittings with sizes above 150 mm shall be fabricated from IS:3589 Class-2 pipes. All fitting used in GI piping shall be threaded type. Welding shall not be permitted on GI piping.

7.03.03 Pipelines carrying water, air etc. should be sized on the basis of following values of allowable velocities based on the rated capacity of the pumps:

Service Description		Velocity in M/Sec.		
		Pipe Size		
		Below 50 mm	50-150 mm	200 mm & upwards
(a)	Pump suction	—	1.2-1.5	1.2-2.0
(b)	Pump discharge	1.2-1.8	1.8-2.4	2.1-2.5

- 7.03.04 For steel pipeline, welded construction should be adopted unless specified otherwise.
- 7.03.05 All piping system shall be capable of withstanding the maximum pressure arising from any condition of operation and testing including water hammer effects.
- 7.03.06 Gate/slucice valve will be used for isolation of flow in pipe lines and shall be as per IS:778/BS-5150 (for size upto 40 mm), IS:780 (for sizes above 40 mm and upto 300 mm) and IS:2906 (for sizes above 300 mm). Valves shall be of rising spindle type. PN 1.6 class valves shall be provided.
- 7.03.07 Gate Valves shall be provided with the following :
- (a) Hand wheel.
  - (b) Position indicator.
  - (c) Draining arrangement of valve seat.
  - (d) Locking facility (where necessary).
- 7.03.08 Gate valves shall be provided with back seating bush to facilitate gland removal during full open condition.
- 7.03.09 Globe valves shall be provided with contoured plug to facilitate regulation and control of flow. All other requirements should generally follow those of gate valve.
- 7.03.10 Non-return valves shall be swing check type. Valves will have a permanent "arrow" inscription on its body to indicate direction of flow of the fluid. These valves shall generally conform to IS:5312.
- 7.03.11 Whenever any valve is found to be so located that it cannot be approached manually from the nearest floor/gallery/platform handwheel with floor stand or chain operator shall be provided for the same.
- 7.03.12 Valves below 50 mm size shall have screwed ends while those of 50 mm and higher sizes shall have flanged connections.
- 7.03.13 **Strainers**
- Basket Strainer**
- (a) Basket strainers shall be of 30mesh and have the following materials of construction :  
Body Fabricated mild steel as per IS:2062 (Tested Quality).  
Strainer Wires of stainless steel (AISI : 316), 30 SWG, suitably reinforced.
  - (b) Inside of basket body shall be protected by two (2) coats of heavy duty bitumastic paint.
  - (c) Strainers shall be Simplex design. Suitable vent and drain connections with valves shall be provided.

- (d) Screen open area shall be at least 4 times pipe cross sectional area at inlet.
- (e) Pressure drop across strainer in clean condition shall not exceed 1.5 MWC at 410 M<sup>3</sup>/hr flow.

7.03.14 **Hydrant Valve (Outdoor) and Indoor Hydrant Valves (Internal Landing Valves).**

The general arrangement of outdoor stand post assembly, consisting of a column pipe and a hydrant valve with a quick coupling end shall be as per TAC requirement.

Materials of construction shall be as follows :

- (a) Column pipe M.S. IS:1239 med. grade.
- (b) Hydrant Valve
  - (i) Body Gun metal.
  - (ii) Trim Leaded tin bronze as per IS:318, Grade-2.
  - (iii) Hand Wheel Cast Iron as per IS:210, Grade-20.
  - (iv) Washer, gasket etc. Rubber as per IS:638.
  - (v) Quick coupling connection Leaded tin bronze as per IS:318, Grade-2.
  - (vi) Spring Phosphor Bronze as per IS:7608.
  - (vii) Cap and chain Leaded tin bronze as per IS:318, Grade-2.

The general design of hydrant valve shall conform to IS:5290.

7.03.15 **Hoses, Nozzles, Branch pipes and Hose boxes**

- (a) Hose pipes shall be of unlined flax canvas/reinforced rubber-lined canvas construction as per IS:4927/type A of IS:636 with nominal size of 63 MM (2 1/2") and lengths of 15 metre or 7.5 metre, as indicated elsewhere. All hoses shall be ISI marked.
- (b) Hosepipes shall be capable of withstanding an internal water pressure of not less than 35 kg/cm<sup>2</sup> without bursting. It must also withstand a working pressure of 8.5 kg/cm<sup>2</sup> without undue leakage or sweating.
- (c) Each hose shall be fitted with instantaneous spring lock type couplings at both ends. Hose shall be fixed to the coupling ends by copper rivets and the joint shall be reinforced by 1.5 mm galvanised mild steel wires and leather bands.
- (d) Branch pipes shall be constructed of copper and have rings of leaded tin bronze (as per IS:318 Grade-2) at both ends. One end of

- the branch pipe will receive the quick coupling while the nozzles will be fixed to the other end.
- (e) Nozzles shall be constructed of leaded tin bronze as per IS:318, Grade-2.
  - (f) Suitable spanners of approved design shall be provided in adequate numbers for easy assembly and dismantling of various components like branch pipes, nozzles, quick coupling ends etc.
  - (g) Hose pipes fitted with quick coupling ends, branch pipes, nozzles spanner etc. will be kept in a hose box, which will be located near point of use. The furnished design must meet the approval of Tariff Advisory Committee.
  - (h) All instantaneous couplings, as mentioned under clause Nos.3.03.19, 3.03.20 and 3.03.21 above shall be of identical design (both male and female) so that any one can be interchanged with another. One male, female combination shall get locked in by mere pushing of the two halves together but will provide leak tightness at a pressure of 8 kg/cm<sup>2</sup> of water. Designs employing screwing or turning to have engagement shall not be accepted.

#### 7.04.00 **Fabrication & Erection**

7.04.01 The contractor shall fabricate all the pipework strictly in accordance with the related approved drawings.

#### 7.04.02 **End Preparation**

- (a) For steel pipes, end preparation for butt welding shall be done by machining.
- (b) Socket weld end preparation shall be sawing/machining.
- (c) For tees, laterals, mitre bends, and other irregular details cutting templates shall be used for accurate cut.

#### 7.04.03 **Pipe Joints**

- (a) In general, pipes having sizes over 25 mm shall be joined by butt welding. Pipes having 25 mm size or less shall be joined by socket welding/screwed connections. Galvanised pipes of all sizes shall have screwed joints. No welding shall be permitted on GI pipes. Screwed joints shall have tapered threads and shall be assured of leak tightness without using any sealing compound.
- (b) Flanged joints shall be used for connections to vessels, equipment, flanged valves and also on suitable straight lengths of pipe line of strategic points to facilitate erection and subsequent maintenance work.

#### 7.04.04 **Overground Piping**

- (a) Piping to be laid overground shall be supported on pipe rack/supports. Rack/supports details shall have to be approved by Employer/Engineer.
- (b) Surface of overground pipes shall be thoroughly cleaned of mill scale, rust etc. by wire brushing. Thereafter one (1) coat of red

lead primer shall be applied. Finally two (2) coats of synthetic enamel paint of approved colour shall be applied.

7.04.05 **Buried Pipe Lines**

- (a) Pipes to be buried underground shall be provided with protection against soil corrosion by coating and wrapping with two coats of coal tar hot enamel paint and two wraps of reinforced fibre glass tissue. The total thickness of coating and wrapping shall not be less than 3 mm. Alternatively corrosion resistant tapes can also be used for protection of pipes against corrosion.
- (b) Coating and wrapping shall be in line with IS:10221.
- (c) Buried pipelines shall be laid with the top of pipe one meter below ground level.
- (d) At site, during erection, all coated and wrapped pipes shall be tested with an approved Holiday detector equipment with a positive signalling device to indicate any fault hole breaks or conductive particle in the protective coating.

7.05.00 **General Instruction for Piping Design and Construction**

7.05.01 While erecting field run pipes, the contractor shall check, the accessibility of valves, instrument tapping points, and maintain minimum headroom requirement and other necessary clearance from the adjoining work areas.

