

# Ahmedabad Municipal Corporation

Tender Notice 05/2026-27

Tender No. 20

## Tender Documents

For

**Providing & Laying Incoming Gravity line, Construction of Storm Water Pumping Stations (Civil, Electrical and Mechanical Work), Rising Main and LT Room Near APJ Abddul Kalam Hall in FP-170, TP-83in Maktampura Ward including O&M work for 2 years in South West Zone of AMC Area**

## Volume I :- Technical Bid

### Part – II : Technical Specifications

**Section : – D**

**Section : – E (Drawings)**

- (1) Date of download Tender Documents : [www.tender.nprocure.com](http://www.tender.nprocure.com)
- (2) Pre-bid meeting : Dt. 24-06-2026 at 11.00 Hr.
- (3) Last date of online Tender Submission : Dt. 29-06-2026 upto 19.00 hours
- (4) Last Date of submission of Blank tender document, EMD & Tender Fee and Other documents. : Dt. 30-06-2026 up to 16.00 hours by Speed Post or Registered Post AD, by courier or Hand delivery.
- (5) Date of e-Tender (Technical Bid) Opening : Dt. 30-06-2026 at 17.00 Hr.

**Municipal Commissioner**  
Ahmedabad Municipal Corporation  
Sardar Patel Bhavan  
Ahmedabad – 380 001  
Gujarat (INDIA)

June-2026

## **SECTION : D**

**VOLUME – I : TECHNICAL BID**

**PART - II : TECHNICAL SPECIFICATIONS**

**SECTION – ‘D’**

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## **D-1 : EARTH WORK IN TRENCH, EXCAVATION AND BACK FILLING**

### **SECTION : D-1**

#### **D.1.1 SCOPE**

- D.1.1.1 This specification covers the general requirements of earth work in excavation for pipe trench, form work etc. in different materials, filling in areas as shown in drawing, filling back around foundations trenches, conveyance and disposal of surplus spoils or stacking them properly as shown on the drawings and as directed by engineer and all operations covered within the intent and purpose of this specification.

#### **D.1.2 APPLICABLE CODES**

- D.1.2.1 The following Indian Standard codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to.

- |    |                |   |
|----|----------------|---|
| 1. | IS 783         | - Code of practice for laying of concrete pipes   |
| 2. | IS 1200        | - Method of measurement of building   |
| 3. | IS 3764        | - Safety code for excavation  |
| 4. | IS 3385        | - Code of practice for measurement of Civil Engineering works                                 |
| 5. | IS 2720        | - Methods of test for soils   |
|    | Part - I       | - Preparation of dry soil samples for various tests.  |
|    | Part – II      | - Determination of water content.   |
|    | Part – IV      | - Grain size analysis.  |
|    | Part – V       | - Determination of liquid and plastic limit.  |
|    | Part – VII     | - Determination of water content dry density relation using light compensation.               |
|    | Part – IX      | - Determination of dry density – moisture content relation by constant weight of soil method. |
|    | Part – XIV     | - Determination of density index (relative density) of cohesionless soils.                    |
|    | Part - XXVIII  | - Determination of dry density of soils in place, by the sand replacement method.             |
|    | Part - XXXIII  | - Determination of the density in place by ring and water replacement method.                 |
|    | Part – XXXIV   | - Determination of density of soil in place rubber baloon method.                             |
|    | Part - XXXVIII | - Compaction control test (Hilf Method)   |

#### **D.1.3 DEFINITIONS**

- D.1.3.1 The following terms shall have the meanings hereby assigned to them
- **Top Soil** - means any surface material including turf , suitable for use in soiling areas to be grassed or cultivated.
  - **Excavation** – means excavation in open cut down to levels required as per approved drawings or otherwise as being the general levels after completion of excavation.

### **D.1.3.2 Drawings**

- D.1.3.2.1 Engineer will furnish drawings wherever, in his opinion, such drawings are required to show areas to be excavated / filled grade level, sequence of priorities etc. The contractor shall follow strictly such drawings.

### **D.1.4 GENERAL**

- D.1.4.1 Contractor shall furnish all tools, plants, instruments, qualified supervision, personnel, labour, materials any temporary works, consumables, any everything necessary, whether or not such items are specifically stated here for completion of the job in accordance with specification requirements.
- D.1.4.2 Contractor shall carry out the survey of the site before excavation and properly establish line and levels for various works such as earthwork excavation for grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference / grid lines at 8 m. intervals or nearer as determined by Engineer based on ground profile. These shall be checked by Engineer and thereafter properly recorded.
- D.1.4.3 The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also furnishing, erecting and maintaining or substantial barricades around excavated areas and warning lamps at night for ensuring safety.
- D.1.4.4 The rates quoted shall also include for dumping of excavated materials in regular heaps, bunds, rip rap with regular slopes as directed by 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 Engineer. As a rule, all softer material shall be laid along the center of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

### **D.1.4.5 Carting and recarting of the excavated material**

- D.1.4.5.1 The rates quoted shall also include the carting and staking properly or spreading the excavated stuff within a lead of 100 m and recarting the same to the site for backfilling the trenches with the selected excavated materials as directed by Engineer in charge.

### **D.1.5 CLEARING**

- D.1.5.1 The area to be excavated filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush etc. and other objectionable matter. If any roots or stumps of trees are met during excavation, they shall also be removed. The material so removed shall be burnt or disposed off as directed by Engineer. Where earthfill is intended, the area shall be stripped of all loose/soft patches, top soil containing objectionable matter / materials before fill commences.

## **D.1.6 PRECIOUS OBJECTS, RELICS, OBJECTS OF ANTIQUITY ETC.**

D.1.6.1 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 Client and Contractor shall duly preserve the same to the satisfaction of Owner and from time to time deliver the same to such person or persons as Owner may from time to time authorize or appoint to receive the same.

## **D.1.7 CLASSIFICATION**

D.1.7.1 All materials to be excavated shall be classified by 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 Engineer regarding the classification of the material shall be final and binding on Contractor and not be a subject matter of any appeal or arbitration.

D.1.7.2 Any earthwork will be classified under any of the following categories :

### **D.1.7.2.1 Ordinary and Hard Soils**

These shall include all kinds of solid containing kankar, sand, silt, moorum 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 meter in any one direction and not more than 200 mm in any one of the other two directions.

### **D.1.7.2.2 Soft and Decomposed Rock**

This shall include rock, boulders, slag, chalk, state, hard micaschist, laetrile 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 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 road and pavements. This shall also include rock boulders not longer than 1 meter 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.

### **D.1.7.2.3 Hard Rock**

This shall include all rock occurring in large continues masses which cannot be removed except by blasting for loosening it. Harder varieties of rock with or without veins and secondary minerals which, in the opinion of 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.

#### **D.1.8 EXCAVATION**

- D.1.8.1 All excavation work shall be carried out by mechanical equipment's unless, in the opinion of Engineer, the work involved and time schedule permit manual work.
- D.1.8.2 Excavation for permanent work shall be taken out of such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by Engineer. Rough excavation shall be carried out to a depth 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed ever below the final level and extra excavation filled up a directed by Engineer. The final excavation if so instructed by Engineer, should be carried out just prior to laying the mud-mat.
- D.1.8.3 Contractor may, for facility of work or similar other reasons, excavate, and also backfill later, if so approved by Engineer, at his own cost outside the lines shown on the drawings or directed by Engineer. Should any excavation be taken below the specified elevations, Contractor shall fill it up, with concrete of the same class as in the foundation resting thereon, upto the required elevation. No extra shall be claimed by Contractor on this account.
- D.1.8.4 All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of Engineer shall be obtained by 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 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 if the slips are due to the negligence of Contractor.
- D.1.8.5 Excavation shall be carried out with such tools, tackles and equipment as described hereinbefore. Blasting or other methods may be resorted to in the case of hard rock; however not without the specific permission of Engineer.
- D.1.8.6 Engineer may also direct that in some extreme case, the rock may be excavated by heating and sudden quenching for splitting the rock. Fire-wood shall be used for burning and payment shall be made for such work as called for in the schedule of quantities.

## **D.1.9 STRIPPING LOOSE ROCK**

- D.1.9.1 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 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.
- D.1.9.2 Any material not requiring removal as contemplated in the work, but which, in the opinion of Engineer, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed as directed by Engineer. The cost of such stripping will be paid for at the unit rates accepted for the class of materials in question.

## **D.1.10 FILL, BACK FILLING AND SITE GRADING**

### **D.1.10.1 General**

- D.1.10.1.1 All fill material will be subject to Engineer's approval. If any material is rejected by Engineer, contractor shall remove the same forthwith from the site at no extra cost to the owner. Surplus fill material shall be deposited / disposed off as directed by Engineer after the fill work is completed upto a distance of 5 Km.
- D.1.10.1.2 No earthfill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by Engineer.

### **D.1.10.2 Material**

- D.1.10.2.1 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 bounders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murrum or earth fill up the voids and the mixture used for filling.
- D.1.10.3 If any selected fill material is required to be borrowed, Contractor shall make arrangements for bringing such material from outside borrow pits. The material and source shall be subject to prior approval of 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 burnt or disposed off as directed by Engineer. Contractor shall make necessary access to borrow areas and maintain the same, if such access road does not exist, at his cost.

### **D.1.10.4 Filling in pits and trenches around foundations of structures, walls etc.**

- D.1.10.4.1 As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches etc. shall be cleaned of all debris, and filled with earth in layers not exceeding 20 cm, each layer being watered,



rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of Engineer. Earth shall be rammed with approved mechanical compaction machines if instructed. Usually no manual compaction shall be allowed unless 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 Engineer or indicated on the drawing.

#### **D.1.10.5 Plinth filling**

D.1.10.5.1 Plinth filling shall be carried out with approved material as described herein before in layers not exceeding 20 cm, watered and compacted with mechanical compaction machines. If required 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 atleast 24 hours, allowed to dry and then the surface again compacted as specified above settlements at a later stage. The finished level of the filling shall be trimmed to the level / slope specified.

D.1.10.5.2 Where specified in the schedule of works, compaction of the plinth fill shall be carried out by roller in case of compaction of granular materials such as stands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by Engineer. As rolling proceeds water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fill.

D.1.10.5.3 The thickness of each unconsolidated fill layer can in this case be upto a maximum of 200 mm. 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 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 if may not be possible to use rollers because of space restrictions etc. Contractor shall then be permitted to use pneumatic tampers, rammers etc. and he shall ensure proper compaction.

#### **D.1.10.6 Sand filling in plinth and other places**

D.1.10.6.1 At places backfilling shall be carried out with local sand if directed by 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 contractor's account. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floor or other structures on sand fill shall not be started until Engineer has inspected and approved the fill.

#### **D.1.10.7 Filling in Trenches**

- D.1.10.7.1 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.
- D.1.10.7.2 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 also be done with selected earth by hand compaction or other approved means in layers not exceeding 20 cm.
- D.1.10.7.3 In case of excavation of trenches in rock, the filling upto a level 30 cm above the top of the pipe shall be done with fine materials, such as earth, moorum etc. The filling up of the level of the centreline of the pipe shall be done by hand compaction in layers not exceeding 20 cm. Also the filling above the centreline of the pipe shall be done by hand compaction or approved means in layers not exceeding 20 cm. The filling from a level 30 cm. Above the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 20 cm mixed with fine material as available to fill up the voids.
- D.1.10.7.4 Filling of the trenches shall be carried simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

#### **D.1.11 GENERAL SITE GRADING**

- D.1.11.1 Site grading shall be carried out as indicated in the drawings and as directed by Engineer. Excavation shall be carried out as specified in the specification. Filling and compaction shall be carried out as specified under Clause 10.0 and elsewhere unless otherwise indicated below.
- D.1.11.2 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 200 mm and levelled uniformly and compacted as indicated in Clause 10.0 before the next layer is deposited.
- D.1.11.3 To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by Contractor at his cost.
- D.1.11.4 Field compaction test shall be carried out at different stages of filling and also after the entire height has been completed. This shall hold good for embankments as well.
- D.1.11.5 Contractor shall protect the earth fill from being washed away by rain or damaged in any other way. Should any slip occur, Contractor shall remove the affected material and make good the slip at his cost.

- D.1.11.6 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.
- D.1.11.7 If specifically permitted by 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 contractor of 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.
- D.1.11.8 If so specified, the rock as obtained from excavation may be used for filling and levelling to indicate grades without further breaking. In such an event, filling layers not exceeding 50 cms approximately. After rock filling 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 materials 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.

#### **D.1.12 FILL DENSITY**

- D.1.12.1 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. Contractor shall demonstrate adequately at his cost, by field and laboratory tests that the specified density has been obtained.

#### **D.1.13 LEAD**

- D.1.13.1 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 centerlines shall be taken as the lead which shall be measured by the shortest straight line route taken by 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.

#### **D.1.14 MEASUREMENT AND PAYMENT**

- D.1.14.1 Payment for Excavation shall be made on actual. The calculation for excavation shall be based on the foundation plan of the structure considering working area of 1m beyond edge of raft / footing. Excavation carried out by contractor for approach ramp or any other purpose shall not be payable.

- D.1.14.2 Unless otherwise specified, the unit rates quoted for excavation in different types of material shall also account for a basic lead of 100 meters for disposal as specified or directed. Only leads beyond the basic lead of 100 meters will be considered as extra lead and paid for at the rates quoted in the schedules.
- D.1.14.3 Backfilling as per specifications 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, compensation etc. as specified. As a rule material to be backfilled shall be stacked temporarily within the basic lead of 100 meters unless otherwise directed by the Engineer. If Engineer directs / permits a lead of over 100 meters for such material, the conveyance of the material for the extra distance over the basic lead of 100 meters for backfilling will be paid for.
- D.1.14.4 Payment for fill inside trenches, plinth of 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 trench dimensions filled. The plinth ground levels shall be surveyed before hand 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.
- D.1.14.5 Backfilling 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 of 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 meters. The lead, lift etc. shall be as indicated in the schedule of quantities.
- D.1.14.6 Actual quantities of consolidated sand filling shall be measured and paid in cubic meters.

## **D-2 : TIMBER SHORING**

### **SECTION : D-2**

#### **D.2.1 SCOPE**

- D.2.1.1 This specification covers the general requirements of timber shoring for excavation of trenches, pits, open excavations etc.

#### **D.2.2 GENERAL**

- D.2.2.1 Close timbering 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 walings of strong wood at maximum 1.2 meters spacings, strutted with ballies or as directed by Engineer. The length of the ballie 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 walings, 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.
- D.2.2.2 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.
- D.2.2.3 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.
- D.2.2.4 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.
- D.2.2.5 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.

- D.2.2.6 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. If, however, Engineer directs any timbering to be left-in, keeping in mind the type of construction or any other factor, contract shall be paid for at the scheduled item rate for such left-in timbering.

### **D.2.3 MEASUREMENT**

- D.2.3.1 The payment for shoring and strutting will be made on sq.m. basis on actual quantity of shoring and strutting as per site condition and as per requirement.

## **D-3 : DEWATERING**

### **SECTION : D-3**

#### **D.3.1 SCOPE**

- D.3.1.1 This specification covers the general requirements of dewatering excavations in general.

#### **D.3.2 GENERAL**

- D.3.2.1 All excavations shall be kept free of water. Grading in the vicinity of excavations shall be controlled 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 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.
- D.3.2.2 Contractor shall visit the site and carry out necessary tests to work out the cost. AMC will not be responsible for subsoil survey or any data given in tender document. Contractor is deemed to have inspected and examined the site and its surroundings and to have satisfied himself to the nature of site before submitting his tender.
- D.3.2.3 When there is a continuous inflow of water and quantum of water to be handled is considered in the opinion of Engineer, as large, well point system – single stage or multistage, shall be adopted. Contractor shall submit to Engineer his scheme of well point system including the stages, the spacing, number and diameter of well points, heads etc. and the number, capacity and location of pumps of approval.

#### **D.3.3 MEASUREMENT & PAYMENT**

Dewatering is deemed to have been included in the unit rates quoted by excavation. No extra payment will be made against dewatering and excavation in wet soil condition.

## **D-4 : RAIN WATER DRAINAGE**

### **SECTION : D-4**

#### **D.4.1 SCOPE**

D.4.1.1 This section covers the drainage of rain water in excavated areas.

#### **D.4.2 GENERAL**

D.4.2.1 Grading in the vicinity of excavation shall be such as to exclude rain / surface water draining into excavated areas. Excavation shall be kept clean of rain and such water as the Contractor may be using for his work by suitably pumping out the same at no extra cost to the owner. The scheme for pumping and discharge of such water shall be approved by the Engineer.



## **D-5 : SITE FILLING**

### **SECTION : D-5**

#### **D.5.1 SCOPE**

- D.5.1.1 Apart from any other work / purpose for which this specification may be made applicable by Engineer, this shall generally govern work involving filling site / plant over the entire area / most of the area to raise the general grade level to the desired elevation. This work shall be carried out as per applicable clauses “Earthwork in Grading, Excavation and Backfilling” particularly clauses 10 & 11.

#### **D.5.2 FILL MATERIAL**

##### **D.5.2.1 General**

- D.5.2.1.1 All fill material whether such material is brought from outside borrow areas or excavation within the site, will be subject to Engineer’s approval. Notwithstanding any approval given to the fill material or borrow areas from which fill material is proposed to be brought, Engineer / Owner reserves the right to reject such material which in his opinion either does not meet the specification requirements or is unsuitable for the purpose for which it is intended.

##### **D.5.2.2 Borrow Areas**

- D.5.2.2.1 It shall be Contractor’s responsibility to locate suitable borrow areas for borrowing fill material. Such areas will be inspected by Engineer and approved before 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 Engineer. Contractor shall arrange to have trial pits of specified dimensions and numbers dug at locations specified, for Engineer to examine the nature and type of material likely to be obtained from the borrow area.

##### **D.5.2.3 Lead, Lift and Transportation**

- D.5.2.3.1 Unless separately provided, for, all lead, lift and transportation required for bringing in the fill material from borrow areas or from excavation from within the site shall be included in the Contractor’s quote unit rates.

##### **D.5.2.4 Quality**

- D.5.2.4.1 The borrowed soil shall be generally granular, and non-cohesive. It shall consist of sand, silty sand, murrum, ordinary soil, gravel and shingle. Dredged material, free from clayey deposit, will be accepted. Fill material shall also be free from sulphates, salts, organic, foreign and other harmful or objectionable materials. Any material rejected by Engineer shall be removed from the site immediately.

### **D.5.3 ACCESS ROAD**

- D.5.3.1 Roads, whether of temporary or other nature, required to be constructed for access and for movement of man, materials. Equipments, transport vehicles, vehicles carrying fill material etc. to or over borrow areas and/or to or over areas on which fill has to be deposited shall be constructed by Contractor at his cost. Such costs shall be deemed to have been included in the unit rates quoted by Contractor. Such access roads shall be maintained in good condition during all seasons to ensure completion of work according to time schedule.

### **D.5.4 CLEARING**

- D.5.4.1 Site clearing before filling shall be carried out as specified in the enclosed specification. Earthwork in Grading, Excavation and backfilling.

### **D.5.5 FILLING**

#### **D.5.5.1 Backfill**

- D.5.5.1.1 Backfill shall be deposited to bring the grade level to desired elevation after compaction of fill.
- D.5.5.1.2 Back fill shall be compacted, where so specified, by 12 tonne rollers as indicated in Clause D.5.5.2.3 below. The fill material shall be compacted to the specified density, where so specified.
- D.5.5.1.3 If the density of fill use of rollers for compaction is not specified. 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. These will reasonably compact the sand fill will be accepted by Engineer. However, Contractor shall ensure that every layer is thus compacted before the succeeding layers are deposited. Each layer shall not exceed 200 mm in thickness.
- D.5.5.1.4 Compaction of back fill by flooring the area shall be carried out where so specified. In this case, Contractor should ensure that the fill material is not washed away. This work shall be carried out as directed by Engineer.

#### **D.5.5.2 Soil Fill**

- D.5.5.2.1 Approval soil fill consisting of ordinary soil, murrum, soil containing gravel, shingle etc. shall be deposited in layers not exceeding 200 mm. Contractor should ensure that all clods of earth are broken down to a size not larger than 100 mm.
- D.5.5.2.2 Where density of fill or use of rollers is not specified, the fill shall be carried out as specified in Clause D.5.5.1.3 above.
- D.5.5.2.3 Where the fill material has to be compacted by use of rollers procedure as specified in Clause D.1.10.5.2 of specification for “Earthwork in Grading, Excavation and Backfilling”.

D.5.5.2.4 Where specified, the required density of fill shall be obtained by proper compaction.

**D.5.6 MEASUREMENT**

D.5.6.1 The rate quoted by the contractor for item no.2 filling available excavated earth (excluding rock if any) will be considered for payment for site filling as per the quantity executed and measured in cubic meter. For site grading the payment will be made on square meter basis.

## **D-6 : CONCRETE WORKS**

### **SECTION : D-6**

#### **D.6.1 SCOPE**

- D.6.1.1 This Specification covers the general requirements for concrete using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing, transporting, placing, curing, protecting, repairing, finishing and testing of concrete; form work; requirements in regard to the quality, storage, bending and fixing of reinforcement; grouting as well as mode of measurement and payment for complete works.
- D.6.1.2 It shall be very clearly understood that the specifications given herein are brief and do not cover minute details. However, all work shall have to be carried out in accordance with the relevant standards and codes of practices or in their absence in accordance with the best accepted current engineering practices or as directed by Engineer from time to time. The decision of Engineer as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on Contractor and no claim whatsoever will be entertained on this account.

#### **D.6.2 APPLICABLE CODES AND SPECIFICATIONS**

- D.6.2.1 The following specifications, standards and codes, including all official amendments / revisions and other specifications and codes referred to therein, should be considered 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 below or other specifications forming a part of this bid document, this specification shall govern.

##### **D.6.2.2 Code for Materials**

- |    |                             |   |
|----|-----------------------------|---|
| 1. | IS : 269                    | - Specification for 33 grade ordinary portland cement   |
| 2. | IS : 455                    | - Specification for portland slag cement  |
| 3. | IS : 1489<br>(Part 1 and 2) | - Specification for portland pozzolana cement   |
| 4. | IS : 8112                   | - Specification for 43 grade ordinary portland cement.  |
| 5. | IS : 12330                  | - Specification for sulphate resisting portland cement  |
| 6. | IS : 383                    | - Specification for coarse and fine aggregates from natural sources for concrete.                                   |
| 7. | IS : 432<br>(Part 1 and 2)  | - Specification for mild steel and medium tensile steel bars and hard drawn steel wires for concrete reinforcement. |
| 8. | IS : 1786                   | - Specification for high strength deformed steel bars and wires for concrete reinforcement.                         |
| 9. | IS : 1566                   | - Specification for hard drawn steel wire fabric for concrete reinforcement.  |

- |     |            |   |
|-----|------------|---|
| 10. | IS : 9103  | - Specification for admixtures for concrete.                  |
| 11. | IS : 2645  | - Specification for integral cement water proofing compounds. |
| 12. | IS : 4990  | - Specification for plywood for concrete shuttering work.     |
| 13. | IS : 12269 | - Specification for 53 grade ordinary portland cement.        |

#### **D.6.2.3 Code for Material Testing**

- |    |                              |  |
|----|------------------------------|--|
| 1. | IS : 4031<br>(Parts 1 to 15) | - Methods of physical tests for hydraulic cement.                                      |
| 2. | IS : 4032                    | - Methods of chemical analysis of hydraulic cement.                                    |
| 3. | IS : 650                     | - Specifications for standard sand for testing of cement.                              |
| 4. | IS : 2430                    | - Methods for sampling of aggregates for concrete.                                     |
| 5. | IS : 2386<br>(Parts 1 to 8)  | - Methods of test for aggregates for concrete.   |
| 6. | IS : 3025                    | - Methods of sampling and test (physical and chemical) water used in industry.         |
| 7. | IS : 6925                    | - Methods of test for determination of water soluble chlorides in concrete admixtures. |

#### **D.6.2.4 Code for Materials Storage**

- |    |           |  |
|----|-----------|--|
| 1. | IS : 4082 | - Recommendations on stacking and storing of construction materials at site. |
|----|-----------|--|

#### **D.6.2.5 Code for Concrete Mix Design**

- |    |                  |   |
|----|------------------|---|
| 1. | IS : 10262       | - Recommended guidelines for concrete mix design. |
| 2. | SP : 23<br>(S&T) | - Handbook on Concrete Mixes.                     |

#### **D.6.2.6 Code for Concrete Testing**

- |    |           |   |
|----|-----------|---|
| 1. | IS : 1199 | - Method of sampling and analysis of concrete.  |
| 2. | IS : 516  | - Method of test for strength of concrete   |
| 3. | IS : 9013 | - Method of making, curing and determining compressive strength of accelerated cured concrete test specimens. |
| 4. | IS : 8142 | - Method of test for determining setting time of concrete by penetration resistance.                          |
| 5. | IS : 9284 | - Method of test for abrasion resistance of concrete.   |
| 6. | IS : 2770 | - Methods of testing bond in reinforced concrete.   |

#### **D.6.2.7 Code for Equipment**

- |     |            |   |   |
|-----|------------|---|---|
| 1.  | IS : 1791  | - | Specification for batch type concrete mixers.   |
| 2.  | IS : 2438  | - | Specification for roller pan mixer.   |
| 3.  | IS : 4925  | - | Specification for concrete batching and mixing plant.   |
| 4.  | IS : 5892  | - | Specification for concrete transit mixer and agitator.  |
| 5.  | IS : 7242  | - | Specification for concrete spreaders.   |
| 6.  | IS : 2505  | - | General Requirements for concrete vibrators : Immersion type.                                 |
| 7.  | IS : 2506  | - | General Requirements for screed board concrete vibrators.                                     |
| 8.  | IS : 2514  | - | Specification for concrete vibrating tables.  |
| 9.  | IS : 3366  | - | Specification for pan vibrators.  |
| 10. | IS : 4656  | - | Specification for form vibrators for concrete.  |
| 11. | IS : 11993 | - | Code of practice for use of screed board concrete vibrators.                                  |
| 12. | IS : 7251  | - | Specification for concrete finishers.   |
| 13. | IS : 2722  | - | Specification for portable swing weigh batchers for concrete (single and double bucket type). |
| 14. | IS : 2750  | - | Specification for steel scaffoldings.   |

#### **D.6.2.8 Codes of Practice**

- |     |                             |   |   |
|-----|-----------------------------|---|---|
| 1.  | IS : 456                    | - | Code of practice for plain and reinforced concrete.   |
| 2.  | IS : 457                    | - | Code of practice for general construction of plain and reinforced concrete for dams and other massive structures. |
| 3.  | IS : 3370<br>(Parts 1 to 4) | - | Code of practice for concrete structures for storage of liquids.  |
| 4.  | IS : 3935                   | - | Code of practice for composite construction.  |
| 5.  | IS : 2204                   | - | Code of practice for construction of reinforced concrete shell roof.  |
| 6.  | IS : 2210                   | - | Criteria for the design of reinforced concrete shell structures and folded plates.                                |
| 7.  | IS : 2502                   | - | Code of practice for bending and fixing of bars for concrete reinforcement.                                       |
| 8.  | IS : 5525                   | - | Recommendation for detailing of reinforcement in reinforced concrete works.                                       |
| 9.  | IS : 2751                   | - | Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.     |
| 10. | IS : 9417                   | - | Specification for welding cold worked bars for reinforced concrete construction.                                  |
| 11. | IS : 3558                   | - | Code of practice for use of immersion vibrators for consolidating concrete.                                       |
| 12. | IS : 3414                   | - | Code of practice for design and installation of joints in buildings.  |
| 13. | IS : 4326                   | - | Code of practice for earthquake resistant design and construction of building.                                    |

14. IS : 4014 - Code of practice for steel tubular scaffolding.  
(Part 1 and 2)
15. IS : 2571 - Code of practice for laying in-situ cement concrete flooring.
16. IS : 7861 - Code of practice for extreme weather concreting.  
(Part – 1) - Recommended practice for hot weather concreting.  
(Part – 2) - Recommended practice for cold weather concreting.

#### **D.6.2.9 Code for Construction safety**

1. IS : 3696 - Safety code for scaffolds and ladders.  
(Parts I and III)
2. IS : 7969 - Safety code for handling and storage of building materials.
3. IS : 8989 - Safety code for erection of concrete framed structures.

#### **D.6.2.10 Code for Measurement**

1. IS : 1200 - Method of measurement of building and engineering works.  
(Part 1 to 28)
2. IS : 3385 - Code of practice for measurement of Civil Engineering works.

### **D.6.3 GENERAL**

D.6.3.1 Engineer shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and Engineer's approval obtained, prior to starting of concrete work. This shall, however, not relieve Contractor of any of his responsibilities. All materials which do not conform to this specification shall be rejected.

D.6.3.2 Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes / standards shall generally be used, other materials may be used after approval of the Engineer and after establishing their performance suitability based on previous data, experience or tests.

### **D.6.4 MATERIALS**

#### **D.6.4.1 Cement**

D.6.4.1.1 Unless otherwise specified or called for by the Engineer, cement shall be ordinary portland cement to IS latest edition) for entire work.

- D.6.4.1.2 Where Portland pozzolana or slag cement are used, it shall be ensured that consistency of quality is maintained, there will be no adverse interactions between the materials and the finish specified is not marred.
- D.6.4.1.3 Only one type of cement shall be used in any one mix. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without approval from Engineer.
- D.6.4.1.4 Cement which is not used within 90 days from its date of manufacture shall be tested at a laboratory approved by Engineer and until the results of such tests are found satisfactory, it shall not be used in any work.

#### **D.6.4.2 Aggregates (General)**

##### **D.6.4.2.1 General**

- D.6.4.2.1.1 “Aggregate” in general designates both fine and coarse inert materials used in the manufacture of concrete (vide BIS 456 & BIS 383) and conforming to tests as per BIS 2386 (Part I to VI).
- D.6.4.2.1.2 “Coarse Aggregate” is aggregate most of which is retained when passed through on 4.75 mm BIS sieve.
- D.6.4.2.1.3 All fine and coarse aggregates proposed for use in the works shall be subject to the Engineer-in-Charge’s approval and after specific materials have been accepted, the source of supply of such materials shall not be changed without prior approval of the Engineer-in-charge.
- D.6.4.2.1.4 Aggregates shall consist of natural sand, stone (crushed or uncrushed) and gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, non-flaky, strong, hard, durable against weathering, or limited porosity and free from deleterious materials that may cause corrosion of the reinforcement or may impair the strength and or durability of concrete. The grading of aggregates shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the “mix design” and preliminary tests on concrete specified later. The aggregates shall be brought from the source as mentioned in Volume-I Clause C.1.39.

##### **D.6.4.2.2 Sampling and testing**

- D.6.4.2.2.1 Samples of the aggregates for mix design and determination of suitability shall be taken under the supervision of the Engineer-in-charge and delivered to the laboratory, well in advance of the scheduled placing of concrete. Records of tests, which have been made on proposed aggregates and on concrete made from this source of aggregates shall be furnished to Engineer-in-charge in advance of the work, for use in determining aggregate suitability. The costs of all such tests, sampling etc. shall be borne by the contractor.



### **D.6.4.2.3 Storage of aggregates**

D.6.4.2.3.1 All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign material and earth during storage and while heaping the materials shall be avoided. The aggregates must be of specified quality not only at the time of receiving at site but more so at the time of loading into mixer. Rakers shall be piled in layers not exceeding 1.20 m in height to prevent coning or segregation. Each layer shall cover the entire area of stock pile before succeeding layers are started. Aggregates that have become segregated shall be rejected.

### **D.6.4.2.4 Specific Gravity**

D.6.4.2.4.1 Aggregates having a specific gravity below 2.4 (saturated surface dry basis) shall not be used.

### **D.6.4.3 Fine Aggregate**

D.6.4.3.1 Fine aggregate shall consist of natural or crushed sand conforming to IS 383 conforming to tests as per IS 2386 part I to IV. The sand shall be clean, sharp, hard, strong and durable and shall be free from dust, vegetable substances, adherent coating, clay, alkali, organic matter, mica, salt or other deleterious substances, which can be injurious to the setting qualities / strength/ durability of concrete.

D.6.4.3.2 Screening and Washing : Sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size fraction.

D.6.4.3.3 Foreign Material limitations : The percentage deleterious substances in sand delivered to the mixer shall not exceeding the following :

<b>Sr. No.</b>	<b>Foreign Material</b>	<b>Percentage by weight</b>	
		<b>Uncrushed</b>	<b>Crushed</b>
1	Material finer than 75 micron IS sieve	3.0	15.0
2	Shale	1.0	--
3	Coal and Lignite	1.0	1.0
4	Clay Lumps	1.0	1.0

D.6.4.3.4 Gradation : Unless otherwise directed or approved by the Engineer-in-charge, the grading of sand shall be within the limits indicated hereunder.

<b>IS : Sieve Designation</b>	<b>Grading Zone-I</b>	<b>Grading Zone-II</b>	<b>Grading Zone-III</b>	<b>Grading Zone-IV</b>
10 mm	100	100	100	100
4.75 mm	99 – 100	90 – 100	90 – 100	95 – 100
2.36 mm	60 – 95	75 – 100	85 – 100	95 – 100
1.18 mm	30 – 70	55 – 90	75 – 100	90 – 100
600 microns	15 – 34	35 – 59	60 – 79	80 – 100
300 microns	5 – 20	8 – 30	12 – 40	15 – 50
150 microns	0 – 10	0 – 10	0 – 10	0 – 15

D.6.4.3.4.1 Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 microns IS sieve, by total amount not exceeding 5%, it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron IS sieve or to percentage passing any other sieve on the coarser limit of grading zone I or the finer limit of grading zone IV. Fine aggregates conforming to grading zone IV shall not be used. Mix designs and preliminary tests shall show its suitability for producing concrete of specified strength and workability.

#### **D.6.4.3.5 Fineness Modulus**

The sand shall have a fineness modulus of not less than 2.2 or more than 4.2. The fineness modulus is determined by adding the cumulative percentages retained on the following IS sieve sizes (4.75 mm, 2.35 mm, 1.18 mm, 600 microns and 150 microns) and dividing the sum by 100.

#### **D.6.4.4 Coarse Aggregate**

D.6.4.4.1 Coarse aggregate for concrete, except as noted above, shall conform to IS 383 and IS 2386. This shall consist of crushed stone and shall be clean and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter.

D.6.4.4.2 Screening and Washing : Crushed rock shall be screened and or washed for the removal of dirt or dust coating, if so requested by the Engineer-in-charge.

#### **D.6.4.4.3 Grading**

D.6.4.4.3.1 Coarse aggregate shall be either in single size or graded, in both cases the grading shall be within the following limits :

IS Sieve Size (mm)	Percentage passing for single sized aggregate of normal size					Percentage passing for graded aggregate of normal size			
	40 mm	20 mm	16 mm	12.5 mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
63	100	--	--	--	--	--	--	--	--
40	85–100	100	--	--	--	95–100	100	--	--
20	0–20	85–100	100	--	--	30–70	95–100	100	100
16	--	--	85–100	100	--	--	--	90–100	--
12.5	--	--	--	85–100	100	--	--	--	90–100
10	0 – 5	0–20	0–30	0–45	85–100	10–35	25–55	30–70	40–85
4.75	--	0–5	0–5	0–10	0–20	0–5	0–10	0–10	0–10
2.36	--	--	--	--	0–5	--	--	--	--

D.6.4.4.3.2 The pieces shall be angular in shape and shall have granular or crystalline surfaces. Friable, flaky and laminated pieces, mica and shale, if present, shall be only within tolerance limits which will not affect adversely the strength and or durability of concrete. The maximum size of coarse aggregate shall be 40 mm for M7.5 and M10 and 20 mm for M15 to M20 concrete, or as directed by the Engineer-in-charge or specified otherwise. The maximum size of coarse aggregate shall be the maximum size specified above but in no case greater than  $\frac{1}{4}^{\text{th}}$  of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. For plain concrete the maximum size of aggregate shall be of 40 mm. for heavily reinforced concrete members, the nominal maximum size of the aggregate shall be 5 mm less than the minimum clear distance between the reinforcing main bars or 5 mm less than the minimum cover reinforcement whichever is smaller.

#### **D.6.4.4.4 Foreign material limitations**

D.6.4.4.4.1 The percentage of deleterious materials in the aggregate delivered to the mixer shall not exceed the following :

Sr. No.	Foreign Material	Percentage by weight	
		Uncrushed	Crushed
1	Material finer than 75 micron IS sieve	3.0	3.0
2	Coal and lignite	1.0	1.0
3	Clay lumps	1.0	1.0
4	Soft fragments	3.0	--

#### **D.6.4.5 Water**

D.6.4.5.1 Water used for both mixing and curing shall conform to IS : 456. Potable water is generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.

#### **D.6.4.6 Reinforcement**

D.6.4.6.1 Reinforcement bars shall conform to IS : 432, IS : 226 or IS : 1786 and the welded wire fabric to IS : 1566 as shown or specified on the drawings. Only T.M.T. bars as for specification will be followed.

D.6.4.6.2 All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill scales, rust, dirty dust or any other substance that will destroy or reduce bond.

D.6.4.6.3 If permitted by Engineer, welding of reinforcement shall be done in accordance with IS : 2751 or IS : 9417 as applicable.

#### **D.6.4.7 Admixtures**

D.6.4.7.1 Plasticizer, water-reducing admixture and concrete water proofer shall conform to IS : 9103 and integral water proofing admixtures to IS : 2645. Dosage of plasticizer used in concrete work shall be 300 ml / 50 kg of cement. Manufacturer must comply ISO-9002 specifications.

D.6.4.7.2 Admixtures may be used in concrete as per manufacturer's instructions only with the approval of Engineer based upon evidence that with the passage of time neither the compressive strength nor its durability is reduced. An admixture's suitability and effectiveness shall be verified by trial mixes with the other material used in the works. If two or more admixtures are to be used simultaneously in the same concrete mix, their interaction shall be checked and trial mixes done to ensure their compatibility. There should also be no increase in risk of corrosion of the reinforcement or other embedments.

D.6.4.7.3 Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted such as in mass concrete works, it shall be dissolved in water and added to the mixing water by an amount not exceeding 1.5 percent of the weight of the cement in each batch of concrete. The designed concrete mix shall be corrected accordingly.

#### **D.6.4.8 Wastage**

D.6.4.8.1 No wastage allowance for cement and steel shall be considered and paid for.

#### **D.6.5 SAMPLES AND TESTS**

D.6.5.1 All materials used for the works shall be tested before use.

D.6.5.2 Manufacturer's test certificate shall be furnished, for each batch of cement / steel and when directed by Engineer samples shall also be got tested by the Contractor in a laboratory approved by Engineer at no extra cost to Client. However, where material is supplied by Client, all testing charges shall be borne by Client; but transportation of material samples to the laboratory shall have to be done by Contractor at no extra cost.

D.6.5.3 Sampling and testing shall be as per IS : 2386 under the supervision of Engineer. The cost of all tests, sampling etc. shall be borne by Contractor.

D.6.5.4 Water to be used shall be tested to comply with requirement of IS : 456.

D.6.5.5 Contractor shall furnish manufacturer's test certificates and technical literature for the admixture proposed to be used. If directed the admixture shall be got tested and approved laboratory at no extra cost.

#### **D.6.6 STORING OF MATERIALS**

D.6.6.1 All material shall be stored in a manner so as to prevent its deterioration and contamination which would preclude its use in the works. Requirements of IS : 4082 shall be complied with.

- D.6.6.2 Contractor will have to make his own arrangements for the storage of adequate quantity of cement even if cement is supplied by Client. Cost of such rejected cement, where cement is supplied by Client, shall be recovered at issue rate or open market rate whichever is higher. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15 bags shall be stacked in any tier. Storage arrangement shall be approved by Engineer. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order or receipt.
- D.6.6.3 Each size of coarse and fine aggregates shall be stacked separately and shall be protected from leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.
- D.6.6.4 Contractor shall make his own arrangements for storing water at site in tanks to prevent contamination.
- D.6.6.5 The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground / water. Each type and size shall be stacked separately.

## **D.6.7 CONCRETE**

### **D.6.7.1 General**

Concrete grade shall be as designated on drawings. In concrete grade M15, M20, M25 etc. the number represents the specified characteristic compressive strength of 150 mm cube at 28 days, expressed in N/sq.mm as per IS : 456. Concrete in the works shall be **“Design Mix Concrete”** or **“Normal Mix Concrete”**. All concrete works of **grade M5, M7.5 and M10 shall be Nominal whereas all other grades, M15 and above, shall be Design Mix Concrete.**

### **D.6.7.2 Design Mix Concrete**

#### **D.6.7.2.1 Mix Design and Testing**

D.6.7.2.1.1 For Design Mix Concrete, the mix shall be designed according to IS : 10262 and SP: 23 to provide the grade of concrete having the required workability and characteristics strength not less than appropriate values given in IS : 456. The design mix shall in addition be such that it is cohesive and does not segregate and should result in dense and durable concrete and also capable of giving the finish as specified. For water retaining structures, the mix shall also result in water-tight concrete. The Contractor shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

D.6.7.2.1.2 Unless otherwise specifically mentioned, the minimum cement content for Design Mix Concrete shall be as given below.

Grade of Concrete	Minimum Cement Content in Kg/Cu.m of concrete
M15	260
M20	315
M25	365
M30	400

The minimum cement content stipulated above shall be adopted irrespective of whether the Contractor achieves the desired strength with less quantity of cement. The Contractor's quoted rates for concrete shall provide for the above eventually and nothing extra shall become payable to the Contractor in this account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the Contractor.

D.6.7.2.1.3 It shall be Contractor's sole responsibility to carry out the mix designs at his own cost. He shall furnish to Engineer at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS : 516 shall comply with the requirements of IS : 456.