7.05.02 Modification of prefabricated pipes, if any, shall have to be carried out by the contractor at no extra charge to the Employer.

7.05.03 **Welding**

- (i) Welding shall be done by qualified welders only.
- (ii) Before welding, the ends shall be cleaned by wire brushing, filing or machine grinding. Each weld-run shall be cleaned of slag before the next run is deposited.
- (iii) Welding at any joint shall be completed uninterrupted. If this cannot be followed for some reason, the weld shall be insulated for slow and uniform cooling.
- (iv) Welding shall be done by manual oxyacetylene or manual shielded metal arc process. Automatic or semi-automatic welding processes may be done only with the specific approval of Employer/Consultant.
- (v) As far as possible welding shall be carried out in flat position. If not possible, welding shall be done in a position as close to flat position as possible.
- (vi) No backing ring shall be used for circumferential butt welds.
- (vii) Welding carried out in ambient temperature of 5°C or below shall be heat-treated.
- (viii) Tack welding for the alignment of pipe joints shall be done only by

qualified welders. Since tack welds form part of final welding, they shall be executed carefully and shall be free from defects. Defective welds shall be removed prior to the welding of joints.

Electrodes size for tack welding shall be selected depending upon the root opening.

- (ix) Tacks should be equally spaced as follows :
- |                             |   |         |
|-----------------------------|---|---------|
| for 65 NB and smaller pipes | : | 2 tacks |
| for 80 NB to 300 NB pipes   | : | 4 tacks |
| for 350 NB and larger pipes | : | 6 tacks |
- (x) Root run shall be made with respective electrodes/filler wires. The size of the electrodes/filler wires. The size of the electrodes shall not be greater than 3.25 mm (10 SWG) and should preferably be 2.3 mm (12 SWG). Welding shall be done with direct current values recommended by the electrode manufacturers.
- (xi) Upward technique shall be adopted for welding pipes in horizontally fixed position. For pipes with wall thickness less than 3 mm, oxyacetylene welding is recommended.
- (xii) The root run of butt joints shall be such as to achieve full penetration with the complete fusion of root edges. The weld projection shall not exceed 3 mm inside the pipe.
- (xiii) On completion of each run craters, weld irregularities, slag etc. shall be removed by grinding or chipping.
- (xiv) Fillet welds shall be made by shielded metal arc process regardless of thickness and class of piping. Electrode size shall not exceed 10 SWG. (3.25 mm). At least two runs shall be made on socket weld joints.

#### 7.06.00 **Tests at Works**

##### 7.06.01 **Pipes**

- (i) Mechanical and chemical tests shall be performed as required in the codes/standards.
- (ii) All pipes shall be subjected to hydrostatic tests as required in the codes/standards.
- (iii) 10% spot Radiography test on welds of buried pipes shall be carried out as per ASME VIII.

##### 7.06.02 **Valves**

- (i) Mechanical and chemical tests shall be conducted on materials of the valve as required in the codes/standards.
- (ii) All valves shall be tested hydrostatically for the seat as well as required in the code/standards for a period of ten minutes.

- (iii) Air test shall be conducted to detect seat leakage.
- (iv) Visual check on the valve and simple operational test in which the valve will be operated thrice from full open to full close condition.
- (v) No repair work on CI valve body, bonnet or wedge shall be allowed.

7.06.03 **Strainers**

- (i) Mechanical and chemical tests shall be conducted on materials of the strainer.
- (ii) Strainers shall be subjected to a hydrostatic test pressure of 1.5 times the design pressure or 10 kg/cm<sup>2</sup>g whichever is higher for a period of one hour.
- (iii) Pressure drop test on one strainer of each size/type shall be conducted.

7.06.04 **Hydrant valves and Indoor Hydrant Valves (Internal Landing Valves)**

- (i) The stand post assembly along with the hydrant valve (valve being open and outlet closed) shall be pressure tested at a hydrostatic pressure of 21 kg/cm<sup>2</sup>g to detect any leakage through defects of casting.
- (ii) Flow test shall be conducted on the hydrant valves at a pressure of 7 kg/cm<sup>2</sup>g and the flow through the valve shall not be less than 900 litres/min.
- (iii) Leak tightness test of the valve seat shall be conducted at a hydrostatic test pressure of 14 kg/cm<sup>2</sup>g.

7.06.05 **Hoses, Nozzles, Branch Pipes and Hose Boxes**

Unlined flax/reinforced rubber-lined canvas hoses shall be tested hydrostatically. Following tests shall be included as per IS:4927/IS:636.

- (a) Percolation test.
- (b) Pressure test at 21 kg/cm<sup>2</sup>g.
- (c) Burst test at 32 kg/cm<sup>2</sup>g (minimum).

The branch pipe, coupling and nozzles shall be subjected to a hydrostatic test pressure of 21 kg/cm<sup>2</sup>g to detect any leakage through defects of casting.

Dimensional checks shall be made on the hose boxes and nozzle spanners.

8.00.00 **AIR VESSELS**

8.01.00 Air vessels shall be designed and fabricated of mild steel as class-II vessels as per IS:2825.

8.02.00 Inside surface of the tank shall be protected by anti-corrosive paints/coatings/linings as required.

8.03.00 Outside surfaces of the vessels shall be provided with one (1) coat of red lead primer with two (2) coats of synthetic enamel paint of approved colour and characteristics.

#### 8.04.00 **Tests & Inspection**

8.04.01 Air vessels shall be hydraulically tested at 1.5 times design pressure or 2 times the working pressure, whichever is higher, for a period not less than one (1) hour.

8.04.02 All materials used for fabrication shall be of tested quality and test certificates shall be made available to the Owner.

8.04.03 Welding procedure and Welder's qualification tests will be carried out as per relevant IS Standard.

8.04.04 NDE tests, which will include 100% Radiography on longitudinal seams and spot Radiography for circumferential seams, for pressure vessel will be carried out.

### 9.00.00 **HEAT DETECTORS/FIRE DETECTORS AND SPRAY NOZZLES**

#### 9.00.01 **Intent of Specification**

This specification lays down the requirements of the smoke detectors, heat detectors and spray nozzles for use in various sub-systems of the fire protection system.

#### 9.00.02 **Codes and Standards**

All equipment supplied shall conform to internationally accepted codes and standards. All equipment offered by Bidders should be TAC approved or have been in use in installations which have been approved by TAC.

#### 9.01.00 **Fire Detectors**

9.01.01 Fire detectors shall be approved by FOC-London or similar international authorities and also by Tariff Advisory Committee of India.

9.01.02 Both smoke and heat type fire detectors shall be used Bidder shall clearly indicate the mode of operation of detectors in his proposal.

9.01.03 The set point shall be selected after giving due consideration for ventilating air velocity and cable insulation. The set point shall be adjustable.

9.01.04 Fire detectors shall be equipped with an integral L.E.D. so that it shall be possible to know which of the detectors has been operated. The detectors which are to be placed in the space above the false ceiling or in the floor void shall not have the response indicators on the body but shall be provided with remote response indicators.

9.01.05 Approval from Department of Atomic Energy (DAE), Government of India shall be made available for ionisation type smoke detectors. All accessories required to satisfy DAE shall also be included in the scope of supply.

9.01.06 Fire detectors shall be guaranteed to function properly without any

maintenance work for a period of not less than ten (10) years.

## **10.00.00 PORTABLE FIRE EXTINGUISHERS**

### 10.00.01 Intent of Specification

This specification lays down the requirement regarding fire extinguishers of following types :

Portable fire extinguishers.

- (a) Pressurised water type.
- (b) Dry chemical powder type.
- (c) Carbon Dioxide type.

10.00.02 All the extinguishers offered by the Bidder shall be of reputed make and should have been approved by erstwhile Tariff Advisory Committee of India or any other international authorities like FOC - London/NFPA-USA. Certificates to this effect shall be furnished by the Bidder. All extinguishers shall be ISI marked.