Grade of Concrete	Minimum Compressive Strength (N/Sq.mm at 7 days)	Specified compressive strength (N/Sq.mm at 28 days)
M 15	10.0	15.0
M 20	13.5	20.0
M 25	17.0	25.0
M 30	20.0	30.0
M 35	23.5	35.0
M 40	27.0	40.0

D.6.7.2.1.4 A range of slumps, which shall generally be used for various types of construction unless otherwise instructed by the Engineer is given below :

Structure / Member	Slump in millimeters	
	Maximum	Minimum
Reinforced foundation walls and footings	75	25
Plain footings, caissons and substructure walls	75	25
T.G. and massive compressor foundations	50	25
Slabs, beams and reinforced walls	100	25
Pumps and miscellaneous equipment foundations	75	25
Building columns	100	25
Pavements	50	25
Heavy mass construction	50	25

#### D.6.7.2.2 Batching and Mixing of Concrete

D.6.7.2.2.1 Proportions of aggregates and cement, as decided by the concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within one percent of the desired value.

D.6.7.2.2.2 Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water cement ratio specified shall be maintained. 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.

D.6.7.2.2.3 Arrangement should be made by Contractor to have the cubes tested in an approved laboratory or in field at his own expense, with prior consent of Engineer. Sampling and testing of strength and workability of concrete shall be as per IS : 1199, IS : 516 and IS : 456.

### **D.6.7.3 Nominal Mix Concrete**

#### **D.6.7.3.1 Mix Design and Testing**

D.6.7.3.1.1 Mix design and preliminary tests are not necessary for Nominal mix Concrete. However works tests shall be carried out as per IS : 456. Proportions for Nominal Mix Concrete and **water / cement ratio may** be adopted as per Table 3 of IS : 456. However it will be Contractor's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

#### **D.6.7.3.2 Batching and Mixing Concrete**

D.6.7.3.2.1 Based on the adopted nominal mixes, aggregates and cement shall be measured by weight.

### **D.6.8 FORM WORK**

D.6.8.1 Form work shall be all inclusive and shall consist of but not limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts, falsework, wedges etc.

D.6.8.2 The design and engineering of the formwork as well as its construction shall be the responsibility of Contractor. However, if so desired by Engineer the drawings and calculations for the design of the formwork shall be submitted to Engineer for approval.

D.6.8.3 Formwork shall be designed to fulfill the following requirements :

- a) Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.
- b) Made of suitable materials.
- c) Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.
- d) Capable of withstanding without deflection the worst combination of self weight, reinforcement and concrete weight, all loads and dynamic effects

arising from construction and compacting activities, wind and weather forces.

- e) Capable of easily striking without shock, disturbance or damage to the concrete.
- f) Soffit forms capable of imparting a camber if required.
- g) Soffit forms and supports capable of being left in position if required.
- h) Capable of being cleaned and / or coated if necessary immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

D.6.8.4 The formwork may be of timber, plywood, steel, plastic or concrete depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of Engineer. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, work holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structures shall be sufficiently tight to prevent loss of slurry from concrete, using seals if necessary.

D.6.8.5 The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces dust etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.

D.6.8.6 Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of Engineer. The Contractor shall equip himself with enough shuttering to allow for wastage so as to complete the job in time.

D.6.8.7 Permanent formwork shall be checked for its durability and capability with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

D.6.8.8 Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves shall be used. Formwork spacers left in situ shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

D.6.8.9 For liquid retaining structures sleeves shall not be provided for through bolts or shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

D.6.8.10 Where specified or shown on drawings, all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size.

D.6.8.11 Forms for substructure may be omitted when, in the opinion of Engineer, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such



excavations shall be slightly larger, as directed by Engineer, than that required as per drawing to compensate for irregularities in excavation.

- D.6.8.12 The Contractor shall provide adequate props carried down to a firm bearing without overloading any of the structures.
- D.6.8.13 The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side limit the drop of concrete to 1.0 m or as directed by Engineer. The Contractor shall temporarily and securely fix items to be cast in (embedments / inserts) in a manner that will not hinder the striking of forms or permit loss of grout.
- D.6.8.14 Formwork showing excessive distortion, during any stage of construction, shall be repositioned and strengthened. Placed concrete affected by faulty form work, shall be entirely removed and formwork corrected prior to placement of new concrete at the cost of the Contractor.
- D.6.8.15 The striking time for formwork shall be determined based on following requirements :
- a) Development of adequate concrete strength;
  - b) Permissible deflection at time of striking form work;
  - c) Curing procedure employed – its efficiency and effectiveness;
  - d) Subsequent surface treatment to be done;
  - e) Prevention of thermal cracking at re-entrant angles;
  - f) Ambient temperature; and
  - g) Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).
- D.6.8.16 Under normal circumstances (generally where temperatures are above 20 Deg. C) forms may be struck after expiry of the time period given in IS : 456, unless directed otherwise by Engineer. For portland pozzolona / slag cement the stripping time shall be suitably modified as directed by the Engineer. It is the Contractor's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resist surface damage and any stressed arising during the construction period.

#### **D.6.9 Reinforcement Workmanship**

- D.6.9.1 Reinforcing bars supplied bent or in coils shall be straightened cold without damage at no extra cost. No bending shall be done when ambient temperature is below 5 Deg. C. Local warming may be permitted if steel is kept below 100 Deg. C.
- D.6.9.2 All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings / schedules or as directed by Engineer.
- D.6.9.3 Re-bending or straightening incorrectly bent bars shall not be done without approval of Engineer.

- D.6.9.4 Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by Engineer prior to concrete placement. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.
- D.6.9.5 Binding wire shall be 16 gauge soft annealed wire. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.
- D.6.9.6 Substitution of reinforcement, laps / splices not shown on drawing shall be subject to Engineer's approval.

#### **D.6.10 TOLERANCES**

- D.6.10.1 Tolerance for formed and concrete dimensions shall be as per IS : 456 unless specified otherwise.
- D.6.10.2 Tolerances specified for horizontal or vertical building lines or footings shall not be construed to permit encroachment beyond the legal boundaries.

#### **D.6.11 PREPARATION PRIOR TO CONCRETE PLACEMENT**

- D.6.11.1 Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets etc. provided.
- D.6.11.2 All arrangements formwork, equipment and proposed procedure, shall be approved by Engineer. **The Contractor shall maintain separate Pour Card for each pour as per the format enclosed** and shall produce before commencement of concreting to Engineer-in-charge.

#### **D.6.12 TRANSPORTING, PLACING AND COMPACTING CONCRETE**

- D.6.12.1 Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.
- D.6.12.2 In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms. The Contractor shall provide suitable drops and 'Elephant Trunks'. Concrete shall not be dropped from a height of more than 1.0 m as stipulated in clause D.6.8.13.
- D.6.12.3 Concrete shall not be placed in flowing water. Under water, concrete shall be placed in position by tremies or by pipeline from the mixer and shall never be allowed to fall freely through the water.

- D.6.12.4 While placing concrete the Contractor shall proceed as specified below and also ensure the following :
- a) Continuously between construction joints and predetermined abutments.
  - b) Without disturbance to forms or reinforcement.
  - c) Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits etc.
  - d) Without dropping in a manner that could cause segregation or shock.
  - e) In deep pours only when the concrete and formwork designed for this purpose and by using suitable chutes or pipes.
  - f) Do not place if the workability is such that full compaction cannot be achieved.
  - g) Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations, withdraw the lining progressively as concrete is placed.
  - h) If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.
  - i) Ensure that there is no damage or displacement to sheet membranes.
  - j) Record the time and location of placing structural concrete.
- D.6.12.5 Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set. Over vibration shall be avoided.
- D.6.12.6 Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by Engineer. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.
- D.6.12.7 Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as determined by Engineer. Concrete shall be protected against damage until final acceptance.

## **D.6.13 MASS CONCRETE WORKS**

- D.6.13.1 Sequence of pouring for mass concrete works shall be as approved by Engineer. The Contractor shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

#### **D.6.14 CURING**

- D.6.14.1 Curing and protection shall start immediately after the compaction of the concrete to protect it from :
- (a) premature drying out, particularly by solar radiation and wind;
  - (b) leaching out by rain and flowing water;
  - (c) rapid cooling during the first few days after placing;
  - (d) high internal thermal gradients;
  - (e) low temperature of frost;
  - (f) vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.
- D.6.14.2 All concrete, unless directed otherwise by Engineer, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessian or other absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.
- D.6.14.3 Where a curing membrane is directed to be used by the Engineer, the same shall be of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be got approved from the Engineer before use and shall be applied with spraying equipment capable of a smooth, even textured coat.
- D.6.14.4 Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.
- D.6.14.5 Extra precautions shall be exercised in curing concrete during cold and hot weather.

#### **D.6.15 CONSTRUCTION JOINTS AND KEYS**

- D.6.15.1 Construction joints will be as shown on the drawing or as approved by Engineer. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approved of Engineer.
- D.6.15.2 Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the drawings or as directed by Engineer.
- D.6.15.3 Before resuming concreting on a surface which has hardened all laitance and loose stone shall be thoroughly removed by wire brushing / hacking and surface washed with high pressure water jet and treated with thin layer of cement slurry for

vertical joints and a 15 mm thick layer of cement sand mortar for horizontal layers, the ratio of cement and sand being the same as in the concrete mix.

- D.6.15.4 When concreting is to be resumed on a surface which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

## **D.6.16 FOUNDATION BEDDING**

- D.6.16.1 All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy area shall be cleaned out and back filled with either soil cement mixture, lean concrete or clean sand compacted as directed by Engineer. The surfaces of absorptive soils shall be moistened.

- D.6.16.2 Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

## **D.6.17 FINISHES**

### **D.6.17.1 General**

- D.6.17.1.1 The formwork for concrete works shall be such as to give the finish as specified. The Contractors shall make good as directed any unavoidable defects consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. The Contractor shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

### **D.6.17.2 Surface finish Type F1**

- D.6.17.2.1 This type of finish shall be for non-exposed concrete surface against which back fill or concrete is to be placed. The main requirement is that of dense, well compacted concrete. No treatment is required except repair of defective areas, filling all form tie holes and cleaning up of loose or adhering debris. For surfaces below grade which will receive waterproofing treatment the concrete shall be free of surface irregularities which could interfere with proper and effective application or waterproofing material specified for use.

### **D.6.17.3 Surface finish Type F2**

- D.6.17.3.1 This type of finish shall be for all concrete work which will be exposed to view upon completion of the job. The appearance shall be that of a smooth dense, well-compacted concrete showing the slight marks of well fitted shuttering joints. The Contractor shall make good any blemishes.

### **D.6.17.4 Surface finish Type F3**

D.6.17.4.1 This type of finish shall be for concrete work which will be exposed to view but to give an appearance of smooth, dense, well-compacted concrete with no shutter marks, stain free and with no discoloration, blemishes, arrises, air holes etc. Only lined or coated plywood with very tight joints shall be used to achieve this finish. The panel size shall be uniform and as large as practicable. Any minor blemishes that might occur shall be made good by Contractor.

#### **D.6.17.5 Integral cement finish on concrete floor**

D.6.17.5.1 In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screened off to proper level and tamped with tamper having conical projections so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener as approved by the Engineer shall be supplied and used as recommended by the manufacturer.

#### **D.6.18 REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE**

D.6.18.1 Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, holes left by form bolts etc. shall be brought to the notice of Engineer who may permit patching of the defective areas or reject the concrete work.

D.6.18.2 All through holes for shuttering shall be filled for full depth and neatly plugged flush with surface.

D.6.18.3 Rejected concrete shall be removed and replaced by Contractor at no additional cost to Client.

D.6.18.4 For patching of defective areas all loose materials shall be removed and the surface shall be prepared as directed by the Engineer.

D.6.18.5 Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the Engineer as to the method of repairs to be adopted shall be final and binding on the Contractor and no extra claim shall be entertained on this account. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as directed by Engineer.

#### **D.6.19 VACUUM DEWATERING OF SLABS**

D.6.19.1 Where specified floor slabs, either on grade or suspended, shall be finished by vacuum dewatering including all operations such as poker vibration, surface vibration, vacuum processing, floating and trowelling as per equipment manufacturers recommendation. The equipment to be used shall be subject to Engineer's approval.

#### **D.6.20 HOT WEATHER REQUIREMENTS**

- D.6.20.1 Concreting during hot weathers shall be carried out as per IS : 7861 (Part – I)
- D.6.20.2 Adequate provisions shall be made to lower concrete temperatures which shall not exceed 40 Deg. C at the time of placement of fresh concrete.
- D.6.20.3 Where directed by Engineer, Contractor shall spray non-wax based curing compound of unformed concrete surfaces at no extra costs.

#### **D.6.21 COLD WEATHER REQUIREMENTS**

- D.6.21.1 Concreting during cold weather shall be carried out as per IS : 7861 (Part-II).
- D.6.21.2 The ambient temperature during placement and upto final set shall not fall below 5 Deg. C. Approved antifreeze / accelerating additives shall be used where directed.
- D.6.21.3 For major and large scale concreting works the temperature of concrete at times of mixing and placing, the thermal conductivity of the formwork and its insulation and stripping period shall be closely monitored.

#### **D.6.22 LIQUID RETAINING STRUCTURES**

- D.6.22.1 The Contractor shall take special care of concrete for liquid retaining structures, underground structures and those others specifically called for to guarantee the finish and water tightness.
- D.6.22.2 The minimum level of surface finish for liquid retaining structures shall be type F2. All such structures shall be hydro-tested.
- D.6.22.3 The Contractor shall include in his price of hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipelines etc.
- D.6.22.4 Any temporary arrangements that may have to be made to ensure stability of the structures shall also be considered to have been taken into account while quoting the rates.
- D.6.22.5 Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement / epoxy pressure grouting, guniting or such other methods as may be approved by the Engineer. All such rectification of the Client / Engineer at no extra cost to the Client.

#### **D.6.23 TESTING CONCRETE STRUCTURES FOR LEAKAGE**

- D.6.23.1 Hydro-static test for water tightness shall be done at full storage by Engineer, as described below :

- D.6.23.1.1 In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.
- D.6.23.1.2 In the case of structures whose external faces are submerged and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling, the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hrs. over a period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period for seven day shall be taken as an indication of the water tightness of the structure. The Engineer shall decide on the actual permissible nature of this drop in the surface level, taking into account weather the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.
- D.6.23.1.3 Each compartment / segment of the structure shall be tested individually and then all together.
- D.6.23.2 For structures such as pipes, tunnels etc. the hydro-static test shall be carried out by filling with water, after curing as specified, and subjecting to the specified test pressure for specified period. If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

#### **D.6.24 OPTIONAL TESTS**

- D.6.24.1 If Engineer feels that the materials i.e. cement, sand coarse aggregates, reinforcement and water are not in accordance with the specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the Engineer, as per relevant IS Codes. Client shall pay only for the testing of material supplied by the Client, otherwise Contractor shall have to pay for the tests. Transporting of all material to the laboratory shall however be done by the Contractor at no extra cost to Client.
- D.6.24.2 In the even of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strengths, Engineer reserves the right to order the Contractor to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, etc. All these tests shall be carried out by Contractor at no extra cost to the Client. Alternatively Engineer also reserves the right to ask the Contractor to dismantle and re-do such unacceptable work at the cost of Contractor.
- D.6.24.3 If the structure is certified by Engineer as having failed, the cost of the test and subsequent dismantling / reconstruction shall be borne by Contractor.



D.6.24.4 The quoted unit rates / prices of concrete shall be deemed to provide for all tests mentioned above.

## **D.6.25 GROUTING**

D.6.25.1 Grout shall be provided as specified on the drawings. The proportion of standard Grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. Surface to be grouted shall be thoroughly roughened and cleaned. All structural steel elements to be grouted, shall be cleaned of oil, grease, dirt etc. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete shall be saturated with water and just before grouting water in all pockets shall be removed. Grouting once started shall be done quickly and continuously. Variation in grout mixes and procedures shall be permitted if approved by ENGINEER. The grout proportions shall be limited as follows :

	Use	Grout Thickness	Mix Proportions	W/C Ratio (max.)
a)	Fluid mix	Under 25 mm	One part Portland cement to one part sand.	0.44
b)	General mix	25 mm and over but less than 50 mm	One part Portland cement to 2 part sand.	0.53
c)	Stiff mix	50 mm and over	One part Portland cement to 3 part sand.	0.53

### **D.6.25.2 Non Shrink Grout**

D.6.25.2.1 Non-shrink grout where called for in the Schedule of Quantities or specified on the drawings shall be provided in strict accordance with the manufacturer's instructions/ specifications on the drawings.

## **D.6.26 INSPECTION**

D.6.26.1 All materials, workmanship and finished construction shall be subject to continuous inspection and approval of Engineer. Materials rejected by Engineer shall be expressly removed from site and shall be replaced by Contractor immediately at no extra cost to Client.

## **D.6.27 CLEAN-UP**

D.6.27.1 Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and any debris, scraps of wood etc. resulting from the work shall be removed and the premises left clean.

## **D.6.28 ACCEPTANCE CRITERIA**

D.6.28.1 Any concrete work shall satisfy the requirements given below individually and collectively for it to be acceptable.

- a) Properties of constituent materials;
- b) Characteristic compressive strength;
- c) Specified mix proportions;
- d) Minimum cement content;
- e) Maximum free-water / cement ratio;
- f) Workability;
- g) Temperature of fresh concrete;
- h) Density of fully compacted concrete;
- i) Cover to embedded steel;
- j) Curing;
- k) Tolerances in dimensions;
- l) Tolerances in levels;
- m) Durability;
- n) Surface finishes;
- o) Special requirements such as :
  - i) water tightness;
  - ii) resistance to aggressive chemicals
  - iii) resistance to freezing and thawing
  - iv) very high strength
  - v) improved fire resistance
  - vi) wear resistance
  - vii) resistance to early thermal cracking

D.6.28.2 The Engineer's decision as to the acceptability or otherwise of any concrete work shall be final and binding of the Contractor.

D.6.28.3 For work not accepted, the Engineer may review and decide whether remedial measures are feasible so as to render the work acceptable. The Engineer shall in that case direct the Contractor to undertake and execute the remedial measures. These shall be expeditiously and effectively implemented by the Contractor. Nothing extra shall become payable to the Contractor. Nothing extra shall become payable to the Contractor by the Client for executing the remedial measures.

#### **D.6.29 MODE OF MEASUREMENT AND PAYMENT**

D.6.29.1 The unit rate for concrete work under various categories shall be all inclusive and no claims for extra payment on account of such items as leaving holes, embedding inserts, etc. shall be entertained unless separately provided for in the schedule of quantities. No extra claim shall also be entertained due to change in the number, position and / or dimensions of holes, slots or openings, sleeves, inserts or on account of any increased lift, lead of scaffolding etc. All these factors should be taken into consideration while quoting the unit rates. Unless provided for in the Schedule of Quantities the rates shall also include fixing insets in all concrete work, whenever required.

D.6.29.2 Payments for concrete will be made on the basis of unit rates quoted for the respective items in the Schedule of Quantities. No deduction in the concrete quantity will be made for reinforcements, inserts etc. and opening less than 0.100

of a sq.m in areas where concrete is measured in sq.m and 0.010 cu.m where concrete is measured in cu.m. Where no such deduction for concrete is made, payment for shuttering work provided for such holes, pockets, etc. will not be made. Similarly the unit rates for concrete work shall be inclusive or exclusive of shuttering as provided for in the Schedule of Quantities.

- D.6.29.3 Payment for beams will be made for the quantity based on the depth being reckoned from the underside of the slabs and length measured as the clear distance between supports. Payment for columns shall be made for the quantity based on height reckoned upto the underside of slab / beams.
- D.6.29.4 The unit rate for precast concrete members shall include formwork, mouldings, finishing, hoisting and setting in position including setting mortar, provision of lifting arrangement etc. complete. Reinforcement and inserts shall be measured and paid for separately under respective item rates.
- D.6.29.5 Only the actual quantity of steel embedded in concrete including laps as shown on drawings or as approved by Engineer shall be measured and paid for, irrespective of the level or height at which the work is done. The unit rates for reinforcement shall include lap chairs, spacer bars etc.
- D.6.29.6 Where the formwork is paid for separately, it shall be very clearly understood that payment for formwork is inclusive of formwork, shuttering, shoring, propping scaffolding etc. complete. Only the net area of concrete formed (shuttered) shall be measured for payment.

## CONCRETE POUR CARD

Client :	Date :
Project :	Structure :
Contractor :	Max. Aggregate size slump : mm/ mm/
Drg. NO. :	Start/ Completion Time :
Concrete Grade :	Mixing Time :

Sr. No.	Item	Contractor's Rep. Signature	Engineer's Signature	Remarks
1	Centre lines Checked			
2	Form work and Staging checked for Accuracy, Strength & finish			
3	Reinforcement Checked			
4	Cover to Reinforcement Checked			
5	Verified test certificate for cement / steel	Yes / No	Yes / No	
6	Adequacy of Materials / Equipment	Yes / No	Yes / No	
7	Embedded Parts checked (Location and Plumb)	Civil		
		Mechanical		
		Electrical		

### Pour Authorised site Engineer

8	Soffit(S) and pour top ( T ) levels checked before ( B ) and after (A) from removal (Only of Beams of over 1 M. span & Important structures link T.G etc.)	S(B) S(A)	T(B) T(A)	
9	Construction joint location & time (If not as per Drawing)			
10	Cement Consumption in Kgs.			
11	Numbers of cubes and identification mark			
12	Test cube results (7 Days / 28 Days)			
13	Concrete Condition on Form removal	<b>Very Good/ Good / Fair / Poor</b>		

Engineer-in-Charge

Contractor

### Notes :

- Each item to be checked & signed by the respective engineers.
- Item 8 to 13 ( Both inclusive ) to be filled by only engineers of the client.
- Each pour to have separate cards in triplicate one each for client & site office.
- Under remarks indicate deviations from drawings & specifications congestion in reinforcement if any unusual occurrences such as failure of equipment sinking of supports / props, heavy rain affecting reasonable. Poor compaction improper curing other deficiencies observations etc.

## **D.6.31 MATERIALS : STRUCTURAL STEEL**

All structural steel shall be comply with the requirements of IS 226-1961 and structural steel work IS 1915-1962 specifications for structural steel.

### **D.6.31.1 Steel for Pins and Rollers**

Rolled steel pins and rollers, shall comply with requirements of the IS specifications appropriate for the work. Steel casting for cast steel pins shall conform to grade 1 or 3 of IS 1030-1956 specifications for steel casting (for general engineering purposes as appropriate).

### **D.6.31.2 Bolts and Nuts**

Mild steel for bolts and nuts when tested shall comply with IS 1608-1960 and shall have tensile strength of not less than 2500 Kg/cm<sup>2</sup>. Plain washers shall be made of steel.

### **D.6.31.3 Welding Electrode**

Mild steel electrodes shall comply with requirements of IS 814-1957 specification for covered electrodes for metal arc welding of mild steel.

### **D.6.31.4 Workmanship**

All work shall be in accordance with the drawings and shall satisfy IS specification No. 1915-1961. Care shall be taken to ensure that all parts in assembly fit accurately together. Notes or specifications on the drawings supplied by the Engineer-in-Charge/consulting Engineer, are to be constructed as superseding or cancelling any clause of this specifications with which they conflict. On all drawings dimensions shown in figures shall be acted in preference to measurement by scale.

### **D.6.31.5 Straightening**

All structural steel members and parts shall have straight edges. All straightening shaping and levelling etc. shall be done by pressure only and not by hammering. All joggles and knees shall be formed by pressure and where practicable in making these, the metal shall not be cut and welded.

### **D.6.31.6 Cutting**

All structural steel parts where required shall be sheared, cropped sawn or flame cut and ground accurately to the required dimensions and shape.

### **D.6.31.7 Bolts Holes**

The diameter of bolts holes shall be 1.5 to 2.0 mm. larger than the nominal diameter of bolt. All holes for bolts shall be drilled unless permitted by Engineer-in-Charge for punching the holes. Care shall be taken, such as surrounding material is not deformed or damaged in case of punching the hole is allowed.

#### **D.6.31.8 Welding**

Welding of steel conforming to relevant IS specifications shall be in accordance with general requirements of metal arc welding. In addition to general requirement, the following care shall be taken :-

- (a) The welding shall be positioned for downward welding wherever practicable.
- (b) The welding current shall conform with respect of voltage and amperage to the recommendations of the manufacturers of the electrode being used. The arc length, voltage and amperage shall be suited to the thickness of material, type of groove and other circumstances of the work.
- (c) The surface to be welded and surrounding material for a distance of at least 155 mm shall be free from scale, dirt, grease, paint, heavy rust or other surface deposit.
- (d) Members to be welded shall be held in correct position by holes, clamps, wedges, jigs or other suitable devices or by tack welding until welding has been completed, such fastening as may be used shall be adequate to ensure safety. Suitable allowance shall be made for warpage and shrinkage.
- (e) Tack welds located where the final welds will later be made shall be subject to the same quality requirements as final welds. Defective and broken tack welds shall be removed before final welding.
- (f) Fusion faces shall be made or cut by shearing, chipping, machining or by gas cutting.
- (g) Exposed faces of welds shall be made reasonably smooth and regular so as to conform as closely as practicable to design requirements and shall not be of less than the required cross section.
- (h) Finished welds and adjacent parts shall be protected with clean boiled linseed oil after all slag has been removed.

#### **D.6.31.9 Safety Precautions**

- D.6.31.9.1
  - (a) Operators of welding and cutting equipment shall be protected from the rays of the arc flame by gloves and by helmet, hand shields, or goggles equipped with suitable filter lenses.
  - (b) Closed space shall be ventilated properly while welding is being done therein.
  - (c) Welders should be provided with such staging as will enable them to perform the welding operation. For site welding shelter should be provided to protect welders and the parts to be welded from the weather.
- D.6.31.9.2 The Constructor shall employ a competent welding supervisor to ensure that the standard of workmanship and the quality of materials comply with requirements laid in these specifications.
- D.6.31.9.3 The Constructor shall provide free access to the representative of Engineer-in-Charge/Consulting Engineer to the work being carried out at all reasonable times and facilities shall be provided so that during the course of welding he may be able to inspect any layer of weld metal. He shall be at liberty to reject

any material that does not conform to the terms of the specifications and to require any defective welds to be cut out and welded. The representative of the Engineer-in-Charge/Consulting Engineer shall be notified in advance of any welding operations.

D.6.31.9.4 Inspection and testing of welds shall be done as laid down in IS 822 and IS 11017.

D.6.31.9.5 No welder shall be employed in any position except those who are fully qualified to welding. Qualification for welders shall be as laid down in IS 812.

#### **D.6.31.10 Joints**

All steel work intended to be bolted together must be in contact over the whole surface. Joints which have to take compressive stress and the ends of all stiffeners shall meet truly over the whole of the butting surface.

#### **D.6.31.11 Assembling**

All member shall be so arranged that they can be accurately assembled, without being unduly packed, strained or forced into position and when built shall be true and free from twist kinks, buckets or open joints between component pieces. Work shall be kept properly bolted together and no drifting shall be allowed except for the purpose of drawing assembled sections together in accuracy's in matching of holes may be corrected. But drifting to enlarge holes is prohibited. Failure in any of the above respect will involve the rejection of defective members.

#### **D.6.31.12 Mode of Measurement and Payment**

D.6.31.12.1 Measurement of this item shall be as per IS 1200(Part VIII) - 1974 or as per its latest revision so far as applicable.

D.6.31.12.2 The contract rate shall be suitable for unit of one metric tonne of structural steel.

### **D.6.32 MATERIALS : REINFORCEMENT**

#### **D.6.32.1 Specification for TMT bars reinforcement**

##### **D.6.32.1.1 Scope of work :**

The scope of work consists of providing and laying mild steel reinforcement and TMT Fe-415 reinforcement for RCC works of various components of the structure. This may be Tiscon or any other approved manufacturer brand and corrosion resistant steel bars approved by the Engineer-in-charge. This includes cuttings, bending, binding, placing, with all equipments and labour required for the work as directed by the City Engineer, AMC, Ahmedabad and all operations covered within the intent and purpose of the specification.

#### **D.6.32.1.2 Bending of Reinforcement :**

Reinforcing steel shall conform accurately to the dimensions shown on relevant drawings and conforming to the relevant IS codes (latest revision)

Bars shall be bent cold to the specified shape and dimensions or as directed by the City Engineer, AMC, Ahmedabad using a proper bar bender, operated by hand or power to attain proper radii of bends.

Bars shall not be bent or straightened in a manner that will cause injury to the material.

Bars bent during transport or handling shall be straightened before being used on work; they shall not be heated to facilitate bending.

The bending of the TMT bars shall be carried out as per the following :

<b>Sr. No.</b>	<b>Operation</b>	<b>Size</b>	<b>TMT Fe-415</b>
1	Bend	Upto 22 mm dia.	3d
		Over 22 mm dia.	4d
2	Rebend	Upto 10 mm dia.	4d
		Over 10 mm dia.	5d

#### **D.6.32.1.3 Placing of Reinforcement :**

All reinforcing bars shall be accurately placed in the exact position shown on the drawings, and shall be securely held in position during placing of concrete by annealed binding wire not less than 1 mm. in size and conforming to IS : 280 and by using stays blocks or metal chairs, spacer, metal hangers, supporting wires or other approved devices at sufficiently close intervals. Bars will not be allowed to sag between supports nor displaced during concreting or any other operation over the work. All devices used for positioning shall be of noncorrodible material. Wooden and metal supports will not extend to the surface of concrete, except where shown on the drawings, Placing bars on layers of freshly laid concrete as the work progresses for adjusting bar spacing will not be allowed. Pieces of broken stone, brick or wooden blocks shall not be used. Layers of bars shall be separated by spacer bars, precast mortar blocks or other approved devices.

Reinforcement after being placed in position shall be maintained in a clean condition untill completely embedded in concrete. Special care shall be exercised to prevent any displacement of reinforcement in concrete already placed.

To protect reinforcement from corrosion, concrete cover shall be provided as indicated on the drawings. All bars protruding from concrete to which other bars are to be spliced and which are likely to be exposed for an indefinite period shall be protected by a thick coat of neat cement grout.

In the case of columns and walls, vertical bars shall be kept in normal position with timber templates having slots accurately cut in for bar position. Such templates shall be removed after the concreting has progressed upto a level just below them.



Bars crossing each other, where required, shall be secured by binding wire (annealed) of size not less than 1 mm and conforming to IS : 280 in such a manner that they do not slip over each other at the time of fixing and concreting. As far as possible, bars of full length shall be used. In case this is not possible, overlapping of bars shall be done as directed by the City Engineer, AMC, Ahmedabad. When practicable, overlapping bars shall not touch each other, but be kept apart by 25 mm or 1 1/4 times the maximum size of the coarse aggregates whichever is greater, by concrete between them. Where this is not feasible, overlapping bars shall be bound with annealed steel wire, not less than 1mm thickness twisted tight in eight shape around the lapped bars. The overlaps shall be staggered for different bars and located at fixed locations only along the span where neither shear nor bending moment is maximum.

#### **D.6.32.1.4 Welding of Bars**

Welding of TMT bars can be permitted if specified on the drawings, joints of reinforcement bars shall be butt welded so as to transmit their full strength. Welded joints shall preferably be located at points where steel will not be subject to more than 75 percent of the maximum permissible stresses and welds so staggered that at any one section, not more than 33 per cent of the rods are welded. No pre-warming or post heat treatment is necessary. Interpass temperature should be limited to 200°C with low heat input and equivalent strength low hydrogen type electrode. Suitable means shall be provided for holding the bars securely in position during welding. It must be ensured that no voids are left in welding and when welding is done in 2 or 3 stages, previous surface shall be cleaned properly. Ends of the bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before welding. Only competent welders shall be employed on the work. Welded pieces of reinforcement shall be tested. Specimens shall be taken from the actual site and their number and frequency of tests shall be as directed by the City Engineer, AMC, Ahmedabad.

The TMT bars shall be tested for any or all of the following tests as directed by the Engineer-in-charge.

- (1) Alternate immersion test
- (2) Salt spray test
- (3) Atmospheric exposure test
- (4) Sulphur dioxide test
- (5) Potentio dynamic test

## **D-7 : GENERAL BUILDING WORKS**

### **SECTION : D-7**

#### **D.7.1 SCOPE**

- D.7.1.1.1 This specification covers the general requirement for brick and stone masonry, plastering, flooring, doors, windows, ventilators, wood work, water proofing, false ceiling, 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 specifications shall consist of furnishing of all tools, plants, labour, materials, any and everything necessary for carrying out the work.

#### **D.7.2 APPLICABLE CODES AND SPECIFICATIONS**

- D.7.2.1 The following codes, standards and specifications are made a part of this specifications. All standards, tentative specification, specification, codes of practices referred to herein shall be latest edition including all applicable official amendments and revisions.

- D.7.2.2 In case of discrepancy between this specification and those referred to herein, these specifications shall govern.

- |           |   |
|-----------|---|
| IS : 1077 | - Common burnt clay bricks  |
| IS : 3102 | - Classification of burnt clay bricks   |
| IS : 2180 | - Burnt clay building bricks, heavy duty  |
| IS : 3495 | - Method of sampling and testing clay building bricks   |
| IS : 2691 | - Burnt clay facing bricks  |
| IS : 2212 | - Code of practice for brick work   |
| IS : 2185 | - Load bearing hollow concrete blocks   |
| IS : 5498 | - Lime-Cement-Cinder hollow concrete blocks   |
| IS : 3115 | - Lime-Cement-Cinder soil blocks  |
| IS : 1597 | - Code of practice for construction of stone masonry  |
| (Part-I)  |   |
| IS : 2394 | - Code of practice for application of lime plaster finish   |
| IS : 2645 | - Integral cement water proofing compounds  |
| IS : 1443 | - Code of practice for laying and finishing of cement concrete flooring tiles                           |
| IS : 2114 | - Code of practice for laying in situ terrazzo floor finish   |
| IS : 777  | - Glazed Earthenware tiles  |
| IS : 4021 | - Timber door, window and ventilator frames   |
| IS : 2202 | - Wooden flush door shutters (Solid Core Type)  |
| (Part-I)  |   |
| IS : 1003 | - Timber panelled and glazed shutters (Parts – I and II)  |
| IS : 4020 | - Methods of tests for wooden flush doors : Type tests  |
| IS : 1761 | - Transparent sheet glass for glazing and framing purposes  |
| IS : 4351 | - Steel door frames   |
| IS : 1038 | - Steel doors, windows and ventilators  |
| IS : 1081 | - Codes of practice for fixing and glazing of metal (steel and aluminum) doors, windows and ventilators |
| IS : 5807 | - Method of test for clear finishes for wooden furniture (Part-I to III).                               |

IS : 1477 (Part-I & II)	- Code of practice for painting of ferrous metals in buildings and allied finishes.
IS : 2338 (Part-I)	- Code of practice for finishing of wood and wood-based materials
IS : 437	- Distemper, dry, colour as required
IS : 428	- Distemper, oil emulsion, colour as required
IS : 2395	- Code of practice for painting concrete, masonry and plaster surfaces
IS : 3384	- Bituminous primer for use in water proofing and damp proofing
IS : 1580	- Bituminous compound for water proofing and caulking purpose
IS : 1322	- Bitumen felts for water proofing and damp proofing
IS : 1346	- Code of practice for water proofing of roofs with bitumen felts

### **D.7.3 BRICK WORK**

D.7.3.1 Bricks used in works shall conform to the relevant Indian Standards. They shall be sound, hard, homogenous in texture, well bunt in kiln without being vitrified, table moulded, deep red, cherry or copper coloured, of regulator shape and size and shall have sharp and square edges and parallel faces. The bricks shall be free from pores, chips, flaws or humps or any kind. Bricks containing unground particles and / or which absorb water more than  $1/6^{\text{th}}$  of their weight when soaked in water for twenty-four hours shall be rejected. Over-burnt or under-burnt bricks shall be liable to rejection. The bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 35 Kg/sq. cm. Unless otherwise noted in drawings. The classes and quality requirements of bricks shall be as laid down in IS : 3102.

D.7.3.2 The size of the brick shall be 23.0 x 11.5 x 7.5 cm unless otherwise specified; but tolerance upto (+/-) 3 mm in each direction shall be permitted. However, bricks conforming in size to IS : 1077 could be used. Bricks shall be provided with frogs. Only full size bricks shall be used for masonry work. Brick bats shall be used only with the permission of the Engineer to make up required wall length or for bonding. Sample bricks shall be submitted to the Engineer for approval and bricks supplied shall conform to approved samples. If demanded by Engineer, brick sample shall be got tested as per IS : 3495 by Contractor at no extra cost to Client. Bricks rejected by Engineer shall be removed from the site of works within 24 hours.

### **D.7.3.3 Mortar**

D.7.3.3.1 Mortar for brick masonry shall be prepared as per IS : 2250 Mix for cement mortar shall be specified in the respective items of work. Gauge boxes for sand shall be of such dimensions that one completed bag of cement containing 50 kg of cement forms one unit. The sand shall be free from clay, shale, loam, alkali and organic matter shall be of sound, hard, clean and durable particles. Sand shall be approved by Engineer, sand shall be thoroughly washed till it is free of any contamination.

- D.7.3.3.2 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. Cement mortar shall preferably be machine mixed, though hand mixing in a thorough manner may be allowed. The mortar so mixed shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be rejected.
- D.7.3.3.3 The Contractor shall arrange for test on mortar samples if so directed by the Engineer. Re-tempering of mortar shall not be permitted.

#### **D.7.3.4 Workmanship**

- D.7.3.4.1 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 230 mm thick and over shall be laid English Bond unless otherwise specified. 115 mm thick work 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 pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.
- D.7.3.4.2 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 course shall be kept uniform. For walls of thickness greater than 230 mm both faces shall be kept in vertical planes. All interconnected brickwork shall be carried out at nearly one level (so that there is uniform distribution of pressure on the supporting structure) and so 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 racked back according to bond (and not saw toothed) at an angle not exceeding 45 degree. But in no case the level difference between adjoining walls shall exceed 1.25 m. Workmanship shall conform to IS : 2212.
- D.7.3.4.3 Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10/15 mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plaster or pointing to be done. 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 brick work 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. If the mortar in the lower course has begun to set, the joints shall be raked out to a depth of 12 mm before another course is laid.
- D.7.3.4.4 All brick work shall be built tightly against columns, floor slabs or other structural members.

D.7.3.4.5 Where drawings indicate that structural steel columns are to be fireproofed with brickwork, the brick shall be built closely against all flanges and webs with all spaces between the steel and brickwork filled with mortar. Steel members partly embedded in brickwork and not indicated to be fireproofed with concrete, shall be covered with not less than 12 mm thick mortar unless directed otherwise by Engineer.

D.7.3.5 Miscellaneous inserts in masonry e.g. sleeves, wall ties, anchors, conduits, structural steel, steel inlets etc. shall be installed by the Contractor at no extra cost to the Owner. Furnishing of any of these inserts by the Contractor, will be paid for separately. Openings, arches etc. shall be provided as shown on the drawings. Chases, pockets etc. shall be provided as shown on the drawings to receive windows, louvers, doors frames etc. Wall ties and flashings shall be built into the brickwork in accordance with the drawings and specifications. It shall be clearly understood that the rates quoted by the Contractor include for fixing of inserts, leaving openings, cutting chases in brickwork for various trades etc.

#### **D.7.3.6 Facing Brickwork**

D.7.3.6.1 Facing bricks of the type specified shall be laid in the positions indicated on the drawings and all facing brickwork shall be well bonded to the backing bricks. No facing brickwork shall at any time be more than 600 mm above the backing brickwork.

D.7.3.6.2 All facing brickwork shall be pointed as the work proceeds and internal faces of the brickwork shall be pointed with neat flush joint to give a fair face.

D.7.3.6.3 Faced work shall be kept clean and free from damage, discoloration etc. at all times. The Contractor shall fill carefully all holes with bricks similar to the surrounding brickwork, point brickwork as required.

D.7.3.6.4 For facing brickwork, double scaffolding shall be used no holes in brickwork for scaffolding shall be permitted.

D.7.3.7 The green work shall be protected from rain by suitable covering bricks shall be kept constantly moist on all faces for a minimum period of ten days. Brickwork shall not be raised more than one metre per day.

D.7.3.8 The rates quoted by the Contractor are exclusive of transoms and mullions. Contractor shall provide the same as shown or indicated on the drawings. These shall be generally provided only in half and full brick walls. Dimensions of the transoms and mullions shall conform to the thickness of the wall. Concrete work for transoms and mullions shall conform to the specifications for concrete and shall be of grade M200.

D.7.3.9 Where shown on the structural drawings, bricks for partitions walls shall be stacked adjacent to the structural member to pre deflect the structural member before the wall is built.

#### **D.7.3.10 Measurement**

D.7.3.10.1 Brick work of thickness one brick i.e. 230 mm and above shall, unless otherwise stated in the Schedule of Quantities, be paid in units of cu.m. or part thereof. Brickwork of thickness less one brick i.e. less than 230 mm thick shall be measured and paid on the basis of rates quoted per sq.m. of part thereof in all cases, the quantities measured and paid for shall be those actually executed after making necessary deductions for openings etc. Brick masonry for steps and such other mass works and encasement shall be paid on the basis of rates quoted per cu.m. or part thereof.

#### **D.7.4 CONCRETE BLOCK MASONRY**

D.7.4.1 Concrete blocks (hollow or solid) shall generally conform to IS : 2185. Blocks shall be regular size and shape and shall be of specified strength. Blocks shall be properly cured before they are brought to site. Half of three quarter size blocks are to be used wherever required to make up length of wall and broken blocks shall not be used. The texture of the blocks shall be such that plaster will adhere to it. The Contractors shall supply samples for approval. Blocks supplied shall conform to approved samples.

##### **D.7.4.2 Mortar**

Mortar shall be similar to mortar in brickwork as given Clause D.7.3.3 herein before.

D.7.4.3 All block work shall be plumb, square and properly bonded. The joints shall be broken. The thickness of the courses shall be uniform with courses horizontal. All connected work shall be carried out at nearly one level and no portion of the work shall be left more than one course lower than the adjacent work.