### 10.01.00 **Design and Construction**

10.01.01 All the portable extinguishers shall be of freestanding type and shall be capable of discharging freely and completely in upright position.

10.01.02 Each extinguisher shall have the instructions for operating the extinguishers on its body itself.

10.01.03 All extinguishers shall be supplied with initial charge and accessories as required.

10.01.04 Portable type extinguishers shall be provided with suitable clamps for mounting on walls or columns.

10.01.05 All extinguishers shall be painted with durable enamel paint of fire red colour conforming to relevant Indian Standards.

10.01.06 Pressurisation of water type fire extinguishers shall either be done by compressed air or by using gas cartridge. The constant air pressure type shall conform to IS:6234 and the gas pressure type shall conform to IS:940. Both these extinguishers shall be ISI marked.

10.01.07 Dry chemical powder type extinguisher shall conform to IS : 2171.

10.01.08 Carbon Dioxide type extinguisher shall conform to IS:2878.

10.01.09 Wheel/ trolley mounted fire extinguishers of Dry chemical powder type shall conform to IS:10658

10.01.10 Wheel/ trolley mounted fire extinguishers of Carbon dioxide type shall conform to IS:2878

### 10.02.00 **Tests and Inspection**

10.02.01 Particulars of shop tests and procedure shall be submitted to the Employer

before hand for approval.

10.02.02 A performance demonstration test at site of five (5) percent or one (1) number whichever is higher, of the extinguishers shall be carried out by the Contractor. All consumable and replaceable items require for this test would be supplied by the Contractor without any extra cost to Employer.

10.02.03 Performance testing of extinguisher shall be in line of applicable Indian Standards. In case where no Indian Standard is applicable for a particular type of extinguisher, the method of testing shall be mutually discussed and agreed to before placement of order for the extinguishers.

#### 10.03.00 **Performance Guarantee**

The Contractor shall guarantee all equipment supplied by him against any defect due to faulty design, material and workmanship. The equipment shall be guaranteed to operate satisfactorily at the rated conditions at site.

#### 10.04.00 **Painting**

Each fire extinguisher shall be painted with durable enamel paint of fire red colour conforming to relevant Indian Standards.

### 11.00.00 **INSTRUMENTS**

#### 11.00.01 **Intent of Specification**

The requirements given in the sub-section shall be applicable to all the instruments being furnished under this specification.

11.00.02 All field mounted instruments shall be weather and dust tight, suitable for use under ambient conditions prevalent in the subject plant. All field mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance can be achieved.

#### 11.01.00 **Local Instruments**

Pressure/Combination/Differential Gauges & Switches.

11.01.01 The pressure sensing elements shall be continuous 'C' bourdon type.

11.01.02 The sensing elements for all gauges/switches shall be properly aged and factory tested to remove all residual stresses. They shall be able to withstand atleast twice the full scale pressure/vacuum without any damage or permanent deformation.

11.01.03 For all instruments, connection between the pressure sensing element and socket shall be braced or hard soldered.

11.01.04 Gauges shall be of 150 mm diameter dial with die-cast aluminium, stoved enamel black finish case, aluminium screwed ring and clear plastic crystal cover glass. Upper range pointer limit stop for all gauges shall be provided.

11.01.05 All gauges shall be with stainless steel bourdon having rotary geared stainless steel movements.

11.01.06 Weatherproof type construction shall be provided for all gauges. This type

of construction shall be fully dust tight, drip tight, weather resistant and splash proof with anti-corrosive painting conforming to NEMA- 4.

- 11.01.07 All gauges shall have micrometer type zero adjuster.
- 11.01.08 Neoprene safety diaphragm shall be provided on the back of the instruments casing for pressure gauges of ranges 0-10 Kg/cm<sup>2</sup> and above.
- 11.01.09 Scales shall be concentric, white with black lettering and shall be in metric units.
- 11.01.10 Accuracy shall be  $\pm 1.0$  percent of full range or better.
- 11.01.11 Scale range shall be selected so that normal process pressure is approximately 75 percent of full scale reading.
- 11.01.12 All gauges shall have 1/2 inch NPT bottom connection.
- 11.01.13 All instruments shall conform to IS : 3624 - 1966.
- 11.01.14 All instruments shall be provided with 3 way gauge isolation valve or cock. Union nut, nipple and tail pipe shall be provided wherever required.
- 11.01.15 Switch element contact shall have two (2) NO and two (2) NC contacts rated for 240 Volts, 10 Amperes A.C. or 220 Volts, 5 Amperes D.C. Actuation set point shall be adjustable throughout the range. ON-OFF differential (difference between switch actuation and de-actuation pressures) shall be adjustable. Adjustable range shall be suitable for switch application.
- 11.01.16 Switches shall be sealed diaphragm, piston actuated type with snap action switch element. Diaphragm shall be of 316 SS.
- 11.01.18 Necessary accessories shall be furnished.
- 11.02.00 **Timers**
- 11.02.01 The timers shall be electro-mechanical type with adjustable delay on pick-up or reset as required.
- 11.02.02 Each timer shall have two pairs of contacts in required combination of NO and NC.
- 11.03.00 **Level Gauges/Indicator/Switches**
- 11.03.01 **Level Gauges**
  - (i) Gauge glasses shall be used for local level indication wherever shown in the flow diagram.
  - (ii) Gauge glasses, in general, shall be flag glass type with bolted cover. Body and cover material shall be of carbon steel with rubber lining.
  - (iii) Level coverage shall be in accordance with operating requirements. Maximum length of a single gauge glass shall not exceed 1.4 M. Should a larger gauge glass be required, multiple gauges of preferably equal length shall be used with 50 mm overlap in

visibility.

- (iv) Reflex type gauge glasses shall be used for colourless liquids and transparent type gauge glasses shall be used for all liquids having colour.
- (v) Each gauge glass shall be complete with a pair of offset valves. Valves shall have union bonnet, female union level connection, flanged tank connection, and vent and drain plug.
- (vi) Offset valves shall have corrosion resistant ball-check to prevent fluid loss in the event of gauge glass breakage. Valve body shall have a working pressure of 200 percent of the maximum static pressure at the maximum process fluid temperature. Valve body materials shall be of carbon steel with rubber lining.

#### 11.03.02 **Level Indicators**

- (i) Float type mechanical level gauges with linear scale type indicator shall be offered for measuring level of tanks wherever shown in the flow diagram.
- (ii) AISI-316 stainless steel float, guide rope and tape shall be used. Housing shall be of mild steel painted with anti-corrosive painting.
- (iii) The scale indicator shall be provided at a suitable height for ease of reading.
- (iv) Accuracy shall be  $\pm 1\%$  of scale range or better.

#### 11.03.03 **Level Switches**

- (i) Level switches shall be of ball float operated magnetic type complete with cage.
- (ii) Materials of construction shall be suitable for process and ambient conditions. The float material shall be AISI-316 stainless steel.
- (iii) Actuating switches shall be either hermetically sealed mercury type or snap acting micro-switches. Actuation set point shall be adjustable. ON-OFF differential (difference between switch actuation and de-actuation levels) shall be adjustable. Adjustable range shall be suitable for switch application. All switches shall be repeatable within  $\pm 1.0$  percent of liquid level change required to activate switch. Contacts shall be rated for 50 watts resistive at 240 V A.C. Number of contacts shall be two NO and two NC for each level switch.

#### 11.04.00 **Solenoid Valves**

- 11.04.01 The body of the valves shall be Forged brass or stainless steel.
- 11.04.02 The coil shall be continuous duty, epoxy moulded type Class-F, suitable for high temperature operation.
- 11.04.03 The enclosure shall be watertight, dust-tight and shall conform to NEMA-4 Standard.
- 11.04.04 The valves shall be suitable for mounting in any position.

- 11.05.00      **Switches, Lamps, Meters Etc.**
- All electrical components on the panel namely push buttons, switches, lamps, meters etc. shall meet the requirements of sub-section Electrical enclosed with the specification.
- 11.06.00      All local instruments shall be inspected by Employer/Consultant as per the agreed quality plan.
- 11.07.00      Makes of control panel and local instruments, accessories shall be as per Employer's approval.
- 12.00.00      **ELECTRIC MOTORS**
- 12.01.00      **General**
- 12.01.01      This clause covers the requirements of three phase squirrel cage induction motors and single-phase induction motors.
- 12.01.02      The motors to be furnished, erected and commissioned as covered under this specification shall be engineered, designed, manufactured, erected, tested as per the requirements specified herein. These requirements shall however be read along with the requirements of the respective driven equipment being supplied under the specification of which this specification forms a part.
- 12.01.03      The motor supplied under this specification shall conform to the standards specified in GTR.
- 12.01.04      Terminal point for all motors supplied under this specification shall be at the respective terminal boxes.
- 12.01.05      Materials and components not specifically stated in this specification but are necessary for satisfactory operation of the motor shall be deemed to be included in the scope of supply of this specification.
- 12.01.06      Notwithstanding anything stated in this motor specification, the motor has to satisfy the requirement of the mechanical system during normal and abnormal conditions. For this the motor manufacturer has to co-ordinate with the mechanical equipment supplier and shall ensure that the motor being offered meets the requirements.
- 12.02.00      **Codes & Standards**
- 12.02.21      The design, manufacture, installation and performance of motors shall conform to the provisions of latest Indian Electricity Act and Indian Electricity Rules. Nothing in these specifications shall be construed to relieve the Contractor of his responsibility.
- 12.02.22      In case of contradiction between this specifications and IS or IEC, the stipulations of this specification shall be treated as applicable.
- 12.02.23      National Electrical code for hazardous location and relevant NEMA standard shall also be applicable for motors located in hazardous location.

12.03.00 **Design Features**

12.03.01 **Rating and type**

- (i) The induction motors shall be of squirrel cage type unless specified otherwise.
- (ii) The motors shall be suitable for continuous duty in the specified ambient temperature.
- (iii) The MCR KW rating of the motors for 40°C ambient shall not be less than the power requirement imposed at the motor shaft by the driven equipment under the most onerous operation conditions as defined elsewhere, when the supply frequency is 51.5 Hz (and the motor is running at 103% of its rated speed).
- (iv) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously in the system having the following particulars :
  - (a) Rated terminal voltage

From 0.2 to 200 kW	415V (3 Phase, solidly earthed)
Below 0.2 kW	240 V (1 Phase, solidly earthed)

Variation in voltage  $\pm 6\%$ .
  - (b) Frequency 50 Hz  $\pm 3\%$ .
  - (c) Any combination of (a) & (b)

12.03.02 **Enclosure**

Motors to be installed outdoor and semi-outdoor shall have hose proof enclosure equivalent to IP-55 as per IS : 4691. For motors to be installed indoor, the enclosure shall be dust proof equivalent to IP-54 as per IS : 4691. For hazardous locations, the enclosures of the motor shall be of flameproof construction.

12.03.03 **Cooling method**

Motors shall be TEFC (totally enclosed fan cooled) type.

12.03.04 **Starting requirements**

- (i) **Induction motor**
  - (a) All induction motors shall be suitable for full voltage direct on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.
  - (b) Motors shall be capable of withstanding the electro-dynamic stresses and heating imposed if it is started at a

voltage of 110% of the rated value.

- (c) The starting current of the motor at rated voltage shall not exceed six (6) times the rated full load current subject to tolerance as given in IS : 325.
- (d) Motors when started with the driven equipment imposing full starting torque under the supply voltage condition specified under Clause 12.03.01 (iv) (a) shall be capable of withstanding atleast two successive starts with coasting to rest between starts and motor initially at the rated load operating temperature. The motors shall also be suitable for three equally spread starts per hour, the motor initially at a temperature not exceeding the rated operating temperature.
- (e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than the starting time with the driven equipment at minimum permissible voltage (clause 12.03.04 (i) (a) by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

#### 12.03.05

#### **Running requirements**

- (i) When the motors are operating at extreme condition of voltage and frequency given under clause no.12.03.01 (iv) the maximum permissible temperature rise over the ambient temperature of 50°C shall be within the limits specified in IS : 325 (for 3-phase induction motors) and IS : 996 (for 1 phase motor) after adjustment due to increase ambient temperature specified herein.
- (ii) The double amplitude of motor vibration shall be within the limits specified in IS : 4729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.
- (iii) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.
- (iv) Induction motors shall be so designed as to be capable of withstanding the voltage and torque stresses developed due to the difference between the motor residual voltage and incoming supply voltage during fast changeover of buses. The necessary feature incorporated in the design to comply with this requirement shall be clearly indicated in the proposal.
- (v) Motors shall be capable of developing the rated full load torque even when the supply voltage drops to 70% of rated voltage. Such operation is envisaged for a period of one second. The pull out torque of the induction motors to meet this requirement shall not be less than 205% of full load torque.
- (vi) The motors shall be capable of withstanding for 10 seconds without

stalling or abrupt change in speed (under gradual increase of torque) an excess torque of 60 percent of their rated torque, the voltage and frequency being maintained at their rated value.

- (vii) Guaranteed performance of the motors shall be met with tolerances specified in respective standards.

#### 12.04.00 **Construction Features**

##### 12.04.01 **Stator**

###### (i) **Stator frame**

The stator frames and all external parts of the motors shall be rigid fabricated steel or of casting. They shall be suitably annealed to eliminate any residual stresses introduced during the process of fabrication and machining.

###### (ii) **Stator core**

The stator laminations shall be made from suitable grade magnetic sheet steel varnished on both sides. They shall be pressed and clamped adequately to reduce the core and teeth vibration to minimum.

###### (iii) **Insulation and winding**

- (a) All insulated winding conductor shall be of copper. The overall motor winding insulation for all 415 volts motors shall be of epoxy thermosetting type i.e., class 'F' but limited to class-B operating from temperature rise consideration. Other motors may be of conventional class-B type. The windings shall be suitable for successful operation in hot, humid, tropical climate with the ambient temperature of 40°C.

##### 12.04.02 **Rotor**

- (i) Rotors shall be so designed as to keep the combined critical speed with the driven equipment away from the running speed by atleast 20%.
- (ii) Rotors shall also be designed to withstand 120% of the rated speed for 2 minutes in either direction of rotation.

##### 12.04.03 **Terminal box leads**

- (i) For motors of 415 Volts and below a single terminal box may be provided for power and accessories leads.
- (ii) Terminal boxes shall be of weatherproof construction designed for outdoor service. To eliminate entry of dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame.
- (iii) Terminal box shall be suitable for top and bottom entry of cables.
- (iv) Unless otherwise approved, the terminal box shall be capable of being turned through 360° in steps in 90°.

- (v) The terminals shall be complete with all accessories for connecting external cables. They shall be designed for the current carrying capacity and shall ensure ample phase to phase to ground clearances.
- (vi) Suitable tinned brass compression type cable glands and cable lugs shall be supplied by the Contractor to match Employer's cable.
- (vii) Terminal box for single core cable shall be of non- magnetic material.
- (viii) Marking of all terminals shall be in accordance with IS : 4728.

12.04.04 **Rating Plates**

- (i) Rating plates shall be provided for all motors giving the details as called for in the following standards.
  - (a) IS : 325 (for three phase squirrel cage induction motors).
  - (b) IS : 996 (for single phase A.C. and universal electric motors).
- (ii) In addition to above, the rating plate shall indicate the following :
  - (a) Temperature rise in °C under normal working conditions.
  - (b) Phase sequence corresponding to the direction of rotation for the application.
  - (c) Bearing identification number (in case of ball/ roller bearing) and recommended lubricants.

12.04.05 **Other Constructional Features**

- (i) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of Employer's earthing conductor to be specified to the successful Bidder.
- (ii) Motor weighing more than 25 kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

12.05.00 **Paint and Finish**

12.05.01 Motor external parts shall be finished and painted to produce a neat and durable surface, which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all sharp edges and scales removed and treated with one coat of primer and two coats of grey enamel paint.