D.7.4.4 Blocks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and nor more than 8 mm. The face joints shall be raked to a minimum depth of 10 mm by raking tools daily during the progress of work when the mortar is still green, so as to provided a proper key for the plaster or pointing. When plastering or pointing is not required, the joints shall be struck flush. For pointed masonry or for masonry without plaster, smooth textured concrete shall be use. The face of block work shall be kept clean at all times.

D.7.4.5 Where blocks are to be used for load bearing walls, the uppermost layer of blocks supporting slab or other structural members, shall be solid of treated as directed by the Engineer.

D.7.4.6 Precast concrete screen blocks or 'jali' work may be used for decorative purpose. The Contractor shall furnish samples for approval.

#### **D.7.4.7 Measurement**

- D.7.4.7.1 Block work of specified thickness shall be paid in units of sq.m. or parts thereof. If reinforcing bars are specified in horizontal courses, it shall be measured and paid for separately at quoted rate for reinforcement. In all cases, the quantities measured and paid for, shall be those actually executed after making necessary deductions for openings etc.
- D.7.4.7.2 Miscellaneous inserts e.g sleeves, ties, anchors, conduits etc. in block masonry shall be installed by Contractor, at no extra cost to Owner. Furnishing of any of these inserts by Contractor will be paid for separately.

#### **D.7.5 RANDOM RUBBLE MASONRY, UNCOURSED IN FOUNDATION, PLINTH AND SUPERSTRUCTURE**

- D.7.5.1 Stones for this work shall be hard, durable rock, close or fine grained and uniform in colour, free from veining, flaws and other defects and shall conform to IS : 1597 (Part-I). The stones shall be laid in mortar proportions specified for the particular item of work. Stones shall be got approved, if desired by Engineer.
- D.7.5.2 For all work below ground level the masonry shall be random rubble uncoursed with ordinary quarry dressed stones for hearting and faced with selected quarry dressed stones.
- D.7.5.3 For all work above ground level and in superstructure the masonry shall be random rubble, well bonded, faced with hammer dressed stones with squared quoins at joints and corners.
- D.7.5.4 No stones shall tail into the wall, either with a point or to length less than 1.5 times its height. The thickness of the joint shall not exceed 12 mm.
- D.7.5.5 Spawls and pinnings shall not be allowed to show on the face of the wall. Two bond stones each of minimum area of 500 sq.cm. for every 1.0 sq.m. of each wall face shall be provided. These shall be through stones in walls 600 mm thick and under. In walls thicker than 600 mm, the length of bond stones shall be 2/3 times the thickness of walls. The stones for hearting of the wall shall not be less than 150 mm in any direction. Chips and Spawls shall be wedged in to avoid thick mortar beds and joints. The quoins shall be of selected stones neatly dressed with chisel to form the required angles and laid header and stretcher alternately.
- D.7.5.6 The exposed face of the work shall be carefully and neatly pointed with mortar in all joints. On the other sides, the joints shall be neatly struck with trowel while the mortar is fresh.
- #### **D.7.5.7 Mortar**
- The mortar for the work shall be as specified in the respective items of work and shall be prepared as per Clause D.7.3.3.
- D.7.5.8 Curing of masonry shall continue for a minimum of ten days.

#### **D.7.5.9 Measurement**

The unit of measurement shall be cu.m. or part thereof. Actual quantity of masonry shall be calculated from dimensions shown on the drawings less opening and shall be paid for.

#### **D.7.6 COURSED RUBBLE MASONRY (FIRST SORT) FOR SUPERSTRUCTURE**

- D.7.6.1 The stones used shall be hard, durable, rock free from veins, flaws and other defects and shall conform to IS : 1597 (part-I). Height of each course in the masonry shall not be less than 150 mm. The stones in each course shall be of equal height. All courses shall be of the same height unless otherwise specified. All stones shall be set in full cement mortar of proportion specified for the respective items of works. Stones shall be got approved, if desired by Engineer.
- D.7.6.2 The free stones shall be squared on all joints and beds. The beds being hammer or chisel dressed true and square for at least 75 mm from the face and the joints for at least 40 mm. The face of the stone shall be hammer dressed so that bushings shall not project more than 40 mm.
- D.7.6.3 No spalls or pinnings shall be allowed in the face. All bed joint shall be horizontal and side joints vertical and no joints shall be more than 10 mm thickness.
- D.7.6.4 No face stone shall be less in breadth than in height or shall tail into the work to a length less than the height and at least 1/3<sup>rd</sup> the number of stone shall tail into the work to at least twice their or in walls over 600 mm in thickness 3 times their height.
- D.7.6.5 Through stones shall be inserted every 1.5 metres to 1.8 metres apart in every course and shall run right when the wall is not more than 600 mm thick. When the wall is more than 600 mm thick a line of two or more headers be laid from the face to face which shall overlap each other by at least 150 mm. A header shall have a length of at least thrice its height.
- D.7.6.6 Stones shall break joint at least half the height of the courses. Quoins shall be formed of stones at least 45 cm. Long, laid stretcher and header alternately. They shall be laid square in their beds, which shall be fair dressed to a depth of at least 100 mm. The corner shall be chisel dressed for a width of 25 mm.
- D.7.6.7 The work on the interior face shall be precisely the same as on the exterior face unless the work is to be plastered in which case the side joints need not be truly vertical.
- D.7.6.8 Hearting shall consist of flat bedded stone carefully laid on their proper beds and solidly bedded in mortar, chips and spalls of stone being wedged in wherever so as to avoid thick beds or joints of mortar. Care shall be taken so that no dry work or hollow spaces shall be left anywhere in the masonry. The face and backing shall be brought up evenly but the backing should not be levelled up at each course by the use of chips.



#### **D.7.6.9 Mortar**

The mortar for the work shall be as specified in the respective items of work and shall be prepared as of Clause D.7.3.3.

D.7.6.10 Curing of masonry shall continue for a minimum of ten days.

#### **D.7.6.11 Measurement**

The unit of measurement shall be cu.m. of part thereof. Actual quantity of masonry shall be calculated from dimensions shown on drawings less openings and shall be paid for.

#### **D.7.7 INSERTS, BOLTS ETC.**

D.7.7.1 Inserts, bolts etc. shall be provided in masonry and concrete works as indicated on the drawings. It is imperative that all inserts, bolts, fixtures and fittings shall be provided in their position very accurately. If the Engineer directs that such inserts and bolts be fixed by use of templates, the Contractor shall make arrangements for providing such templates. If as a consequence of negligence on the part of the Contractor, the inserts, bolts, fixtures, fittings etc. are out of alignment, the Contractor shall make arrangement to have the inserts and bolts removed and refixed in their proper position as directed by the Engineer, at no cost to the Owner.

#### **D.7.7.2 Measurement**

Inserts, bolts etc. shall be measured and paid for as indicated in Schedule of Quantities.

#### **D.7.8 RUBBLE PACKING**

D.7.8.1 Rubble used for packing under floors, foundations etc. shall be hard, durable rock free from veins, flaws and other defects. The quality and size of the rubble shall be subject to the approval of the Engineer.

D.7.8.2 Rubble shall be hand packed as directed by Engineer. This shall be laid closely in position on the sub-grade. All interstices between the stones shall be wedged in with smaller stones of suitable size well driven to ensure tight packing and complete filling of interstices. Such filling shall be carried out simultaneously with the placing in position of rubble stones and shall not lag behind.

D.7.8.3 Small interstices shall be filled with hard clean sand and well watered and rammed.

#### **D.7.8.4 Measurement**

D.7.8.4.1 The unit of measurement shall be sq.m. for the specified thickness of rubble packing.

## **D.7.9 CEMENT POINTING**

- D.7.9.1 The joints of masonry shall be raked atleast 12 mm deep. 3 or 4 days after the courses are laid if not done earlier. The dust shall then be brushed out of the joints and the wall, washing with water.
- D.7.9.2 The mortar shall consist of one part of cement to one part of fine sand. Mortar shall filled into joints and well pressed with special steel trowels. The joints hall not be touched again after it has once begun to set.
- D.7.9.3 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 of 'V' as may be directed. No false joints shall be allowed.
- D.7.9.4 The work shall be kept we for a after the pointing is complete. Whenever coloured pointing has to be done, the colouring pigment of the colour requirement shall be added to cement in such proportion as recommended by the manufactures and as approved by the Engineer.

### **D.7.9.5 Measurement**

- D.7.9.5.1 The area pointed shall be calculated in sq.m. from dimensions shown on drawings less opening and shall be paid for.

## **D.7.10 CEMENT PLASTER WORK**

- D.7.10.1 All joints in masonry shall be raked to a depth of 12 mm with a hooked tool made for the purpose when the mortar is still green and in any case within 48 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose plastering work is commended. Concrete surfaces to be rendered will however be kept dry. The wall should not too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall. Cement shall be sulphate resistance cement confirming to IS 12330 for underground work and in OPC for the work above ground level.
- D.7.10.2 The proportion if the mortar shall be as specified under the respective items of work. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per IS : Standards. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to stand for more than 25 minutes after mixing with water. Cement be sulfate resistant cement conformity to IS : 12330 for under ground work at OPC for the work above ground low.
- D.7.10.3 Curing of plaster shall be started as soon as the applied plaster has hardened enough so as not to be damaged. The decision, as to when the plaster has hardened, will be given by the Engineer. Curing shall be done by continuous applying water in a spray and shall carried out for atleast 7 days.

- D.7.10.4 Whenever the specifications or the item of work calls for water proofing, the Contractor shall provide the percentage of water proofing compound as specified in the items of work.
- D.7.10.5 Where lath plaster is specified, it shall be paid for at the same rate as for plasterwork without metal lath except that separate payment for metal lath will be made.
- D.7.10.6 Ceiling plaster shall be done before wall plaster and wall plaster shall commence at top and work downwards.
- D.7.10.7 **Interior plaster** - This plaster shall be laid in a two coats of 12 and 8 mm for 20 mm and single coat for 15 mm & 10 mm thickness. The mortar shall be dashed on the prepared surface with a trowel and finished smooth by trowelling on the surface with neeru (lime cream). Neeru shall be properly slaked fat lime. The standard of finish expected is high and shall conform to IS : 2394. Interior plaster shall be carried out on jambs, lintel and sill faces, top and undersides etc. as shown in the drawing or as directed by the Engineer. Rate quoted for plasterwork shall be deemed to include plastering of all those surfaces. However, if the item of work includes plaster finish, no separate payment would be made under 'plastering work'.
- D.7.10.8.1 **Exterior Plaster** – Exterior plasterwork shall be carried out in 2 layers. The first layer being 12 mm thick and the second layer being 8 mm thick. The first layer shall be dashed against the prepared surface with a trowel to obtain an even surface. The second layer shall then be applied and finished leaving an even and uniform surface, trowel finished unless otherwise directed by the Engineer.
- D.7.10.8.2 **Exterior Sand Faced Plaster** – The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 12 mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item of work. The scratch coat shall be cured for at least 7 days and then allowed to dry.
- D.7.10.8.3 The second coat shall be 8 mm thick and it shall not be applied until at least 10 days have elapsed after the application of the scratch coat shall be evenly dampened. This coat shall be applied from top to bottom in one operation and without joints, finish shall be straight, true and even. The mortar proportions of this coat shall be as specified under the respective item of work. Only approved white sand shall be used for the second coat and for finishing work. Sand for finish shall be used for the second coat and for finishing work. Sand for finish shall be even coarse size and shall be dashed on the surface and sponged.
- D.7.10.8.4 Wherever 32 mm thick plaster has been specified, this is intended for purpose of providing beading, bands etc. This work should be carried out in two or three layers and as directed by the Engineer.

D.7.10.8.5 In the case of pebble face finished plaster, pebbles of approved size and quality shall be dashed against the final surface to obtain as far as possible uniform pattern. In all cases, workmanship shall conform to IS : 1661.

#### **D.7.10.9 Measurement**

D.7.10.9.1 The quantity of work to be paid for under this item shall be calculated by taking the projected surface of the area plastered after making necessary deductions for opening, doors, windows, fan openings etc. The actual plasterwork carried out on jambs of doors, windows openings etc. shall be measured and added. However, for purposes of payment under this item, plaster work carried on surface of items of work, which include plaster finished, shall not be taken into account.

#### **D.7.11 WATERPROOFING ADMIXTURES**

D.7.11.1 If directed by the Engineer, the Contractor shall use approved waterproofing admixtures made by reputed manufacturer in the mortar for plasterwork. The quantity to be used etc. shall be in accordance with the manufacturer's instructions subject however to the approval of the Engineer. These admixtures shall not contain calcium chloride unless specifically allowed by Engineer and shall conform to IS : 2645 with property of strong hydro phober and corrosion inhibitor. Dosage – 2% by weight of cement i.e. 1 kg per 50 kg bag of cement. Manufacturer must comply ISO – 9002 specifications. Payment shall be made for actual quantity of such admixture used unless it is already covered in the rates for the work concerned.

#### **D.7.12 MOSAIC, TERRAZZO AND PLAIN CEMENT TILING WORK IN FLOORING**

D.7.12.1 The type, quantity, size, thickness, colour etc. of the tiles for flooring and skirting work shall be of best quality approved by the Engineer. For this purpose, the Contractor shall provide the Engineer with necessary samples for his selection.

D.7.12.2 Before the tiling work of commenced, the sub-surface shall be thoroughly cleaned and washed of all loose materials, dirt and scum or laitance and then well wetted without forming water pools on the surface.

D.7.12.3 The tiles shall be laid on cement mortar bedding of about 20 to 25 mm thick. The proportion of mortar shall be one part of cement, 6 parts of sand. The mortar shall be evenly spread on the sub-floor. The tiles shall be fixed on this bed one after another, each tiles being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be perfectly straight and uniform in thickness. The tiles shall be laid perfectly in level unless otherwise specified or required or desired by the Engineer. After laying the tiles the joints shall be finished with white cement or cement of approved colour.

D.7.12.4 Floor tiles laid adjoining the wall shall project 12 mm under the plaster, starting or dado as may be required by the Engineer. Half tiles and pieces shall not be avoided as far as possible. After laying, the flooring shall be allowed to cure undisturbed for seven days. Design traffic shall not be allowed on the floor for atleast 14 days after laying the tiles.

- D.7.12.5 About a week after laying the tiles, each and every tile shall be lightly tapped with a small wooden mallet to find out if it gives a hollow sound; if it does, such tiles alongwith any other cracked or broken tiles shall be removed and replaced with a new tile proper line and level. The same procedure shall be followed again after the tiles are finally polished. For the purpose of ensuring that such replaced tiles match with those earlier laid, it is necessary that the Contractor order enough extra tiles from the factory to meet this contingency. The tiles shall finally be cleaned and polished by using dilute oxalic acid or any other method recommended by the manufacturer and approved by the Engineer.
- D.7.12.6 After the joints have developed sufficient strength, the floors shall be machine polished to the desired finish as approved by the Engineer. Sufficient quantity of water shall always be used during polishing to prevent scratching.
- D.7.12.7 For dado and skirting work, the vertical surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with about 12 mm thick 1:2 cement mortar. For this work the tiles as obtained from the factory shall be of the size required and practically fully polished. The back of each tile to be fixed shall be covered with a thin layer of near cement paste and the tile shall then be gently tapped against the wall with a wooden mallet. This shall be done from the bottom off the surface upwards. The joints shall be as close as possible and the work shall be truly vertical and flush. After the work has set, hand polishing with carborandum stones shall be done so that the surface attains a high glossy finish. Corners and junctions shall be finished true. The workmanship shall conform to IS : 1443.
- D.7.12.8 The work is subject to the approval of the Engineer. If the Engineer rejects any portion of the work, the same shall be removed and redone by the Contractor to the satisfaction of the Engineer at no extra cost to the Owner.
- D.7.12.9 The procedure for laying and finishing cement tiles in floor and dado shall be as for mosaic tiles except that in this case the tiles shall be cement tiles instead of mosaic / terrazzo tiles.

#### **D.7.12.10 Measurement**

- D.7.12.10.1 Unit of measurement for floor tiling, and dado shall be sq.m. or part thereof of the superficial area. Actual quantity of tiling work carried out will be measured and paid for after making deductions for openings etc. For skirting, unit of measurement shall be running metre for the specified width.

#### **D.7.13 IN-SITU TERRAZZO / MOSAIC FLOORING**

- D.7.13.1 The marble chips shall be of approved size, colour and shade. The cement used may be white coloured cement or cement mixed with colouring pigments as directed by the Engineer. The proportion of marble chips to cement shall be as directed by the Engineer but in no case it shall be less than 2.5:1.

- D.7.13.2 Samples of terrazzo / mosaic work shall be prepared for approval of the Engineer. The entire work shall be conform to the approved samples. For in-situ mosaic on stair treads, floors at building entrances etc. the Contractor shall provide a chequered non-slippery finish at no extra cost.
- D.7.13.3 The terrazzo chips shall be laid after placing the base. The base shall consist of a layer of cement mortar 15 mm thick spread and levelled. Chips shall be thoroughly mixed dry and then white cement or cement of approved colour shall be added in specified proportion. Chips and cement shall be thoroughly mixed and evenly spread on the platform and not heaped. Water shall then be added to obtain a plastic mix of suitable consistency as directed by the Engineer.
- D.7.13.4 Terrazzo layer shall be placed as soon as the screed cost has set sufficiently but in no case than the day thereafter. The thickness of terrazzo topping shall not be less than 10 mm. The surface shall be rammed to obtain the consolidation and a level surface. Additional chips shall be sprinkled on the surface and rammed in until surplus cement is worked out and chips forced together so that the finished floor will show not less than 70% aggregate. The surface is finally trowelled lightly.
- D.7.13.5 The Contractor shall keep the floor moist for not less than six days. Their surface shall then be machine polished. Voids shall be filled with neat grouting of same kind and colour as matrix, this grouting shall remain atleast 72 hours before being removed for final cleaning. The floor shall be refinished wherever necessary to leave the work in first class condition. The workmanship shall conform to IS : 2114.
- D.7.13.6 While the underbed is still plastic, metal dividing strips of brass or aluminium, about 35 mm wide and 1.25 mm thick, shall be inserted in mortar bed according to the design of the floor, care being taken to see that no section exceeds 1.5 sq.m in area. The top of strips shall be 10 mm above the surface of the underbed and shall conform to the finished level of the floor.

#### **D.7.13.7 Measurement**

- D.7.13.7.1 Measurement and payment shall be as per Clause D.7.12.11.

#### **D.7.14 GLAZED TILE WORK**

- D.7.14.1 The glazed tiles in paving and dado shall be of the best available first class quality approved by the Engineer and they should be laid on a base of 12 mm thick cement mortar for flooring and 15 mm thick cement mortar for skirting. The proportion of C.M. will be (1:3). The tiles shall be of standard size without warp and with straight edges true and even in shape and size and of uniform colour. They shall be laid truly vertical on walls and truly horizontal on floors or to slopes as directed. The joints shall be very thin, uniform and perfectly straight. The joint shall be floated with white cement as approved by the Engineer. The rate quoted for paving and dado work shall be inclusive of angles, corner piece and approved colour border on top. Glazed tiles shall conform to IS. 777.

#### **D.7.15 SHAHBAD/TANDUR/KOTA STONE FLOORING.**

- D.7.15.1 Stones, should be of approved quality, hard, durable and uniform thickness. Edges shall be chisel dressed and the top surface shall be machine polished with joints running true and parallel from side to side. Stones should be laid on a bed of cement mortar. Thickness of mortar bedding should not be less than 12 mm and not more than 25 mm. The proportion of C.M. will be (1:6). For skirting base should be 12 mm thick and C.M. proportion will be (1:3). Before laying, the stone slabs should be thoroughly wetted with clean water. Neat cement should be spread over the mortar bed over as much area as could be covered with the slabs within half an hour. The slabs are then laid and gently tapped with wooden matter till it is firmly and properly bedded. These should be no hollows left. The joints should not be more than 2 mm thick. The joints should be struck smooth. The floor should be kept covered with damp sand or water for a week. Slabs should meet all the required properties and test requirements as stipulated in IS Code 1124.

#### **D.7.16 INTEGRAL CEMENT FINISH ON CONCRETE FLOOR**

- D.7.16.1 In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded off to proper level and tamped with tamper having conical projections so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener as approved by the Engineer shall be supplied and used as recommended by the manufacturer.

#### **D.7.17 WOODWORK IN DOORS, WINDOW, PARTITIONS, LOUVERS, RAILINGS ETC.**

- D.7.17.1 Wood used for all work shall be the best of the respective class specified, and properly seasoned by at least 6 months air drying, suitable for joiner's work, should be of natural growth, uniform in texture, straight grained, free from sapwood, deal knots, opens shakes, boreholes, rot, decay and any and all other defects and blemishes.
- D.7.17.2 The thickness specified for joiner's wrought timbers are, unless otherwise specified, prior to planning and 3 mm will be allowed from the thickness started for each wrought face.
- D.7.17.3 All joining shall be wrought on all faces and finished off by hand with sandpaper, with slightly rounded arises.
- D.7.17.4 The joints shall be pinned with hard wood pins and put together with white lead. Jointing shall be by means of mortice and tennon or dovetailed joints as approved.
- D.7.17.5 Any joiner's work which shall split, fracture, shrink, or show flaws or other defects due to unsoundness, inadequate seasoning or bad workmanship, shall be removed and replaced with sound material at the Contractor's expense.

- D.7.17.6 Doors, windows and ventilator frames, transoms and mullions shall be rebated. All dimensions shall be as per drawings. The top framing member of doors and top and bottom framing of windows and ventilators shall project about 25 mm below finished floor. Surface coming in contact with brickwork shall be painted with bitumen as directed by the Engineer. Each of the door and window frames shall be provided with 3 Nos. M. S. 225 X 25 X 6 flat split hold fasts on each side. These hold fasts shall be embedded in masonry of concrete work. The work shall conform to IS-4021.
- D.7.17.7 The doors shall be paneled or solid flush doors as described in the item of work. All flush doors shall be supplied with approved fittings such as hinges, mortice lock of approved make with handles on both sides, oxidised brass lower bolts and latch arrangements, door stops etc. and as shown in drawings but exclusive of door closers. Door closers, where separately specified shall be of heavy duty hydraulic type to be approved by Engineer. Panelled doors shall have the same fittings except in place of union lock, an aldop shall be provided. Each door leaf shall have two 250 mm tower bolts, two aluminium or oxidised brass handles, and one door stopper be made of weatherproof plywood. Flush doors shall conform to IS:2202 (Part – 1).
- D.7.17.8 Doors will generally have no sills but if a few have to be provided, the Contractor shall do so at no extra cost to the Client.
- D.7.17.9 The type of window shall be as specified. Each shutter shall have one pair of hinges, two lower bolts (one 225 mm long and another 150 mm long), one handle and one hook with tie and pegstay. Ventilators shall have two M. S. hold fasts and hinges, one handle and one hook and eye at each and one small tower bolt in the centre. Where so directed by the Engineer, the doors and windows shall be provided with parliamentary type hinges at no extra cost.
- D.7.17.10 The workmanship of all door and window shutters shall conform to the requirements of IS : 1003 (Part – I & II) and IS:2202(Part-I). If required, flush door panels shall be tested as per IS:4020.
- D.7.17.11 Cupboards, almirahs and shelves shall be provided as shown in drawings. The doors could be of either hinged type or sliding type as approved by the Engineer. All dimensions as furnished in the drawings shall be followed. Fixtures and fittings as shown on drawings or as directed by Engineer shall be used.
- D.7.17.12 Railings and architraves shall conform to the shape shown on drawings or as approved and fixed by means of screws (counter sunk or otherwise) or bolts.
- D.7.17.13 The finish expected is of a very high order and the work shall be all inclusive weather or not all detailed specifications have been spelt out and the work shall be free from blemish.
- D.7.17.14 No iron bars or grills are proposed to be provided in the windows or ventilators. Glass louvred ventilators where specified shall be provided.



D.7.17.15 Glazed windows, louvres, ventilators and doors shall be provided with either clear or pinheaded glass 5 mm thick which shall be free from all blemishes and shall conform to IS : 1761. It should be clearly understood that glass which does not have uniform refractive index or which is wavy, will be rejected.

D.7.17.16 Woodwork shall not be painted, oiled or otherwise treated before it has been approved by the Engineer.

#### **D.7.17.17 Measurement**

D.7.17.17.1 All doors, windows, ventilators, louvers, will be measured in sq. m. The measurement will be taken to the outside of frame work exclusive of horns, projections, etc. The rate quoted shall be all inclusive such as nails, screws, glazing, fixtures, fittings, providing peep holes, locking device, handles, door stops etc. The rate shall also be inclusive of polishing / painting with 2 coats of approved paint over primer coat.

#### **D.7.18 STEEL DOORS, WINDOWS AND FITTINGS.**

D.7.18.1 The steel doors, windows, ventilators shall conform to IS : 4351 and 1038. All steel doors, windows, ventilators, louvers etc. shall be of sizes as specified and conform to the description in the respective item of work. Whether or not specifically mentioned, all fixtures and fittings necessary for the satisfactory operation of the doors and windows shall be provided. Doors, windows and ventilators shall be obtained from an approved manufacturer. Specific approval for such purchase shall be obtained before hand. Sample shall also be got approved before further manufacture starts, unless this is waived in writing by the Engineer. All steel doors shall be of pressed steel (18 gauge) flush type with or without removable transoms. All doors shall be provided with a three way bolting device and locking arrangement with duplicate keys and handles on both sides and operable from either side. The Contractor shall obtain windows with friction hinges in place of windows with pegstays if so directed by the Engineer. For center hung and top hung ventilators suitable spring catch/pulley and chord arrangement shall be provided for facility of opening. Whenever fly mesh over windows have been called for, they shall be fixed on the window and suitable lever type or roto type arrangement shall be provided for opening or closing of the glazed panels from inside. Prior approval of Engineer shall be taken before order is placed with the manufacturer.

D.7.18.2 Where specified, steel doors supplied shall be airtight. For this purpose, the Contractor shall provide necessary padding material such as rubber, felt or any other approved material.

#### **D.7.18.3 Measurement**

D.7.18.3.1 Doors, windows shall be measured in sq.m. of the actual size measured to the outside of the steel framework.

D.7.18.3.2 The rate quoted shall be inclusive of glazing with 5.0 mm thick glass free from all blemishes. The workmanship shall conform to IS:1081. The rate quoted shall also be inclusive of fixing doors, windows, ventilators, louvres etc. in brick work, steel framing etc. by making holes/drilling holes in steel work where required complete.

D.7.18.3.3 The rate shall also include cost of painting two coats of approved enamel. Paint over one coat of approved zinc rich primer.

#### **D.7.19 ROLLING SHUTTERS**

D.7.19.1 The rolling shutters shall conform to the size indicated in drawings and shall be of quality specified in the Schedule of Quantities. The rolling slats shall be in one piece and be made of heavy gauge steel sheets minimum 18 Swg in thickness. A cylindrical hood shall be provided on the top to enclose the shutter when it is open. The rolling shutters shall be provided with suitable locking arrangements and deep channel guides. In case galvanised rolling shutters are specified the rolling shutter shall be made of hot dip galvanised slats, hood, deep channel guides all preferably in one piece.

D.7.19.2 In case of hand operated pull and push type rolling shutters of sizes larger than 10 sq. m. in area and in case of very large gear operated and/or as directed by the Engineer, rolling shutters shall be provided with ball bearings for smooth and efficient operation. In case of large rolling shutters and depending upon local wind conditions, the rolling shutters should be provided with special locking type of wider channel guides or it shall be provided with central moveable channel supports to take up the design wind pressures in the area.

D.7.19.3 The rates quoted shall be inclusive of providing three coats of approved paint over one coat of approved primer coat where not galvanised. Rates quoted shall also inclusive cost of lever lock and erection. Fixing lugs to be provided to guide channel to suit actual site conditions or as directed by the Engineer at no extra cost.

D.7.19.4 The payment will be made on Sq.m. basis.

#### **D.7.20 POLISHING / PAINTING FOR WOOD WORK & IRON WORK**

D.7.20.1 Paint/Polish to be used for various item of work shall be of best quality and shall be obtained ready mixed in sealed containers from approved manufacturer. The Contractor shall obtain the Engineer's approval for the make and colour of the paint he proposes to use. If required, polish for woodwork shall be tested as per IS:5807 (Parts-I & III)

D.7.20.2 All surfaces shall be thoroughly cleaned of all dirt, loose particles and rust and approved prior to application of paint. For wood surfaces, a priming coat without colouring matter shall be first applied after and all knots properly killed with quick-lime. Workmanship shall conform to IS:1477 (Part-I & II) and 2338 (Part-I).

D.7.20.3 Specified number of coats shall be applied and at least 24 hours shall elapse between the application of successive coats. No painting shall be carried out on exterior work in wet weather or on surfaces which are not entirely dry.

D.7.20.4 Polishing / painting rate shall include all necessary scaffolding, cradles and plant. Measurements will be on the basis of sq. m. for doors and windows, only the projected area will be measured. If such painting/polishing is not already a part of the item, without deducting for the glazed portions though not painted. The Contractor's rate should take this into account.

## **D.7.21 DISTEMPERING, WHITE/COLOUR WASHING AND PAINTING OF WALLS**

### **D.7.21.1 Distempering**

D.7.21.1.1 The surface to be treated shall be thoroughly cleaned of all dirt and loose particles etc. Inequalities and holes shall be filled with gypsum, which would be allowed to set hard before distemper is applied.

D.7.21.1.2 Distemper shall be of well-known brands of approved make. It shall be applied by a board stiff brush in two coats over a coat of primer. The first and second coat shall be applied only after the primer has thoroughly dried. The first coat shall be of a lighter tint. The shade of the distemper shall be got approved by Engineer. Water bound and oil bound distemper shall conform to the requirements of IS : 427 and 428 respectively.

### **D.7.21.2 White Wash**

D.7.21.2.1 Walls to be thoroughly cleaned before white wash is applied. White wash shall be of ordinary fat lime and of good quality. It shall be slaked with an excess of water to the consistency of a cream and allowed to remain under water for 2 days. It shall then be strained through a cloth and 2 kg of clean gum added for every cubic metre of lime ready for white washing.

D.7.21.2.2 Each coat is to be applied with a brush. It shall be laid with a stroke of the brush from the top downwards, another from bottom upward over the first stroke and similarly, one stroke from the right and another from the left over the first brush before it dries. Three such coats shall be applied.

### **D.7.21.3 Colour Wash**

D.7.21.3.1 Colour wash shall be applied the same way as white wash. Necessary and approved colouring matter shall be added to the white wash, which has been strained. Only wash sufficient for the day's work shall be prepared each morning. If the finished surface is powdery and comes off easily or the general appearance is streaky, the work shall be rejected.

### **D.7.21.4 Painting**

D.7.21.4.1 Paint to be used for the various items of work should be of approved make and colour. It is imperative that the Contractor should obtain Engineer's permission in

regard to the make and colour of paint that he proposes to use for the various items of work. The painting work shall be carried out as directed by Engineer keeping, however, in view the recommendation of the manufacturer.

D.7.21.4.2 Where painting with plastic emulsion is specified, all uneven surfaces shall be made up by use of putty of appropriate quality, after the surface has been thoroughly cleaned of all dust, dirt and sand prepared. One primer coat and two coats of emulsion paint shall be applied. Workmanship shall conform to the requirements of IS : 2395.

#### **D.7.21.5 Measurement**

The actual quantity of work carried out will be measured in sq.m. after making deduction for openings etc. and shall be paid for.

### **D.7.22 EXPANSION JOINTS, WATER STOPS, PREMOULDED JOINT FILTERS, FLASHINGS**

#### **D.7.22.1 Expansion Joints**

D.7.22.1.1 Expansion joints shall be provided galvanised strips of 250 mm width at locations shown on drawings or as approved by Engineer. The strips shall be bent to the shape indicated of the drawing and embedded properly in masonry. The joint width shall be uniform throughout and special care shall be taken to ensure proper bonding at expansion joints. Expansion joints shall be continuous and where two or more strips meet, they shall be lapped to the extent of 75 mm and joints properly soldered. The expansion joints shall be filled with premoulded joint fillers and sealed with mastic compound. For purposes of measurement, the laps provided will be neglected. Wherever an expansion joint between the existing part and new part is proposed the rate quoted shall be inclusive of making necessary connections with existing part.

#### **D.7.22.2 Water Stops**

D.7.22.2.1 Water stops shall be of rubber or PVC Bars of approved make. These shall be provided at locations indicated on drawings. Water stops shall be lapped 100 mm and that sealed to obtain continuity. Water stops shall be cleaned thoroughly of all concrete and mortar coating as directed before resuming concrete work. Water stops shall be in long lengths to avoid joints as far as possible.

#### **D.7.22.3 Joint Filler**

D.7.22.3.1 Pre-moulded joint fillers shall be of a non-deteriorating and resilient type. A sample of material shall be approved by the Engineer before being brought on site. Installation shall be carried out properly and as directed.

#### **D.7.22.4 Flashings**

D.7.22.4.1 Metal or tar felt flashings shall be fixed as directed by the Engineer. Metal flashings where provided shall be welded / soldered to obtain continuity. Tar felt flashings shall be lapped for a minimum length of 150 mm.

D.7.22.4.2 Flashings shall be measured and paid for in linear metres for the specified width disregarding laps or joints.

### **D.7.23 WATER PROOFING WORK**

D.7.23.1 All surfaces to be water proofed shall be dry, clean, smooth and free from dust and loose particles.

#### **D.7.23.2 Tar felt Type**

D.7.23.2.1 For a five layer treatment, bitumen primer conforming to IS : 3384 shall be applied. Over this primer coat, hot bitumen conforming to IS : 1580 shall be applied at the rate of 1.2 kg/sq.m. Hessian based felt type 3 grade 2 conforming to IS : 1322 shall be spread and embedded in the previously laid bitumen while hot. Hot bitumen will again be applied over the felt at the rate of 1.2 kg/m. Pea size gravel or grit shall be uniformly spread at the rate of 0.008 cu.m./sq.m. The end and side laps of each sheet shall not be less than 100 and 175 mm respectively and shall be firmly bonded with bitumen. The extreme ends shall be taken up about 100 – 150 mm along parapet wall and embedded in chases made in the wall and brick masonry and made good in plaster. The standard of water proofing shall comply with IS : 1346. For seven layer treatment, one additional layer of bitumen shall be laid before gravel layer in a manner described above for give layer treatment.

#### **D.7.23.3 Brickbat Coba China Mosaic type**

D.7.23.3.1 In case of works where brick bat coba and china mosaic are specified, brick bat coba of average thickness specified in the item of work shall be laid to the required slopes as shown on the drawing. Proportion of brick bat shall be 2 parts of brick bat to one part of lime mortar (one part of lime to 2 parts of sand). The brick bats shall be hard, well brunt and of size varying from 12 mm to 25 mm. Lime shall be of best quality of hydraulic lime double ground. While preparing brick bat concrete, jaggery in proportion indicated by the Engineer shall be added. The brick bat coba shall then be laid to slopes, providing necessary wattas and beaten atleast for 48 hours after laying. Over the brick bat coba a bedding of 1:2 lime mortar 20 mm to 25 mm thick, shall be provided. A layer of neat cement grout, about 10 mm thick shall then be laid. Immediately on application of cement grout, assorted pieces of coloured china, previously soaked in water shall be set closely on the fresh surface and properly tamped to the required grade. The cement grout freshly laid shall work its way to the top surface. The surface after completion of work shall be finally cleaned with saw dust and waste and if so directed by the Engineer with dilute acid. China mosaic shall be cured for atleast 10 days. If so directed by the Engineer, a border of colour of white mosaic shall be provided.

D.7.23.3.2 Brickbat coba and china mosaic shall be taken up the parapet walls to a height of 125 mm to 150 mm. Necessary wattas shall be provided towards drain pipes as shown on drawings or as directed by the Engineer.

D.7.23.3.3 On prior approval from the Engineer, cement based proprietary type of waterproofing may be allowed to be done by a Specialist.

D.7.23.3.4 The Contractor shall give a guarantee for any / all types of waterproofing for a minimum period of 7 years against bad or faulty material and construction and shall rectify the work at his own cost during the guarantee period.

#### **D.7.23.4 Measurement**

Payment for work executed would be made for projected area only between the inside of plastered walls. No payment would be made for rounding off at corners or for work carried in vertical faces of walls, slabs, parapet walls or column projection.

### **D.7.24 EPOXY PAINTING WORK**

#### **D.7.24.1 Material**

D.7.24.1.1 The epoxy material shall be non-sag, high build, solvent free, epoxy base coating, manufacturer must comply with ISO – 9002 specification.

#### **D.7.24.2 Chemical Resistance**

D.7.24.2.1 Formaldehyde 40% solution, Acetic Anhydride, alcohol, Alum, of compounded of Aluminium, Ammonia, Acetone, Beer, Boric acid, Citric acid, Fatty acid, Glycerin, Sodium hydroxide 50% solution, sulphuric acid 50% solution, Hydrochloric acid 50% solution, Nitric acid 10% solution, Acetic acid 50% solution, Sea water, Lactic acid 50% solution, Styrene, Stearic acid, Petrol, Oxalic acid etc.

#### **D.7.24.3 Surface preparation**

D.7.24.3.1 The surface should be free from excessive laitance, dust, grease, oil curing compound, chemicals, standing water etc. Ensure that the concrete, surface must be sound, cutting back where necessary and repair good using suitable cementitious or epoxy repair system. Ensure also that all blow holes and surface imperfection are made good prior to application. Mortars and concrete should be fully cured i.e. atleast 21 days at 25°C.

#### **D.7.24.4 Mixing**

D.7.24.4.1 Before mixing hardner and base each container should be thoroughly stirred to homogenous consistency for 3 to 5 minutes. The mixing should continued for 3 minutes. Hydrophobic compound and corrosion inhibitor in water proofing compound.

#### **D.7.24.5 Application**

D.7.24.5.1 First primer coat should be applied after cleaning the concrete surface. After application of primer coat 2 coats of epoxy paint should be applied as per directed by Engineer-in-charge.

#### **D.7.24.6 Technical Data**

Mixing Ratio	:	Hardner : Base : 1 by weight
Service Temperature	:	5°C – 45°C
Relative Density	:	1.25 ± 0.02
Pot Life	:	50 ± 10 minutes
DFT per coat	:	150 to 200 microns
Coverage	:	3 to 5 sq.m/kg/coat for the mixed material depending upon surface texture and porosity
Tack Free Time	:	4 ± 1 hours
Initial Cure	:	6 ± 2 hours
Full Cure	:	5 to 7 days
Minimum Re-coating time	:	3 to 5 hours
Maximum Re-coating time	:	8 to 9 hours
Bond Strength	:	> 180 kg/cm <sup>2</sup>
Compressive Strength	:	> 700 kg/cm <sup>2</sup>
Flexural Strength	:	> 300 kg/cm <sup>2</sup>
Amount of Shrinkage	:	< 0.0030 cm

#### **D.7.24.7 Measurement and payment**

D.7.24.7.1 Measurement shall be made square meter basis.

## **D-8 : ADDITIONAL SPECIFICATIONS FOR BUILDING AND ALLIED WORKS**

### **SECTION : D-8**

#### **D.8.1 PVC (VINYL) ASBESTOS TILE FLOORING**

- D.8.1.1 PVC (Vinyl) asbestos floor tiles shall have smooth surface and shall be homogenous. The tiles shall be of best quality and of approved make and shall conform to IS:3461. The tiles shall be plain or mottled. The colour, finish and mottling shall match as per the sample approved by Engineer. Plain tiles shall have the colour uniformity distributed through the tile. Mottled tiles shall have the colours distributed at random throughout the thickness of the tile. The material shall not develop any toxic effect in service and shall not give disagreeable odour. The type, thickness and size of tiles shall be as specified in the item of work. The PVC (Vinyl) asbestos floor tiles when tested in accordance with the methods given in IS : 3464 shall conform to the requirements specified in Table 1 of IS : 3461. The Contractor shall send test results along with the sample for approval. The tiles used shall be of Marbles or approved equivalent and shall be fixed on floor/walls as per the manufacturer's specification.

#### **D.8.2 WATERPROOFING OF TERRACE AND STAIRCASE ROOF SLAB**

- D.8.2.1 In case of works where brick bat coba and Indian Parent stone are specified, brick bat coba of average thickness specified, in the item of work shall be laid to required slope as shown on the drawing. Proportion of brickbat shall be 2 parts of brick bat to one part of the lime mortar (one part of lime to 2 parts of sand). The brick bats shall be hard, well brunt and of size varying from 12mm to 25mm Lime shall be of best quality of hydraulic lime double ground. While preparing brick bat concrete, jaggery in proportion indicated by the Engineer shall be added. The brick bat coba shall then be laid to slopes, providing necessary vattas, and beaten and thoroughly soaked atleast for 48 hours after laying and properly consolidated. The surface of brickbat coba shall be grouted with neat cement slurry. Indian patent stone flooring shall be laid in two layers, an under bed of 34 mm thick and topping of 6 mm thick. Before placing the under bed any excess standing water shall be mopped out. The under bed shall consist of cement concrete with 10 mm down clean well graded, hard, approved stone chips and clean, sharp, coarse sand. The proportions of the mix shall be 1 part cement 1.5 parts sand and 3 parts stone chips by volume. Water proofing compound of approved make shall be added as per manufacturer's specifications. Water content shall be minimum, just sufficient to give a workable consistency, which will allow a smooth finish to be obtained without excessive trowelling. Generally a water cement ratio of 0.4 should suffice. The floor shall be cast to required slope, in panels in a chequer board sequence so that no two adjacent panels one has before the contraction of the previous one has taken place. At least 48 hours shall be allowed to pass after casting a panel before the adjacent panel shall not exceed 5 sq.metres in area and shall not have sides exceeding 2.5 meters. Edges of individual panels shall be supported by flat bars of steel or wood well oiled to prevent sticking. These bars shall be removed before



concreting the adjoining panels. The concrete of the new panel shall be well compacted against the edges of the previous panel. After laying, the under bed shall be levelled and compacted and brought to proper grade with a wooden screed of float.