12.05.02 Motor fans shall also be painted to withstand corrosion.

12.05.03 All fasteners used in the construction of the equipment shall be either of corrosion resistant material or heavy cadmium plated.

12.05.04 Current carrying fasteners shall be either of stainless steel or high tensile brass.

- 12.06.00 **Tests at Manufacturers Works**
- 12.06.01 Motors shall be subject to routine tests in accordance with the following standards :
- (a) For 3 phase induction motors IS : 325 & IS : 4029
  - (b) For single phase induction motors IS : 996
- 12.06.02 In addition, the following tests shall also be carried out :
- (a) 20% over speed test for 2 minutes on all rotors.
  - (b) Measurement of vibration.
  - (c) Measurement of noise level.
  - (d) Phase sequence and polarity checks relative to mechanical rotation.
- 12.06.03 Results of routine tests carried out on all motors in accordance with the standards indicated above shall be furnished to the Engineer in six (6) copies for his scrutiny and approval. Only on acceptance from his side, motors can be considered suitable for despatch.
- 12.06.04 The Employer reserves the right to send his representative(s) to witness the tests. At least 3 weeks notice shall be given intimating the date of tests.
- 12.06.05 **Tests after installation at site**
- (i) After installation and commissioning at site, the motors alongwith the driven equipment shall be subject to tests to ascertain their conformity with the requirement of this specification and those of the driven equipment specification and the performance data quoted by the Bidder.
  - (ii) In case of non-conformity of the motor with these specifications and performance requirement, the Engineer may at his discretion reject or ask for necessary rectification/replacement
- 13.00.00 **BATTERY & BATTERY CHARGERS**
- This clause covers the design, performance, manufacturing, construction features and testing of Battery and Battery charger used primarily for starting the diesel engine driving the fire water pumps.
- 13.01.00 **General Information**
- 13.01.01 The equipment specified hereinafter are required for starting the diesel engines and other operation of the plant as required.
- 13.01.02 For each diesel engine there shall be two (2) sets of Battery and two (2) sets of Battery Charger.
- 13.01.03 The D.C. voltage shall be obtained normally after necessary rectification by battery charger. The Battery Charging system shall be capable of meeting the following requirements :

- 13.01.04 Float charging the Battery.
- 13.01.05 Boost Charging the Battery.
- 13.01.06 The battery shall be large enough to crank the engine 10 times without charging in between and without getting drained to an extent which will affect its life.
- 13.01.07 The Bidder shall indicate the battery voltage and battery capacity in Ampere- Hour at ten (10) hour discharge rate. The battery voltage at any time during operation shall not be less than the minimum voltage required for operation of the D.C. loads.
- 13.02.00 **General Design**
- The Battery and Battery Charger shall be located indoor.
- The Battery Charger shall have suitable provision for mounting on column/wall.
- 13.02.01 **Battery**
- (i) The cells shall be lead-acid type. The Battery shall be automotive type.
  - (ii) The cells shall be sealed in type with anti-splash type vent plug.
  - (iii) The cell terminal posts shall be provided with connector bolts and nuts, effectively coated with lead to prevent corrosion. Lead or lead coated copper connectors shall be furnished to connect up cells of battery set.
  - (iv) Positive and Negative terminal posts shall be clearly and indelibly marked for easy identification.
  - (v) The electrolyte shall be of battery grade Sulphuric Acid conforming to IS : 226-2962. Water for storage batteries conforming to IS : 1069 shall be used in the preparation of the electrolyte.
- 13.02.02 **Battery Charger**
- (i) The Bidder shall furnish the battery charging scheme complete with all necessary accessories such as transformers, switches, fuses, starters, contactors, diodes, ammeters, voltmeters and other devices as required for trouble free operation. All devices and equipment shall conform to relevant Indian Standard or shall be Superior to it.
  - (ii) The scheme of the battery charger shall be such that the battery can be charged automatically as well as manually.
  - (iii) The boost charger shall have sufficient capacity to restore a fully discharged Battery to a state of full charge in eight (8) hours with some spare margin over maximum charging rate. Suitable provision shall be kept so that, for a particular engine, any of the two (2) charger units can be used for charging any of the two (2) batteries.

- (iv) The charging equipment shall be housed in a panel of sheet steel construction with hinged door on the front side. The minimum thickness of sheet steel shall be 2.5 mm. The panel shall have suitable provision for taking the cable from bottom/top.
- (v) The instruments, switches and lamps shall be flush/semi-flush mounted on the front panel. Name plate of approved type shall be provided for each of these equipment.
- (vi) The panel shall be complete with internal wiring and input-output terminal block. Terminal blocks shall be clip on type of suitable rating. All equipment and wire terminals shall be identified by symbols corresponding to applicable schematic/wiring diagram.
- (vii) Space heaters of adequate capacity shall be provided to prevent moisture condensation in the panel.
- (viii) The panel shall be chemically cleaned, rinsed, bonderised, rinsed and air dried. Immediately after bonderising, the steel shall be sprayed with a coat of primer. The finish of the panel shall consist of two coats of sprayed-on pearl grey enamel or lacquers (IS:631).

13.03.00 **Testing**

13.03.01 The Battery Charger shall also be subjected to the following tests at manufacturer's works as per IS - 4540

13.03.02 Insulation test.

13.03.03 Connection checking.

13.03.04 Measurement of voltage regulation.

13.03.05 Auxiliary of devices.

13.03.06 Alternating current measurement.

13.03.07 Performance test.

13.03.08 Temperature rise test.

13.03.09 Following acceptance tests shall be carried out in batteries as per IS : 1651.

- (a) Marking and packing.
- (b) Verification of dimensions.
- (c) Test for capacity.
- (d) Test for voltage during discharge.

14.00.00 **CONTROL & ANNUNCIATION PANELS**

14.01.00 **Intent of Specification**

The following requirement shall be applicable to the control and

annunciation panels furnished under these specifications.

14.02.00 **General Information**

14.02.01 The equipment specified herein are required for controlling, metering, monitoring and indication of electrical systems of the plant offered.

14.02.02 The selection and design of all the equipment shall be so as to ensure reliable and safe operation of the plant and shall be subjected to approval by the Employer.

14.02.03 The reference ambient temperature outside the panel shall be taken as 40°C and relative humidity 100%.

14.03.00 **Equipment to be Furnished**

Control & annunciation panels shall be furnished complete with all accessories and wiring for safe and trouble free operation of the plant. Details are included in sub-section General.

14.04.00 **Constructional Details**

14.04.01 The panel frames shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 2.5 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary.

14.04.02 Free standing type panels shall be provided with hinged door with locking arrangement. The access doors, cutest and covers shall be equipped with neoprene/synthetic rubber all around and the latches sufficiently strong to hold them in alignment when closed. The panels to be installed outdoor or semi outdoor shall have a degree of protection of IP:55 and those installed indoor shall have a degree of protection of IP:52 as per IS:2147.

14.04.03 If a panel consists of a number of panels, each panel should be mounted side by side and bolted together to form a compact unit, when two panels meet, the joints shall be smooth, close fittings and un-obstructive.

14.04.04 Removable eye bolt or lifting lugs shall be provided on all panels to facilitate easy lifting.

14.04.05 The heights of all operating equipment on the panel shall be between 800 mm to 1600 mm from the finished floor level. If the control panel height is small then it should be mounted on a separate support so that the operating height of the equipment comes within the above limit. The proper supporting arrangement shall be provided by the Contractor.

14.04.06 Cable entries to the panel may be from bottom or top. The cable entry required will be intimated to the successful Bidder. A suitable removable gland plate of 3 mm thick shall be mounted not less than 200 mm above the floor level.

14.04.07 All equipment mounted on the front face of the panels shall be flush or semi-flush type. All equipment shall be so located that their terminal and adjustment are readily accessible for inspection or maintenance and their removal and replacement can be done without interruption of service to

other equipment. The contractor shall submit the panel general arrangement drawings clearly bringing out internal mounting details, dimensions of equipment, clearance between the equipment and the edges of the panel, for approval.