- D.8.2.2 A topping of 6 mm thickness of the same mix as the under bed shall be laid when the latter is still green, and shall be trowelled smooth with a mixture of cement and sand in the proportion of 1:1 by volume. The under bed and topping shall be completed in one operation. The topping shall be trowelled smooth Engineer's satisfaction and all trowel marks mopped with a soft cloth to present a clean, even and smooth surface. Care shall be taken to see that no foot prints etc. are formed on the green topping surface during its laying, finishing and curing. The finished flooring shall be cured by ponding with water for a period of 7 days. The top surface shall be cleared of all dust and loose material and the joints shall be filled with bitumen as directed by Engineer.

### **D.8.3 HEAVY DUTY TOPPING FLOOR**

- D.8.3.1 Heavy duty topping floor layer consisting of one part of floor hardner, two parts of sand and four parts of cement, shall be laid over 30mm thick cement, concrete 1:2:3 using 12 mm size chips. For one square meter surface area of 20 mm thick to be covered minimum 2.25 Kg. Of floor hardner of approved make shall be used as per manufacturer's instructions. The contractor shall take prior approval of the manufacturer's specification from the Engineer before starting the work. The top layer shall be laid while the under bed is still very green within about 3 hours of laying the latter. The finish shall be uniform, smooth and without any trowel marks, pin holes etc. Cutting shall start on the next 7 days after finishing and shall be continued for 7 days.

### **D.8.4 CHEQUERED PLATING AND KERBING**

- D.8.4.1 Chequered plating complete with cut-outs and in sizes suitable for removal by hand shall be of mild steel and of sufficient thickness to carry minimum live load of 500 Kilograms per square metre but never less than 7 millimeters thick. This shall be measured excluding the pattern which shall be of non-slope type.
- D.8.4.2 Each length shall have two tapped holes for screwing in lifting hooks. Two pairs of lifting hooks shall be supplied for every 5 sq. m. of plating. Where a single area is covered by several pieces of plating, the direction of patterning of all plates shall be the same.
- D.8.4.3 Kerbing shall be built in so as not to reduce the width of the opening and it shall provide at least 25 mm bearing for the chequered plating. It shall be supplied with fixing lugs at suitable centers, not exceeding 1 m. Care shall be taken to ensure that the kerbing and chequered plating is set flush with the surrounding finished floor level. Chequered plate, kerbing and supports shall be galvanised after fabrication.

D.8.4.4 Unless otherwise specified, chequer plating shall be screwed to its kerbing by countersunk screws of galvanised mild steel.

D.8.4.5 The contractor shall be responsible for the detailing, supply and installation of chequer plate, kerbing and supports as specified herein.

#### **D.8.5 OPEN TYPE FLOORING : (M.S.GRATING)**

D.8.5.1 Open type flooring shall be capable of carrying a minimum live load of 500 Kilograms per square meter per the spans indicated in the drawings. It shall be free from sharp edges and ragged welds and shall be delivered to site complete and cut to size to accommodate plant, pipes, ducts and the like.

D.8.5.2 Before fabrication of the open type flooring, the Contractor shall supply to the Engineer a copy of the manufacturer's working drawings for approval.

D.8.5.3 Kerbing to open type flooring shall be raised at least 50 mm from the top of the flooring and shall be adequately fastened to it.

D.8.5.4 M.S. kerbing and flooring shall be hot-dip galvanised.

#### **D.8.6 ACCESS LADDERS**

D.8.6.1 Access ladders shall be of mild steel shall be 60 cm wide with angle of 75 x 75 x 6 mm as support and rungs shall be 25 mm diameter at 200 mm centres.

D.8.6.2 Ladders shall be fixed at the top and the bottom and at intervals not exceeding 2 m by brackets of 50 mm x 10 mm flat, of such length that the rungs are not less than 200 mm from wall, secured by galvanised ragbolts of an approved type Brackets shall be fixed to the ladders by one 16 mm diameter bolt thorough each stringer. Ladders may also be fixed at the bottom by bending the stringers and bolting to the floor. Ladders shall be painted with two coats of approved paint over one coats of primer.

#### **D.8.7 HAND RAILING**

D.8.7.1 Hand railing and vertical posts shall be made from galvanised mild steel pipes and fittings. The design of the railing shall be approved by the Engineer to whom the Contractor shall submit manufacturer's drawings showing positions of vertical posts, joints, expansion joints and joint details and all fixing details. Fabrication shall not start until these drawings have approved by the Engineer.

D.8.7.2 Hand railing and vertical posts fabricated from galvaniseed mild steel pipes and fittings shall conform to the following requirements :-

D.8.7.2.1 The height of the top railing shall be 1067 mm above finished floor level unless otherwise shown. The lower railing shall 533 mm above finished floor. Subject to the Engineer's approval these and other leading dimensions may be varied slightly to suit manufacturer's standard products.

D.8.7.2.2 Unless otherwise shown, handrails and vertical posts shall be made of galvanised mild steel tubes (light class) of 40 mm nominal bore and fittings such as Tees, Bends, Crossed etc. of heavy class conforming to IS : 1239.

D.8.7.2.3 In general the vertical posts shall be spaced at 1.5 metre c/c and shall be built into the concrete or bolted to the M.S. plate embedded in concrete as shown on detailed drawing.

D.8.7.2.4 Hand railing and vertical posts shall be painted with 3 coats of approved paint.

## **D.8.8 GLAZING AND METAL WORK.**

### **D.8.8.1 Glass general**

D.8.8.1.1 Glass shall conform to the requirements of IS : 1761. And shall be free from bubble, smoke wanes, air holes, scratches and other defects and shall be cut to fit the rebates with due allowance for expansion.

### **D.8.8.2 Sheet glass**

D.8.8.2.1 Sheet glass shall be ordinary glazing quality of required thickness as mentioned in respective item of work.

### **D.8.8.3 Wired glass**

D.8.8.3.1 All wired glass shall be 6 mm thick polished Georgian or equivalent wired glass with both faces ground and polished. The glass conform to IS:5437.

### **D.8.8.4 Plate glass**

D.8.8.4.1 Generally where specified, windows shall be glazed in polished plate or float glass of glazing glass quality (G.G) of 6 mm or 10 mm thickness as specified in the item.

### **D.8.8.5 Glazing**

D.8.8.5.1 Putty for glazing to wood shall be prepared in accordance with IS:1635. Compound for glazing to metal is to be an approved special compound manufactured for the purpose.

## **D.8.9 SYNTHETIC GRADE RUBBER WATER STOPS.**

D.8.9.1 The specification of the synthetic grade rubber water stop shall be as follows :

i)	Tensile strength	110 Kgf/sq.cm.
ii)	Elongation at break	350 %
iii)	Modulus at 300% elongation	51 Kgf/sq.cm.
iv)	Specific gravity	1.12
v)	Compression set (constant deflection) Percent of original deflection at 70 deg. C for 22 hours)	24 %

vi)	Change in weight water immersion (2 days at 70 deg. C)	1.6 % Max.
vii)	Tensile strength and elongation at break as % of original, after oxygen pressure test, 48 hours, 70 deg. C. 21.1 Kgf/sq.m. before ageing. a) Tensile strength b) Elongation at break	85 % min. 83 % min.

D.8.9.2 The water stop shall be synthetic grade corrugated ‘**Caparstops**’ with centre bulb and with end grips type C1/C2 or equivalent of specified width and thickness mentioned in Schedule of Quantities.

D.8.9.3 The Contractor shall obtain prior approval from Engineer before procurement of waterstops and shall submit sample of water stops that he proposes to procure for this contract and test results for the same Engineer for his approval.

D.8.9.4 The storage, fixing in position, splicing of water stops shall be as per manufacturers’ instructions.

#### **D.8.10 CHAIN LINK FENCING**

D.8.10.1 Chain link fencing shall be of required height as shown on drawings, made of G.I. 75 mm mesh size and 10 gauge wires and shall be fixed with suitable G.I. wire nails and 10 mm dia. M.S. bars on angle posts of 65 mm x 65 mm x 6 mm thick. These angles shall be anchored in 1:3:6 PCC blocks of size 300 mm x 300 mm x 600mm deep and shall be spaced at maximum distance of 2 metres including corners. Every fifth bay shall be braced with angle of 75 mm x 75 mm x 6 mm size diagonal tracing and with angle of 50 mm x 50 mm x 6 mm size at top and bottom runner throughout the length. 3 coats of Aluminium paint shall be provided over & coat of primer on exposed steelwork. The measurement shall be done on square metre basis of the exposed chain link area and paid accordingly.

#### **D.8.11 BARBED WIRE FENCING**

D.8.11.1 Barbed wire fencing of required height shall be constructed of 14 gauge galvanised barbed wire and M.S. angles of 75 mm x 75 mm x 6 mm thick. The angles shall be anchored in 1:3:6 PCC and shall be spaced at minimum distance of 2.5 metres. The galvanised barbed wires shall be fixed at 150mm c/c and with necessary cross wires. The exposed steelwork shall be painted with 3 coats of Aluminium paint over a coat of primer. The measurement shall be done with item of compound wall on running meter basis.

#### **D.8.12 IPS FLOORING**

D.8.12.1 Concrete (1:2:4) with water cement ratio of 0.5 shall be laid in bays of suitable sizes but not exceeding 6 sq.m. each, and to required slope in a chess board alternate panel fashion and neatly finished smooth in red colour with lines drawn as directed. Concrete shall be laid in two layers. Bottom layer shall be 25 mm

thick with 10 mm to 6mm graded stone aggregates and shall be finished rough. Top layer shall be 15 mm thick with 6 mm and down size aggregates. This layer shall be thoroughly tamped, spread, trowelled and finished smooth with a floating coat of neat cement. The concrete shall be coast against teakwood stop-off boards, which shall be removed only after the concrete is set. No dry cement shall be allowed to be used for finishing the surface. Mechanical mixing of concrete may be resorted to. The surface shall be kept well watered after it is dry for a period of 8 days. Where specified a floor hardner (ironite powder) of approved quality shall be supplied and used as recommended by the manufacturer.

#### **D.8.13 CATTLE TRAP**

- D.8.13.1 This item includes of necessary excavation PCC 1:3:6 in foundation 1:6 brick masonry wall and fixing of 32 mm pipes over channel section size 350mm x 75mm supporting over 35 mm thick brick wall. The brick wall shall be plastered with C.M. (1:3). The item rate shall be in the unit of one No.

#### **D.8.14 GLASS COPING**

- D.8.14.1 The glass pieces for glass coping shall be of best quality, multi coloured, having non-Uniform dimensions with sharp edges and should be placed in plain cement concrete. In scattered manner with centre to centre distance not more than 3 cm. It should be placed in such a way that 2 cm of each piece should be above the PCC. The curing should be done properly to ensure that the glass pieces get embedded firmly. The payment for glass coping shall be made on a running metre basis. In case of any discrepancy, the Engineer-in-Charge should be consulted.

#### **D.8.15 M.S. FAN CLAMPS**

- D.8.15.1 The fan clamps shall be made of tor. Steel bar of size not less than 6 mm. The M.S. fan clamp shall be of the size of the corresponding reinforcement and should be strong enough to sustain the weight of the fan attached. The fan clamp should be properly embedded in concrete and proper anchorage shall be provided by binding it with the slab reinforcement. The size of clear opening shall be enough for the fittings of the fan.

#### **D.8.16 BIRD SCREEN**

- D.8.16.1 Bird screen shall be of precast RCC of the appropriate size to prevent the entry of the birds and shall be approved by Engineer-in-Charge.

## **D.8.17 PROVIDING, SUPPLYING AND LAYING RUBBLE AT OVERFLOW STRUCTURE**

### **D.8.17.1 Supplying of Rubble**

The Rubble to be used for pitching shall be obtained from quarries approved by Engineer-in-charge. It shall be hard, durable, and tough and of regular shape and shall be free from dust clay and other impurities for use in Rubble filling approx. weighing minimum 20 Kg. to 50 Kg. Any one side of which shall not be less than 23 cm. It shall be stacked at site of work as directed by Engineer in charge.

### **D.8.17.2 Rubble**

The Rubble for Rubble filling shall be from standard quarry approved by the Engineer in charge and shall be hard, durable, tough and free from dust, clay and other impurities. The Rubble shall be large, flat and of minimum weight 20 Kg to 50 Kg size of Rubble shall not be less than 23 cm in any one directions and in other direction the size of Rubble shall be greater to account for the minimum weight of 20 Kg to 50 Kg.

### **D.8.17.3 Laying**

The Rubble should be laid to the correct line and level and to the slopes and shape as shown in the drawing and as directed by the Engineer in charge. The intercises between the Rubble should be filled with spouls, kapchas etc. free from rubbish and foreign materials and should be packed close tight as directed by the Engineer in charge.

### **D.8.17.4 Payment**

Payment for this item of Rubble filling shall be made on cu.m. basis of finished section.

## **D-9 :PLUMBING SYSTEM**

### **SECTION : D-9**

#### **D.9.1 SCOPE**

- D.9.1.1 This specification covers the general requirements for execution of plumbing system comprising of water supply and distribution pipes, fittings, sanitary appliances, traps, soil, waste, vent and rain water pipes, building drains and sewers including their respective connections, devices and appurtenances within or adjacent to any building.

#### **D.9.2 APPLICABLE CODES**

- D.9.2.1 The following specifications and codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the specifications and codes shall be referred to. In case of discrepancy between this specification and those referred to herein, this specification shall govern.

##### **D.9.2.2 Codes of Practice**

- 1) IS : 1172 - Basic requirements for water supply, drainage and sanitation.
- 2) IC : 2065 - Water Supply in buildings.
- 3) IS : 1742 - Building drainage.
- 4) IS : 5329 - Sanitary pipe work above ground for buildings.
- 5) IS : 2064 - Selection, installation and maintenance of sanitary appliances
- 6) IS : 4127 - Laying of glazed stoneware pipes.
- 7) IS : 2527 - Fixing rainwater gutters and down-pipes for roof drainage.

##### **D.9.2.3 Specifications for Materials**

- 1) IS : 3989 - Centrifugally cast (spun) iron spigot and socket soil, waster and ventilating pipes, fittings and accessories.
- 2) IS : 1729 - Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
- 3) IS : 1230 - Cast iron rainwater pipes and fittings.

- |     |                           |   |
|-----|---------------------------|---|
| 4)  | IS : 1239 STEEL           | - Mild steel tubes, tubular and other wrought fittings : Part I<br>- Mild Steel tubular and other rough steel pipe fittings : Part – II |
| 5)  | IS : 404                  | - Lead pipes  |
| 6)  | IS : 1626                 | - Asbestos cement building pipes, and fittings. (spigot and socket type.)   |
| 7)  | IS : 651                  | - Salt-glazed stoneware pipes and fittings.   |
| 8)  | IS : 778                  | - Gunmetal gate, globe and check valves for general purposes.   |
| 9)  | IS : 781                  | - Cast copper alloy screw-down bib taps and stop valves for water services.   |
| 10) | IS : 1795                 | - Pillar taps for water supply purpose.   |
| 11) | IS : 1703                 | - Ball valves (horizontal plunger type ) including floats for water supply purpose.   |
| 12) | IS : 774                  | - Flushing cisterns for water closets and urinals (Valve less siphon type).   |
| 13) | IS : 2326                 | - Automatic flushing cistern for urinals.   |
| 14) | IS : 771                  | - Glazed earthenware sanitary appliances.   |
| 15) | IS : 2526<br>Part-I to XV | - Vitreous sanitary appliances (Vitreous china)   |
| 16) | IS : 1726                 | - Cast iron manhole covers and frames intended for use in drainage works.   |
| 17) | IS : 5455                 | - Cast from steps for manholes.   |

### **D.9.3 GENERAL**

- D.9.3.1 The plumbing work shall be carried out through licensed plumber and shall comply in all respects with the requirements of these specifications.
- D.9.3.2 All sanitary appliances including sanitary fitting fixtures shall be as specified in the item of work and as per the sample approved by Engineer.
- D.9.3.3 Any openings made in wall/slab for providing pipes etc. should be made good by Contractor. Also any scaffolding / temporary supports required for execution of wall shall be provided by Contractor at no extra cost to Owner.
- D.9.3.4 All the tests certificates required for sanitary fixtures are to be made available by contractor and the testing of water supply and drainage system to be done as per the specifications at no extra cost to Owner.
- D.9.3.5 The location of plumbing fixtures. Fittings and related ancillary works shall be shown on relevant drawing.
- D.9.3.6 However, detailed drawing, if required shall be prepared by Contractor and got approved from Owner / Engineer before commencing the plumbing work.



## **D.9.4 WATER SUPPLY SYSTEM**

### **D.9.4.1 Storage Tanks**

#### **D.9.4.1.1 Underground Storage Tanks**

In case of underground storage for domestic purpose, the following requirements shall be complied with :

- a) The tank shall project at least 30 cm above the highest flood level. Where this is not possible the manhole cover shall be raised 30 cm above the highest flood level of the locality or ground level whichever is higher.
- b) The tank shall be such as to provide for the drawing of the tank when necessary and water shall not be allowed to collect round about the tank.
- c) The tank shall be perfectly watertight.
- d) The inner surface of the tank shall be rendered smooth as far as possible.
- e) The top of tank shall be so leveled as to prevent accumulation of water thereon.
- f) The tank shall have a complete concrete cover leaving a manhole opening provided with a properly fitting fibre reinforcement cover. Where tank is of large size, adequate number of manholes shall be provided as per detailed drawing.
- g) No gap shall be allowed to remain found the suction pipe and arrangements shall be provided for proper discharge of spill water from the electric pump by connecting the pump cabin to the water drain or by providing a small hole which will enable the water to flow out.
- h) The overflow pipes or vent shafts if provided shall have a wire gauge cover of 1.5 mm mesh properly screwed tightly to the opening. The underground storage tank shall be of such type and size as mentioned in respective item of work.

#### **D.9.4.1.2 Overhead Storage Tanks**

D.9.4.1.2.1 The overhead storage tanks shall be of such type and size as specified in the item of work. The general requirements shall be as follow :

D.9.4.1.2.2 The tanks shall be watertight and properly covered with a closed fitting mosquito-proof lid fitted with a locking arrangement and shall be provided with a sound and suitable ball valve and float conforming to IS : 1703 securely fixed to the tank and set in such a position that the body of the ball valve can not become submerged when the tank is full up to the water line. Ball valve shall be so adjusted as to limit the level of water in the tank to 25 mm below the lip of the warning or overflow pipe. A stop valve / gate valve shall be provided as near the tank as practicable on every outlet pipe from the storage tank, excepting the warning pipe. The outlet pipe from the storage tank, excepting the warning pipe. The outlet pipes shall be fixed 50 to 75 mm above the bottom of the tank and provided preferable with copper gauge strainers. The washout or draining pipe shall be made flush at the bottom of the tank at its lowest point. The floor of the tank shall be erected so as to give a slight fall to the washout pipe for cleaning purpose. All the tanks shall be perfectly watertight. In case of M. S.

tank these shall be painted with one coat of red oxide primer both internally and externally. On the inside two coats of bitumastic paint shall be applied and on the exterior two coats of paint of approved make and tint shall be applied.

#### **D.9.4.2 Water Supply Pipes and Fittings**

##### **D.9.4.2.1 G. I. Pipes and Fittings**

D.9.4.2.1.1 .Pipes shall be galvanised mild steel butt welded and seamless, screwed, socketed and plain and tubes (Commonly known as G.I. Pipes) conforming to IS:1239 Part-I. The fittings shall be galvanised wrought steel welded and seamless conforming to IS : 1239 Part-II. The pipes and fittings shall be of such class and diameter (nominal bore) as specified in the respective items or work. These shall be cleanly finished and reasonable free from scale, surface flaws, lamination and other defects. The screw threads of pipes, sockets and fittings shall be clean and well cut the ends shall be cut cleanly and square with the axis of the pipe unless otherwise specified. Galvanizing of pipes and fittings shall be in accordance with IS : 4736. Pipes laid below ground shall be of heavy class and shall be coated with bitumastic paint and enwrapped with Hussein cloth. Pipes used above ground shall be of medium class. The pipes shall be cleaned and cleared and cleared of all foreign matter before being laid / fixed. In jointing the pipes the inside of the socket and the screwed and of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped around the screwed and of the pipe. The end shall then be screwed in the socket, tee etc., with the pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of water Soil or any other foreign matter. All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to wall with standard pattern holder but clamps of required shape and size so as to fit tightly on the pipes when tightened with screwed bolts. All pipes inside the shaft shall remain clear off wall by at least 12 mm. All exposed G. I. pipes and fittings shall be painted with one coat of red oxide primer and two coats of oil paint of approved make and colour as directed by Engineer. Where concealed, piping is required to be done as per item of work, pipes and fitting after jointing shall first be coated with bitumatic paint and enwrapped with Hussein cloth and then embedded in a chase of required size cut in internal wall. The chase shall be filled with cement mortar (1:3) as directed by Engineer. The length of piping required to be concealed shall be measured and paid separately.

#### **D.9.4.3 Water Supply Fittings and Appliances**

##### **D.9.4.3.1 General Requirements**

D.9.4.3.1.1 All cast fittings shall be sound and free from laps, blowholes and pitting; and both external and internal surfaces shall be clean, smooth and free from sand. Burning, plugging or patching of the casting shall not be permissible. The bodies, bonnets, spindle and other parts shall be machined so that when

assembled the parts shall be axial, parallel and cylindrical, with surfaces smoothly finished. The fittings shall be fully examined and cleaned of all foreign matter before being fixed. The fittings shall be fixed in the pipeline in workman like manner. The joints between fittings and pipes shall be made watertight.

#### **D.9.4.3.2 Gate, Globe and Check Valves**

- D.9.4.3.2.1 The gunmetal gate, globe and check valve shall conform to IS : 778 and shall be of such class (1/2), type (screwed / flanged) and size (nominal bore) as mentioned in respective item of work.

#### **D.9.4.3.3 Bib Taps and Stop Valves**

- D.9.4.3.3.1 Screwed down bib taps and stop valves shall conform to IS : 781 whereas pillar taps shall conform to IS : 1795. In case of chromium plated (CP) fittings the thickness of plating shall not be less than service grade No. 2 of IS : 4827. The plating shall be capable of taking high polish and shall not easily tarnish or scale. The standard size of fittings shall be designated by the nominal bore of the pipe outlet to which the fittings are attached.

#### **D.9.4.3.4 Self Closing Taps**

- D.9.4.3.4.1 Self-closing taps shall be of non-concussion type and shall comply with IS : 1711. In case other special fittings are required to be used for water supply system, these shall be of such size, shape and of approved make as per the requirements of competent authority.

#### **D.9.4.3.5 Shower Rose**

- D.9.4.3.5.1 The shower rose shall be of chromium plated brass of specified diameter. It shall have uniform perforations. The inlet size shall be 15 mm or 20 mm as specified. In case of shower rose vitreous china, this shall conform to IS : 2556 (Part-XI).

#### **D.9.4.3.6 Flushing Cisterns**

- D.9.4.3.6.1 The flushing cisterns shall be automatic or manually operated, high level or low level and of such capacity as specified in item of work for urinals and water closets. Valve-less siphonic type flushing cistern shall be of cast iron, glazed earthenware, vitreous china or pressed. Steel complying with the requirements of relevant I. S. codes and shall be provided as mentioned in respective item of work. A high level cistern is intended to be operated with minimum height of 125 cm and a low level cistern with a maximum height of 30 cm between the top of pan and the underside of the outlet shall be of 32 mm nominal bore and in the case of low level cisterns, the outlet shall be of 40 mm nominal bore. Ball valve shall be of screwed type 15 mm in diameter and shall conform to IS : 1703. The chain of cistern shall be galvanised steel wire and shall be of such strength as to sustain a dead load of 50 Kg. without any apparent or permanent deformation of shape of the link. The chain shall terminate in a suitable handle or 'Pull' which

shall be of galvanised iron or non-ferrous metal, or a moulding in any heat resisting and non-absorbent plastic. The finish shall be smooth and free from burrs. In case of low level flushing cisterns the handle shall be chromium plated. The overflow pipe for cistern shall be of not less than 20 mm nominal bore with mosquito-proof device. The cast iron cistern shall be painted with two coats of black bitumastic paint on the inside and one coat of grey paint or a coat of emulsion on the outside. The cisterns shall be supported on two R. S. cast iron or mild steel brackets of size as approved by Engineer. The discharge rate of the cistern shall be about 5 liters in 3 seconds when connected to an appropriate flush pipe and there shall be no appreciable change in the force of flush during the period of discharge. The cistern shall have discharge capacity of 5, 10 or 12.5 liters as specified in item of work with a tolerance of (+/-) 0.5 liter or of 15 liters with a tolerance of (+/-) 1 liter.

## **D.9.5 SANITARY APPLIANCES**

### **D.9.5.1 General Requirements**

D.9.5.1.1 All sanitary appliances and their components shall be durable. Impervious, corrosion resisting and have a smooth surface, which can be easily cleaned. These shall conform to relevant Indian Standards where it exists. In other cases these shall be of the best quality, workmanship and approved make. In general all glazed earthenware sanitary appliance shall (vitreous china) shall conform to IS : 2556 (Part-I to XV). Utmost care shall be taken to avoid any damage to sanitary appliances during transport, handling and fixing etc.

### **D.9.5.2 Wash Basins**

D.9.5.2.1 Wash basins shall conform to the requirements given in IS : 771 or IS : 2556 (Part-IV) as mentioned in item of work. The wash basin shall be made in one piece and shall include a combined overflow and shall be such so as to facilitate cleaning. Where the wash basins are fixed in ranges, it is desirable that they shall be placed at centre to centre of at least 75 cm to ensure comfort when basins are in use; the centre line of the last basin shall be kept at least 40 cm away from the adjacent wall. The overflow shall be an open-weir type with removable grating of a slot type. The basin shall be such as to prevent slopping. Soap traps or sinkings shall be provided to drain into the basin. Tap holes shall be square or round to suit pillar tap conforming to IS : 1795 and shall be leveled around the opening to enable fixing of pillar taps perpendicular to wash basins. The waste outlet shall be bevelled or rebated to receive a waste fitting. Where there is no other means of fixing, a hole shall be provided for the setting of the plug of the chain. Cast iron brackets and supports for wash basins and sinks shall conform to IS : 775. Brackets for screwing to walls are provided with ear holes for fixing screw, which should be screwed into suitable wall plug. In the case of this partition walls especially where this appliances are heavy, suitable from of floor support may be used, if however (as in the case of light appliances), wall fittings are used, they should be bolted through the wall, using back plates on the remote side.

### **D.9.5.3 Sinks**

D.9.5.3.1 Sinks for kitchen use shall conform to IS : 771. Sinks for laboratory use shall conform to IS : 771 or IS : 2556 (Part-V). Hot and cold water supplies shall be provided as specified, the tap being mounted above the sink. The sinks shall be of one-piece construction, including a combined overflow. The floor of the sink shall gently slope towards the outlet. The outlet shall in all cases be suitable for waste fittings having flanges of 38 mm diameter of 65 mm at the bottom to suit the waste fittings. The waste hole shall be either rebated or bevelled having a depth of 10 mm. Sink shall be provided with a non-ferrous 50 mm dia waste fitting. The sink shall have overflow of the weir type and the invert shall be 30 mm below of the edge. Sink shall be provided with a waste plug, of suitable dia, chain and stay. The general requirements of fixing the sinks shall be same as mentioned for wash basins.

### **D.9.5.4 Urinals**

D.9.5.4.1 Urinals shall conform to the requirements given in IS : 771 or IS : 2556 (Part-VI). The type, size and shape of urinals shall be as per respective item of work. The urinals shall be durable non-corrodable and shall have a hard glazed surface and these shall be manufactured in one piece without crack, joint or recess. The sidewall and back of urinals shall be made of hard, durable, impervious material. It shall be provided with a drain ending with a trap and provision for cleaning the floor. Urinals shall be provided such that a minimum clear width of 60 cm between the partitions is kept. Top of bowl shall be about 60 cm from the floor level. A drain of such width as shown on drawing shall be provided at the bottom of stall urinals so that other places are not fouled in usage. In case of open drain, it shall be of glazed type. Half-round channels for urinals shall conform to IS : 771 or IS : 2556 (Part-VIII). Urinals shall be provided with flushing cistern (manually operated / automatic) discharging through flush pipes and spreaders as mentioned in respective item of work. Urinal outlet shall be provided with dome shaped removable grating.

### **D.9.5.5 Water Closets**

#### **D.9.5.5.1 Squatting Pans (European Type W.C.)**

D.9.5.5.1.1 Water closets shall be either of white glazed earthenware, white glazed vitreous china or white glazed fire clay as specified and shall be of "Siphonic Wash down type" conforming to IS : 2556 (Part VIII). The closets shall be of one piece construction with approved plastic / bakelite seat and cover. Each water closet shall have 4 fixing holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type. It shall also have an inlet of supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. The water closet shall have a weephole at the flushing inlet. Each water closet shall have an integral trap with either "S" or "P" outlet with atleast 50 mm water seal. The water closets shall have an antisiphonage 50 mm dia. vent born on the outlet side of the trap. The inside of water closets and traps shall be uniform and smooth in order to ensure in efficient flush. The serrated part of the outlet shall not be glazed externally. The water closet when

sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 10 litres of water between the normal water level and the highest possible water level of the water closet installed.

## **D.9.6 WASTE WATER SYSTEM**

### **D.9.6.1 Cast Iron Soil, Waste and Vent Pipes and Rain Water Pipe and Fittings**

D.9.6.1.1 Cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories shall conform to IS : 1729 or IS : 3989. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surfaces being as nearly as practicable concentric. They shall be sound and nicely cast and shall be free from cracks, laps, pin holes or other imperfection and shall be neatly dressed and carefully reasonably square to their axis. The cast iron pipes and fittings shall be of such nominal diameter as mentioned in the respective item of work and the pipes shall be of longest length available unless shorter lengths are either specified or required at the junctions etc. The pipes and fittings shall be supplied without ear unless specified or directed otherwise. All pipes and fittings shall ring clearly when struck over with a light hand hammer and shall be capable of being easily worked with a drill or file. All soil, wastes and ventilating pipes shall be carried up above the roof, if required to such height as specified or directed and shall be provided with C. I. cowl. The minimum diameter of soil and rain water, waste water and vent pipes shall be 100 mm, 75 mm and 50 mm respectively. All pipes and fittings shall be properly cleared of foreign material and shall be perfectly dry before jointing. The spigot shall be centered in the socket by tightly caulking in sufficient turns of tarred gasket or hemp yarn to leave unfilled half the depth of socket for lead. A jointing ring shall then be placed round the barrel and against the faces of the socket. Molten pig lead shall then be poured into fill the remainder of the socket. The lead shall then be solidly caulked with suitable tools and hammer of not less than 3 Kg. Weight right round the joint to make up for the shrinkage of the molten metal on cooling and shall be perfectly finished 3 mm behind the socket face. Lead for caulking shall conform to IS : 782. In case the cement mortar joint is specified in the item of work, the following procedure shall be adopted. The joint is first yarned with hemp yarn dipped in the cement slurry. The yarn is first inserted to slight depth and well pressed in the same manner as for lead jointing. Then cement mortar (1:1) with a water cement ratio not exceeding (1:5) shall be rammed into the joint by caulking tools and the joint completely filled. The joint shall be kept wet for 24 hours after making. The pipes and fittings shall be fixed to the walls on wooden cleats fixed to the stone and or brick walls by means of special W.I. clamps and round headed nails so as to keep clear of the surface of the walls unless projecting ears with fixing holes are provided at socket end of pipes or by approved inserts well fastened to the walls. The access door fittings shall be such as to avoid dead spaces in which filth may accumulate. Doors shall be provided with 3 mm rubber insertion packing and when closed and bolted, these shall be air and watertight. The floor traps, nahani traps etc. shall conform to IS : 3989. All exposed cast iron pipes and fittings shall be painted with one coat of red oxide primer and two coats of zinc based paint of approved make and shade.

### **D.9.6.2 Lead Pipes**

D.9.6.2.1 Lead pipes shall conform to IS : 404. The pipes shall be sound and free from lamination, flaws, pronounced extrusion marks or other imperfections and shall be as far as possible, be circular in cross section, smooth and of uniform wall thickness throughout. The chemical composition, wall thickness, weights and other specifications of lead pipes shall be as per relevant tables depending on different types of uses as specified in IS : 404. Lead pipes of when not supported on bearers, shall be supported by strong lead-tacks at least 40 mm wide soldered on to the pipes at suitable intervals. All joints for lead pipes shall be of wiped solder joints. The pipe ends to be jointed shall be cleaned with wire brush and shall be free from oxide if any. Chalk shall brush and shall be free from greasy nature of lead. After this, plumber's black shall be applied. Suitable length of joint (approximately 60 mm to 90 mm) shall be marked on the pipe. A fine shaving of lead shall be removed from this length with shave hook. Tallow shall then be smeared over the prepared surface. The molten solder, an alloy composed of 3 parts of tin and 7 parts of lead, shall be poured in a thin stream from a ladle moved in elliptical direction over the joint position, when sufficient solder has been poured, the joint shall be wiped with a pad of wiped cloth with long continuous movements in one direction only so as to leave a neatly formed elliptical shaped be removed with a tool called "draw off". The joint shall be air and water tight and free from tears, burrs, strings, ribbons or dropping. The jointing of lead pipes with C. I. or stone ware pipes shall be as follows :

D.9.6.2.2 One end of the brass ferrule or thimble shall be slipped into or over the lead pipe and jointed to it by means of a wiped solder joint. The other end of the ferrule shall then be inserted into the socket of the cast iron or stone ware pipe. In the case of the former, the joints shall be made with molten lead and in the case of the later with cement mortar. Brass screwed cleaning access shall be provided on lead pipes wherever necessary. Lead pipes shall be painted as directed by Engineer.

### **D.9.6.3 Asbestos Cement Soil, Waste, Vent Pipes and Fittings**

D.9.6.3.1 Asbestos cement soil, waste and pipes and fittings shall confirm to IS : 1626. The pipes and fittings shall be of spigot and socket ends and shall be of such nominal diameter as mentioned in the respective item of work. The pipes shall be straight and the ends of the pipes and fittings shall be finished square to their axes. The finished pipes and fittings shall be true and smooth, their inner and outer surfaces being as nearly as concentric. The shall be in all respect sound, homogeneous and free from impurities or other imperfections. The joints for pipes and fittings shall be in cement mortar (1:1) as mentioned in detail for C. I. pipes. The general requirements for fixing a. C. pipes and fittings on wall etc. shall be as described for C. I. soil waste and vent pipes and fittings. All exposed A. C. pipes and fittings shall be painted with two coats of paints approved type, make and colour as specified and directed by Engineer.

#### **D.9.6.4 Salt-Glazed Stoneware Pipes and Fittings**

D.9.6.4.1 Salt-glazed stoneware pipes and fittings shall conform to IS : 651. The pipes and fittings shall be of spigot and socket ends and shall be of such grade (A/AA) and internal diameter as mentioned in respective items of work. These shall be sound, free from invisible defects such as fire crack or hair cracks. The glaze of the pipes and fittings shall be free from crazing. The pipes shall give a sharp clear note when struck with a light hammer. There shall be no broken blisters. The length of pipes shall be 60 cm exclusive of the internal depth of socket unless otherwise specified. The pipes and fittings shall be handled with sufficient care to avoid damage to them. In general, laying, jointing and testing of salt-glazed stoneware pipes shall be as per IS : 4127. The pipes shall be laid to the required alignment. Levels and gradient as per the relevant drawings. The socket ends shall face the upstream. The bottom of the trench shall be well compacted before the pipes are laid. Where the pipes are laid on a soft soil, with the minimum water table level lying as the invert level of the pipe or where the pipe line is crossing the road, the pipes shall be bedded in concrete or shall be fully encased as directed or specified in the item of work. The pipes shall be jointed by following procedure:

D.9.6.4.2 In each joint spun yarn soaked in neat cement slurry or tarred gasket shall be placed round the joint and inserted in it by means of a caulking tool. More skeins of yarn or gasket shall be added if necessary and shall be well caulked. Yarn or gasket so rammed shall not occupy more than fourth of the depth of socket. Cement mortar (1:1) (one part of cement to one part of sand) shall be slightly moistened and carefully inserted by hand into the remaining space of the joint after caulking of yarn or gasket. The mortar shall then be caulked into the joint with a caulking tool. More cement shall be added until the space of joint has been completely filled with tightly caulked mortar. The joint shall then be finished off neatly outside the socket at an angle of 45 degrees. The cement mortar joint shall be cured at least for seven days before testing. The backfilling of trenches shall not be undertaken until the joints of the pipes are thoroughly set and have been inspected, tested and approved by Engineer. The backfilling from the bottom of pipe upto 300 mm above the top of pipe shall be done by selected earth free of any hard material. Care shall be taken not to disturb the joints during backfilling.

#### **D.9.6.5 Gully Trap**

D.9.6.5.1 In case gully trap is required to be provided before the wastewater pipe is connected to inspection chamber, this shall be of salt-glazed stoneware with square mouth and with 'P' or 'S' trap and shall conform to IS : 651. The size of gully trap as well as the brick masonry chamber in which it is fixed shall be as per the respective item of work. Gully trap shall have one C. I. grating of square size. Corresponding to the dimensions of inlet of gully trap. It will also have watertight C. I. cover and frame with inside clear dimensions of 300 mm x 300 mm, the cover weighting not less 5 Kg. And the frame not less than 3 Kg. The grating, cover and frame shall be of good sound and good casting and shall have truly square machined seating face. The cover for Gully Trap may be of precast concrete if specified in the item. The gully trap shall be fixed on cement concrete M-100 foundation, 680 mm square and 150 mm thick. The jointing of gully trap outlet to



the branch drain shall be done similar to jointing of glazed stoneware pipes. After fixing and testing gully and branch drain, a brick masonry (1:5) shall be built with 115 mm thick brick work round the gully trap from the top of the bed concrete upto ground level. The space between the chamber walls and the trap shall be filled in with cement concrete M-100. The space between the chamber walls and the trap shall be filled in with cement concrete M-100. The upper portion of the chamber i.e. above the top level of the trap and inside face of chamber shall be cement plastered 12 mm thick in C. M. (1:3) finished with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating. C. I. cover with frame 300 mm x 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete M150 and rendered smooth. The finished top of cover shall be left about 40 mm above the adjoining ground level so as to exclude the surface water from entering the gully trap. The item shall be executed as per the detailed drawing and as directed by Engineer.

#### **D.9.6.6 Inspection Chamber**

- D.9.6.6.1 Inspection Chamber shall be provided at every change of alignment, gradient or diameter of sewer/storm water drains, bends and junctions in the sewer / drain shall be grouped together in inspection chamber as far as possible. The maximum distance between inspection chambers shall be about 25 meters. Where the diameter of sewer/drain is increased, the soffit of the pipe shall be fixed at the same level and necessary slope given to the channel of inspection chamber. The minimum internal sizes of inspection chamber shall be as per the respective item of work. The inspection chamber shall be constructed as per the detailed drawings and as directed by Engineer. The bed concrete BBCC (1:5:10) and for channel CC (1:2:4) and the brick masonry shall be constructed of such thickness as shown on drawing. The brick masonry shall be constructed in C. M. (1:5), plastered on both faces with 15 mm cement plaster in C. M. (1:3). The channel shall be semicircular in the bottom half and of diameter equal to the sewer/drain. Above the horizontal diameter, the sides shall be extended vertically to the same level as the crown of the outgoing pipe and the top edge shall be suitable rounded off. The branch channels shall also be similarly constructed with respect to the benching out at their junction with the main channel as appropriate fall suitable rounded off in the direction of flow in the main channel shall be given. The channel at the bottom of inspection chamber shall be plastered with C. M. (1:1) and finished smooth. Rungs shall be provided in all inspection chambers over 0.6 m in depth and shall be of cast iron conforming to IS : 5455. These rungs shall be fixed staggered in two vertical runs, 300 mm apart horizontally and 300 mm c/c vertically. The top rung shall be 450 mm below the inspection chamber over and the lowest not more than 300 mm above / the benching. The inspection chamber frame and cover and the lowest not more than 300 mm above the benching. The inspection chamber frame and cover shall be of cast iron of specified weight and shall conform to the requirements given in IS : 1726. The covers and frames shall be cleanly cast and they shall be neatly dressed and carefully trimmed. All castings shall be free from voids whether due to shrinkage, gas inclusion or other causes. Covers shall have a raised chequered design on the top surface to provide an adequate nonslip grip. Cover shall be capable of easy opening and closing and it shall be fitted in the frame in workmanship like manner. The cover shall be

gas tight and water tight. The size of covers specified shall be considered as the clear internal dimensions of the frame. Covers and frames shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. The frame of inspection chamber cover shall be firmly embedded to correct alignment and level in cement concrete on the top of the masonry. The item shall be executed as per the detailed drawing as directed by Engineer. Light duty CI seat and cover of required size shall be provided.

#### **D.9.6.7 Intercepting Trap**

- D.9.6.7.1 Intercepting trap shall be salt glazed earthenware and shall conform to IS : 651. This trap shall be provided in the last manhole/ inspection chamber of building properly before the sewer is connected to street manhole/septic tank as directed and specified in the item of work. This item shall, however, be provided as per the requirements of local authority. The connection to street manhole/septic tank shall be done in good workmanship manner and as per the requirements of local authority.

### **D.9.7 STORM WATER DRAINAGE SYTEM**

#### **D.9.7.1 Rain Water Pipes and Fittings**

Cast iron rain water pipes and fittings shall conform to IS : 1230 whereas those of asbestos cement shall conform to IS : 1626. The general requirements of C. I. and A. C. rain water pipes and fittings, their fixing and jointing procedure, painting, etc., shall be as per the details described for respective type of pipes and fittings under the items for drainage work. The rain water pipe shall discharge directly or by means of a channel into or over an inlet to a surface drain or shall discharge freely in compound, drained to surface drain as directed by Engineer. In case the rain water pipe is to be connected to street drain this shall invariably be connected through gully trap. A rainwater pipe shall not discharge into or connect with any soil, waste or ventilating pipe nor shall discharge into a sewer unless specifically permitted to do so by the local authority in which case such discharge into a sewer shall be intercepted by means of gully trap. The diameter, spacing and type of rainwater pipe shall be as per the detailed drawing and respective item of work. A bell mouth inlet at the roof surface be provided with suitable grating. Generally, minimum diameter of rainwater pipe shall be 100 mm unless otherwise specified. Fixing of rain water gutters and down pipes for roof drainage shall conform to the requirements of IS: 2527.

### **D.9.8 MISCELLANEOUS ITEMS**

- D.9.8.1 Miscellaneous items such as special types of plumbing fixtures and fittings not covered in this specification but which are required to be provided as per the items of work shall be of best quality and of approved make. Other items which are invariably provided in sanitary units such as C. P. towel rail, liquid soap holder, mirror, etc., shall be of such size and type as mentioned in respective item of work and shall be of best quality and as approved by Engineer.

## **D.9.9 TESTING OF PLUMBING SYSTEMS**

- D.9.9.1 All pipes, fittings and appliances shall be stated as per the requirements of relevant I.S.S. and/local authority and necessary test certificates shall be submitted by Contractor whenever called for by Engineer at no extra cost to Owner / Engineer.
- D.9.9.2 When water supply system is completed, it shall be slowly and carefully charged with water, allowing all air to escape and avoiding all shock or water hammer. The system shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely watertight.
- D.9.9.3 Comprehensive tests of all sanitary appliances shall be made by simulating conditions of use. Overflows shall also be examined for obstructions.
- D.9.9.4 All soil, waste, vent pipes, fittings and their joints above ground shall be proved perfectly gas-tight by conducting a smoke test under a pressure 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke shall be produced by burning oil waste or tar paper or similar material in the combustion chamber of smoke machine. Contractor shall also perform water tests if required by Engineer before the appliances are connected. This test may be carried out in sections so as to limit the static head to 4.5 m. All the openings affected by the test shall be sealed and provided with supports to the plugs, which are used as stoppers during the test. All the pipes, fittings and their joints shall be proved water-tight.
- D.9.9.5 Discharge test shall be performed from all the sanitary appliances, singly and collectively. Obstruction in any of the pipe lines shall be traced and the whole system examined for proper hydraulic performance, including the retention of an adequate water seal in each trap.
- D.9.9.6 After laying and jointing salt glazed stoneware pipes, R.C.C. pipes suitable stretches of pipes inclusive of manhole/chambers shall be subjected to a test pressure of at least 1.5 meters head of water at the highest point of section water test. The tolerances figure of two liters per centimeter of diameter per kilometer shall be allowed during a period of ten minutes.
- D.9.9.7 Rain water pipes and fittings shall be tested to a height of water equivalent to the height of the building plus 3 meters to ensure no leakage in case of choking the pipe, by first installing test plugs in all openings, erecting 3 meters long stand pipe and filling the entire system with water. Pipes shall be deemed to have passed the test, if water levels in the stand pipe remains reasonably constant for a period of one hour.

## **D.9.10 MEASUREMENT**

- D.9.10.1 Unless otherwise stated, all pipes such as C.I., G.I., lead, etc. shall be measured net, length as actually laid or fixed shall be measured over all fittings, like bends, tees, junctions, etc.(which shall not be measured separately), in running meters

correct to a cm. The length shall be taken along the centre line of the pipes and fittings. No allowance shall be made for any wastage etc. The rate shall include the cost of material and labour involved and inclusive of laying, jointing, testing necessary excavating and backfilling, shoring, dewatering, etc. complete for pipes for laid below ground. In case the pipes are laid above ground the rate shall include the cost of material and labour involved and inclusive of fixing, jointing, testing, painting, necessary scaffolding, cutting through walls, floors, etc. and making good the same etc. complete. This shall however, not include concealed pipe work in which case the length of pipes and fittings concealed shall be measured and paid separately.

- D.9.10.2 The lengths of salt glazed stoneware pipes shall be measure in running metres nearest to a cm as actually laid from inside face of one manhole / chamber to the inside face of the other manhole/ chamber. The length shall be taken along the centre line of the pipes over all fittings such as bends, junction, etc. shall not be measured separately.
- D.9.10.3 All valves (sluice, gate, globe, check etc.) and taps (bib, stop, pillar, etc.) and similar fittings used for water supply system shall be enumerated and paid separately unless otherwise included in the items of work for sanitary appliances. The rate shall include the cost of materials and labour involved inclusive of fixing, testing, etc. complete.
- D.9.10.4 Sanitary appliances such as water closets, urinals, wash basins, sinks etc. shall be enumerated and shall cover all the relevant items as described in respective items of work for sanitary appliances. The rate shall include the cost of materials and labour involved inclusive of supporting fixing, testing, making necessary connections etc. complete.
- D.9.10.5 Gully traps, floor traps, intercepting traps, etc. shall be separately enumerated as per their sizes and shall cover all the relevant items as described in the respective items of work for traps. The rate shall include the cost of materials and labour involved inclusive of fixing the traps, necessary chamber, excavation, backfilling, dewatering, testing, etc. complete.
- D.9.10.6 Manholes and inspection chambers shall be separately enumerated as per their sizes and shall cover all the relevant items as described in the respective items of work for manhole/inspection chamber. The depth of the manhole shall be reckoned from the top level of C. I. /precast R.C.C. cover to the invert level of channel. The depth shall be measured correct to cm. The extra depth shall be measured as an extra over the specified depth in the enumerated item, and paid in running metre under separate item following the main item. The rate shall include the cost of materials and labour involved inclusive of necessary excavation, backfilling, dewatering, testing etc. complete.
- D.9.10.7 Rain water pipe and fittings shall be measured in running meters correct to a cm, the length being taken along their centre line. The rate shall include the cost of materials and labour involved inclusive of fixing, joint, painting, etc.

## **D.9.11      NAHNI TRAP**

### **D.9.11.1      Materials :**

- D.9.11.1.1    Nahni trap shall be of cast iron and shall be sound and free from porosity or other defects which affect serviceability. The thickness of the base metal shall not be less than 6.5 mm. The surface shall be smooth and free from craze, ships and other flaws or any other kind of defects which affect serviceability. The size of nahni trap shall be as specified and shall be self cleaning design.
- D.9.11.1.2    The nahni trap shall be of quality approved by the Engineer in charge and shall generally conform to the relevant Indian Standards.
- D.9.11.1.3    The Nahni trap provided shall be with deep seal, minimum 50 mm, except at places where trap with deep seal can not be accommodated. The cover shall be cast iron. Perforated cover shall be provided on the trap of appropriate size.
- D.9.11.1.4    The C.I. hinged of screwed down cover shall be of best quality.

### **D.9.11.2      Workmanship :**

- D.9.11.2.1    The Nahni trap with 100 mm. dia. inlet and 50 mm. dia. outlet shall be fixed as per drawing or as directed.
- D.9.11.2.2    The Nahni trap shall be jointed with C. I. pipe, 75 mm. dia. with lead joints. The lend joints shall be done in confirmation with IS 782-1976.

### **D.9.11.3      Mode of measurements & payment :**

- D.9.11.3.1    The rate includes cost of all labour, materials, tools and plants etc. required for satisfactory completion of this item including lead jointing and testing.
- D.9.11.3.2    The rate shall be for a unit of one number.

## **D-10 : LAYING OF PIPES AND FITTINGS / SPECIALS**

### **SECTION : D-10**

#### **D.10.1 SCOPE**

D.10.1.1 The specification covers the requirements for laying of pipes below ground.

#### **D.10.2 APPLICABLE CODES**

D.10.2.1 The laying of pipes and fittings / specials shall comply with all currently statutes, regulations, standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred to. In all cases, the latest revision of the standards / codes shall be referred to. If requirements of this specification conflict with the requirements of the standards / codes, this specification shall govern.

##### **D.10.2.2 Codes of Practice**

- a) IS : 783 - Code of practice for laying of concrete pipes.
- b) IS : 3114 - Code of practice for laying of cast iron pipes
- c) IS : 3764 - Safety code for excavation work
- d) IS : 4127 - Code of practice for laying of glazed stoneware pipes
- e) IS : 5822 - Code of practice for laying of electrically welded steel pipes for water supply
- f) IS : 6530 - Code of practice for laying of asbestos cement pressure pipes

#### **D.10.3 CARTING AND HANDLING**

D.10.3.1 The pipes and other materials required shall be transported from the factory to the work sites at places along the alignment of pipeline as directed by the Engineer-in-charge. The Contractor shall be responsible for the safety of pipes and fittings / specials in transit, loading / unloading. Every care shall be exercised in handling pipes to avoid damage. While unloading, the pipes and fittings / specials shall not be thrown down from the truck on to hard surfaces. They shall be unloaded on timber skids with steadying ropes or by any other approve means. Padding shall be provided between coated pies, fittings /specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervals in order to permit access from one side to the other. In case of spigot socket pipes, care should be taken regarding orientation of pipes while unloading. As far as possible pipes shall be unloaded on one side of the trench only. The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for reclamation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded. Dragging of pipes and fittings / specials along concrete and similar pavement with hard surfaces shall be prohibited.

- D.10.3.2 New Pipes can be brought to site only after the mandatory tests (i.e. cube tests, three edge bearing tests, hydrostatic tests, water absorption test etc.) are completed and **necessary test certificates from the manufacturer are produced alongwith each delivery of batch of pipes.**

#### **D.10.4 STORAGE**

- D.10.4.1 Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom layer to keep the stack stable. The stack shall be in pyramid shape or the pipes laid lengthwise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stock shall not exceed 1.5 m.
- D.10.4.2 Fittings/specials shall be stacked under cover and separated from pipes.
- D.10.4.3 Rubber rings shall be stored in a clean, cool store away from windows, boiler, electrical equipment and petrol, oils or other chemicals. Particularly in the field where the rubber rings are being used it is desirable that they are not left out on the ground in the sun or overnight under heavy frost or snow conditions.

#### **D.10.5 LAYING**

##### **D.10.5.1 Excavation**

- D.10.5.1.1 Before excavating the trench the alignment of pipeline shall be approved by the Engineer-in-charge. The excavation of trenches and pits for manholes / chambers shall be carried out in accordance with the specification of earthwork in excavation and backfilling and shall be done such that it does not get far ahead of the laying operation as approved by the Engineer-in-charge.
- D.10.5.1.2 To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for the traffic to use the roadways. The relevant Indian Standards and the rules and regulations of local authorities in regards to safety provisions shall be observed.
- D.10.5.1.3 Suitable fencing shall be provided along the sides of trenches and pits. The posts of fencing shall be of the timber securely fixed in the ground not more than 3 m. apart and they shall not be less than 75 mm in diameter or less than 1.2 m. above surface of the ground. There shall be two rails, one near the top of the post and the other about 450 mm above the ground and each shall be from 50 mm to 70 mm in diameter and sufficiently long to run from post to post to which they shall be bound with strong rope. The method of projecting rails beyond the post and tying them together where they meet will not be allowed on any account. All along the edges of the excavation trenches a bank of earth about 1.2 m. high shall be formed where required by the Engineer-in-charge for further protection.

- D.10.5.1.4 The road metal and also the rubble packing shall first be stripped off for the whole width of the trench / pit and separately deposited in such place or places as may be determined by the Engineer-in-charge.
- D.10.5.1.5 During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately. The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench and pit, or as may be necessary to prevent the sides of the trench pit to slip or fall, or at such a distance and in such a manner as to avoid covering fire hydrants, sluice valves, manholes covers etc. and so as to avoid abutting the wall or structure or causing inconvenience to the public and other service organisations or otherwise as the Engineer-in-charge may direct.
- D.10.5.1.6 Contractor shall take into account additional excavation if any as the Engineer-in-charge may require in order to locate the position of water pipes, drains, sewers etc. or any other works which may be met with, in or about the excavation of trenches/pits while quoting the rates for excavation of trenches/pits while quoting the rates for excavation. Such service lines if met with during excavation shall be properly maintained by Contractor, by means of shoring, strutting, planking over, padding or otherwise as the Engineer-in-charge may direct, and shall be protected by the Contractor from damage during the progress of the work. All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure / pipe line of water, gas, sewage etc.
- D.10.5.1.7 If the work for which the excavation has been made is not completed by the expected date of the setting of monsoon as stipulated in "Data Sheet-I" or the setting in of rain whichever is earlier, or before the day fixed by Engineer-in-charge for filling in any excavation on account of any festival or special occasion, Contractor shall backfill such excavation and consolidate the filling.
- D.10.5.1.8 Utmost care shall be taken to see that the width of the trench at the top of pipe is not more than that specified in "Data Sheet-I". In case additional width is required it shall be provided only in the top portion from the ground level upto 300 mm above the top of pipe. If any extra width is provided in the area below this portion, Contractor shall have to provide remedial measures in the form of lime concrete or rubble masonry otherwise at the discretion and to the satisfaction of the Engineer-in-charge. If rock is met with, it shall be removed to 15 cm below the bottom of pipes and fittings/specials and the space resulting shall be refilled with granular materials and properly consolidated. Bottom of trenches / pits shall be saturated with water well rammed wherever the Engineer-in-charge may consider it necessary to do so.
- D.10.5.1.9 Wherever a socket or collar of pipe or fitting / special occurs, a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe may have a fair bearing on its shaft and does not rest upon its socket. Such grip shall be of sufficient size in every respect to admit the hand all around the socket in order to make the joint, and the grip shall be maintained clear until the joint has been approved by Engineer-in-charge.



D.10.5.1.10 When welding is to be carried out with the pipes and specials in the trench, additional excavation of not more than 60 cm in depth and 90 cm in length shall be made at joints in order to facilitate welding.

D.10.5.1.11 The excess excavated material shall be carried away from site of works to a place up to a distance as directed by the Engineer-in-charge. This shall be done immediately so as not to cause any inconvenience to the public or traffic. If the instructions from Engineer are not implemented within seven days from the date of instructions to cart the materials and to clear the site, the same shall be carried out by the Engineer-in-charge and any claim or dispute shall not be entertained in this respect.

#### **D.10.5.2 Dewatering**

D.10.5.2.1 During the excavation, if subsoil water is met with, Contractor shall have to provide necessary equipment and labourers for dewatering the trenches/pits by bailing out water; if pumping out subsoil water is found to be necessary, Contractor shall provide sufficient number of pumps for the same. In both the above cases the excavation shall be done to the required level and the pipes shall be laid to proper alignment and gradient. Contractor shall also make necessary arrangement for the disposal of drained water nearby storm water drain or in a pit if allowed by Owner/ Engineer. In no case the water shall be allowed to spread over the adjoining area. Before discharging this water into public sewer/drain, Contractor shall take necessary permission from the local authorities.

#### **D.10.5.3 Special, foundation in poor soil**

D.10.5.3.1 Where the bottom of the trench and subgrade is found to consist of material which is unstable to such a degree that in the opinion of the Engineer-in-charge, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, a suitable foundation for the pipes, consisting of piling, timbers or other materials, in accordance with relevant drawings and as instructed by Engineer-in-charge shall be constructed.

#### **D.10.5.4 Wooden shoring**

D.10.5.4.1 Contractor shall suitably design polling bards, waling and struts to meet different soil conditions that might be encountered in excavating trenches/pits. The horizontal and vertical spacing of struts shall be such that not only the sides of trenches shall be prevented from collapse but also easy lowering of pipe in trenches shall be ensured without creating undue obstructions for the excavation of the work. Any inconvenience and/or delay that might be caused in lowering pipes in trenches as a result of adopting improper spacing of struts by Contractor shall be his sole responsibility. No part of shoring shall at any time be removed by Contractor without obtaining permission from the Engineer-in-charge. While taking out shoring planks the hollows of any form must simultaneously be filled in with soft earth well rammed with rammers and with water.

D.10.5.4.2 The Engineer-in-charge may order portions of shoring to be left in the trenches/pits at such places, where it is found absolutely necessary to do so to avoid any damage which may be caused to buildings, cables, gas-mains, water mains, sewers etc. in close proximity of the excavation, by pulling out the shoring from the excavations. Contractor shall not claim, on any reason whatsoever, for the shoring which may have been left in by him at his own discretion.

#### **D.10.5.5 Steel Plate Shoring**

D.10.5.5.1 Where the subsoil conditions are expected to be of a soft and unstable character in trench / pit excavation, the normal method of timbering may prove sufficient to avoid subsidence of the adjoining road surface and other services. In such circumstances contractor will be required to use steel trench sheeting or sheet piling adequately supported by timber struts, waling etc. as per the instructions, manner and method directed by Owner / Engineer. Contractor shall supply, pitch, drive and subsequently remove trench sheeting or piling in accordance with other items of the specifications

#### **D.10.5.6 Boning staves and sight rails**

D.10.5.6.1 In laying the pipes and fittings/specials the centre for each manhole /chamber or pipeline shall be marked by a peg. Contractor shall dig holes for and set up two posts (about 100 x 100 x 1800 mm) at each manhole/chamber or junction of pipelines at nearly equal distance from the peg and at sufficient distances therefrom to be well clear of all intended excavation, so arranged that a sight rail when fixed at a certain level against the post shall cross the centre line of the manhole/chamber or pipelines. The sight rail shall not in any case be more than 30 m apart, intermediate rails shall be put up if directed by Engineer-in-charge.

D.10.5.6.2 Boning staves of 75 mm x 50 mm size shall be prepared by Contractor in various lengths, each length being of a certain whole number of metres and with a fixed tee head and fixed intermediate cross pieces, each about 300 mm long. The top edge of the cross piece must be fixed below the top edge of the tee head at a distance equal to the outside diameter of the pipe or the thickness of the concrete bed to be laid as the case may be. The top of cross pieces shall indicate different levels such as excavation for pipe line, top of concrete bed, top of pipe etc. as the case may be.

D.10.5.6.3 The sight rail of size 250 mm x 40 mm shall be screwed with the top edge resting against the level marks. The centre line of the pipe shall be marked on the rail and this mark shall denote also the meeting point of the centre lines of any converging pipes. A line drawn from the top edge of one rail to the top edge of the next rail shall be vertically parallel with the bed of the pipe, and the depth of the bed of pipe at any intermediate point may be determined by letting down the selected boning staff until the tee head comes in the line sight from rail to rail.

D.10.5.6.4 The post and rails shall be perfectly square and planed smooth on all sides and edges. The rails shall be painted white on both sides, and the tee-heads and cross-piece of the boning staves shall be painted black.

D.10.5.6.5 For the pipes converging to a manhole / chamber at various levels, there shall be a rail fixed for every different level. When a rail comes within 0.60 m. of the surface of the ground, a higher sight-rail shall be fixed for use with the rail over the next point.

D.10.5.6.6 The posts and rails shall in not case be removed until the trench is excavated, the pipes are laid and the Engineer-in-charge gives permission to proceed with the backfilling.

#### **D.10.5.7 Bedding**

D.10.5.7.1 The type of bedding for pipes shall be as per relevant item.

#### **D.10.5.8 Laying of pipes and fittings**

D.10.5.8.1 All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure / pipeline of water, gas, sewage etc. After excavation of trenches, pipes shall not be lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches and approved and measured by the Engineer-in-charge. Pipes and fittings / specials shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes and fittings / specials shall be made by Contractor. In no case pipes and fittings / specials shall be dropped. Slings of canvas or equally non-abrasive material of suitable width or special attachment to fit the ends of pipes and fittings / specials shall be used to lift and lower the coated pipes and fittings / specials. The pipes and fittings / specials shall be inspected for pipes and fittings / specials shall be inspected for defects and be rung with light hammer preferably while suspended to detect cracks. If doubt persists, further conformation shall be done by pouring a little kerosene / dye on the inside of the pipe at the suspected spot. No sign of kerosene / dye should appear on the outside surface. Pipes and fittings / specials damaged during lowering or aligning shall be rejected by the Engineer-in-charge.

D.10.5.8.2 All the pipes are to be laid perfectly true both in alignment and to gradient specified. In case of spigot and socket pipe the socket end of the pipe shall face upstream, except when the pipeline runs uphill in which case the socket ends should face the upgrade. The laying of pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centred in the socket and the pipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes and fittings / specials which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes and fittings / specials of proper dimensions to ensure such uniform space. Precautions shall be taken to prevent dirt from entering the jointing space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by Engineer-in-charge. During the period that the plug is on the contractor shall take proper precautions against floating of the pipe owing to entry of water into the trench. Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted the deflection allowed at joints shall not exceed 2.5% .

In case of pipes, with joint to be made with loose collars, the collars shall be slipped on before the next pipe is laid. The pipes shall be laid such that the marking on pipes appears at the top of the pipes.

D.10.5.8.3 The cutting of pipe for inserting valves, fittings or specials shall be done in a neat and workman like manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. For this purpose, pipe-cutting machine shall be used.

#### **D.10.5.9 Thrust block**

D.10.5.9.1 Thrust blocks shall be provided, to counteract hydraulic thrust, at places wherever directed by owner / engineer and as per relevant drawing.

#### **D.10.5.10 Jointing**

D.10.5.10.1 Jointing for pipes and fittings / specials shall be done in accordance with the relevant specifications depending upon the type of pipes being used.

#### **D.10.5.11 Testing and Commissioning**

D.10.5.11.1 Testing and commissioning of pipes shall be done in accordance with the relevant specifications.

#### **D.10.5.12 Backfilling**

D.10.5.12.1 Trenches shall be backfilled with approved selected excavated material only after the successful testing of the pipeline. The tamping around the pipe shall be done by hand or other hand operated mechanical means. The water content of the soil shall be as near the optimum moisture content as possible. Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressure does not occur. Backfilling shall be done in layers not exceeding 15 cm. Each layer shall be consolidated by water into, ramming, case being taken to avoid damage to the pipeline. In case of mild steel pipes / specials, the spiders provided during assembly and welding shall be retained until the trench is refilled and consolidated. Where timbers are placed under the pipeline to aid alignment, these timbers shall be removed before backfilling.

#### **D.10.5.13 Reinstatement of Road / Footpath**

D.10.5.13.1 Reinstatement of road / footpath shall be done as per the requirements of local authorities and the relevant specifications after completion of work.

#### **D.10.5.14 Clearing of site**

D.10.5.14.1 All surplus materials, and all tools and temporary structures shall be removed from the site as directed by Engineer-in-charge and the construction site left clean to the satisfaction of Engineer-in-charge.

## **D.10.6 MEASUREMENT**

D.10.6.1 The measurement for excavation in trenches shall be done in following manner and will be paid accordingly.

- i) Length : As per the actual length of pipes and fittings / specials laid at work site.
- ii) Width and cross sections : As per Drawing.
- iii) Depth : Average depth of trench from ground level to bottom of bedding.

D.10.6.2 Excavation of asphalt road and reinstatement of road shall be measured on per square meter basis and the length and width at top of trench shall be considered same as those mentioned for excavation of trench.

D.10.6.3 Shoring (open / close) shall be measured on the square meter basis of the actual area of trenches shored.

D.10.6.4 The measurement for removal of excess excavated material upto a specified distance shall be as per the relevant items (s) in the schedule of Quantities and Rates and shall be measured on cubic meter basis. In case of soil 30% deduction shall be done to take account for voids where as it will be 40% in case in case of rubble.

D.10.6.5 Measurement for pipes and fittings / specials shall be in accordance with the relevant clause(s) of specification for particular type of pipes.

### **D.10.6.6 Notes**

D.10.6.6.1 Fencing provided along the sides of trenches and pits shall not be paid for separately and contractor shall take into account the costs of such works and quote accordingly.

D.10.6.6.2 In case of the metal packing or dressed stones not being deposited as specified or being mixed up with excavated materials and not available for the reinstatement of road / pavement, the cost of the new metal packing or dressed stones requires shall be charged to Contractor by Engineer-in-charge.

D.10.6.6.3 Service lines if damaged during excavation shall be made good either by Contractor or by other agency as Engineer-in-charge may decide and wholly in either case at the expense of Contractor.

D.10.6.6.4 Contractor shall not be paid any additional compensation for excess excavation over what is specified as well as for any remedial measures that are specified.

D.10.6.6.5 The excess excavated material shall be carried away from site of works as specified, failing which in view of public safety and traffic convenience the Engineer-in-charge may carry out the work by any other agency at Contractor's risk and cost.

D.10.6.6.6 Portion of shoring left in the excavated trenches or pits shall be measured and paid separately, if instructed by Engineer-in-charge to do so.

## **D-11 : REINFORCED CEMENT CONCRETE PIPES SOCKET & SPIGOT**

### **SECTION - D: 11**

#### **D.11.0 SCOPE**

This specification covers the requirements for manufacturing, testing, supplying, jointing and testing at work sites of Reinforced Cement Concrete (RCC) pipes, of both pressure and non pressure varieties used for pumping mains and gravity, sewers and storm water drains. Laying of pipes and fittings/specials are covered in Technical Specifications: Section-D6. The two parts are complementary and are to be read together for a correct interpretation of the provisions of this specification.

#### **D.11.1 APPLICABLE CODES**

The manufacturing, testing, supplying, jointing and testing at work sites of RCC pipes shall comply with all currently applicable statutes, regulations, standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of this specification conflict with the requirements of the codes and standards, this specification shall govern.

#### **D.11.2 MATERIALS**

- a) IS: 458- Specification for precast concrete pipes (with and without reinf.)-2021
- b) IS: 3597 -Method of tests for concrete pipes.
- c) IS: 5382 -Specification for rubber sealing rings for gas mains, water mains and sewers.
- d) IS: 516 -Method of test for strength of concrete.

#### **D.11.3 CODE OF PRACTICE**

- a) IS: 456-Code of practice for plain and reinforced concrete
- b) IS: 783-Code of practice for laying of concrete pipes

#### **D.11.4 DESIGN**

Design of RCC pipes including reinforcement details and the ends of pipes shall be in accordance with the relevant clauses of IS: 458-2021.

## **D.11.5 MANUFACTURING**

### **GENERAL :**

**Pipe should be with ISI mark confirming to IS-458-2021. Pipe can be manufactured by spinning process or by vibrated casting process.**

The method of manufacture shall be such that the form and the dimensions of the finished pipes are accurate within the limits specified in relevant clause of IS: 458. The surfaces and edges of the pipes shall be well defined and true, and their ends shall be square with the longitudinal axis. The ends of the pipes shall be further reinforced by an extra ring of reinforcement to avoid breakage during transportation.

The RCC pipes and rubber rings shall be systematically checked for any manufacturing defects by experienced supervisors so as to maintain a high standard of quality.

Owner/Engineer shall at all reasonable times have free access to the place where the pipes and collars/rubber rings are manufactured for the purpose of examining and testing the pipes and collars/rubber rings and of witnessing the test and manufacturing.

All tests specified either in this specification or in the relevant Indian Standards shall be performed by the supplier/contractor at his own cost and in presence of Owner/Engineer if desired. For this, sufficient notice before testing of the pipes and fittings shall be given to Owner/Engineer.

If the test is found unsatisfactory, Owner/Engineer may reject any or all pipes of that lot. The decision of Owner/Engineer in this matter shall be final and binding on Contractor and not subject to any arbitration or appeal.

## **D.11.6 MATERIALS**

### **Cement**

Cement used for the manufacture of RCC pipes should be OPC and shall confirm to relevant IS codes.

### **Aggregates**

Aggregates used for the manufacture of RCC pipes shall conform to IS:383. The maximum size of aggregate should not exceed one-third the thickness of the pipe or 20 mm, whichever is smaller.

### **Mixing and Curing Water**

Water shall be clean, colorless and free from objectionable quantities of organic matter, alkali, acid, salts or other impurities that might reduce the strength, durability or other desirable qualities of concrete and mortar.

### **Reinforcement**

Reinforcement used for the manufacture of the RCC pipes shall be mild steel Grade I or medium tensile steel bars conforming to IS: 432 (Part-I) or hard-drawn steel wire conforming to IS: 421 (Part-2). Reinforcement cages for pipes shall be as per relevant requirements of IS: 458.

### **Concrete**

Concrete used for the manufacture of RCC pipes shall conform to IS: 456. The minimum cement content and minimum compressive strength of concrete shall be as per relevant requirements of IS:458 (Latest Edition). Compressive strength tests shall be conducted on 15 cm cubes in accordance with the relevant requirements of IS: 456 and IS: 516.

### **Rubber Ring**

Rubber ring chords used in pipe joints shall be EPDM rubbering as per IS 5382 : 1985.

## **D.11.7 CURING**

Pipes manufactured in compliance with IS:458 (Latest Edition) shall be either water cured or steam cured for minimum stipulated curing period in accordance with relevant requirements of the latest revised IS:458 (Latest Edition).

## **D.11.8 DIMENSIONS**

The internal diameter, wall thickness and length of barrel and collar of pipes, reinforcement (longitudinal and spiral), type of ends and minimum clear cover to reinforcement and strength test requirements shall be as per the relevant clauses/tables of IS: 458 for different classes of pipes.



**Table – 3 of IS-458-2021**

**Design and Strength Test Requirements of Concrete Pipes of Class NP3  
Reinforced Concrete, Medium Duty, Non-Pressure Pipes made by spinning process**

(Clauses 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2 and 8.1 and Table 20)

Internal Diameter of Pipes in mm	Barrel Wall Thickness	Reinforcements			Strength Test Requirements for Three Edge Bearing Test	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Draws Steel	Load to Produce 0.25 mm Crack kN/linear metre	Ultimate Load
		Minimum number	Kg/linear metre	Kg/linear metre		kN/linear metre
(1)	(2)	(3)	(4)	(5)	(6)	(7)
300	40	8	0.78	1.53	15.50	23.25
400	75	8	0.78	1.6	19.16	28.74
450	75	8	0.78	1.9	21.56	32.34
600	85	8 or 6+6	1.18	2.82	28.74	43.11
800	95	8 or 6+6	2.66	6.87	38.32	57.48
900	100	6 + 6	2.66	11.55	43.11	64.67
1000	115	6 + 6	2.66	15.70	47.90	71.85
1200	120	8 + 8	3.55	24.74	57.48	86.22
1400	135	8 + 8	3.55	46.21	67.06	100.60
1600	140	8 + 8	3.55	65.40	76.64	114.96
1800	150	12 + 12	9.36	87.10	86.22	129.33
2000	170	12 + 12	9.36	97.90	95.80	143.70
2200	185	12 + 12	9.36	133.30	105.38	158.07

**Note :**

1. If mild steel is used for spiral reinforcement, the weight specified under col.5 shall be increased to 140/125.
2. The longitudinal reinforcement given in this table is valid for pipes upto 2.5 m. effective length for internal diameter of pipe upto 250 mm and upto 3 m. effective length for higher diameter pipes.
3. Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col.4 by the length of the pipe and then deducting for the cover length provided at the two ends.
4. Concrete for pipes shall have a minimum compressive strength of 35 N/mm<sup>2</sup> at 28 days.

**Table – 5 of IS- 458-2021**

**Design and Strength Test Requirements of Concrete Pipes of Class NP3  
Reinforced Concrete, Medium Duty, Non-Pressure Pipes Made by Vibrated Casting  
Process**

(Clauses 5.5.1, 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2 and 8.1 ; and Table 20)

Internal Diameter of Pipes in mm	Minimum Barrel Wall Thickness	Reinforcements			Strength Test Requirements for Three Edge Bearing Test	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Draws Steel	Load to Produce 0.25 mm Crack kN/linear metre	Ultimate Load kN/linear metre
		Minimum number	Kg/linear metre	Kg/linear metre		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
300	50	8	0.78	1.53	15.5	23.25
400	60	8	0.78	1.6	19.16	28.74
450	65	8	0.78	1.9	21.56	32.34
600	75	8 or 6 +6	1.18	2.2	28.74	43.11
800	95	8 or 6 +6	2.66	6.87	38.32	57.48
900	100	6 + 6	2.66	11.55	43.11	64.67
1000	115	6 + 6	2.66	15.7	47.9	71.85
1200	125	8 + 8	3.55	21.25	57.48	86.22
1400	140	8 + 8	3.55	30	67.06	100.6
1600	165	8 + 8	3.55	50.63	76.64	114.96
1800	180	12 + 12	9.36	64.19	86.22	129.33
2000	190	12 + 12	9.36	83.12	95.8	143.7
2200	210	12 + 12	9.36	105.53	105.4	158.07

**Note :** Concrete for pipes shall have a minimum compressive strength of 35 N/mm<sup>2</sup> at 28 days

**Table – 6 of IS-458-2021**

**Design and Strength Test Requirements of Concrete Pipes of Class NP4  
Reinforced Concrete, Heavy Duty, Non-Pressure Pipes**

(Clauses 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2 and 8.1 ; and Table 20)

Internal Diameter of Pipes in mm	Minimum Barrel Wall Thickness	Reinforcements			Strength Test Requirements for Three Edge Bearing Test	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Draws Steel	Load to Produce 0.25 mm Crack kN/linear metre	Ultimate Load kN/linear metre
		Minimum number	Kg/linear metre	Kg/linear metre		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
300	40	8	0.78	1.53	26.4	39.6
400	75	8	0.78	1.97	33.9	50.9
450	75	8	0.78	3.36	36.9	55.3
600	85	8 or 6 + 6	2.34	8.5	46.3	69.4
800	95	8 or 6 + 6	3.44	16.72	59.3	89.1
900	100	6 + 6	3.44	20.92	66.3	99.4
1000	115	8 + 8	6.04	26.7	72.6	108.9
1200	120	8 + 8	6.04	46.25	88.3	132.4
1400	135	8 + 8	9.36	59.2	99.1	148.65
1600	140	12 + 12	9.36	86.6	109.90	164.85
1800	150	12 + 12	14.88	103.3	120.7	181.05
2000	170	12 + 12	14.88	125.28	131.5	197.25
2200	185	12 + 12	14.88	154.94	142.2	213.3

- Note :**
1. If mild steel is used for spiral reinforcement, the weight specified under col.5 shall be increased to 140/125.
  2. The longitudinal reinforcement given in this table is valid for pipes upto 2.5 m. effective length for internal diameter of pipe upto 250 mm and 3 m. effective length for higher diameter pipes.
  3. Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col.4 by the length of the pipe and then deducting for the cover length provided at the two ends.
  4. Concrete for pipes shall have a minimum compressive strength of 35 N/mm<sup>2</sup> at 28 days.

**Table – 8 of IS-458-2021**

**Design and Strength Test Requirements of Concrete Pipes of Class NP4  
Reinforced Concrete, Heavy Duty, Non-Pressure Pipes  
made by Vibrated casting process**

(Clauses 5.5.1, 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2 and 8.1 ; and Table 20)

Internal Diameter of Pipes in mm	Minimum Barrel Wall Thickness	Reinforcements			Strength Test Requirements for Three Edge Bearing Test	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spirals, Hard Draws Steel	Load to Produce 0.25 mm Crack kN/linear metre	Ultimate Load kN/linear metre
		Minimum number	Kg/linear metre	Kg/linear metre		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
300	50	8	0.78	1.53	26.4	38.6
400	60	8	0.78	1.97	33.9	50.9
450	65	8	0.78	3.36	36.9	55.3
600	75	8 or 6 + 6	2.34	8.50	46.3	69.4
800	95	8 or 6 + 6	3.44	16.72	59.3	89.1
900	100	6 + 6	3.44	20.92	66.3	99.4
1000	115	8 + 8	6.04	26.70	72.6	108.9
1200	125	8 + 8	6.04	42.42	88.3	132.4
1400	140	8 + 8	9.36	51.39	99.10	148.65
1600	165	12 + 12	9.36	61.81	109.9	164.85
1800	180	12 + 12	14.88	78.03	120.70	181.05
2000	190	12 + 12	14.88	103.5	131.5	197.25

**Note :** Concrete for pipes shall have a minimum compressive strength of 35 N/mm<sup>2</sup> at 28 days.

The tolerances regarding overall length, internal diameter of pipes or sockets and barrel wall thickness shall be as per relevant clause of IS: 458.

#### **D.11.9 WORKMANSHIP AND FINISH**

Pipes shall be straight and free from cracks except that craze cracks may be permitted. The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench no opening between ends in contact shall exceed 3 mm in pipes up to 600 mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter.

The outside and inside surfaces of the pipes shall be smooth, dense and hard, and shall not be coated with cement wash or other preparation unless otherwise agreed to between Owner/Engineer and the manufacturer or supplier.

The pipes shall be free from defects resulting from imperfect grading of the aggregate, mixing or moulding.

The pipes shall be free from local dents or bulges greater than 3 mm in depth and extending over a length in any direction greater than twice the thickness of barrel.

The deviation from straight in any pipe throughout its effective length, tested by means of a rigid straight edge parallel to the longitudinal axis of the pipe shall not exceed, for all diameters 3 mm forever meter run.

#### **D.11.10 TESTING**

All pipes for testing purposes shall be selected at random from the stock of the manufacturer and shall be such as would not otherwise be rejected under the criteria of tolerances as mentioned in IS:458 (Latest Edition).

During manufacture, tests on concrete shall be carried out as per IS:456. The manufacturer shall supply, when required to do so by Owner/Engineer the results of compressive tests of concrete cubes and split tensile tests of concrete cylinders made from the concrete used for the pipes. The manufacturer shall supply cylinders or cubes for test purposes required by the Owner/Engineer and such cylinders or cubes shall withstand the tests prescribed by the manufacturer for the hydrostatic test pressure. For non-pressure pipes, 2 percent of the pipes shall be tested for hydrostatic test pressure.

The specimen of pipes for the following tests shall be selected in accordance with relevant Clause of IS:458 (Latest Edition) and tests in accordance with the methods described in IS:3597.

- i) Hydrostatic test
- ii) Three edge bearing test
- iii) Absorption test

Note: Three edge bearing strength to produce 0.25 mm crack in case of special design of pipes shall be as per IS:458:2003.

For Inspection at manufacturing site 24 hrs. access shall be provided to AMC Engineers as well as engineer appointed by PMC/TPI agency. Apart from this AMC will establish its own pipe testing facility where pipes will be randomly tested. The cost of transporting the pipe to the testing facility & testing charges shall be borne by the contractor.

#### **D.11.11 SAMPLING AND INSPECTION**

In any consignment, all the pipes of same class and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. The conformity of a lot to the requirements of this specification shall be ascertained on the basis of tests on pipes selected from it.

The number of pipes to be selected from the lot for testing shall be in accordance with Table 15 of IS:458 (Latest Edition).

Pipes shall be selected at random. In order to ensure randomness, all the pipes in the lot may be arranged in a serial order and starting from any pipe, every 'n'th pipe be selected till the requisite number is obtained, n being the integral part of  $N/n$ , where N is the lot size and n is the sample size.

All pipes selected as per IS : 458 shall be inspected for dimensional requirements, finish and deviation from straight. A pipe failing to satisfy one or more of these requirements shall be considered as defective.

The number of pipes to be tested for tests under IS : 458 shall be in accordance with column 4 of Table 15 of IS:458 (Latest Edition). These pipes shall be selected from pipes that have satisfied the requirements mentioned in Clause above.

A lot shall be considered as conforming to the requirements of IS:458 (Latest Edition) if the following conditions are satisfied.

- (a) The number of defective pipes shall not be more than the permissible number given in column 3 of Table 15 of IS:458 (Latest Edition).
- (b) All the pipes tested for various tests as per IS-458 shall satisfy corresponding requirements of the tests.
- (c) In case the number of pipes not satisfying requirements of any one or more tests, one or two further samples of same size shall be selected and tested for the test or tests in which failure has occurred. All these pipes shall satisfy the corresponding requirements of the test.

#### **D.11.12 MARKING**

The following information shall be clearly marked on each pipe :

- a) For AMC USE
- b) Internal diameter of pipe
- c) Class of pipe
- d) Date of manufacture, and
- e) Name of manufacturer or his registered trademark or both.

#### **D.11.13 LAYING OF PIPES**

The laying of RCC pipes shall conform to Technical Specifications: Section-D-6.

#### **D.11.14 JOINTING**

##### **GENERAL**

Jointing of RCC pipes shall be done with OPC cement only and as per the requirements of following specifications and as per the relevant IS. The type of joints shall be as below. After jointing, extraneous material, if any, shall be removed from the inside of the pipe and the newly made joints shall be thoroughly cured. In case, rubber-sealing rings are used for jointing, these shall conform to IS 5382 and shall be of such type as mentioned in IS-458:2003.

#### **D.11.15 FLUSH JOINT (INTERNAL)**

This joint shall be generally used for culvert pipes of 900-mm diameter and over. The ends of the pipes are specially shaped to form a self-centering joint with an internal jointing space 13-mm wide. The finished joint is flush with both inside and outside with the pipe wall. The jointing space is filled with cement mortar in the proportion as specified in IS-458-2003, mixed sufficiently dry to remain in position when forced with a trowel or rammed.

##### **FLUSH JOINT (EXTERNAL)**

This joint is suitable for pipes which are too small for jointing from inside. This joint is composed of specially shaped pipe ends. Each end shall be butted against each other and adjusted in correct position. The jointing space shall then be filled with cement mortar as specified in IS-458-2003, sufficiently dry and finished off flush. Great care shall be taken to ensure that the projecting ends are not damaged as no repairs can be readily affected from inside the pipe.

##### **SPIGOT AND SOCKET JOINT (FLEXIBLE)**

The RCC pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The RCC pipes shall be of spigot and socket type and rubber rings as specified in IS-458-2003, shall be used, and the manufacturers instructions shall be deemed to form a part of these specifications. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

Socket & Spigot NP3 & NP4 pipe with rubber ring roll on joint for diameter upto 900 mm should be provided as per table 14 pf IS 458 : 2003.

Socket & spigot NP3 & NP4 pipe with rubber ring confined joint for diameter 1000 mm to 2200 mm should be provided as per Table -17 of IS 458:2003.

#### **D.11.16 CLEANING OF PIPES**

As soon as a stretch of RCC pipes has been laid complete from Machinehole to Machinehole or for a stretch as directed by Owner/Engineer, contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of pipes. The open end of the incomplete stretch of pipeline shall be securely closed as may be directed by Owner/Engineer to prevent entry of mud or silt etc.