**14.05.00 Name Plates and Labels**

14.05.01 Each panel shall be provided with prominent, engraved identification plates for all front mounted equipment. Panel identification name plate shall be provided at front and rear as required.

14.05.02 All name plates shall be of non-rusting metal or 3 ply lamincold, with white engraved lettering on black background. Inscription and lettering sizes shall be subjected to Employer's approval.

14.05.03 Suitable plastic sticker labels shall be provided for easy identification of all equipment located inside the panel. These labels shall be positioned so as to be clearly visible and shall give the device number, as mentioned in the wiring drawings.

**14.06.00 AC/DC Power Supply**

14.06.02 The Employer will provide one feeder each for AC and DC to the panel. The Contractor shall make for his own arrangements for providing these power supplies to different panels.

14.06.02 The Contractor shall provide suitable isolating switch fuse unit in the control panel for receiving the above incoming AC and DC supplies. Fuse and link shall be provided for isolating of individual circuit without disturbing other circuits.

**14.07.00 Wiring**

14.07.01 All inter panel wiring and connections between panels (if there is group of panels) including all bus wiring for AC & DC supplies shall be provided by the Contractor.

14.07.02 All internal wiring shall be carried out with 1100 V grade, single core, 1.5 square mm or larger stranded copper wires having colour-coded PVC insulation. CT circuits shall be wired with 2.5 square mm copper wires, otherwise similar to the above.

14.07.03 Extra-flexible wire shall be used for wiring to devices mounted on moving parts such as doors.

14.07.04 Spare contacts of auxiliary relays, timers and switches shall be wired out to the terminal blocks as required by the Employer/Engineer at the time of detailed engineering.

**14.08.00 Terminal Blocks**

14.08.01 Terminal Blocks shall be of 650V grade, rated for 10 Amps and in one-piece moulding. It shall be complete with insulating barriers, clip-on-type terminals, and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. It shall be similar to 'Elmex-Standard' type terminals.

14.08.02 Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal block.

14.08.03 The terminal blocks shall have at least 20% spare terminals.

14.09.00 **Grounding**

A continuous copper bus 25 x 3 mm size shall be provided along the bottom of the panel structure. It shall run continuously throughout the length of the panel and shall have provision at both ends for connection to the station grounding grid (25 x 6 mm MS Flat).

14.10.00 **Space Heater and Lighting**

14.10.01 Space heaters shall be provided in the panels for preventing harmful moisture condensation.

14.10.02 The space heaters shall be suitable for continuous operation on 240V AC, 50 Hz, single phase supply and shall be automatically controlled by thermostat. Necessary isolating switches and fuses shall also be provided.

14.10.03 Free standing panel shall have a 240V AC, plug point and a fluorescent light operated by door switch.

14.11.00 **Control and Selector Switches**

14.11.01 Control and selector switches shall be of rotary type, with escutcheon plates clearly marked to show the function and positions.

14.11.02 Control/selector switches shall be spring return or stay put type as per the requirements. Handles of control/selector switches shall be black in colour. Shape and type of handles shall be to the approval of the Employer.

14.11.03 The contact ratings shall be at least the following :

- (i) Make and carry continuously 10 Amp.
- (ii) Breaking current at 240V DC 1Amp. (Inductive)
- (iii) Breaking current at 240V DC 5 Amp. at 0.3 p.f. lagging

14.12.00 **Push Buttons**

14.12.01 Push buttons shall be spring return, push to actuate type and rated to continuously carry and break 10A at 240V AC and 0.5A (Inductive) at 220V DC. The push buttons shall have at least 1 NO and 1 NC contact. All contact faces shall be of silver or silver alloy.

14.12.02 All push buttons shall be provided with integral escutcheon plates marked with its function.

14.12.03 The colour of buttons shall be as follows :

- Green For motor START, Breaker CLOSE, Valve/ damper OPEN.
- Red For motor TRIP, Breaker OPEN, Valve/ damper CLOSE.
- Black For all annunciation functions, overload reset and

miscellaneous.

14.12.04 Red push buttons shall always be located to the left of green push buttons. In case of clinker grinder etc. the push buttons would be black-red-green from left to right.

14.13.00 **Indicating Lamps**

14.13.01 Indicating lamps shall be of the panel mounting, filament type and of low-watt consumption. Lamps shall be provided with series resistors preferably built-in- the lamps assembly. The lamps shall have escutcheon plates marked with its function, wherever necessary.

14.13.02 Lamp shall have translucent lamp covers of the following colours :

Red	for motor OFF, Valve/damper OPEN, Breaker CLOSED.
Green	for motor ON, Valve/damper CLOSED, Breaker OPEN.
White	for motor AUTO-TRIP.
Blue	for all healthy conditions (e.g. control supply, lub oil pressure and also for spring charged).
Amber	for all ALARM conditions (e.g. pressure low, over load and also for 'service' and 'Test' position indication).

14.13.03 Bulbs and lamps covers shall be easily replaceable from the front of the panel.

14.13.04 Indicating lamps should be located directly above the associated push button/control switches. Red lamps shall variably be located to the right of the green lamp. In case a white lamp is also provided, it shall be placed between the red and green lamps. Blue and amber lamps should normally be located above the red and green lamps.

14.14.00 **Fuses**

14.14.01 All fuses shall be of HRC cartridge plug-in-type and shall be of suitable rating, depending upon circuit requirements.

14.14.02 All fuses shall be mounted on fuse carriers, which shall be mounted on fuse-bases.

14.15.00 **Contactors**

14.15.01 Contactors shall be of air break, electromagnetic type rated as per requirement. These shall be of utilisation category AC 3 as per IS:2959.

14.15.02 Operating coils of AC contactors shall be of 240V AC or 220V DC or 110V DC as required. AC contactors shall operate satisfactorily between 85% to 110% of the rated voltage. The Contactor shall not drop out at 70% of the rated voltage.

14.15.03 DC contactors shall have a coil voltage of 220V or 110V DC and shall be suitable for satisfactory continuous operation at 80% to 110% of the rated voltage.

14.16.00 **Relays and Timers**

- 14.16.01 All auxiliary relays & timers shall be of proven design and of reputed make. Contacts of relays and timers shall be of solid silver or silver cadmium oxide or solid silver faced. Timers shall have the provision to adjust the delay on pick-up or reset as required.
- 14.16.02 All relays and timers shall have at least two NO and two NC contacts.
- 14.16.03 All relays and timers shall be suitable for 240V AC and 110V or 220V DC as required. DC relays shall operate satisfactorily between 70% to 110% and AC relays shall be suitable for voltage variation between 80% to 110%.
- 14.17.00 **Indication Instruments**
- 14.17.01 All indicating and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96 mm square size with 90 degree scales and shall have an accuracy class of 2.0 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.
- 14.17.02 All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities. Means shall be provided for zero adjustment removing or dismantling the instruments.
- 14.17.03 All instruments shall have white dials with black numerals and lettering. Black knife edge pointer with parallax free dials will be preferred.
- 14.17.04 Ammeters provided on motor feeders shall have a compressed scale at the upper current region to cover the starting current.
- 14.18.00 **Annunciation System**
- 14.18.01 The annunciation system shall be complete with all necessary relays, flashers and other accessories required for the proper operation of the equipment and shall be completely solid state. The control circuit shall be mounted on plug-in type glass epoxy printed circuit boards. Audible alarms for the system shall be mounted inside the panel. One set of acknowledge, test and reset push buttons shall be mounted on the panel.
- 14.18.02 Indications shall be engraved on Acrylic inscription plate window and shall be visible clearly when the indication lamp is lighted (black letters on white background). Each window shall be provided with two lamps.
- 14.18.03 Audible horn shall sound when a trouble contact operates and shall continue to sound until the acknowledge button is pressed.
- 14.18.04 Indication lamps shall flash when trouble contact operates and shall continue flashing until acknowledge button is pressed.
- 14.18.05 After acknowledge button is pressed, the horn and flashing shall stop but the indication lamp shall remain lighted.
- 14.18.06 After trouble is cleared indication lamps shall be ready and shall go off only when reset.
- 14.18.07 Silencing the horn in conjunction with one trouble contact shall not stop and horn sounding if another trouble contact operates.
- 14.18.08 When test button is pressed, all lamps shall flash and horn shall sound.