If as a result of the removal of any obstructions Owner/Engineer considers that damages may have been caused to the pipelines, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, contractor shall amend the work and carry out such further tests as are required by Owner/Engineer.

It shall also be ascertained by contractor that each stretch from Machinehole to Machinehole or the stretch as directed by Engineer is absolutely clear and without any obstruction by means of visual examination of the interior of the pipeline suitably enlightened by projected sunlight or otherwise.

#### **D.11.17 TESTING AT WORK SITE**

After laying and jointing of RCC pipes is completed the pipeline shall be tested at work site as per the following specifications and as directed by Owner/Engineer. All equipment for testing at work site shall be supplied and erected by contractor. Water for testing of pipes shall be arranged by him. Damage during testing shall be contractor's responsibility and shall be rectified by him to the full satisfaction of Owner/Engineer. Water used for test shall be removed from pipes and not released to the excavated trenches.

After the joints have thoroughly set and have been checked by Owner/Engineer and before backfilling the trenches, the entire section of the sewer or storm water drain shall be proved by contractor to be water tight by filling in pipes with water to the level of 1.50 m above the top of the highest pipe in the stretch and heading the water up for the period of one hour. The apparatus used for the purpose of testing shall be approved by Owner/Engineer. Contractor if required by Owner/Engineer shall dewater the excavated pit and keep it dry during the period of testing. The loss of water over a period of 30 minutes should be measured by adding water from a measuring vessel at regular 10 minutes intervals and noting the quantity required to maintain the original water level. For the approval of this test the average quantity added should not exceed 1 litre/hour/100 linear metres/10 mm of nominal internal diameter. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good.



In case of pressure pipeline the completed stretch of pipeline shall be tested for site test pressure as specified in IS-458-2003. The site test pressure should not be less than the maximum operating pressure plus the calculated surge pressure, but in no case should it exceed the hydrostatic test pressure as specified in IS:458 (Latest Edition).

#### **D.11.18 MEASUREMENT**

All RCC pipes shall be measured according to the work actually done and no allowance will be made for any waste in cutting to the exact length required. The measurement for pipes shall be in running meter nearest to a cm. of length along the centre line of pipe as actually laid at work sites.

The rate for providing, laying and jointing of RCC pipes shall be deemed to include the cost of rubber rings, jointing material, testing and extra excavation required for ordinary bedding of pipes and also for pipe sockets, if any.

#### **D.11.19 NOTES**

- If any damage is caused to the pipeline during the execution of work or while cleaning/testing the pipeline as specified. Contractor shall be held responsible for the same and shall replace the damaged pipeline and retest the same at his own cost to the full satisfaction of Engineer.
- Water for testing of pipeline shall be arranged by Contractor at his own cost.
- Pipes shall be brought on site proportionate to the required progress for Thirty days only.

## **D-12 : CONSTRUCTION OF MANHOLES, CHAMBERS AND VENT SHAFTS**

### **SECTION : D-12**

#### **D.12.1 SCOPE**

D.12.1.1 This specification covers the requirements for providing and constructing ancillary works such as manholes, scraper manholes, vent shaft etc.

#### **D.12.2 APPLICABLE CODES**

D.12.2.1 The following standards/codes, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. If requirements of this specification conflict with the requirements of the codes and standards, this specification shall govern.

##### **D.12.2.2 Code for Materials**

- |               |   |   |
|---------------|---|---|
| (a) IS : 210  | - | Specification for grey iron castings  |
| (b) IS : 269  | - | Specification for ordinary and low heat portland cement   |
| (c) IS : 383  | - | Specification for coarse and fine aggregates from natural sources for concrete                                  |
| (d) IS : 432  | - | Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement |
| (e) IS : 516  | - | Methods of tests for strength of concrete   |
| (f) IS : 651  | - | Specification for salt-glazed stoneware pipes and fittings  |
| (g) IS : 1077 | - | Specification for common burnt clay building bricks   |
| (h) IS : 1728 | - | Specification for cast iron manhole covers and frames   |
| (i) IS : 1786 | - | Specification for high strength deformed steel bars and wires for concrete reinforcement                        |
| (j) IS : 2116 | - | Specification for sand for masonry mortars  |
| (k) IS : 3495 | - | Methods of tests of burnt clay building bricks  |
| (l) IS : 5455 | - | Specification for cast iron steps for manholes  |

##### **D.12.2.3 Codes of practice**

- |               |   |   |
|---------------|---|---|
| (a) IS : 456  | - | Code of practice for plain and reinforced concrete                      |
| (b) IS : 2212 | - | Code of practice for brickwork  |
| (c) IS : 2250 | - | Code of practice for preparation and use of masonry mortars             |
| (d) IS : 4111 | - | Code of practice for ancillary structures in sewerage system – manholes |
| (e) IS : 4127 | - | Code of practice for laying of glazed stoneware pipes                   |

### **D.12.3 MANHOLES**

#### **D.12.3.1 Location**

Manholes shall be constructed at places as shown on relevant drawings (the detailed drawings will be furnished during execution of the work) and as directed by the Engineer-in-charge.

#### **D.12.3.2 Excavation**

Excavation, shoring, dewatering etc. for the pits of manholes shall be done in accordance with specification given in Section D-1, D-2 and D-3 for excavation, shoring and dewatering and specification given in Section D-11 for laying of pipes and fittings/specials. The rate quoted for manhole shall be inclusive of excavation and backfilling, bailing out water and shoring.

#### **D.12.3.3 Bed Concrete**

The bed concrete for manholes shall be done in accordance with specification given in Section D-6 for concrete work. The concrete grade is 1:4:8.

##### **D.12.3.3.1 Top slab concrete**

Precast reinforced concrete slab shall be casted on top of manhole.

#### **D.12.3.4 Bricks**

D.12.3.4.1 Bricks used for construction of manholes shall conform to the relevant Indian Standards. They shall be sound, hard, homogeneous in texture, well burnt in kiln without being vitrified, table moulded, deep red, cherry or copper coloured, of regular shape and size and shall have sharp and square and parallel faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing unground particles and/or which absorb water more than  $1/6^{\text{th}}$  of their weight when soaked in water for twenty-four hours shall be rejected. Overburnt or underburnt bricks shall be liable to rejection. The bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 35 Kg/sq.cm. unless otherwise noted in drawings. The class and quality requirements of bricks shall be as laid down in IS : 1077.

D.12.3.4.2 The size of the brick shall be 23.0 x 11.5 x 7.5 or unless otherwise specified; but tolerance upto (+) 3 mm. in each direction shall be permitted. Only full size brick shall be used for masonry work. Brick bats shall be used only with the permission of the Engineer-in-charge to make up required wall length or for bonding. Sample bricks shall be submitted to the Engineer-in-charge for approval and bricks supplied shall conform to approved samples. If demanded by the Engineer-in-charge, brick sample shall be got tested as per IS : 3495 by Contractor at no extra cost to the client. The bricks rejected by the Engineer shall be removed from the site of works within 24 hours.

### **D.12.3.5 Cement Mortar**

D.12.3.5.1 Mortar for brick masonry shall be prepared as per IS : 2250. Manholes shall be constructed in brick masonry with cement mortar (1:4), 20 mm thick inside plaster with plasticized water proofing material consisting of 12 mm thick backing coat in CM 1:3 and 8 mm thick finishing coat in CM 1:1 and 15 mm thick outside plaster in CM 1:3, unless otherwise specified in items. Gauge boxes for sand shall be of such dimensions that one bag containing 50 Kg. of cement forms one unit. The sand shall be free from clay, shale, loan, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be as approved by Engineer-in-charge. If so directed by the Engineer-in-charge sand shall be thoroughly washed, till it is free of any contamination.

D.12.3.5.2 For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry conditions. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be rejected.

D.12.3.5.3 Contractor shall arrange for test on mortar samples if so directed by the Engineer-in-charge. Retempering of mortar shall not be permitted.

### **D.12.3.6 Brick Masonry**

D.12.3.6.1 All bricks shall be thoroughly soaked in clean water for atleast one hour immediately before being laid. The cement mortar for brick masonry work of manholes shall be in the proportion specified in 3.5.1. Brick work 230 mm. thick and over shall be laid in English Bond unless otherwise specified. 115 mm thick brick work 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 pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.

D.12.3.6.2 All brickwork shall be plumb and square unless otherwise shown on drawing 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. For walls of thickness greater than 230 mm both faces shall be kept in vertical planes unless otherwise specified. 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 degrees. But in no case the level difference between adjoining walls shall exceed 1.25 m. Workmanship shall conform to IS : 2212.

D.12.3.6.3 Brick shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 12 mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plastering to be done. When plastering 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. If mortar in the lower courses has begun to set, the joints shall be raked out to a depth of 12 mm before another course is laid. No extra payment will be made for raking joints.

#### **D.12.3.7 Cement Plaster**

D.12.3.7.1 All joints in masonry shall be raked to a depth of 12 mm. with a hooked tool made for the purpose when the mortar is still green and in any case within 46 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material, grease etc. and thoroughly wetted for 6 hours before plastering work is commenced. Concrete surfaces to be rendered will however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall.

D.12.3.7.2 The proportion of the cement mortar shall be as specified on relevant drawings. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per relevant I.S. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to remain for more than 25 minutes after mixing with water.

D.12.3.7.3 Curing of plaster shall be started as soon as the applied plaster has hardened enough so as not to be damaged. The decision as to when the plaster has hardened, will be given by the Engineer-in-charge. Curing shall be done by continuously applying water in fine spray and shall be carried out for at least 7 days.

D.12.3.7.4 Plastering shall be done on both faces of brick masonry, 20 mm thick inside and 15 mm thick outside.

#### **D.12.3.8 Cement concrete channel**

D.12.3.8.1 The channel for the manhole shall be constructed in cement concrete of M15 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer. They shall be benched up in concrete and rendered in cement mortar (1:1) of 20 mm thickness and formed to a slope of 1 in 12 towards the channel.

#### **D.12.3.9 Pipe entering or leaving manhole**

D.12.3.9.1 Whenever a pipe enters or leaves a manhole, bricks on edge must be cut to a proper form and laid around the upper end of the pipe so as to form an arch. All around the pipes, there shall be a joint of cement mortar (1:2) 13 mm thick between it and the bricks.

#### **D.12.3.10 Plastic moulded reinforced steps**

D.12.3.10.1 Plastic moulded reinforced steps shall be as per IS 5455. The steps shall be of 8 mm TOR steel bar conforming to IS 1786 and Fe 415 grade with plastic polypropylene (P.P.) material (vergin).

Casting shall be of polypropylene conforming to an ASIM D 4101. The moulding shall be injection moulded.

#### **D.12.3.11 Frame and covers**

D.12.3.11.1 Frame and covers for manholes shall be of required type and dimensions as per the relevant drawings and as specified in Data Sheet – III. Following information shall be clearly marked on each cover.

- (a) Year of manufacture
- (b) Identification mark of the purchaser
- (c) SEWER / SWD
- (d) Arrow showing direction of flow
- (e) Name of manufacturer / Trade mark

#### **D.12.3.11.2 Cast iron frame and cover**

The cast iron frame and cover shall be of grey cast iron as per IS : 1728. The general requirements for casting and coating of CI frame and cover shall be as specified for CI steps in Clause D.12.3.10.1. The covers shall have a raised chequered design to provide an adequate non-slip grip. The rise of the chequer shall be not less than 4 mm. The locking device for cover shall be not less than 4 mm. The locking device for cover shall be provided as directed by the Engineer-in-charge. The CI covers for load test shall be selected at one for every lot of fifty or part thereof for each type and size manufactured and as directed by the Engineer-in-charge. The frame shall be fixed in cement concrete of M15 grade all round and finished with neat cement. The manhole frame shall have 580 mm diameter clear opening and shall weigh not less than 100 Kg. including cover. In case of rectangular CI frame and cover of 900 mm x 600 mm clear opening, the total weight shall not be less than 275 Kg.

#### **D.12.3.11.2 Fibre Reinforced Concrete Frame and Cover**

Fibre reinforced concrete frame and cover shall be as per item description load. The frame shall be fixed in cement concrete of M20 grade all around and finished with neat cement. The fibres shall constitute 1% of the weight of the concrete in the form of 50 mm to 100 mm long high tensile steel wires. For the cover, MS sheet lapping of 16 gauge shall be provided to avoid damage to the edges. Similarly for frame, MS angle / flat shall be provided along the edge. Both MS sheet and angle shall be painted with black bituminous paint. The cover should have suitable lifting arrangement. The fibre reinforced frame and cover shall be manufactured as per the drawing approved by the Engineer-in-charge.

#### **D.12.3.11.3 Reinforced Cement Concrete Frame and Cover**

Reinforced cement concrete frame and cover for manholes shall be of required dimensions and shape as shown on drawing and as specified in Data Sheet – III. The frame and cover shall be cast in cement concrete of M20 grade. Minimum cover to the reinforcement shall be 40 mm. The edges of frame and covers shall be provided with mild steel angles to avoid damages to the corners. These angles shall be painted with black bituminous paint. The covers should have suitable lifting arrangement.

#### **D.12.3.12 Drop Manhole**

D.12.3.12.1 When a sewer connects a main sewer, and where the difference in level between water line (peak flow levels) of main line and the invert level of branch line is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection within 600 mm, a drop connection shall be provided for which a manhole shall be constructed as per relevant drawing, incorporating a vertical drop pipe from the higher sewer to the lower one. This pipe shall be provided outside the shaft and encased in concrete. A continuation of the branch sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange. The diameter of the back drop should be at least as large as that of the incoming pipe. The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degrees or less to the direction of the flow in the main sewer. The pipe unless of cast iron should be surrounded with 150 mm thick concrete.

D.12.3.12.2 In the case of sewers over 450 mm in diameter the drop in level may be accomplished by one of the following methods as shown on relevant drawings

- (a) A cascade
- (b) A ramp
- (c) By drops in previous manholes

### **D.12.3.13 RCC Manhole**

- D.12.3.13.1 In general, plain and reinforced concrete work for manholes shall be carried out in accordance with the specification shown in Section D-6 unless otherwise specified in this specification. The top slab of manhole shall be cast with shutters lined with plywood and shall be smooth finished. For avoiding surface cracks due to variation in atmosphere temperature and exposure to direct sunlight, RCC slab of manholes after casting shall be kept wet. M25 grade of concrete used for construction of RCC manhole shall have minimum cement content of 330 Kg/cum of concrete. Reinforcement used for construction of manhole shall be per TMT – CRS as per relevant Specification given in tender document. Minimum cover to the reinforcement shall be 40 mm.

### **D.12.4 VENT SHAFTS**

#### **D.12.4.1 General**

- D.12.4.1.1 Vent shafts shall be erected at such places as shown on relevant drawings (the detailed drawings will be furnished during execution of the work) and as directed by the Engineer-in-charge.

#### **D.12.4.2 Mild steel vent shaft**

- D.12.4.2.1 Mild steel vent shaft shall be of 150 mm diameter and 12.17 m. height from ground level with C. I. Ornamental cap. This shall be fixed firmly and encased in cement concrete of M15 grade as shown on relevant drawing with necessary mild steel bolts, plates etc. for foundation. The vent shaft shall be painted with one coat of silver paint over one coat of red lead oxide paint. The vent shaft shall be connected to manhole by 150 mm diameter glazed stoneware pipe encased by M10 concrete of 150 mm thickness all around as per drawing and as directed by Engineer-in-charge.

#### **D.12.4.3 RCC vent shaft**

- D.12.4.3.1 Reinforced cement concrete vent shaft shall be of M20 grade concrete, 200 mm diameter at bottom and tapered to 100 mm diameter at top (both inside clear openings) and 6 m height from ground level. The vent shaft shall be embedded in concrete of M10 grade and anchored by 2 Nos. of 16 mm diameter and 600 mm long MS bars as per the relevant drawing. The vent shaft shall be connected to manhole as specified in clause D.12.4.2 of this specification through a brick masonry flue chamber as per relevant drawing.

#### **D.12.4.4 Jointing Stoneware Pipes**

- D.12.4.4.1 The salt glazed stoneware pipes and fittings shall conform to IS : 651. The spigot and socket joints of stoneware pipes shall be of rigid type and shall be caulked with tarred gasket (prepared ready for use before being brought on the work) in one length for each joint and sufficiently long to entirely surround the spigot end of the pipe. The gasket should be driven upto one fourth depth of socket by means of caulking tools. After the pipes are thoroughly cleaned and



moistened, mixture of one part of cement and one part of clean fine sand tempered with just sufficient water to have a consistency of semi-dry condition should be forced into the joint and well rammed with caulking tools, so that the whole space around the spigot and socket is completely filled with lightly caulked mortar and the joints shall be finished off with a splayed fillet sloping at 45 degrees to the side of the pipe. The joint shall be thoroughly cured. The laying, jointing and testing of stoneware pipes and fittings shall be as per IS : 4127.

#### **D.12.4.5 Measurement**

##### **D.12.4.5.1 Manholes**

D.12.4.5.1.1 The depth of manhole shall be measure from the top of cover to the invert level of the deepest outgoing sewer from the manhole. The rate quoted in schedule of quantities and rates for brick masonry manhole shall include all items such as brick masonry, plastering on both sides, bed concrete and concrete in channel, concrete coping at top, fibre reinforced concrete or RCC cover , C.I. steps etc. inclusive of excavation and backfilling, bailing and pumping out water and shoring. The measurement shall be per number basis and as per the actual depth of manhole constructed. In case of drop manholes / RCC manholes the mode of measurements for individual items of work shall be as per schedule of quantities and rates.

##### **D.12.4.5.1 Vent shafts**

D.12.4.5.2.1 The rate quoted in Schedule of Quantities and Rates for mild steel vent shaft shall deem to include the cost of vent shaft with C. I. Ornamental cap and / or base including M. S. bolts and plates, necessary excavation, dewatering, backfilling, foundation, stoneware pipe connection to manhole inclusive of concrete encasement, painting, erecting etc. complete. The measurement for vent shaft shall be per number basis. The measurement for vent shaft shall be per number basis.

##### **D.12.4.5.2 Notes**

D.12.4.5.2.1 If any damage is caused to the other services such as water supply pipeline, sewer, cable etc. during the construction of manholes and erection of vent shafts, Contractor shall be held responsible for the same and shall replace the damaged services at his own cost to the full satisfaction of the Engineer-in-charge.

D.12.4.5.2.2 The interior of manholes shall be cleared of all debris after construction and before testing the same for water tightness by Contractor at his own cost.

D.12.4.5.2.3 Water for testing of manholes along with pipeline shall be arranged by Contractor at his own cost.

## **D-13 : SPECIFIC TECHNICAL REQUIREMENTS FOR CONSTRUCTION OF SEWAGE PUMPING STATIONS AND ALLIED WORKS**

### **SECTION : D-13**

#### **D.13.1 SCOPE**

- D.13.1.1 This section specified the specific technical requirements for construction of sewage pumping station and allied works. This section and other specifications of Section – D are mutually dependent and essential for correct interpretation of the contract. In case of conflict in any of these specifications, the requirements of this section shall govern.

#### **D.13.2 EXCAVATION**

- D.13.2.1 Before excavation, the setting out of sewage pumping station and alignment of pipelines at site shall be approved by Client / Engineer. The excavation shall be carried out in accordance with the specification given in Section – D1. All excavation works for construction of sewage pumping station may be carried out manually unless, in the opinion of engineer, the work involved and time schedule required use of mechanical equipment.
- D.13.2.2 All precaution shall be taken during excavation and construction to guard against possible damage to any existing structure / pipelines etc. also utmost care shall be taken to prevent wide collapses during excavation. No payment for removal of any collapsed earth shall be made.
- D.13.2.3 Contractor shall provide suitable barricade, fencing on all sides of excavation for its full length / perimeter. Also necessary construction signs, red lanterns and guards as required shall be provided and maintained during the progress of construction and pipe laying work.
- D.13.2.4 Stable side slopes to excavation shall be provided wherever permitted by Engineer. The side slopes for excavation towards the building side having independent foundations shall be as steep as possible so as to avoid keep column footings. The side slopes shall be as directed by Engineer. Engineer's approval for side slopes during excavation shall not relieve Contractor from his responsibility for any damage or subsidence. Where side slopes are not feasible and / or not permitted by Engineer, Contractor shall provide suitable shoring and strutting for excavation. Contractor shall suitably design polling boards, walings and struts to meet the different soil conditions that might be encountered in excavating trenches or pits. The horizontal and vertical spacing of struts shall be prevented from collapse but also ease of laying of pipes / construction of structure in trenches / pits shall be ensured without creating undue obstructions for the execution of the work. Any inconvenience and / or delay that might be caused in laying of pipe / construction in trenches / pits as a result of adopting improper spacing of struts by Contractor shall be his sole responsibility.

- D.13.2.5 If during excavation, any soft or loose soil is met with under the substructure, it shall be immediately informed to Engineer and remedial measures taken as directed by Engineer.
- D.13.2.6 The material from excavation shall be deposited at such places as directed by Engineer leaving adequate clear distance from the edge of the trench / pit as may be necessary to prevent the sides of the trench / pit from slipping or collapsing. The basic lead for disposal of excavated material shall be 30 m for pipeline work and 50 m for construction of SPS work as against 100 m mentioned in Section – D1, Earthwork in Grading, Excavation and Backfilling.
- D.13.2.7 Service lines met with during excavation shall be properly maintained by Contractor by means of shoring, strutting, planking over, padding or otherwise as Client / Engineer may direct and shall be protected by Contractor from damage during the progress of the work and if damaged, such damage shall be made good either by Contractor or by other agency, as Client / Engineer may decide and wholly, in either case, at the expenses of Contractor. Supports for pipes above 150 mm diameter and to high tension cables shall be paid separately only if special measures have been taken to support the above services by Contractor and deemed fit by the Engineer.
- D.13.2.8 Utmost care shall be taken to see that width of trench at the top of pipe is not more than that specified in Data Sheet A of Section – D. In case additional width is required it shall be provided only in the top portion from the ground level upto 300 mm above the top of pipe. If any extra width is excavated in the area below this portion Contractor shall have to provide remedial measures as directed by Engineer. Contractor shall not be paid for extra excavation as well as for any remedial measures.
- D.13.2.9 In case of excavation of existing roads, the road metal and also the rubble packing shall first be stripped off for the whole width of the trench pit and separately deposited in such place or places as may be determined by Engineer. In case of the metal packing or khandakies not being so deposited or being mixed up with excavated material and not being available for making good the road surface, the cost of the new metal packing or khandakies as required shall be charged to the Contractor. Excavation in asphalt / concrete road or pavement of any thickness shall be considered as separate item for payment as provided for Schedule of Quantities and Rates. Such work shall neither be part of excavation in hard rock or soft rock as mentioned in Section – D1, Item 7.1 (b) and 7.1 (c) respectively.
- D.13.2.10 The excess excavated material shall be carried away from sites of works to a place up to distance specified in Schedule of Quantities as directed by Client / Engineer so as not to cause any inconvenience to other agencies, failing which, Client / Engineer shall carry out the work by any other agency at Contractor's risk and cost. If the instructions from Engineer are not followed within seven days from the date of instructions, to cart the materials and to clear the site, the same shall be carried out by Client / Engineer at the risk and cost of Contractor and no claim or dispute shall be entertained in this respect.

- D.13.2.11 Excavation with side slopes and suitable berms as approved by Engineer shall be measured and paid.

### **D.13.3 DEWATERING**

- D.13.3.1 Contractor should take into account the subsoil and ground water conditions, which may be encountered, particularly the running sand conditions at work site and shall adequately allow for shoring / strutting and dewatering by pumping.
- D.13.3.2 Drainage channels and sumps shall be provided in the pit to drain all surface and ground water by pumping. Contractor shall dewater and maintain excavated pits dry at all times by use of dewatering sump pumps including ancillary equipment for the construction of substructure SPS during actual excavation; laying PCC and RCC, inspection, testing and backfilling etc. or as directed by Engineer at the site where inflow of ground water in the opinion of Engineer Obstructs the progress of work, leads to in sanitary conditions by stagnation, retards the speed of construction, is detrimental to the safety of workers, materials, structure, equipment and such other causes. The ground water level shall be lowered well below the founding level to provide dry firm working conditions and to prevent sand boiling or bottom heave with consequent loss of bearing capacity. Heavy pumping in excavation which may result in removal of fine material from soil shall be avoided. Contractor shall ensure that there is no damage to existing adjoining structures due to dewatering operations. Contractor shall also make necessary arrangements for the disposal of drained water to nearby storm water drain or nullah if allowed by Engineer or upto a lead of 100 m from excavated trench / pit as directed by Engineer. In no case removal of water shall be allowed to spread over the adjoining area.
- D.13.3.3 Contractor shall exercise his own judgement regarding the extent of pumping required and approximate size of dewatering pumps as other facilities required to keep the excavation dry. Contractor shall submit his scheme and also indicate sequence of operation, limits of excavation and the capacity and other details of the equipment and accessories he intends to use for dewatering during the construction and the number, capacity and location of pumps etc. The Contractors shall bring to site only such equipment and accessories, which are approved by Engineer in writing. The contractor shall provide adequate standby arrangement for pumping incase of electric power failure / mechanical failure.
- D.13.3.4 No separate payment whatsoever shall be made for dewatering if required to be done during excavation, laying PCC and construction of RC substructure upto the plinth level, laying and jointing of pipes, construction of manholes, inspection, testing and backfilling etc. and Contractor should quote accordingly.

### **D.13.4 BACKFILLING**

- D.13.4.1 Backfilling all around the substructure of SPS shall be done in equal successive layers by watering, ramming and consolidating in layers of 15 cm after obtaining permission from Engineer to backfill. Trenches shall be back filled with approved selected excavated material only after successful testing of the pipeline. The tamping around the pipe shall be done by hand or other hand operated mechanical

means. The water content of the soil shall be as near the optimum moisture content as possible. Filling of the trench shall be carried out simultaneously on both sides of pipe in such a manner that unequal pressure does not occur. Backfilling shall be done in layers not exceeding 30 cm. Each layer shall be consolidated by watering, ramming, care being taken to avoid damage to pipeline.

#### **D.13.5 PLAIN AND REINFORCED CONCRETE**

- D.13.5.1 In general, plain and reinforced concrete work for construction of sewage pumping station shall be carried out in accordance with the specification mentioned in Section – D6 unless otherwise specified in this specification.
- D.13.5.2 Mix design and testing, shall be as per clause No. D.6.7.2.1 of Specification mentioned in Section – D6, is applicable only to reinforced concrete. For concrete used in manholes, encasing of pipes, supports, blinding layer in foundation etc. such tests may be called for at the discretion of Engineer.
- D.13.5.3 The size of aggregates for concreting of raft shall be 40 mm downgraded and for other concreting items this shall be 20 mm downgraded.
- D.13.5.4 The inside and outside faces of walls of substructure shall be cast with shutters lined with plywood and shall be smoother finished as per clause D.6.8 of above mentioned specification.
- D.13.5.5 The exposed faces of other RCC members shall be cast with shutters lined with plywood and shall have smooth finish and with rough board finish at other locations.
- D.13.5.6 Through bolts or ties for formwork shall not be allowed and the formwork shall be suitably supported by studs, walers, braces, ties, straps, shores etc. to hold the forms in proper position without any distortion whatsoever, until the concrete has set sufficiently to permit removal of forms. The lift for vertical walls shall be about 2 m unless otherwise shown on drawing.
- D.13.5.7 Casting of panels for raft and vertical walls shall be done as per the sequence shown on relevant drawings.
- D.13.5.8 The interval between successive vertical concrete pours in any wall panel shall be minimum 3 days. Casting of adjacent floor / wall panels shall be done after an interval of 7 days. While casting the raft utmost care shall be taken by Contractor to see that the dowels for pump foundations are placed at exact location as shown on the drawing. Also vertical walls shall be cast only after all the pipes / plate inserts are placed at proper location as shown on drawing and as approved by Engineer.
- D.13.5.9 M25 grade of concrete used for construction of substructure of sewage pumping station inclusive of screen chamber and inlet chamber below plinth level shall have minimum cement content of 365 kg/cu.m. of concrete. Incase as per mix design the cement required is more than 365 kg/cu.m of concrete, Contractor shall have to provide the same at his cost. For construction of superstructure M20 grade of concrete shall be used as per the mix design.

- D.13.5.10 To avoid surface cracks due to variation in atmospheric temperature and exposure to direct sunlight, exposed faces of substructure shall be kept wet by frequent spray of water or by saturated coverings till testing and backfilling is carried out. Contractor should take this aspect into consideration and quote accordingly. No extra claim on this account shall be entertained.
- D.13.5.11 Ends of panels cast first shall be provided with grooved keys and synthetic grade rubber water stops (Caper stops or equivalent water stop), as shown on detailed construction drawings. Contractor shall ensure thorough vibration of concrete around the water stops. 225 mm wide water stops shall be provided in raft and 150 mm wide water stops in walls.
- D.13.5.12 All inserts required to be provided by Contractor shall be fixed by him during casting of structural members. Details and locations of such inserts shall be as per the relevant drawing.
- D.13.5.13 The pockets required for fixing sluice gates, trash screens, pumps, motors etc. shall be provided as per detailed drawing.
- D.13.5.14 Bar bending schedule for reinforcement shall be prepared by Contractor and got approved from Engineer-in-charge before proceeding with the work.
- D.13.5.15 An unaccountable wastage for issued steel reinforcement upto 2% will be allowed for reconciliation.

#### **D.13.6 TESTING OF SUBSTRUCTURE FOR WATERTIGHTNESS**

- D.13.6.1 After constructing the substructure upto plinth level and before backfilling is done all around the substructure, Contractor shall test the wet well and inlet chamber as described below for watertightness. The leakage, if any, shall be observed from outside and shall be rectified by pressure grouting at no extra cost to Client / Engineer. After successful testing rectification of any leakages observed during above test, backfilling shall be done around the wet wells and dry wells. Leakage, if any, shall be observed from inside the dry well and rectified as mentioned above.
- D.13.6.2 The wet well shall be separately tested for water tightness by filling it with water upto formation level after temporarily closing the CI puddle pipes provided for suction. Seven days after the filling, the level of water shall be recorded again at subsequent intervals of 24 hours over a period of next seven days. The total drop in surface level over the second period of seven days shall be taken as an indication of the water tightness of the wet well. The wet well shall be deemed to be watertight if the total drop in the surface level over the second period of seven days does not exceed 40 mm. If the wet well does not satisfy this condition and the daily drop in water level shows decreasing trend, the period of test may be extended for further seven days and if specified limits are then reached, the structure may be considered as satisfactory. Otherwise Contractor has to take necessary measures to make the wet well watertight to the satisfaction of Engineer and at no extra cost to Client / Engineer.

### **D.13.7 GROUTING FOR SUCTION PIPES**

D.13.7.1 Opening of required dimensions shall be provided by contractor at the exact locations shown on relevant drawing during the casting of wall between wet well and dry well. The CI pipes and fittings for suction and delivery shall be supplied and erected by mechanical contractor. After the approval of water tightness test for wet well and after the installation of above CI pipes and fittings by mechanical contractor, the contractor shall grout the annular space between the openings and CI suction pipe as per the detailed specifications for special grout given Section – D. The contractor shall ensure perfect water tightness of this annular grout and in case any leakage is observed he has to rectify it at his own cost to the complete satisfaction of Engineer.

### **D.13.8 SUPPORT FOR H.O.T. CRANE**

D.13.8.1 The beams for supporting H.O.T crane shall be constructed in perfect line and M.S. plate inserts and bolts shall be embedded at locations as shown on drawing for fixing rails.

### **D.13.9 INLET CHAMBER**

D.13.9.1 The inlet chamber of sewage pumping station includes sluice gate and screen chamber shall include manually operated fixed screen. Sluice gate and the fixed screens shall be supplied and erected by contractor as per specifications. Necessary pockets / plate inserts etc. shall be provided at required locations by contractor as per the detail drawing and as directed by Engineer.

### **D.13.10 BUILDING WORK**

#### **D.13.10.1 Ventilation Duct**

D.13.10.1.1 Ventilation duct is to be provided for dry well with the RCC jali above the plinth level. The RCC jali shall be as shown on drawing and approved by Engineer.

#### **D.13.10.2 MCC Room**

D.13.10.2.1 PVD (Vinyl) asbestos floor tiles in MCC room shall be laid only after all the equipments are erected in these rooms.

### **D.13.11 CIVIL STRUCTURE – GENERAL**

D.13.11.1 Contractor shall co-operate with other agencies working in or near the sewage pumping station. Any damage caused by Contractor to the structure, sanitary fixtures, electrical and mechanical equipment etc. shall be made good and resorted to its original condition / or replaced at no extra cost to Client / Engineer. Final coat of painting shall be done after all the mechanical and electrical equipments are tested and commissioned.

D.13.11.2 Contractor shall rectify all defects in civil works during the defects liability period.

### **D.13.12 R.C.C. PIPES**

- D.13.12.1 RCC pipes and collars shall strictly conform to I.S. 458. The internal diameter, type, class and three edge bearing strength of pipes shall be as per Section –I .
- D.13.12.2 The pipes shall be laid perfectly true both in alignment and gradient on specified bedding as shown on relevant drawing. The type of joint and the cement mortar proportions for jointing of pipes shall be as per Section I.
- D.13.12.3 RCC pipes after jointing inclusive of manholes shall be tested for water tightness in suitable stretches before backfilling excavated earth, as per Clause No. D.13.7.1 and D.13.7.2 of specification given in Section – D13 for Reinforced Cement Concrete Pipes.

### **D.13.13 MANHOLES**

- D.13.13.1 Manhole frame and cover shall be of heavy-duty fibre reinforced concrete type with 560 mm clear opening and shall weigh total 180 Kg.
- D.13.13.2 The measurement for brick masonry manholes shall be as per Clause No. D.7.5.1 of specification given in Section D-7 inclusive of cost of RCC slab with necessary formwork but exclusive of requirement.

### **D.13.14 CAST IRON PIPES AND FITTINGS**

- D.13.14.1 The cast iron pipes of LA class shall conform to the 1536 and fittings as per IS 1538 and laying shall be as per IS 3114.
- D.13.14.2 The test procedures, the scale of sampling and the criteria for acceptance of rubber rings shall be as per IS : 5382 and IS : 3400.
- D.13.14.3 The spigot socket joints shall be with lead joints. The lead jointing is done by first caulking in spun yarn and then filling the remainder of the joint space by running in molten lead, taking care that no dross enters the joint, and then thoroughly caulking the lead. The spun yarn shall be used to centre the spigot in the socket and to prevent the flow of molten lead into the bore of the pipe. The spun yarn shall be effectively disinfected before use.
- D.13.14.4 After laying and jointing of CI pipes and fittings the pipelines shall be tested at work site in suitable stretches before backfilling excavated earth, as per clause No. D.1.6 of specification given in Section – D1.
- D.13.14.5 The measurement for CI pipes and fittings shall be as per clause No. D.1.7 of above specification.



### **D.13.15 CLEANING OF PIPES AND FITTINGS**

- D.13.15.1 Contractors shall ascertain that each stretch of pipeline is absolutely clear and without any obstructions by means of visual examination of the interior of pipeline suitably lighted by projected sunlight or otherwise. The open end of an incomplete stretch of pipelines shall be securely closed as may be directed by Client / Engineer to prevent entry of mud or silt etc.
- D.13.15.2 If as a result of the removal of any obstructions Client / Engineer considers that damages may have been caused to the pipeline, he shall be entitled to order the stretches to be tested immediately. Should such test prove unsatisfactory, Contractor shall amend the work and carry out such further tests as are required by Client / Engineer.

### **D.13.16 PIPE LAYING WORK – GENERAL**

- D.13.16.1 Contractor should protect the completed work of pipeline from any damage and prevent the backfilled earth entering into the pipe at his own cost. After laying and jointing of pipeline Contractor should clear the entire pipelines inclusive of manholes / chambers of all debris before testing and commissioning.

### **D.13.17 REMOVAL OF PLASTER FROM EXISTING WALLS INCLUDING DISPOSAL OF UNSERVICEABLE MATERIALS ETC, COMPLETE WITH ALL LEAD AND LIFT**

- D.13.17.1 The existing cement plaster on brick / stone masonry walls shall be removed completely without damaging the existing masonry walls or ceiling. The plaster will be removed to a sufficient depth upto face of existing masonry or ceiling. The masonry wall or ceiling shall be cleaned of all old plaster. The new plaster as specified shall be applied only after the approval of the Engineer.
- D.13.17.2 The payment shall be made on sq. m of the existing plaster removed.

### **D.13.18 REPLACEMENT OF EXISTING WINDOW SHUTTERS BY PROVIDING AND FIXING 35 MM THICK TEAK WOOD FULLY GLAZED SHUTTERS FOR WINDOWS INCLUDING BLACK ENAMELED IRON OXIDIZED FIXTURES AND FASTENINGS INCLUDING PRIMER COAT OF APPROVED QUALITY AND TWO COATS OF OIL PAINT ETC. COMPLETE AS DIRECTED**

Fully glazed type shutters with 5 mm thick sheet  
Glasses

(1.1 m x 0.85 m) – 2 Nos.

(0.96 m x 1.2 m) – 2 Nos.

#### **(a) Replacement of existing window shutters :**

The existing window shutters shall be carefully taken out and will be stacked as directed. The taking out of existing shutters will be carried out in such a manner that the existing frames will not be teared off and the existing masonry will not be damaged.

**(b) Materials :**

**(i) Teak wood :**

The teak wood for shutters shall be of good quality as required for the item to be executed. Good Indian Teak Wood as approved shall be used. The teak wood shall generally be free from large, loose, dead or cluster knots flaws, shakes, warps, twists, bends or any other defect. It shall generally be uniform in substance and of straight fibres as far as possible. It shall be free from rot, decay harmful fungi and other defects of harmful nature which shall affect the strength, durability of its usefulness for the purpose for which it is required. The colour shall be uniform as far as possible. Any effort like painting, using any adhesive or resin materials made to hide the defects shall render the pieces liable to rejection by the Engineer in charge. All scantalings, planks etc. shall be sawn in straight lines and planes in the direction of grains and of uniform thickness. The tolerances in the dimension shall be allowed at the rate of 1.5 mm per face to be planed.

**(ii) Glass :**

All glass shall be of the best quality free from specks, bubbles, smokes, veins, air holes, blisters and other defects. The glass shall be sheet glass 5 mm thick. Thickness of glass panes shall be uniform. For panes larger than 600 mm x 600 mm and upto 800 mm x 800 mm, the glass weighing not less than 8.75 Kg./sq.m. shall be used, for bigger panes upto 900 mm x 900 mm glass weighing not less than 11.25 Kg/sq.m. shall be used. Sheet glass shall be patent flattened glass of best quality and for glazing and framing purposes shall conform to I. S. 1761. Sheet glass of specified colours shall be used if so required by Engineer in charge.

**(iii) Fixtures and Fastenings**

The fixtures and fastenings i.e. butt hinges, tee and strap hinges, tower bolts handles casement window fasteners shall be of black enameled oxidised iron. The item of iron mongery with moving parts shall be properly oiled by the contractor.

**(iv) Painting :**

**(a) Applying priming coat over new wood and based surfaces after and including preparing the surface by thoroughly cleaning of dirt grease, dust and other foreign matter, sand papering and knotting: Ready mixed paint, brushing wood primer pink.**

**1.0 Materials :**

1.1 The ready mixed paint, brushing, wood primer pink shall conform to I. S. 3536-1966.

## **2.0 Workmanship :**

- 2.1.1 All wood work shall be dry and free from any foreign matter incidental to building operations. Nails shall be punched well below the surface to provide a firm key for stopping. Mouldings shall be carefully smoothened with abrasive paper and projecting fibres shall be removed. Flat portion shall be smoothened off with abrasive paper used across the grain prior to painting and with the grain prior to staining or if the wood is to be left in its natural colour, wood work which is to be stained may be smoothened to scraping instead of by glass papering if so required.
- 2.1.2 Any knots, resinous or streaks or blueish sap wood that are not large enough to justify cutting out shall be treated with two coats of pure shellac knotting applied thinly and extended about 25 mm. beyond the actual area requiring treatment.

## **2.2 Application of primer :**

- 2.2.1 After the preparation of the surface, the priming coat shall be applied immediately. The brushing operations are to be adjusted to the spreading capacity advised by the manufacturer of the primer. The paint shall be applied evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area over with paint, brushing alternatively in opposite directions, two or three turns and then finally brushing lightly in the directions at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying will constitute one coat.
- 2.2.2 During painting, every time after the priming coat has been worked out of the brush bristles or the brush has been unloaded of the bristles of the brush angles to the surface, so that bristles thereafter will collect the correct amount of paint when dipped again into a paint container. The primary coat shall be allowed to dry completely before painting is started.
- 2.2.3 No hair marks from the brush or clogging at paint puddles in the corner or panels angles of mouldings etc. shall be left on the work.
- 2.2.4 Special care shall be taken while painting over bolts, nuts, rivets overlaps etc.
- 2.2.5 The container when not in use shall be kept close and free from air so that paint does not thicken and also shall be kept guarded from dust.

- (b) Painting two coats (excluding priming coat) on new wood and wood based surfaces with of ready mixed paint brushing, oil gloss, semi-gloss, to give an even shade including cleaning all dust, dirt and other foreign matter sand papering and stopping.**

**1.0 Materials :**

The ready mixed paint shall conform as follows

**1.1 Oil paints :**

Oil paints shall be of the specified colour and shade, and as approved. The ready mixed paints shall only be used. However, if ready mixed paint or specific shade or tint is not available, white ready mixed paint with approved stainer will be allowed. In such a case, the contractor shall ensure that the shade of the paint so allowed shall be uniform.

All the paints shall meet with following general requirements :

1. Paint shall not show excessive setting in a freshly opened full can and shall easily be redispersed with a paddle to a smooth homogeneous state. The paint shall show no curdling, livering, caking or colour separation and shall be free from lumps and skins.
2. The paint as received shall brush easily, possess good leveling properties and show no running or sagging tendencies.
3. The paint shall not skin within 48 hours in a three quarters filled closed container.
4. The paint shall dry to a smooth uniform finish free from roughness, grit, unevenness and other imperfections.

Ready mixed paint shall be used exactly as received from the manufacturers and generally according to their instructions and without any admixtures whatsoever.

The ready mixed paint brushing gloss, semi gloss shall conform to I.S. 129-1962 and I.S. 117-1964.

**2.0 Workmanship :**

**2.1 General**

- 2.1.1 The materials required for work of painting work shall be obtained directly from approved manufacturers or approved dealer and brought to the site in maker's drums, kegs etc. with seal unbroken.
- 2.1.2 All materials not in actual use shall be kept properly protected, lids of containers shall be kept closed and surface of paint in open or partially open containers covered with a thin layer of turpentine to prevent formation of skin. The materials which have become state or flat due to improper and long storage

shall not be used. The paint shall be stirred thoroughly in its container before pouring into small containers. While applying also the paint shall be continuously stirred in smaller container. Bo left over paint shall be put back into stock tins. When not in use, the containers shall be kept properly closed.

- 2.1.3 If for any seasons, thinning is necessary, the brand of thinner recommended by the manufacturer shall be used.
- 2.1.4 The surface to be painted shall be thoroughly cleaned and dusted. All rust, dirt and grease shall be thoroughly removed before painting is started. No. painting on exterior or other exposed parts of the work shall be carried out in wet, damp or otherwise unfavourable weather and all the surfaces shall be thoroughly dry before painting work is started.

## **2.2 Application**

- 2.2.1 Brushing operations are to be adjusted to the spreading capacity advised by the manufacturer of particular paint. The paint shall be applied evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area over 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 direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.
- 2.2.2 Each coat except the last coat shall be allowed to dry completely and lightly rubbed with very fine grade of sand-paper and loose particles brushed off before next coat is applied. Each coat shall vary slightly in shade and shall be got approved from Engineer in charge before next coat is started.
- 2.2.3 Each coat except the last coat shall be lightly rubbed down with sand paper of fine pumie stone and cleaned of dust before the next coat is applied. No hair marks from the brush or clogging of paint puddles in the corners of panels angles of moulding etc. shall be left on the work.
- 2.2.4 Special care shall be taken while painting over bolts, nuts, rivets, overlaps etc.

Approved best quality brushes shall be used.

### **3.0 Mode of measurements & payment :**

- 3.1 The rate for shutter includes cost of providing block and clear for keeping the shutter in open position as directed. The dimension of the shutter shall be measured clear size of the shutter in close position between the grooves of the frame.
- 3.2 The rate shall be unit of one sq.metre.

#### **D.13.19 APPLYING PRIMING COAT OVER STEEL SURFACE INCLUDING PREPARING THE SURFACE BY THOROUGHLY CLEANING, OIL, GREASE, DIRT & OTHER FOREIGN MATTER & SCOURED WITH BRUSHES FINE STEEL WOOD, SCRAPERS & SAND PAPER WITH READY MIXED PRIMING PAINT BRUSHING RED LEAD AND PAINTING SECOND COAT WITH ENAMEL PAINT, BRUSHING TO GIVE AN EVEN SHADE INCLUDING CLEANING THE SURFACE.**

**Applying priming coat over new / old steel and other metal surfaces after and including preparing the surface by thoroughly cleaning oil, grease, dirt and other foreign matter and secured with brushes, fine steel, wood scrapes and sand paper, with ready mixed priming paint, brushing red lead.**

#### **1.0 Materials :**

- 1.1 The ready mixed primer, brushing red lead shall conform to I S. 102-1962.
- 1.2 The thinner (linsed oil) shall conform to I. S. 1973. If for any reason, thinning is necessary in case of ready mix paint, the brand of thinner recommended by manufacturer shall be used.

#### **2.0 Workmanship :**

##### **2.1 Preparing of surfaces :**

The surfaces to be painted shall be cleaned of all rust, scale, dirt and other foreign matter sticking to it with wire brushes, steel wool, scrapers, sand paper etc. This surface shall then be wiped finally with mineral turpentine which shall also removed grease and perspiration of hand marks. The surface shall then be allowed to dry.

##### **2.2 Application of primer :**

- 2.2.1 After the preparation of the surface, the priming coat shall be applied immediately. The brushing operations are to be adjusted to the spreading capacity advised by the manufacturer of the particular primer. The paint shall be applied evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area over with paint, brushing alternately in opposite directions, two or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

- 2.2.2 During painting, every time after the priming coat has been worked out of the brush bristles or after the brush has been unloaded of the bristles of the brush shall be opened up by striking the brush against portion of the unpainted surface with the end of the bristles, held at right angles to the surface, so that bristles thereafter will collect the correct amount of paint when dipped again into a paint container. The primery coat shall be allowed to dry completely before painting is started.
- 2.2.3 No hair marks from the brush or clogging at paint puddles in the corner or panels angles of mouldings etc. shall be left on the work.
- 2.2.4 Special care shall be taken while painting over bolts nuts, rivets overlaps etc.
- 2.2.5 The container when not in use shall be kept close and free from air so that paint does not thickness and also shall be kept guarded from dust.
- 3.0 Painting one coat (excluding priming coat) on previously painted steel and other metal surface with enamel paint, brushing to given and even shade including cleaning the surface of all dirt, dust and other foreign matter.**
- 3.1 Materials & Workmanship :**
  - 3.1.1 The relevant specifications of item no. above shall be followed except that painting shall be carried out in one coat with enamel paint on previously painted steel and metal surface.
- 4.0 Mode of measurements & payment :**
  - 4.1 The new steel and other metal surface shall be measured under this item.
  - 4.2 All the work shall be measured net in the decimal system as executed subject to the following limits unless otherwise stated hereinafter :
    - (a) Dimensions shall be measured to the nearest 0.01 metre.
    - (b) Areas shall be worked out to the nearest 0.01 sq.metre.
  - 4.3 No deductions shall be made for openings not exceeding 0.5 sq.mt. each and no addition shall be made for painting to beadings, mouldings, edges, jambs, soffits, etc. of such opening.
  - 4.4 In case of fabricated structural steel and iron work, priming coat of paint shall be included with fabrication. In case of trusses if measured in sq.m. compound girders, stnachions, lattices, girder and similar work, actual area shall be measured in sq.m. and no extra shall be paid for painting on bolts, heads, nuts, washers etc. No addition shall be made to the weight calculated for the purpose of measurements of steel and iron works for paint applied on shop or at site.
  - 4.5 The different surfaces shall be grouped into one general item, areas of uneven surface being converted into equivalent plain areas in accordance with the standard practice.
  - 4.6 The rate shall be for a unit of one sq.metre.

**D.13.20      REPAIRING CRACKS INCLUDING CHIPPING OF THE PLASTER IN THE CRACKED REGION, CLEAN THE SURFACE, FILL UP THE CRACK WITH NON-SHRINK GROUT FIXING G. I. WELD MESH ON EXPOSED SURFACE, APPLY 15 MM THICK LAYER OF CEMENT MORTAR WITH GRIT AND POLYMER, AFTER SETTING THE FIRST LAYER, APPLY SECOND COAT OF PLASTER WITH 1:3 CEMENT MORTAR ENTIRE TO THE SATISFACTION OF ENGINEER IN CHARGE.**

The existing cracks will be cut to V-section and scrapping of plaster on either side in width about 3 cms will be carried out. The cracks will be thoroughly cleaned and wetted. The cracks will then be filled with non shrink grout like epoxy grout in ratio of 1 : 0.8 (1 part of resin using + 0.8 part of hardner). The mix epoxy grout is to be injected by means of pressure pumps at 4 KG/cm<sup>2</sup> pressure into the cracks. Instead of epoxy grouting of cracks, polymer grouting i.e 1 part cement : 1 part polymer (by weight) and inject the slurry by pressure pump as above. The slurry will penetrate in fine cracks.

Sealing of cracks will then be carried out after the pressure grouting by means of polymer mortar (Cement + polymer additives) i.e. 1 part cement : 3 parts of sand with polymer 1 part (by weight).

The parts so prepared will be applied in 15 mm thick as polymer mortar. After setting of this polymer mortar, the second coat of ordinary cement plaster in C.M. 1:3 of required thickness or as directed by Engineer in charge shall be applied.

Before applying polymer mortar G.I. welded mesh on the exposed surface shall be fixed.

The rate quoted by the contractor for this item includes crack filling by epoxy or polymer grouting as per specifications, sealing of the cracks by polymer mortar with G. I. Welded mess, finishing with neat cement slurry with existing surface with colour as per site condition, labour, materials, machinery, equipment, scaffolding, curing, cleaning etc. complete and will be paid on running meter basis for such work carried out.



## **D-14 : C.I. & D.I. PIPES, VALVES AND FITTINGS**

### **SECTION : D-14**

#### **D.14.1 CAST IRON PIPES**

##### **D.14.1.1 SCOPE**

D.14.1.1.1 This specification covers the requirements for manufacturing, testing, supplying, jointing and testing at work sites of cast iron pipes and fittings used for water supply and sewerage system.

##### **D.14.1.2 APPLICABLE CODES**

D.14.1.2.1 The manufacturing, testing, supplying, jointing and testing at work sites of cast iron pipes and fittings shall comply with all currently applicable statutes, regulations, standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of this specification conflict with the requirements of the codes standards, this specification shall govern.

##### **D.14.1.2.2 Materials**

- |    |           |   |  |
|----|-----------|---|--|
| a) | IS : 210  | : | Specification for grey iron casting  |
| b) | IS : 290  | : | Specification for coal tar black paint.  |
| c) | IS : 638  | : | Specification for sheet rubber jointing and rubber insertion jointing                      |
| d) | IS : 782  | : | Specification for caulking lead  |
| e) | IS : 1387 | : | General requirements for the supply of metallurgical material.                             |
| f) | IS : 1537 | : | Specification for vertically cast iron pressure pipes for water, gas and sewage.           |
| g) | IS : 1536 | : | Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage. |
| h) | IS : 1538 | : | Specification for cast iron fittings for pressure pipes for water, gas and sewage.         |
| i) | IS : 1500 | : | Method for Brinell hardness test for grey cast iron.                                       |
| j) | IS : 2078 | : | Method for tensile testing of grey cast iron.  |
| k) | IS : 5382 | : | Specification for rubber sealing rings for gas mains, water mains and sewers               |
| l) | IS : 6587 | : | Specification for spun hemp yarn.  |

##### **D.14.1.2.3 Code Of Practice**

- |    |           |   |   |
|----|-----------|---|---|
| a) | IS : 3114 | : | Code of practice for laying of cast iron pipes. |
|----|-----------|---|---|

#### **D.14.1.2.4 MANUFACTURE**

- D.14.1.2.4.1 The metal used for the manufacture of pipes shall be good quality cast iron. It shall be prepared, at the discretion of the manufacturer, in a cupola or an active mixer or other suitable furnace.
- D.14.1.2.4.2 The pipes shall be stripped with all precautions necessary to avoid warping or shrinkage defects. The pipes shall be free from defects, other than any unavoidable surface imperfections which result from the method of manufacture and which do not affect the serviceability of the pipes. By agreement between the purchaser and the manufacturer, minor defects may be rectified
- D.14.1.2.4.3 The pipes shall be such that they could be cut, drilled or machine Pipes shall be accepted provided the hardness of the external unmachined surface does not exceed Brinell hardness of 230 HB.
- D.14.1.2.4.4 Spun pipes shall be subjected to heat treatment, if necessary, to ensure that the Brinell hardness does not exceed the limit specified
- D.14.1.2.4.5 In case of rubber joints, the spigot ends shall be suitably chamfered for smooth entry of pipe in the socket fitted with the rubber gasket.
- D.14.1.2.4.6 In case of flanged pipes, the flanges shall be at right angles to the axis of the pipe and machined on face. The bolt holes shall be drilled
- D.14.1.2.4.7 The bolt hole circle shall be concentric with the bore, and the two flanges of the pipe shall be correctly aligned
- D.14.1.2.4.8 Cast iron pipes having screwed-on-flanges shall be sealed at the threaded joint between the pipes and the flange by a suitable sealing compound Unless otherwise specified, the sealing compound applied to the threaded joint shall be suitable for use with 'raw' and potable water (upto a temperature of 100<sup>0</sup> C), gas normal domestic sewage.
- D.14.1.2.4.9 Alternative types of sealing compound for pipes used for other duties, such as the carrying of industrial effluents or chemicals shall be the subject of agreement between the manufacturer and the purchaser.
- D.14.1.2.4.10 For flanged pipes, only Class A and Class B (see D.14.1 and Tables 9 and 10) pipes with screwed flanges have been covered. The method of screwing and the exact form of the thread are left to the discretion of the manufacturer in view of the fact that the flanges are never removed after screwing on the barrels of the pipes.

#### **D.14.1.3 MECHANICAL TESTS**

- D.14.1.3.1 Mechanical tests shall be carried out during manufacture. Test for every four hours of production shall be conducted. The results obtained shall be taken to

represent all the pipes of all sizes made during that period as per IS – 1536 – 1976.

#### **D.14.1.4 TESTS**

D.14.1.4.1 Two test pieces obtained by cutting rings or bars from the spigot end of two pipes selected for testing, when tested in accordance with the methods specified in Appendix A, shall satisfy the following requirements.

**(a) Ring Test (for pipes Centrifugally Cast in Metal Moulds) :**

<b>Nominal Diameter</b>	<b>Modulus of Rupture, Min N/ mm<sup>2</sup> (Kgf/mm<sup>2</sup>)</b>
Upto and including 300 mm	390 (40)

**(b) Tensile Test**

<b>Sr. No.</b>	<b>Type of Moulding</b>	<b>Nominal Diameter</b>	<b>Tensile Strength, Min N/mm<sup>2</sup> (Kgf/mm<sup>2</sup>)</b>
1	For pipes centrifugally cast in metal moulds	Over 300 mm and upto and including 600 mm	200 (20)
		Over 600 mm	180 (18)
2	For pipes centrifugally cast in sand moulds	All diameters	180 (18)

All pipes from which rings or bars have been cut shall be accepted by the purchaser as complete lengths.

#### **D.14.1.5 BRINELL HARDNESS TEST**

D.14.1.5.1 For checking the Brinell hardness specified in 4.3 the test shall be carried out on the test rings of bars cut from the pipes used for tests under 5.1, in accordance with IS : 1789-1961. The test shall be carried out by applying either a load of 3000 Kg to a ball of 10 mm diameter for 15 seconds, or a load of 750 Kg to a ball of 5 mm diameter for 10 seconds.

#### **D.14.1.6 RETESTS**

D.14.1.6.1 If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail, the lot shall be deemed as not complying with this standard.

#### **D.14.1.7 HYDROSTATIC TEST**

D.14.1.7.1 For hydrostatic test, all pipes shall be kept under pressure for 15 seconds; they may be struck moderately with a 700-g hammer. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. As far as possible the hydrostatic test shall be conducted before coating the pipes.

#### **D.14.1.8 WORKS TEST REQUIREMENTS**

D.14.1.8.1 All pipes shall withstand hydrostatic test pressures specified under col. 2 of Tables 1 & 2.

#### **D.14.1.9 INSTALLATION TEST REQUIREMENTS**

D.14.1.D.14.1 All pipes shall withstand hydrostatic test pressures specified under col. 3 of Tables 1 & 2.

D.14.1.D.14.2 When pipes are required for higher test pressures, test pressures are subject to special agreement between the purchaser and the manufacturer.

#### **D.14.1.10 SIZES**

D.14.1.10.1 The dimensions of pipes, sockets, spigots and flanges shall conform to the sizes specified in Tables 3 to 10.

**TABLE – 1**  
**HYDROSTATIC TEST PRESSURES FOR CENTRIFUGALLY**  
**CAST SOCKET AND SPIGOT PIPES**

<b>Class</b>	<b>Hydrostatic test pressure at works N/mm<sup>2</sup> (Kgf/cm<sup>2</sup>)</b>	<b>Maximum hydrostatic test pressure after installation N/mm<sup>2</sup> (Kgf/cm<sup>2</sup>)</b>
LA	3.5 (35)	1.2 (12)
A	3.5 (35)	1.8 (18)
B	3.5 (35)	2.4 (24)

**TABLE – 2**  
**HYDROSTATIC TEST PRESSURES FOR CENTRIFUGALLY**  
**CAST FLANGED PIPES (UPTO 600 MM DIAMETER)**

<b>Class</b>	<b>Hydrostatic test pressure at works N/mm<sup>2</sup> (Kgf/cm<sup>2</sup>)</b>	<b>Maximum hydrostatic test pressure after installation N/mm<sup>2</sup> (Kgf/cm<sup>2</sup>)</b>
A	3.5 (35)	1.8 (18)
B	3.5 (35)	2.4 (24)

#### **D.14.1.11 TOLERANCE**

D.14.1.11.1 Tolerance on External Diameter of the Barrel, the Internal Diameter of the socket and the Depth of the socket : The tolerance for lead jointing shall be as follows :-

<b>Sr. No.</b>	<b>Dimensions</b>	<b>Nominal Diameter (DN)</b>	<b>Tolerance mm</b>
a)	External diameter of barrel (DE)	All diameters	$\pm f = \pm (4.5 + 0.0015 \text{ DN})$
b)	Internal diameter of socket (DI)	All diameters	$\pm f = \pm (3 \pm 0.001 \text{ DN})$
c)	Depth of socket (P)	1) Upto and including 600 mm 2) Over 600 mm and upto and including 1000 mm	$\pm 5$ $\pm 10$

NOTE 1 : It is the caulking space of the joint in millimeters and is equal to  $9 + 0.003 \text{ DN}$ .

NOTE 2 : The jointing tolerances applicable to rubber joints (mechanical or push in joints) shall be as specified by their manufacturer and shall be within the tolerance specified above.

The maximum or minimum jointing space resulting from these tolerances is such that the jointing of the pipes and fittings is not adversely affected

#### **D.14.1.12 TOLERANCE ON THICKNESS**

D.14.1.12.1 The tolerance on the wall thickness and flange thickness of pipes shall be as follows :-

<b>Sr. No.</b>	<b>Dimension</b>	<b>Tolerance in mm</b>
a)	Wall thickness	$-(1 + 0.05 e)^*$
b)	Flange thickness	$\pm (2 + 0.05 b)$

Where e is the thickness of the wall in millimeters, and b is the thickness of the flange in millimeters.

### **D.14.1.13 TOLERANCE ON LENGTH**

D.14.1.13.1 The tolerance on length of pipes shall be as follows :-

<b>Sr. No.</b>	<b>Type of Casting</b>	<b>Tolerance in mm</b>
a)	Wall thickness	$\pm 25$
b)	Flanged pipes	$\pm 10$

Of the total number of socket and spigot pipes to be supplied in each diameter, the manufacturer may supply upto 10 percent in lengths shorter than the specified length as follows :-

<b>Specified Length</b>	<b>Decrease in Length</b>
Upto 4 m	0.5, 1 m.
Over 4 m	0.5, 1, 1.5, 2 m.

### **D.14.1.14 PERMISSIBLE DEVIATION FROM A STRAIGHT LINE**

D.14.1.14.1 The pipes shall be straight. When rolled along two gantries separated by approximately two thirds the length of the pipe to be checked, the maximum deviation  $f_m$  in millimeters shall not be greater than 1.25 times the length  $l$  in meters of this pipe, thus  $f_m \leq 1.25 l$ .

### **D.14.1.15 MASS**

D.14.1.15.1 The standard masses of uncoated pipes shall be those given in tables 3 to 10. The masses have been calculated, for the lengths generally used, by taking into account in each case the mass of socket or flange fixed arbitrarily as a proportion of the mass of the pipe barrel. For this purpose the density of cast iron has been taken as  $7.15 \text{ Kg/cm}^3$ .

D.14.1.15.2 The permissible tolerances on standard mass of pipe shall be  $\pm 5$  percent.

D.14.1.15.3 If mutually agreed upon, pipes of a heavier mass than the maximum may be accepted, provided they comply in every other respect with the requirements of this standard.

### **D.14.1.16 COATING**

D.14.1.16.1 Each pipe shall be coated as given under 12.2 to 12.7.

D.14.1.16.2 Coating shall not be applied to any pipe unless its surfaces are clean, dry and free from rust.

D.14.1.16.3 Except when otherwise agreed to between the purchaser and the manufacturer, all pipes shall be coated externally and internally with the same material, the pipes being heated prior to total immersion in a bath containing a uniformly heated composition having a tar or other suitable base.

- D.14.1.16.4 The coating material shall set rapidly with good adherence and shall not scale off.
- D.14.1.16.5 In all instances where the coating material has a tar or similar base, it shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 77<sup>0</sup> C but not so brittle at a temperature of 0<sup>0</sup> C as to chip off when scribed lightly with a penknife.
- D.14.1.16.6 When the pipes are to be used for conveying potable water, the inside coating shall not contain any constituent soluble in such water or any ingredient which could impart any taste of odour whatsoever to the potable water after sterilization and suitable washing of the mains.
- D.14.1.16.7 In the case of pipes (wholly or partially coated) which are imperfectly coated or where the coating does not set or conform to the required quality, the coating shall be removed and the pipes recorded.

#### **D.14.1.17 MARKING**

- D.14.1.17.1 Each pipe shall have cast, stamped or indelibly painted on it the following appropriate marks.
- a) Manufacturer's name, initials or identifications mark;
  - b) The nominal diameter;
  - c) Class reference;
  - d) Mass of pipe;
  - e) The number of this Indian Standard; and
  - f) The last two digits of the year of manufacture.

#### **D.14.1.18 MARKING MAY BE DONE**

- A) On the socket faces of pipe centrifugally cast in metal mould, and
  - B) On the outside of the socket or on the barrel of pipe centrifugally cast in sand mould.
- D.14.1.18.1 Any other marks required by the purchaser may be painted on.
- D.14.1.18.2 The pipes may also be marked with the ISI Certification Mark.

#### **D.14.1.19 JOINTING**

##### **D.14.1.19.1 General**

Jointing of CI pipes and fittings shall be done as per the requirements of the following specifications and as per the relevant IS. The type of joints shall be as per specific item. After jointing, extraneous material, if any, shall be removed from the inside of the pipe. In case, rubber sealing rings are used for jointing, these shall conform to IS : 5382 and shall be of such type as mentioned in specific item.

### **D.14.1.19.2 Lead Joints**

The jointing shall be done with molten lead and spun yarn, Pig lead shall be of uniform quality, clean and free from foreign materials. It shall be of uniform softness and capable of being easily caulked or driven. It shall conform to IS : 782. Spun yarn shall be of clean hemp and of good quality. It shall conform to IS : 6587. The quantity of lead to be used for jointing of different diameters of CI pipes and fittings shall be as per table 1 of IS : 3114.

Lead shall be heated in a melting pot kept in easy reach of the joint to be poured so that the molten metal will not be chilled in being carried from the melting pot to the joint and shall be brought to a proper temperature so that when stirred it will show a rapid change of colour. Before pouring, all scum shall be removed. Each joint shall be made with a continuous pour filling of the entire joint space with solid lead. Spongy or immediately filled joints shall be burnt out and repoured.

The joint runner shall fit snugly against the face of the socket and the outside of the pipe shall be dammed with clay to form a pouring lip to provide for filling the joint flush with the face and to the top of the socket.

The jointing is done by first caulking in spun yarn, then filling the remainder of the joint space by running in molten lead, taking care that no dross enters the joint, and then thoroughly caulking the lead. The spun yarn shall be used to center the spigot in the socket and to prevent the flow of molten lead into the bore of the pipe. The spun yarn shall be effectively disinfected before use.

After the lead has been run into the lead shall be thoroughly caulked. Caulking of joints shall be done after a convenient length of the pipe has been laid and leaded. The leading ring shall first be removed with a flat chisel and then the joint caulked around three times with caulking tools of increasing thickness and hammer of 2 Kg. weight. Lead run joints shall be preferably finished 3 mm behind the socket face. The joints shall not be covered till the pipeline has been tested under specified hydrostatic test pressure, though the rest of the pipe line should be covered up to prevent expansion and contraction due to variation in temperature.

The quantity of lead required for different sizes of pipes shall be as follows :

#### **QUANTITY OF LEAD FOR DIFFERENT SIZES OF PIPES**

<b>Nominal size of pipe mm.</b>	<b>Lead / joint Kg.</b>	<b>Depth of lead joint mm</b>
<b>(1)</b>	<b>(2)</b>	<b>(3)</b>
80	1.8	45
100	2.2	45
125	2.6	45
150	3.4	50
200	5.0	50
300	7.2	55



<b>Nominal size of pipe mm.</b>	<b>Lead / joint Kg.</b>	<b>Depth of lead joint mm</b>
350	8.4	55
400	D.14.5	55
450	14.0	55
500	15	60
600	1D.14.0	60
700	22.0	60
750	25.0	60
800	31.5	65
900	35.0	65
1000	41.0	65
1100	46.0	65
1200	52.0	70
1500	66.5	75

In case of wet condition the jointing shall be done by lead wool and spun yarn. The quantity of lead wool and spun yarn required for different sizes of pipes shall be as follows.

#### QUANTITY OF LEAD WOOL AND SPUN YARN FOR DIFFERENT SIZES OF PIPES / JOINT

<b>Nominal Internal Diameter mm.</b>	<b>Lead wool weight Kg.</b>	<b>Spun yarn weight Kg.</b>
<b>(1)</b>	<b>(2)</b>	<b>(3)</b>
80	1.30	0.17
100	1.70	0.23
150	2.41	0.34
175	2.89	0.37
200	3.37	0.57
225	3.63	0.64
250	4.11	0.74
300	4.82	0.82
350	6.04	1.17
375	6.52	1.25
400	7.00	1.33
450	D.14.64	1.84
500	10.86	1.99
600	12.79	2.83
750	15.68	3.52
825	17.12	3.88
900	18.80	4.25
1200	28.44	6.01

#### D.14.1.19.3 Tyton Joints

In jointing Cast iron spigot and socket pipes and fittings with Tyton flexible joints the contractor shall take into account the manufacturer's

recommendations as to the methods and equipment to be used in assembling the joints. In particular the Contractor shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly chamfered, that the rubber ring as per IS : 5382, is correctly positioned in line before the joint is made. The rubber rings and any recommended lubricant shall be obtained only through the pipe supplier or as otherwise directed by Engineer.

#### **D.14.1.19.4 Cement Joints**

Where cement joints are used for cast iron gravity sewers, cement as permitted in IS :456 shall be use

Closely twisted spun yarn gasket for such diameter as required to support the spigot of the pipe at the proper grade and make truly concentric joints, and in one piece of sufficient length to pass around the pipe and lap at the top, shall be thoroughly saturated in cement paste. This gasket shall be laid in the socket for the lower third of the circumference of the joint and covered with cement mortar (1 cement : 1 coarse sand). The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted and carefully driven home, after which a small amount of mortar shall be inserted in the annular space around the entire circumference of the pipe and solidly rammed into the joint with a caulking tool, the mortar previously place being driven ahead of the gasket. The remainder of the joint shall then be completely filled with mortar and bevelled off at an angle of 45 degrees with the outside of the pipe. On pipes 450 mm in diameter or larger, the joints shall be pointed and smoothened from the inside. While making cement joints, one lead joint shall be introduced for every ten cement joints.

The inside of the pipe shall be cleaned after the mortar sets slightly by dragging a large gunny-wrapped block of wood or straw through the pipe. Care is however, necessary to see that this block is not left in the sewer when the work is interrupted or complete

Pipes laid with cement joints shall not be filled with water until a lapse of twelve hours after the last joint in any valved section has been made. The pressure shall not be permitted in the pipe until all joints have been properly cure

#### **D.14.1.19.5 Flanged Joints**

The gaskets used between flanges of pipes shall be compressed fibre board or natural / synthetic rubber conforming to IS : 638 of thickness between 1.5 to 3 mm. the fibre board shall be impregnated with chemically natural mineral oil and shall have a smooth and hard surface. Its weight per square metre shall be not less than 112 g/mm thickness.

Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after another is highly undesirable. The bolts shall be of mild steel unless otherwise specified

#### **D.14.1.19.6 Cleaning of Pipes and Fittings**

Contractor shall ascertain that each stretch of pipeline is absolutely clear and without any obstruction by means of visual examination of the interior of pipeline suitably lighted by projected sunlight or otherwise. The open end of an incomplete stretch of pipeline shall be securely closed as may be directed by Owner / Engineer to prevent entry of mud or site etc.

If as a result of the removal of any obstructions Owner / Engineer considers that damages may have been caused to the pipeline. He shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, contractor shall amend the work and carry out such further tests as are required by Owner/Engineer.

#### **D.14.1.19.7 Testing at Work Site**

After the pipes and fittings are laid, jointed and the trench partially back filled except at the joins the stretch of pipeline as directed by Engineer shall be subjected to pressure test and leakage test. Where any section of the pipe line is provided with concrete thrust block or anchorages, the pressure test shall not be made until at least five days have elapsed after the concrete was cast. If rapid hardening cement has been used in these blocks or anchorages, the tests shall not be made until at least two days have elapsed

Each section of the pipe line shall be slowly filled with water and all air shall be expelled from the pipe by tapping at points of highest elevation before the test is made and lugs inserted after the tests have been complete. The specified test pressure as per items, based on the elevation of the lowest point of the line of section under corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipes as directed by Engineer.

The duration of tests shall not be less than 5 minutes. The exposed joints shall be carefully examined and all such joints showing visible leaks shall be recaulked until water tight. Any cracked or defective pipes and fittings in consequence of this pressure test shall be removed and replaced by sound material by contractor at no extra cost to Owner / Engineer and the test shall be repeated to the satisfaction of Owner/Engineer.

After the satisfactory completion of pressure test, the section of pipeline shall be subjected to leakage test at a pressure as specified in item. The duration of test shall be 2 hours. No pipe installation shall be accepted until the leakage is less than the number of cm<sup>3</sup>/h as determined by the formula :

$$Q_t = \frac{ND(P)^{1.2}}{3.3}$$

Where =

$Q_t$  = the allowable leakage in cm<sup>3</sup>/h

$N$  = number of joints in the length of the pipeline

- D = Diameter in mm , and  
P = The average test pressure during the leakage test in Kg/cm<sup>2</sup>.

Should any test of pipe laid indicate leakage greater than that specified above, the defective joints shall be repaired by contractor at no extra cost to Owner / Engineer until the leakage is within the specified allowance.

Necessary equipments and water used for testing shall be arranged by contractor at his own cost. Damage during testing shall be contractors responsibility and shall be rectified by him at no extra cost to Owner/Engineer. Water used for testing shall be removed from the pipe and not released in the excavated trenches.

After the tests mentioned above are completed to the satisfaction of Owner/Engineer, the backfilling of trenches shall be done as per specification given in Section : D1.

#### **D.14.1.19.8 Disinfection of Water Mains**

The mains intended for potable water supplies should be disinfected before commissioning them for use.

After pressure testing the main, it should be flushed with water of sufficient velocity to remove all dirt and other foreign materials. When this process has been completed, disinfection (during liquid chlorine, sodium or calcium hypochlorite) can proceed by one of the following methods.

##### **Continuous Feed**

In this method, water from the distribution system or other approved source and the chlorine are fed at constant rate into the newly laid main at a concentration of at least 20 to 50 mg/l. A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution feed chlorinator and booster pump shall be used. The chlorine residual should be checked at intervals to ensure that the proper level is maintained. Chlorine application should continue until the entire main is filled. The water should remain in the main for a minimum of 24 hours. During which time all valves, hydrants, etc. along the main should be operated to ensure their proper disinfection. Following the 24 hours period, not less than 10 mg/l chlorine residual should remain in the main.

##### **Slug Method**

In this method a continuous flow of water is fed with a constant dose of chlorine but with rates proportioned to give a chlorine concentration of at least 300 mg/l. The chlorine is applied continuously for a period of time to provide a column of chlorinated water that will contact all interior surfaces of the main for a period of at least three hours. As the slug passes tees, crosses etc., proper valves must be operated to ensure their disinfection. This method shall be used principally for large diameter mains where continuous feed is impractical.

Regardless of the method used, it is necessary to make certain that back flow of the strong chlorine solution into the supplying line does not occur. Following the prescribed contact period as directed by Engineer, the chlorinated water should be flushed to waste until the remaining water has a chlorine residual approximating that throughout the rest of the system. Bacteriological tests should be taken and if the result fails to meet minimum standards, the disinfection procedure must be repeated and the results again tested before placing the main in service.

#### **D.14.1.19.9 Laying of Pipes and Fittings**

All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure / pipeline of water, gas, sewage etc. After excavation of trenches, pipes shall not be lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches and approved and measured by the Engineer-in-charge. Pipes and fittings / specials shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes and fittings / specials shall be made by Contractor. In no case pipes and fittings / specials shall be dropped. Slings of canvas or equally non-abrasive material of suitable width or special attachment to fit the ends of pipes and fittings / specials shall be used to lift and lower the coated pipes and fittings / specials. The pipes and fittings / specials shall be inspected for pipes and fittings / specials shall be inspected for defects and be rung with light hammer preferably while suspended to detect cracks. If doubt persists, further conformation shall be done by pouring a little kerosene / dye on the inside of the pipe at the suspected spot. No sign of kerosene / dye should appear on the outside surface. Pipes and fittings / specials damaged during lowering or aligning shall be rejected by the Engineer-in-charge.

All the pipes are to be laid perfectly true both in alignment and to gradient specified. In case of spigot and socket pipe the socket end of the pipe shall face upstream, except when the pipeline runs uphill in which case the socket ends should face the upgrade. The laying of pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centred in the socket and the pipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes and fittings / specials which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes and fittings / specials of proper dimensions to ensure such uniform space. Precautions shall be taken to prevent dirt from entering the jointing space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by Engineer-in-charge. During the period that the plug is on the contractor shall take proper precautions against floating of the pipe owing to entry of water into the trench. Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted the deflection allowed at joints shall not exceed 2.5% . In case of pipes, with joint to be made with loose collars, the collars shall be slipped

on before the next pipe is laid. The pipes shall be laid such that the marking on pipes appears at the top of the pipes.

The cutting of pipe for inserting valves, fittings or specials shall be done in a neat and workman like manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. For this purpose, pipe-cutting machine shall be use

#### **D.14.1.19.10 Measurement**

All pipes shall be measured according to the work actually done and no allowance will be made for any waste in cutting to the exact length require Pipes and fittings shall be described by their internal diameter and length measured in running metres. The measurement shall be taken along the centre line of pipe excluding fittings, which shall be measured separately. The lengths of pipes shall not include the portion of spigots within the sockets of fittings and pipes.

The rate for providing, laying and jointing of C. I. pipes and fittings shall be deemed to include the cost of jointing material and testing at work site.

#### **D.14.1.19.11 Notes**

If any damage is caused to the pipeline during the execution of work or while cleaning / testing the pipeline as specified, Contractor shall be held responsible for the same and shall replace the damaged pipeline and retest the same at his own cost to the full satisfaction of Engineer.

### **D.14.2 VALVES**

#### **D.14.2.1 SLUICE VALVES**

##### **D.14.2.1.1 General**

The contract shall be covering manufacturing, supplying, testing at factory and delivery of :

Sluice valves conforming to IS :14846-2000 with body, length over flanges Alt II with ISI certification mark on each valve.

##### **D.14.2.1.2 Standards**

The C. I. Sluice valves to be manufactured, supplied and delivered under the scope of this contract shall be manufactured in accordance with and conforming to Indian standard specifications and with ISI certification mark on each sluice valves.

#### **D.14.2.1.3 Temperature Variations**

All sluice valves, manufactured, supplied, tested and delivered shall be subjected to drinking water under variable temperature conditions ranging from 4<sup>0</sup> to 45<sup>0</sup> C.

#### **D.14.2.1.4 Marking**

The legible and indelible markings upon each valve shall indicate the following :

- (i) ISI certification mark on each sluice valve.
- (ii) Manufacturer's brand name and/or trade mark.
- (iii) Size of valve and nominal pressure of valve
- (iv) Heat number of cast.
- (v) Serial number in punch.
- (vi) Where a valve has been tested for only open end test, it should be marked "O" distinctly and permanently.
- (vii) Any other important matter that the manufacturer deems fit to be inscribed/embossed

#### **D.14.2.1.5 Test Certificate**

- (1) The contractor shall always provide manufacturer's test certificate in accordance with every batch / lot of valves so manufactured and supplied
- (2) The contractor shall also produce; in addition to manufacturer's test certificate as above, the inspection certificate issued by the authorised person of AMC.

#### **D.14.2.1.6 Nominal Pressure**

Each valve shall be subjected to hydrostatic tests as per IS : 14846-2000. The test pressure and test duration shall be as per table given below Table 1 and Table 2.

**Table 1 : Test Pressure for Sluice Valves**

<b>PN Rating</b>	<b>Test for Body / Seat</b>	<b>Test Pressure MPa (Gauge)</b>
PN 1.0	Body	1.5
	Seat	1.0
PN 1.6	Body	2.4
	Seat	1.6

**Table 2 : Test Duration for Sluice Valves**

<b>Valve Size mm</b>	<b>Test for Body / Seat</b>	<b>Test Duration Min.</b>
50 to 1200	Body	5
	Seat	2

#### **D.14.2.1.7 Material**

The material for different component parts of Sluice valves shall conform to IS : 14846 – 2000.

#### **D.14.2.1.8 Flanges**

The flanges and their dimension of drilling shall be in accordance with part –IV and VI of IS:1538 (Part – I to XXII) 1976 (specification for cast iron fittings for pressure pipes for water, gas and sewage) or its latest revision.

#### **D.14.2.1.9 Testing**

Defects noted during test and operation of sluice valve shall be refitted by the contractor at his own cost without any extra claim to the entire satisfaction of the Engineer-in-charge.

#### **D.14.2.1.10 Fixing of Valves**

Loading at store and unloading at site of works shall be done carefully using suitable mechanical handling devices such as crane, chain pulley etc. The arrangement of housing the valves with chambers and stable and firm foundations. The chamber and top roof cover with removable lid shall be provided so that it shall be possible to remove or replace or recondition the valves seats and to remove the parts without removing the valves from the pipe work. For this suitable flange adapters may be provided

Valves used on pipeline shall be straight through type and non chokable. Each valve or its operation equipment shall bear an approved name plate stating its function. All operation spindles, gears and head stocks shall be provided with adequate points for lubrications.

The tightening of nut and bolts shall be done smoothly in such a way that no excessive strain occurs on any one side. The nuts shall be tightened on diametrically opposite site at a time.

#### **D.14.2.1.11 Information Required**

Following documents/drawings shall be submitted by Bidder alongwith the quotation.

Preliminary outline dimensional drawings.

Typical cross section drawings.

Supplier's data sheet showing valve size, pressure rating, test pressures, list of tests to be conducted etc.



#### **D.14.2.1.12 Scope**

The rate of item covers cost of supply of valves with ISI mark along with all jointing materials and all labours for overhauling, lowering, laying, jointing with main pipe including all jointing materials like nuts bolts, rubber packing, and testing etc. The cost shall also includes all taxes, duties, insurance etc. complete.

#### **D.14.2.1.13 Payment**

Payment shall be on number basis of the completed item.

### **D.14.3 VALVE CHAMBERS**

The valves chambers consists the following items for construction.

- a) Excavation
- b) P.C.C. 1:3:6
- c) R.C.C. 1:1.5:3
- d) Providing and fixing HYSD bar reinforcement for RCC work
- e) Interior and exterior plain faced 15 mm thick cement plaster 1:3
- f) Providing and fixing fiber reinforced seat and heavy duty cover in line and level in CC 1:2:4
- g) Brick masonry in C.M. 1:5
- h) Providing and fixing cast iron steps confirming to IS 5455

- a) Excavation :

The excavation for chambers will be carried out as per the general technical specifications laid down under section “D-1”, “Work in Trench Excavation and Back Filling”. The excavation shall be carried out in all sorts of strata of soil and rock. The rate includes shoring, strutting and dewatering for which no extra payment will be made. The measurement shall be carried in length, Breadth and depth. The excess excavation carried out by the contractor will be filled with approved material for which no extra payment will be made. The excavation will be paid on cubic meter basis.

- b) P.C.C. 1:3:6 for foundation levelling course plain cement concrete proportion 1:3:6 shall be “Nominal Mix Concrete”. The general technical specification as laid down for Nominal Mix Concrete in section D-6, Concrete Works shall apply to the item also. P.C.C. 1:3:6 is to be carried out for levelling course of the chamber after excavation is carried out. P.C.C. 1:3:6 will be carried out as per dimension length, breadth and thickness given in drawings. No extra payment will be made for the concrete of larger dimensions executed than shown in the drawings.

The payment will be made on cubic meter of concrete carried out.

- c) R.C.C. 1:1.5:3 for base slab, pedestal walls and slabs

R.C.C. 1:1.5:3 for different components of chambers shall be “Mix Design” and the technical specifications as laid down under section D-6” concrete works for mix design shall also apply to this item. The necessary tests for mix – design shall be carried out by contractor as directed by engineer in charge. The mix design for the concrete will be carried out by contractor at his cost. The payment will be made on cubic meter of concrete carried out.

- d) Reinforcement – TMT bars

The reinforcement shall be TMT bar reinforcement for different components like walls, base slab and top slab of the chamber.

The general technical specifications as laid down under section D-6, “Concrete Works” sub head materials – Reinforcement specification for TMT bars reinforcement shall apply to this item also. The TMT bars shall be paid on weight basis i.e. MT and the weight will be arrived at using the standard weight per meter length of bar of each diameter.

- e) Cement plaster 15 mm thick in C. M 1: 3

The cement plaster 15 mm thick in CM 1:3 is to be applied to inside of walls fully and from ground level to top of the manhole / chambers on outside.

#### Materials

The proportions of the cement mortar for plastering 15 mm thick shall be 1:3 (one part of cement to three parts of sand) unless otherwise specified under the respective items of work. Cement and sand shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water and cement 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 upto 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.