- 14.18.09 Annunciator systems shall operate on 220V or 110V DC Systems.
- 14.18.10 The annunciation system shall include alarm for AC control system failure (working on DC supply), DC supply failure (working on AC supply) and test facilities for these alarms.
- 14.18.11 List of annunciations required on the panels has been listed elsewhere. The Contractor shall also provide additional annunciations if desired by the Employer/Engineer during Vendor drawing review stage and for such additional annunciations no extra charges shall be claimed by the Contractor, if the number of such additions are within 10% of the number stipulated in this specification.
- 14.18.12 20% spare windows shall be provided on the panel.
- 14.19.00 **Painting**
- 14.19.01 All sheet steel work shall be pre-treated, in tanks, in accordance with IS:6005. Degreasing shall be done by alkaline cleaning. Dust and scale shall be removed by pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be "Class-C" as specified in IS:6005. The phosphated surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint on panels shall be applied. Electrostatic painting shall also be acceptable. Finishing paint on outdoor equipment shall be shade 632 (smoke grey) and on indoor equipment & panels shall be shade 631 of IS:5 unless required otherwise by the Employer. The inside of the panels shall be glossy white. Each coat of finishing shall be properly stoved. The paint thickness shall not be less than 100 microns. Finished parts shall be coated by peelable compound by spraying method to protect the finished surface from scratches, grease, dirt and oily spots during testing, transportation handling and erection.
- 14.20.00 **Tests**
- 14.20.01 Following tests/inspection shall be carried out by the Contractor in the presence of Employer's representative:
- (A) Factory Tests:
- (1) Compliance with approved drawings, data and specification.
  - (2) Visual check for workmanship.
  - (3) Wiring continuity and functional checks.
  - (4) Calibration of instruments, relays and metres wherever required by inspector.
  - (5) HV test.
  - (6) Insulation resistance measurement before and after HV test.
  - (7) Testing to observe compliance to degree of protection as per IS - 2147 (latest).
- (B) Inspection/Testing at site:
- (1) IR test before and after HV test.
  - (2) HV Test..
  - (3) Functional Testing.
- (C)
- (1) The Fire detection and annunciation panel shall be Tested as per

- (2) **BS:3116 Part-IV.**  
The Annunciation System shall be routine tested.

## STANDARD PERFORMANCE GUARANTEE TEST PROCEDURE

### 1.0.0 SCOPE, PURPOSE AND CODES

#### 1.1.0 Scope

This test procedure shall cover the performance guarantee tests for all the subsystems covered in the subject package.

#### 1.2.0 Purpose

The purpose of this test procedure is to describe the criteria of acceptance test for the subsystems of fire protection system.

#### 1.3.0 Codes

The following codes and standards shall be applicable for conducting test unless otherwise modified or supplemented by the enclosed procedure and mutually agreed to, between the employer and the contractor.

- (1) NFPA - 13 : Standard for the installation of sprinkler system.
- (2) NFPA - 15 : Standard for water spray fixed system for the fire protection.
- (3) NFPA - 12A : Standard for Halon 1301 Fire Extinguishing System.
- (4) NFPA - 72E : Standard on Automatic Fire Detectors.
- (5) Fire Protection Manual by TAC (Latest Edition).
- (6) NFPA - 12 : Standard on Carbon dioxide extinguisher systems.
- (7) IS : 3034 : Fire safety of industrial building : Electrical generating and distributing stations code of practice.
- (8) IS : 2878 : CO<sub>2</sub> (Carbon Dioxide) Type Extinguisher.
- (9) IS : 2171 : DCP (Dry Chemical Powder) type.
- (10) IS : 940 : Pressurised Water Type.

2.0.0           **CONDITIONS OF TEST**

2.1.0           **Conduct of Test**

Test shall be conducted by accredited representatives of the contractor and the Employer. The contractor shall be given permission to inspect the entire system in advance and make it ready for the test. Contractor's representatives shall witness all phases of the test and record and data jointly with the Employer's representatives.

- 2.1.1           (a)     The responsibility for conducting the test rests with the contractor.
- (b)     Any instruments required for the PG test will be provided by the contractor. Calibration of test instruments shall be the responsibility of the contractor.
- (c)     Calibration of instruments to be used in the test shall be carried out at a Govt. approved test lab. calibration of instruments should be carried out previous to, but not more than six months before the commencement of test. The calibration certificate of the instruments should be valid for the period of test.
- (d)     Replacement of fused/damage parts. i.e. quartzoid bulb and liner heat sensing cable etc., during the test shall be responsibility of contractor.
- 2.1.2           The design performance of the equipment/systems shall be demonstrated by the contractor after evaluating the acceptance test. Should the results of the test deviate from the design values, the contractor shall be given opportunity to modify the equipments as required to enable it to meet the acceptance criteria. In such cases the acceptance test shall be repeated for retest and the cost of modifications, including labour, materials and cost of additional testing shall be borne by the contractor. The chance for repeat testing will be given only once during the contract period.
- 2.1.3           All hand appliances and their accessories as well as components of hydrant and other protective equipments shall be of a type and make, as per norms of Tariff Advisory Committee/IS.
- 2.1.4           All operating parts of the systems shall be fully tested to arrive that they are in operating condition.
- 2.1.5           The operating tests shall include the tests of automatic detection equipment.
- 2.1.6           Provision shall be made for the disposal of water issuing from outlets to avoid property damage.
- 2.1.7           Contractor should furnish a written statement to the effect that the work covered in this contract has been completed and all specified flushing of underground, above ground piping has been successfully completed together with specified hydrostatic pressure tests.

2.1.8 All the erection/commissioning protocols in respect of hydrotest of hydrant mains, spray lines, vibration/noise level, data of pumps, holiday test results of pipe coatings, IR/conductor resistance values of LHS cables, alarm/annunciation/control systems, batteries, pipe line flushing laying of pipelines as per approved drawings, compliance of all hand appliances and their accessories as well as all components of hydrant/sprinkler/spray/other protective equipments to TAC, BIS ; all other systems/equipment shall be made available before conducting the PG test. Sample checking of all the above mentioned items shall be carried out during PG test.

### 3.0.0 **HYDRANT SYSTEM**

- 3.1.0
- (1) Sequential auto start of the electric and diesel engine pumps shall be checked by opening the test hydrants.
  - (2) The minimum running pressure of 3.5 kg/sq.cm at the highest/farthest (hydraulically most remote hydrant point) shall be available with Hydrant pump running at full capacity and 2 hydrants open simultaneously.

This test shall be repeated every month during guarantee period.

- (3) Vibration and noise level measurements for the pumps at 100% and 150% duty points should be below the specified value indicated in the approved data sheets.
- (4) Auto operation of jockey pump, for pressurising of system shall be checked for eight hours and reading of actuating/cut of pressures shall be recorded.
- (5) Control panel/annunciation panel shall be checked for operation i.e. proper functioning and audiovisual indicators.
- (6) Battery and battery charger shall be checked for auto charging and providing sufficient power for three successive starting kicks to diesel engine within five minutes with A.C. supply switched off.
- (7) The hydrant mains shall be hydraulically tested and shall be capable withstanding for 30 minutes a pressure equivalent to 150% of the design pressure or 200% of maximum operating pressure, whichever is higher. In case these test have been conducted before commissioning, such test is not mandatory and shall be verified.
- (8) All the hydrant valves, isolating valves and valves of monitors shall be operated repeatedly for smooth operation and there shall be no leakage.
- (9) For diesel engine test shall be carried out for two (2) hours out of which half hour at full load and on 10% overload for half hour. Performance of diesel engine shall be observed at the end of the above test.

Following readings shall be taken after every half an hour and shall be compared with the specified values indicated in the approved data sheet.

- (a) Exhaust temp. (with engine mounted calibrated temp. gauge).
- (b) Closed circuit water temp. (with engine mounted calibrated temp. gauge).
- (c) Lubricating oil pressure (with engine mounted calibrated temp. gauge).
- (d) Lubricated oil pressure (with engine mounted calibrated pressure gauge).
- (e) Speed (with digital non-contract RPM meter/tacho-meter).

Efficiency of combustion shall be verified from the colour of the exhaust. The colour of exhaust shall be haze clear and not black.

Vibration and noise level measurement shall also be taken at full load and at overload run test. It shall be below the specified value indicated in approved data sheet.

### 3.3.0 **Fire Alarm System**

The entire installation shall be tested to ensure that it operates satisfactorily and that :

- (1) All detector and manual call points function properly.
- (2) The control and indicating equipment correctly registers and indicates the state of the installation.
- 3) All ancilliary equipment functions properly.
- (4) A restorable heat detector shall be tested with heat source, such as a hair dryer or shielded heat lamp, until it responds. After each heat test, the detector shall be reset.
- (5) The percent of all non-restorable detectors i.e. heat detector, QB and thermoelectric sprinkler shall be operated. These detectors shall be replaced by the contractor at his own cost.
- (6) Smoke detector shall be tested with rapid developing fire source emitting visible or invisible smoke particles. Fire of this type included smouldering and fast burning fires of wood, paper, rubber, natural and synthetic fabrics, plastic and common liquid hydrocarbons. After each test smoky atmosphere near the detector should be cleared so that the detector shall reset.

### 3.4.0 **Linear Heat Sensing Cable Type Heat Detection System**

- 1) Conductor resistances and insulation resistances values of all LHS cables shall be measured.

- 2) A portion of a cable shall be heated by burning coal/blow lamp till the time it gets short. Check all the indications, alarms and actuating signals are in operation.
- 3) Location of LHS cable may be checked physically w.r.t specification requirements.

**3.6.0 Portable Fire Extinguishers**

- 1) All portable fire extinguishers of same type, shape, design and capacity produced by the same manufacturer from similar materials shall be grouped together to constitute a lot.
- 2) Each lot shall be considered individually for the purpose of evaluation of quality.
- 3) One number of sample, for testing, to be taken at random from a lot.
- 4) The samples tested shall pass the tests, indicated in the relevant IS code, for the lot to be declared to conform the performance test requirements.

**VENDOR LIST FOR FIRE PROTECTION PACKAGE**

S.No.	Equipment/Material	Make
1.	Fire Water Pumps (Horizontal Centrifugal)	KBL/M&P/B&C
2.	Jockey Pumps (Horizontal Centrifugal)	KBL/M&P/B&C
3.	Motors (L.T.)	KEC/SIEMENS/ NGEF/CROMPTON
4.	Diesel Engine (Horizontal Multi Cylinders)	Ruston & Hornsby (Greaves)/ KCL
5.	Air Compressor	KGK/ELGI/INGERSOL RAND
6.	Batteries	Exide/AMCO
7.	Battery Charger	CHABBI/UNIVERSAL INDUSTRIAL PRODUCT/FOUR-D UPTRON POWERTRONICS LOGICSTAT/CALDYN
8.	M.S./G.I Pipes	JINDAL/PRAKASH/ SAIL/ LLOYD METALS & ENGINEERS LTD.
9.	C. I. Valves (Gate & Check)	H. Sarkar/Venus/Kalpana
10.	Gun Metal Valves (Globe)	Leader
11.	Float operated Gate Valve	Levcon/Sigma
12.	Strainer (Y-Type & Basket Type)	Grandprix/Jaypee/Multitex/ Gujarat Otofilt
13.	Hume pipe	Indian Hume Pipe/Pargate Concrete Udyog Delhi

S.No.	Equipment/Material	Make
15.	H. V. Spray Nozzles	H.D. Fire/ACE Turnkey
16.	Q. B. Detectors	H.D Fire/ACE Turnkey
17.	Pressure Gauge	H. Guru/General Instrument
18.	Pressure Switches	Indfos/Switzer/Verma Trafag
19.	Level Switches	Levcon/Sigma
20.	Level Indicator	Levcon/Sigma
21.	Level Gauge	Levcon/Sigma
22.	Hydrant Valves & Accessories	Sukan/Shah Bhogilal
23.	Hoses (Flax Canvas)	Jayshree Calcutta/Newage
24.	Solenoid Valves	AVCON/ROTEX
25.	Heat & Smoke Detectors	Apollo, U.K. /Pyrotonics / System Sensor/ Nittan
26.	Cables	Polycab/Delton/P. Rakesh
27.	Fire Extinguishers	Nitin/Vijay Fire/Lightex/ Zenith/ Minimax
28.	Annunciation Panels	Suchitra/ECS/Vikas Engg.
29.	Annunciators	Peacon/Piri/Procon
30.	Dished Ends	Anoop Engg./Motilal/Kanara
31.	D.E. Panels with charger	Suchitra/ECS/Vikas Engg.
32.	Local Control Panels for	Suchitra/ECS/Vikas Engg.
33.	A.C. & D.C. Distribution Boards	Suchitra/ECS/ Elemech

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S.No.	Equipment/Material	Make
34.	Response Indicators/Hooters Break Glass Units	M.C. Engineering Delhi/ Maths, Bombay/ Mehta & Associates, Ahmedabad.
35.	Base Frames/Hose Box	/Mehta & Associates, Ahmedabad.
36.	H. P. Tank	Ratan Industries /Ratnamani

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**HORIZONTAL CENTRIFUGAL PUMPS**

Sl. No.	Description	Hydrant Pumps	Jockey Pumps
1.0	Number of units	*Two (2) (One Diesel engine driven & One motor driven)	<b>Two(2)</b>
2.0	Type	Horizontal centrifugal	Horizontal centrifugal
3.0	Location	Indoor	Indoor
4.0	Service	-As per TAC regulation-	
5.0	Liquid to be pumped	--Raw Water--	
6.0	Capacity	As per requirement during detailed engineering	
7.0	Total dynamic head	56 MWC	56 MWC
8.0	Hydrostatic test pressure	_ As per Specifications -	
9.0	Suction condition/temp.	--Flooded/36 <sup>0</sup> C --	
10.0	Nature of BHP curve	-Non-over loading type -	
11.0	Type of bearing	-As per manufacturing standard -	
12.0	Sealing/cooling/lubrication	Graphited asbestos packing/self liquid cooling/lubrication	

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\*Both the HVW pumps should be of same model and their components interchangeable.

Sl. No.	Description	H.V.W. Spray/Hydrant Pumps	Jockey Pumps
13.0	Material of Construction		
	a) Casing	--C1,IS:210 FG: 260 --	
	b) Impeller	--Leaded Gun metal to IS:318 Grade-II--	
	c) Wearing ring	-Leaded gun metal to IS:318 Grade V. -	
	d) Base Plate	-- Fabricated Steel IS:226 --	
	e) Shaft	- Mild Steel to BS:970 EN.8	
	f) Shaft sleeve	-- SS-316 --	
	g) Stuffing box	-- 2.5% Nickel CI to IS:210 Grade FG 260--	
	h) Gland	--- do ---	
	I) Gland Packing	--- Graphite Asbestos ---	
14.0	Drive Motor Particulars		
	a) Type	AC Squirrel cage Induction Motor	
	b) Enclosure	TEFC -IP – 54	
	c) Insulation Class	Class F with temp. rise limited to Class B	
	d) Starter	Direct on-line (DOL).	
15.0	Accessories to be provided with each pump by the supplier	Common base plate, companion flanges, drain plug, vent, priming connection, coupling guard, eye bolts, lifting lugs etc.	