#### Workmanship

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

Plastering operations shall not be commenced until installation of all fittings and fixtures in manhole /chambers are complete

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 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 and exterior plain faced plaster this plaster shall be laid in 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.

Wherever more than 20mm thick plaster 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 atleast 7 days.

Where specified in the drawings, rectangular grooves of the dimensions indicated shall be provided in external 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 atleast 7 days.

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

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

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

## 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.

### f) Heavy duty fibre cover with frame

The item includes providing and fixing heavy duty fibre reinforced seat and cover of approved quality and capacity. The same shall be fixed in line and level in C. C. 1:2:4 and will be finished smooth as directed by Engineer – in – charge. The payment will be made on number basis. The rates includes transportation loading and unloading of the FRC Cover.

### g) Brick Work

#### 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 200 mm x 100 mm x 100 mm with the permissible tolerances over the actual size of 190 mm x 90 mm x 90 mm 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 230 mm x 115 mm x 75 mm with tolerance upto +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, 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 minimum crushing strength of 5 N/sq.mm unless otherwise specified in the item.

The average water absorption shall not be more than 20 percent by weight upto 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 Owner. Bricks rejected by Engineer shall be removed from the site of works within 24 hours.

#### Fly Ash Bricks :

The bricks shall be hand or machine moulded and made from Fly ash, sand lime and additive. They shall be free from cracks, flaws. They shall have smooth rectangular faces with sharp corners and shall be uniform in colour. The bricks shall be machine moulded with a frog of size 100 mm. X 40 mm., and 10 mm. To 20 mm. Deep on one of its flat sides. The bricks shall not break when thrown on the ground from a height of 6 m.

The size of the conventional bricks shall be (9"x4.4/8" x 2.3/4") 225 mm. X 110 mm. X 75 mm.

Only bricks of one standard size shall be used on a particular work site. The following tolerances shall be permitted in the conventional size adopted in a particular work site.

Length : + 1/8"(3.0 mm.) Width : + 1/6" (1.50 mm.) Height : + 1/6" (1.50 mm.)

The crushing strength of the bricks shall not be less than 35 Kg/cm<sup>2</sup>. The average water absorption shall not be more than 15% by weight. Necessary tests for crushing strength and water absorption etc. shall be carried out as per IS : 3495 (Part I to IV) 1976.

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 as specified 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 tempered by adding water as required to restore consistency, but this will be permitted only upto 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 forth with from the site. Droppings of mortar shall not be re-used under any circumstances.

The Contractor shall arrange for test on mortar samples if so directed by the Engineer.

## 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 200 mm / 230 mm thick and over shall be laid in English Bond unless otherwise specified 100 mm/115 mm 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 leveled. The thickness of brick thick or half brick thick wall, atleast 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. Brick work 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 be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10 mm / 15 mm 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 brick work shall be cleaned daily and all mortar droppings remove. 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 I). 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 / pointing.

In the event of usage of traditional bricks of size 230 mm x 115 mm x 75 mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof / floor 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 item 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 20 mm thick cement sand mortar 1:4 over all the steel surfaces. Steel sections partly embedded in brick work 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 owner 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 provide in the pockets for the hold fasts of door / window frames etc. shall however, be measured and paid for separately under the respective items of work.

#### Measurement

Measurement shall be in cu.m. correct to two places of decimal for brickwork of thickness one brick i.e. 200 mm/230 mm and above. Measurement shall be in sq.m. correct to two places decimal for facing brickwork and brickwork of thickness half brick i.e. 100 mm / 115 mm and below. Measurement shall be for the quantities as actually executed duly deducting for openings, lintels, 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.

- h) Providing and fixing cast iron rungs / steps in chamber in line and levels etc. complete.

The C. I. Rungs / steps will be fabricated out of approved section of cast iron in concrete or masonry walls of chamber. The same shall be fixed at 35 cm. C/C and 35 cm staggered or as approved by Engineer in charge. The payment will be made on number basis.

### **D.14.4 DUCTILE IRON (DI) K-9 CLASS**

The hydrostatic site test pressures and hydraulic working pressures of each size of pipe shall be as per Annexure – E (Table – 1) of IS : 8329 : 2000.

#### Applicable Codes

Following IS code shall be applicable for :

1. The pipes shall conform to IS 8329-2000 with BIS certification markings on each pipe.
2. The rubber gaskets shall conform to IS : 5382 – 1969 or its latest edition.

### **D.14.4.1 GENERAL TECHNICAL SPECIFICATIONS**

#### Scope

The items includes following operations.

- a) The pipe shall be manufactured for centrifugally cast (spun) ductile iron pipe for pressure pipes, manufactured in metal (lined or unlined) or sand moulds and their joints for construction of pipelines to convey water and to be installed underground and to be operated with pressure.
- b) Cement mortar lining shall be as per Annexure B of IS 8329 – 2000 and thickness, tolerances and maximum crack width shall be as given below.

The lining shall be with Ordinary Portland Cement



- c) The pipes will be externally coated with bituminous coating as per Annexure – C of IS – 8329-2000 at store at site of work.

#### **D.14.4.2 Standards**

The ductile iron pipes to be manufactured, supplied and delivered under the scope of this contract shall be manufactured in accordance to and conforming to 8329-2000 or its latest revision **with ISI certification marking.**

##### **Scope of Item**

The scope of item shall include all cost for labour, materials and machinery etc. necessitated to be utilized for :-

- a) Proper manufacturing of the D.I. Pipes.
- b) All tests required to be undertaken at manufacturer's premises as per IS.
- c) Transportation of the pipes either by rail and or road services with all the covers duly appropriately insured by contractor.
- d) Delivery of pipes with proper loading, unloading, stacking at site of work as indicated by Engineer- in-charge.

#### **D.14.4.3 Marking**

The method of marking all the pipes to be delivered under scope of this item shall ensure that all the information will remain legible even after transportation, stacking on site etc. In general the legible and indelibly marking upon each pipe shall be indicate the followings.

- i) Manufacturer's brand name and / or trade mark.
- ii) The nominal diameter and class reference.
- iii) The lasts two digits of the year of manufacture.
- iv) BIS certification marking.
- v) Any other important matter, the manufacturer deems fit to be describe

All these marking shall be done :-

- (a) On the socket faces of pipe, centrifugally cast in metal mould and
- (b) On the outside of socket or on the barrel of pipe, centrifugally cast in sand mould

#### **D.14.4.4 Workmanship**

All pipes shall be well finished and when visually inspected shall be free from defects such as cracks surface flaws, laminations etc.

Rubber gaskets used with push – on – joints shall conform IS:5382 shall be compatible with drinking water to be conveyed at the working pressure and temperature. Therefore, the **rubber gaskets shall not deteriorate the quality of water and shall not impart any bad taste or foul odour.**

## Sampling

Sampling criteria for various tests shall be as laid down in IS : 11606.

The mechanical acceptance tests shall be carried out on samples of DI pipes as shown in Clause D.14.2 of IS : 8329 – 2000.

## Mechanical Tests

Mechanical tests shall be carried out during manufacturing of the pipes in the factory. The following tests are required to be carried out.

- (a) Tensile Test
- (b) Brinell Hardness Test
- (c) Retest

## Hydraulic Test

All the pipes shall be tested hydrostatically at a pressure specified in Table No. 1 of IS:8329 – 2000.

### **D.14.4.5 Test Certificates**

- a. The contractor shall always provide manufacturers test certificate for the grade of material and tensile strength in accordance with every batch/lot of goods as manufactured and supplied
- b. The contractor shall also produce in addition to manufacturer's test certificate as mentioned above test certificate from person / agency appointed by Municipal corporation for third party inspection.
- c. If the test reports of pipe are not satisfactory, the entire lot will be rejected
- d. Each pipe and special shall be inspected and tested in factory and a special register of pipe testing shall be maintained and a copy of the same shall be submitted alongwith the delivery of pipes and specials every time.

### **D.14.4.6 DETAILED TECHNICAL SPECIFICATION**

#### Manufacture

- a) The metal used for the manufacture of pipes shall be of good quality commensurate with the mechanical requirements laid down in IS-1387. It shall be manufactured by any method at the discretion of the manufacturer provided that the requirements defined in this standard are complied with.
- b) The pipes shall be stippled with all precautions to avoid warping or shrinkage defects, detrimental to their good quality. The pipes shall be sound and free from surface or other defects. Pipes showing small imperfections which result from the method of manufacture, and which do not affect service ability, shall not be rejected on that account alone. Minor defects arising out of manufacturing process may be rectified with the consent of the purchaser.

- c) Pipes centrifugally cast shall be heat treated in order to achieve the necessary mechanical properties and to relieve casting stresses caused due to the method of manufacture and repair work.
- d) If necessary the pipes may be subjected to reheat treatment to ensure that Brinell hardness does not exceed the specified value and the specified mechanical properties are achieved as specified
- e) Pipes shall be delivered internally and externally coated

**Internal lining :** Ordinary Portland Cement mortar lining as per Annexure – B of IS 8329 : 2000

**External coating:** Bituminous coating as per Annexure – C of IS : 8329 : 2000

#### Length of Pipes

The standard working length of socket and spigot pipes shall be 4.0 meter, 5.0 meter, 5.5 meter and 6.0 meter and for flanged pipes shall be 4 meters, 5 meters and 5.5 meters.

#### Tolerance on Thickness

Tolerance on thickness, external diameter, length and ovality shall be as per IS 8329:2000 or its latest revision or amendment.

#### Testing of Pipes

The main test among others to be conducted shall be as per IS 8329-2000 or with its latest revision or amendments and the **test reports shall be submitted alongwith each delivery of pipes and / or specials.**

#### Rubber Gaskets

- A) Rubber gaskets for use with push-on-joints or mechanical joints shall conform to IS : 5382 – 1969 or its latest edition.
- B) Rubber gaskets for push-on, mechanical and flanged joints shall be compatible with the fluid to be conveyed for materials, pressure and temperature.
- C) Rubber gaskets for mechanical joints may be suitably protected so that the elastomer does not come in direct contact with the water.
- D) Rubber gaskets for use with flanged joints shall confirm to IS 638:197D.14.
- E) While conveying potable water, the gaskets should not deteriorate the quality of water or should not impart any bad taste or foul order.

#### Stacking of Pipes

On receipt the pipes shall be stacked on wooden/concrete sleepers to ensure that they do not come in contact with earth. The contractor shall take necessary precautions for safety of pipes; so that no damage occurs during stacking.

## Inspection

Inspection of pipes and specials will be carried out by Engineer in Charge or his representative agency appointed by AMC. All the expenditure for inspection shall be borne by the Contractor except, inspection charges if any, in case of inspection agency appointed by AMC, shall be paid by AMC.

## Laying, Jointing and Anchoring

Pipes shall at all times be handled with care in accordance with manufacturer's recommendations. Pipes shall be lowered into the trench with tackle suitable for the mass of the pipes. A mobile crane or a well designed set of shear legs shall be used and the positioning of the sling checked, when the pipe is just clear of the ground to ensure a proper balance where lifting equipment is not available, small diameter pipes (normally DN 250 Mx) shall be lowered by hand using suitable ropes.

All persons shall vacate the section of the trench into which the pipe is being lowered

All construction debris should be cleared from the inside of the pipe either before or just after a joint is made. This can be done by passing a pull through along the pipe or by hand, depending on a diameter of the pipe. When laying is not in progress, a temporary closure shall be filleted securely to the open end of the pipeline. This may make the pipes buoyant in the event of end trench becoming flooded in which case the pipes shall be held down either by partial re-filling of the trench or by temporary strutting.

Jointing procedures will vary according to the type of joint being use

- (a) Clean lines of all parts
- (b) Correct location of components
- (c) Centralization of spigot within socket and
- (d) Strict compliance with the manufacturers jointing instructions.

The inside of sockets and the outside of spigots shall be cleaned for atleast the insertion depth for each joint.

Gaskets shall be wiped clean and inspected for damage. Where lifting gear has been used to support the pipe and assist in centralizing the spigot in the socket. Where the pipeline is suspected to be subject to movement due to ground settlement or temperature variation a suitable gap shall be left between the end of the spigot and the bottom of the socket. To ensure this two hand marks and made near the spigot end after jointing the end of the socket must end between these two bands.

The cutting of pipe for inserting valves, fittings etc. shall be done in a neat and workmanlike manner without damage to the pipe or lining so as to leave a

smooth end at right angles to the axis of the pipe. The burr left after cutting shall be trimmed off by light grinding or by filing.

In case of short length requirement if DI pipe is required to be cut, contractor has to cut. Pipe by electric cutter and the cut end should be chamfered for to be suitable for push – on – joint. No extra payment shall be made for this.

#### Jointing pipes laid on gradients

If pipes are laid on steep gradients where the soil/pipe friction is low, care shall be taken to ensure that no excessive spigot entry or withdrawal occurs. As soon as the joint assembly has been made. The pipe shall be held in place and the trench back filled over the barrel of the pipe.

Unless the gradient 1:2 or steeper, anchorage's are not normally necessary. However on these very steep gradients, restrained joints or anchor blocks at each socket are recommended

#### Anchoring

External anchorage shall be provided at blank ends, bends, tees, tapers and valves to resist the thrust arising from internal pressure and dynamic loading. Anchor and thrust blocks shall be designed to withstand the forces resulting from the internal pressure when the pipeline is under test, taking into account the safe bearing pressure of the surrounding soil. Considerations shall also be given to forces on the pipeline, when empty, and precautions taken against possible flotation. Wherever possible, concrete anchor blocks shall be of such a shape as to leave the joint area clear.

#### Hydrostatic Testing of the Pipeline

- \* A test length shall not be more than 1000 m. on straight or curved line.
- \* All air shall be expelled from the test segment by marking air vents at the highest point of the test section.
- \* The first part of the testing shall be to stabilize the section at a lower pressure of 1-2 kg/sq/cm at the highest point for a duration of at least 4 hours. On satisfactory completion of this, joints shall be tested against leakage by increasing the test pressure to 1.5 times the maximum working pressure in the section or as specified and holding it for 15 minutes.
- \* If the pressure drop is less than 0.2 kg/sqcm over this period, the test shall be deemed satisfactory.
- \* For the purpose of the test, either power-driven or manual reciprocating pumps shall be used with clean water.
- \* The pressure gauges shall be in good condition and of suitable ranges such as 0.4 kg/sq.cm or 0.7 kg/sq.cm, as require
- \* The air vent holes shall be properly plugged and sealed with M-Seal on completion of the test.

A pipe segment once tested shall not be used as a support to anchor the end blocks used for testing the next segment.

## Cleaning

Before a pipeline can be considered ready for service, it shall be cleaned internally as thoroughly as possible to ensure that no foreign matter remains inside the pipe. The first stage of the cleaning operation i.e. cleaning individual pipes during jointing, shall be performed Pigs of suitable design e. g. polyurethane swabs, may be used provided that the pipeline has been constructed to allow the passage of such pigs. Here the pipeline is to be tested with water, the fillings and emptying of the pipeline may to some extent cleanse the line.

### **D.14.4.7      The Scope for the item covers :**

- Cost required for jointing cleaning the site of all scrubs, bushes, and trees and dewatering where necessary.
- Cost of all materials like steel, cement, aggregate, bolts, nuts, washers, gasket etc. necessary for pipe lowering, laying & jointing.
- Labour for laying pipes in trenches to correct alignment at required depth with tools, including cutting of pipes and specials if required for laying of pipes including connecting pipes to specials and appurtenances.
- Cost of scaffolding, tools and plants, ropes etc.
- Protection of existing works from damage and cost of repair to the damages carried out of the existing structures, sewer line, telephone/electricity cables, gas pipe line, water supply / irrigation pipe line etc.
- Labour for making joints including jointing material for joints, tools as well as tests. Testing of pipes for leakage under water pressure and flushing the pipes after testing and construction work shall have to be arranged by the contractor at his own cost.

### **D.14.4.8      Method of Measurement and Payment**

The measurement shall be made in running meter basis.

### **D.14.4.9      Ductile Iron fitting**

#### Specifications

The fittings shall be tees, bends, reducers etc. Ductile iron fittings shall conform to IS – 9523 with the latest revision inclusive of high alumina internal cement mortar lining at the store or site of work including freight, loading, unloading stacking including all taxes, insurance etc. complete. The fittings shall be bitumen coating on the external surface of fittings.

### **D.14.5      DI RESILIENT (SOFT) SEATED GLANDLESS SLUICE VALVES**

#### **D.14.5.1      SPECIFICATION:-**

- (1) All Ductile Iron resilient seated sluice valves shall be manufactured strictly in accordance with and conforming to Indian Standard specification IS:14846/ BS:5163/ AWWA C 509 Or its latest amendments and detailed specification of AMC
- (2) The valves intended to be used in water supply systems up to 70°C in vertical/ horizontal position. All the sluice valves shall be Double flanged of rising spindle type and shall be of PN1.0 type.
- (3) The Material of Construction for different components, parts of sluice valves shall conform to requirements given in table below:

Sr.	Components	Material	Ref. to IS No.	Grade or Designation
1	Body and Bonnet	Ductile iron/ SG Iron	GGG-50/40 or 1865	500/7 or 400/15
2	Stem	Stainless steel	AISI 304 / 316	
3	Stem sealing	NBR wiper ring		NBR O-rings
4	Wedge	Ductile iron/ SG Iron	GGG-50/40 or 1865	500/7 or 400/15, core fully encapsulated with EPDM rubber with integral wedge nut
5	Bonnet bolts	Stainless steel	AISI 420	Sealed with hot melt
6	Bonnet gasket	EPDM rubber	WRAS or DVGW approved	EUW-70
7	Wedge Nut	Aluminum Bronze		
8	Coating	Electro statically applied epoxy powder coating	DIN 30677-2 or GSK guide lines	Internally and externally RAL Blue colour

#### **D.14.5.2 Manufacturing:-**

- a) Dimensions of each part of the valve shall conform to IS:14846-2000/ BS:5163 / AWWA C 509 or Manufacturer's standard
- b) The valve shall be glandless and pocket less for smooth flow of water.
- c) The valve shall be easy in operation having negligible head loss and it shall be maintenance free.
- d) Resilient wedge with double sealing points provides absolute water tightness.
- e) Ductile Iron wedge core is fully vulcanized with EPDM rubber on all sides.
- f) The valve shall be open anticlockwise.
- g) The flange of the valve shall conform to IS:1538-1993/ BS EN:1092-2 table-9 or its latest amendments.
- h) Hand wheel:-All valve shall be provided with hand wheels as per required size. The direction of closing shall be indicated on the top of the hand wheel.

- i) The supplier shall submit a detailed G.A. drawing which is to be approved by the AMC after awarding the work. The valves shall be manufactured and supplied according to this approved drawing.

#### **D.14.5.3 Testing:-**

The DI Sluice Valve shall be tested according to IS:14846-2000/ as per approved drawings in presence of representatives of AMC or / and AMC appointed TPI consultant. Representative of AMC or / and AMC appointed Third Party Inspection Consultant [TPI] may visit/inspect the worksite at any stage of manufacturing for inspection/testing and may reject any material which does not conform to the specified requirement. The supplier shall give at least 15 days notice period for the inspection/testing of the material. All the charges towards testing/ inspection including traveling charges of AMC representatives shall be borne by the manufacturer. T.P.I. Charges shall be borne by AMC

All valves shall be provided with enclosed greased packed spur gear box (for 400 mm dia. and above size). The valves shall be vertically operated by removable key from top accordingly the design of the shaft and Gear box shall be done. The gear box essentially be of worm and worm wheel design, self locking type with or without additional Spur gear arrangement to ensure that the effort on hand wheel is limited to 180 N pull and Push.

#### **MARKING:-**

The following information shall be cast/punched/painted on each valve body in raised letters.

- (a) The manufacturer's name or trade mark.
- (b) The nominal pressure of valve.
- (c) The size and serial number of valve.
- (d) Year of manufacturing.
- (e) Heat number of cast.
- (f) AMC/ or any other mark.

#### **Packing:**

All valves shall be supplied with the wedge close Valve of small diameter may be packed in wooden case parts liable to injury in transit shall be wrapped with wood-wool or similar material as a protection.

#### **Mode of Measurement and payment:**

The rate shall be paid in Nos. basis.

#### **D.14.6 Butterfly Valves as per IS 13095 with PN 1.0 - Gear operated**

SCOPE – Fabricated valve will not be considered

This standard cover double flanged and wafer type of metal seated, resilient seated cast iron, ductile iron, and carbon steel and lined butterfly valves for



general purpose. Valves covered under this standard are manually, pneumatically, hydraulically or electrically operate

It covers valves of nominal pressure designations up to and including 4 Mpa. and class 300 with ends flanged in accordance with appropriate table of I.S 6418 : 1971 'Cast iron and malleable cast iron flanges for general engineering purpose' or wafer type valves with bodies designed to be accommodate between pipe work flanges in accordance with appropriate table of IS 6418 : 1971 or IS 6392 : 1971 'steel pipe flanges' in nominal size DN 40 to DN 2000. It also covers valves up to class 300 and flanges as per the pressure/temperature ratings given in IS 13159 ( Part 1) : 1991 'steel pipe flanges and flanged fittings : part I dimensions' and IS 6418 : 1971 'cast iron and malleable cast iron flanges for general engineering purposes'.

#### **D.14.6.1 REFERENCE**

The Indian standards are necessary adjuncts to this standard

#### **D.14.6.2 TERMINOLOGY AND DEFINITIONS**

Terminology and definition covered in IS 4854 (Part3) : 1974 are generally applicable.

#### **D.14.6.3 VALVE END CONNECTIONS**

Double flanged valves

A valve having flanged ends for connection to pipe flanges by individual bolting.

#### **D.14.6.4 SERVICE APPLICATIONS**

Valves shall be suitable for one or more of the following applications.

- (a) Tight shut off - A valve having no visible leakage on the disc in closed position under test conditions.
- (b) Regulating - A valve intended for regulating purpose and which may have a clearance between the disc and the body in close position.
- (c) Low leakage - A valve which has specified maximum leakage rate on the disc in the closed position.

Vacuum Condition

Where valve are to be used under vacuum conditions, purchaser shall mention specifically and the detailed design provision shall be mutually agreed between the purchaser and the manufacturer.

#### **D.14.6.5 NOMINAL SIZES**

The range of nominal valve size (DN) in mm shall be as follows:

40, 50, 65, 80, 100, 150, 200, 250, 300, 350, 400, 450, 500, 600, 700, 750, 800, 900, 1000, 1200, 1400, 1600, 1800 and 2000

#### **D.14.6.6 NOMINAL PRESSURES**

Valve shall be designated by nominal pressure (PN) defined as the maximum permissible working pressure (Mpa) at 20 °C temperature as follows:  
PN 0.25, PN0.6, PN1.0, PN 1.6, PN 1.25 and PN4.0

The class designation for valves specified by nominal pipe size shall be class 125, class 150 and class 300.

#### **D.14.6.7 PRESSURE / TEMPERATURE RATINGS**

Maximum permissible gauge working pressure and operating temperatures shall be in accordance with IS 6418 : 1971 and IS 13159 ( Part I ) : 1991 except that restriction on temperature may be placed by the manufacturer on valves in accordance with this standard by reason of valve type, trim materials or other factors. However, all valves shall be suitable for continuous use at their PN designation within the temperature range of -10 °C to 65 °C.

#### **D.14.6.8 BODY ENDS**

Double Flanged Body Ends

The dimensions of flanged body ends and drillings shall be in accordance with the requirement given in Annex B. Flanges as per any other specific requirements of the purchaser may also be given as agreed to between the manufacturer and the purchaser or as per I.S. 13159 ( part I ) : 1991.

Flanges shall be at right angles to the axis of the bore and concentric with the bore. Flanges shall be drilled unless otherwise specified and bolt holes shall be off centers. Tapped by the design of the valve

Wafer Body Ends

Body ends shall be capable of being fitted between the pipe flanges complying with the requirements of annex B flange drilling.

The joint faces shall be at right angles to the axis of the bore and concentric with the bore.

Holes may be provided, where required by the design, for the passage of the bolts securing the flanges and the valve. Where through bolting is not practicable due to the presence of valve shaft, bearing housing, tapped holes may be provided for individual bolting of each flange.

#### **D.14.6.9 FACE TO FACE DIMENSIONS**

Face to face dimensions of double flanged and wafer types of valve shall be as per Table 1.

Face to face dimensions given in Table 1 are exclusive of the sealing gaskets at both ends.

The manufacturer shall ensure that adequate space will be available between valve flanges for bolting when flanged valve with short body face to face to face or wafer long face to face are manufacture

Tolerance on face to face dimension in Table 1 shall be as follow

Face to face dimension of Unlined valve MM		Tolerance MM
Over	Up to and Including	
0	250	$\pm 2$
250	500	$\pm 3$
500	800	$\pm 4$
800	100	$\pm 5$
1000	2400	$\pm 6$

#### **D.14.6.10 BODIES**

Bodies end ports shall be circular and the numerical valves of the diameter shall be as close as possible to the valve of DN.

#### **D.14.6.11 DISC AND SHAFT**

The disc and shaft shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The shaft may be of one piece design or in two pieces separately attached to the disc. Any means of attachment between the shaft and the disc shall be such as to preclude components becoming loose in service.

#### **D.14.6.12 SEATING AND LININGS**

Non-integral seating, and lining shall be used, and their means of attachment shall be such as to preclude their becoming loose in service.

#### **D.14.6.13 BEARINGS**

The bearings shall be suitable for the maximum loads imposed by the shaft during testing and in service.

For valves DN 350 and above, a bearing shall be provided to take the axial thrust, spring retaining clips (circlips) shall not be used as thrust bearing.

Suitable sealing shall be provided for the shaft where it passes outside the pressure containing enclosure.

#### **D.14.6.14 MATERIAL OF CONSTRUCTION**

This standard is based on materials specified in I.S.S. Unless otherwise agreed, the materials shall be of a grade equivalent to those given in I.S.S. or superior. Other material may be used as per agreement between the manufacturer and the purchaser. The material of construction shall be as per table given below

<b>Sr. No.</b>	<b>Part Component</b>	<b>Pressure Rating (1 Bar + 1 atmosphere)</b>
1.	Body	I. / S.G.IRON IS 1865 GR 400/12 or 500/7
2.	Disc	I. / S.G IRON IS 1865 GR 400/12 or 500/7
3.	Shaft (DE/NDE)	SS AISI 410
4.	Seal	EPDM Rubber having Properties equal or superior to the following. 1) Tensile strength Min. 130 Kg/cm <sup>2</sup> 2) Elongation at break: Min 375% 3) Tear resistance : Min.35 Kg/cm <sup>2</sup> Compression set at 100°C for 72 hours: Max. 20%.
5.	Seat ring / Retaining Ring	SS AISI 316
6.	Bearing	Steel backed PTFE
7.	Internal Hardware	SS AISI 316
8.	External Hardware	C S to IS 1367
9.	Hand wheel	M.S. round, Chrome Plated
10.	Cast Steel parts to be protected with coating suitable for tropics.	Clause 16 of B.S. 1218
11.	Drilling of valves flange	Drilling of the flange shall be as per Table of BS 4504 / IS 1538 and thickness of the flange as per the pressure rating of the valves.

The material of construction of Gear Box for valves shall be as per table given below

Sr. No.	Description	Materials
1.	Gear Case & Cover	Cast Steel ASTM A 216 Gr. WCB or S.G Iron to IS 1865 Gr. 400/15
2.	Sector Gear	I. / S.G.I. IS 1865 Gr. 600/3
3.	Worm / Shaft, spur Gear /pinion /shaft	BS 970 EN 19 / EN 24
4.	Fastners / Dowels	SS 316 / SS 304
5.	O – Rings	Nitrile Rubber with Shore hardness of 65 $\pm$ 5
6.	Bearing for shaft	Ball / Roller bearing.

#### **D.14.6.15 OPERATION**

##### **Manual Operation**

All valves shall be capable of operated at a differential pressure across the disc as marked on the valve. Lever, worms gear / travelling nut type or any other suitable type of operator can be use

##### **Direction**

Unless otherwise, specified manually operated valves shall be closed by turning hand wheel or lever in a clockwise direction when facing the hand wheel or lever. The design of lever when fitted shall be such that the lever may only be assembled to the valve so that it is parallel to the direction of flow when the valve is open.

All gear travelling nut operators shall be provided with suitable stops to prevent movement of the shaft beyond the limit corresponding to the fully closed position of the disc.

All gear travelling nut operators shall be packed with grease for life time operation. Gear / travelling nut operators shall be totally enclosed and weather proof for general application. For special applications such as marine, submerged service etc. the purchaser may specify special en-closer.

All gear / travelling nut operators shall be self locking type. All leaver operated valve shall be capable of being locked at least three intermediate position.

The operating hand-wheels shall be marked 'CLOSE' or 'SHUT' to indicate the direction of closer.

The operator shall be provided with arrangement to indicate the disc position.

#### **D.14.6.16 TESTING**

All valves shall hydrostatically tested by the manufacturer before dispatch. The pressure shall be obtained without any significant hydraulic shock. Testing shall be carried on before application of paint or other similar treatment unless otherwise agreed between the purchaser and the manufacturer. There shall be no air entrapped within the part of the valves subjected to test pressure.

##### **Performance Testing**

Each valve shall be shop operated from fully closed to fully open position and reverse, under no pressure and no flow condition to demonstrate that the complete assembly is workable.

##### **Body Test**

Completely assembled valve shall be tested as follows:

‘The body ends shall be blanked so that the valve is subjected to the full pressure in all directions include by the test pressure wafer valves may be tested in any suitable manner agreed between the purchaser and the manufacturer. The valve disc shall be in slightly open position and pressure equivalent to 1.5 times the maximum permissible working pressure shall be applied with water. The duration of this test shall be as in Table 3 below in Para 17.3.

##### **Seat Test**

The seating surface of the valve shall be cleaned unless a surface treatment forms an integral part of the design or the use of a temporary surface treatment has been agreed between the manufacturer and the purchaser to avoid the possibility of damage under the condition of the test.

<b>NOMINAL DIA MM</b>	<b>MINIMUM TEST DURATION IN MINUTES</b>	
	<b>BODY TEST</b>	<b>SEAT TEST WHEN APPLICABLE</b>
Up to and including 50	0.25	0.25
65 to 150	1.00	1.00
200 to 300	2.00	2.00
350 to 1000	5.00	2.00
1200 to 2000	5.00	3.00

Each valve shall be shop tested for leaks in close position. The test shall be conducted with the body flanges in a horizontal position. Pressure shall be applied to the upstream end of the valve, the downstream being open to atmosphere. The duration of test shall be as per Table above. There shall be no indication of leakage past the valve disc during test and valves shall be drop tight. Seat test shall be carried out in both the direction of valve if agreed between the manufacturer and the purchaser. The seat pressure applied on

upstream side shall be equivalent to 1.1 times the maximum permissible working pressure at 20 °C and shall be applied with water.

For regulating type valves seat test shall not be applicable.

#### Disc Strength Test

The test shall be conducted with the body flanges in horizontal position. The test pressure shall be 1.5 times the maximum permissible pressure at 20 °C. With disc in closed position, hydro test pressure shall be applied to the lower face of the disc for duration as per table-3. There shall be no damage to the valve disc nor shall any part of valve or disc be permanently deformed by the test. The purpose of this test is to provide evidence of the adequacy and structural integrity of disc and body. Any leakage past the seat shall not be the criteria for rejection of the valve (Sampling test sample as per IS 2500). For regulating type valves, disc strength shall not be applicable.

Maximum permissible leakage shall be as given in Table in para 18.0.

### **D.14.6.17 TEST CERTIFICATES**

When specified by the purchaser, the manufacturer shall issue a test certificate confirming that the valves have been tested in accordance with this standard and stating the actual pressures and medium used in the test.

<b>VALVE TYPE</b>	<b>LEAKAGE RATE</b>
Tight shut-off	No visible leakage for duration of test
Low leakage	0.1 mm <sup>2</sup> /s X DN (sec 5)
Regulating	Not specified Outside the scope of this standard

### **D.14.6.18 INSPECTION**

The purchaser or his authorized representative shall have access to the manufacturer's works at all reasonable times to inspect assembled valve at factory. The bidder has to make necessary arrangements for testing facilities of the valves as per the relevant IS at factory.

### **D.14.6.19 WITNESSING OF TESTS**

When the purchaser desires to witness the tests, this shall be specifically agreed in advance.

### **D.14.6.20 MARKING**

Marking shall be cast integral on the body or on a plate securely attached to the body. The markings shall be in accordance with I.S. 9866: 1981.

#### **D.14.6.21 PREPARTION FOR DISPATCH**

- (a) Valve shall be complete in all respect when dispatche Each valve shall be drained, cleaned, prepared and suitable protected with 2 coats of red oxide on un machined surfaces and rust preventive coats on machined and flanged surfaces for dispatch in such a way as to minimize the possibility of damage and deterioration during transit and storage. Painting other than specified on the finished valve shall be as per the agreement between the manufacturer and the purchaser.
- (b) Disc shall be unseated when dispatched, but care shall be taken to ensure that there is no risk of damage to the disc.
- (c) When specified, the body ends shall be suitably sealed to exclude foreign matter during transit and storage.
- (d) Components shipped unattached shall be adequately protected and identified to permit correct field assembly.

#### **D.14.6.22 MODE OF PAYMENT**

The payment will be made on No. basis.

#### **D.14.7 Tamper proof double acting Kinetic Air Valves**

Tamper proof double acting Kinetic Air Valves are to be supplied which shall be designed as per IS 14845 / AWWA C512-92 standards.

##### **D.14.7.1 GENERAL**

The double air valves shall have two ball chambers, having one outlet of large capacity for admission and release of bulk volume of air during emptying and filling of the main and another having small outlet for escape of smaller quantities of entrapped air. This type of air valves shall be of flanged type with full conformation with IS:1538.

The ball sealed orifice always remains open while air is exhausting and is immediately closed when water rises in the chamber, lift the ball and seals the orifice. It shall also ensure that there are no recesses or pockets, sheltering, escaping air for the large orifice (low pressure) valve to drop into when the valve is open. Turbulent air at the time of filling of pipe shall not circulate in such cavities and cause the ball to blown into when the valve is open. Turbulent air at the time of filling of pipe shall not circulate in such cavities and cause the ball blown into the discharging air streams, blowing the valve shut prematurely.

The cone angle of the lower pressure chamber shall be such that even at the critical velocity of air escape at 300 m/sec. The total impact force on the ebonite covered ball is less than the suction force on the angular area between the ball and the cone. The design of the valve should be such as to allow maximum free air discharge at various pressure differentials. The tenderer shall submit with the tender full set of curves showing discharge of free set of



curves showing discharge of free air valves pressure differential for all sizes of valves offered by him.

Under no circumstances shall be large orifice ball blow shut prematurely.

The low pressure cover shall be massive and designed to withstand full operating thrust in working conditions.

Air valve shall be design to prevent premature closure prior to all air having been discharge from the line. The orifice shall be positively sealed in the close position but float ( Ball) shall only be raised by the liquid and not by mixer of air and liquid. The sealing shall be design to prevent the floats sticking after long period in the close position.

All branched outlets including outlets for Air valves will be with compensation pads (Dia of Main / For branch Dia ratio greater than 3). Diameter of compensation pad will not be less than 1.75 times the O. of the branched outlet. Plate thickness for pads will be same that of the main.

For outlets with above ratio less than three, then the joints will be of plate reinforcement type.

All branched outlets including air valve tee's will be provided with one ½" BSP coupling duly plugged for measurement of pressure in due course. The closing plug will be in Stainless Steel (AISI 304 or equivalent) with Hex. Head and will be provided with copper washer for sealing.

The neoprene seat ring shall be held securely in place under the low pressure cover by a joint support ring to prevent it from sagging when the ball is not sealing the orifice.

The valve body, the orifice cover, cowl of the air valves shall be made of cast iron of grade 2 of IS:210.

Where tenderer considers necessary a suitable drain plug shall be provided

#### **D.14.7.2 HIGH PRESSURE ORIFICE**

The high pressure orifice and the high pressure chamber shall be so designed that the orifice is effectively sealed in working conditions by "EPDM" coated float.

The material of the orifice shall be gunmetal. The orifice shall be of size not less than 3 mm and tapering to 100 mm suitable to release accumulated air within the pipe. The profile of the orifice shall be carefully chosen to avoid damage to the float surface. The orifice shall be protected by a suitable plug of stainless steel.

### **D.14.7.3 VALVE FLANGES**

All valves flanges shall be designed to withstand the stresses to which they would be subjected under hydraulic tests. Flanges shall be machined flat. The flanges shall be drilled in accordance with IS:1538 (part – I to XXII) – 1976 (specifications for C. I. Fittings for pressure pipes for water etc.)

### **D.14.7.4 COATING**

The casting shall be such that it shall not impart any taste or smell to water. The coating shall be smooth, glossy and tenacious, sufficiently hard so as not to flow when posed to a temperature of 770 C and not so brittle at a temperature of 150 C as to chip off when scratched lightly with the point of penknife.

Alternatively, two coats of black Japan conforming to type 8 of IS 341-1971 (Or latest edition) or paint conforming to type – 2 of IS 158-1969 (OR latest edition) shall be applied

### **D.14.7.5 TAMPER PROOF AIR RELEASE VALVES**

The bidder has to supply tamper proof Air Release Valves.

The valves shall be

- (i) 100% tamper proof
- (ii) Zero water leakage
- (iii) Unaffected by strong air flow
- (iv) Maintenance free

The tamper proof air release valve shall have following:

- (i) Double orifice & double float.
- (ii) Stainless steel large & small float.
- (iii) Stainless steel guiding stem for large float shall give 100% perfect closing.
- (iv) Aerodynamic bucket design for maximum airflow & which should restrict entry of foreign material.
- (v) Integral vent welded to inverted cap made of MS should restrict tampering of Air Release Valve large orifice.
- (vi) Small orifice automatic valve vertically assembled should discharge small quantity of dissolved air / air pockets automatically.
- (vii) Design shall be as per AWWA C512-92 standards.
- (viii) Air Release Tamper Proof Valves shall be tested as per IS 14845 – 2000.

### **9.7.6 MATERIAL OF CONSTRUCTION OF KINETIC AIR VALVES**

<b>Sr. No.</b>	<b>Kinetic Air Valves</b>	<b>Material Description PN 10, PN 16 / PN 25</b>
1	Body	Ductile Ion DIN 1693-GG40/ Spheroidal Graphite Iron IS 1865 Gr 400/15
2	Float (Large)	Stainless Steel : ISI – 304 / 316 / 316L

<b>Sr. No.</b>	<b>Kinetic Air Valves</b>	<b>Material Description PN 10, PN 16 / PN 25</b>
3	Nozzle	Gun Metal : IS 318 LB2 / GM + Neoprene Rubber
4	Gasket	Rubber : Neoprene
5	Cover	Carbon Steel : Plate
6	Fasteners	Carbon Steel : IS 1363

#### **D.14.7.7 TESTING**

The air valves shall be tested as per IS 14845 – 2000. The air valves shall withstand 1.5 times the working pressure. The joints and air valve shall be water tight. During test if the joints of air valve are found leaking or the air valve is found not functioning properly then the same shall be got rectified or replaced by the contractor to the satisfaction of Engineer-in-charge.

#### **D.14.7.8 MODE OF PAYMENT**

The payment will be made on No. basis.

**D.14.7.9 Fixing of Valves :** All type of valves shall be lowered and fixed in proper position and right to the plumb and flange joints with the sets of tail pieces shall be carried out perfectly water type. Nut, bolts, rubber insertion etc. required shall be got approved by the Engineer in charge of AMC.

## **D-15 : SPECIFICATIONS FOR SINKING OF WELLS FOR FOUNDATIONS**

### **SECTION : D-15**

#### **D.15.1 SINKING OF WELLS FOR FOUNDATIONS**

##### **Scope**

This specification covers the general requirements of sinking of wells for foundations, bottom raft of well, M. S. cutting edge for R.C.C. well curbs, controlled cement concrete (with sulphate resistant cement) M-30 mix for well curbs, M-30 mix with for well steining, M-30 mix for base slab etc.

#### **D.15.2 SINKING OF WELLS**

##### **General**

This item includes sinking of wells for foundations through sand, gravel, loose boulders silt, clay, soft and hard murrum and all such other similar strata except through rock to the required level as may be directed by the engineer-in-charge including removal of excavated stuff, isolated boulders, any tree, logs or any other similar objects, and adopting for this purpose, suitable methods such as open dredging or mechanical grabbing by using winches, including use of drop chiselling, employing of divers including pneumatic drilling for breaking and reiving loose isolated boulders and all such other methods of well sinking except resorting to pneumatic sinking.

The well shall as far as possible be sunk true and vertical through all types of soils. The well shall be sunk by excavating materials uniformly from inside the dredge hole. Sinking or loading of the well with kentledge shall be commenced only after the steining has been cured for at least 48 hours or as specified in the approved specifications/ drawings. Kentledge shall be placed in an orderly and safe manner and in such a way that it does not interfere with the excavation or material from the damage hole and also does not in any way damage the steining of the well. Normally dewatering of well shall not be permitted as a means for sinking the well. It also shall never be resorted to if there is any danger of sand blowing under the well. Water jetting may be employed for well sinking, wherever necessary.

Explosives shall not be generally used as an aid for well sinking. However, in cases where explosives are to be used, prior approval of the Engineer-in-charge shall be obtained. Blasting of any sort shall only be done in the presence of Engineer-in-charge and not before the concrete in the steining has hardened sufficiently and is more than 7 days old. Mild explosive charges may be used as an aid for sinking of the well only with the prior permission of the Engineer-in-charge. If blasting has been used for setting the well after it has reached the design foundation level normally 24 hours shall be allowed to lapse before the bottom plug is laid. The charges shall be exploded well below the cutting edge by making a sump so as to avoid chances of any damage to the curb or to the steining of the well. All prevalent laws concerning handling, storing and using of explosives shall be strictly followed.

When the wells have to be sunk close to each other and distance between them is not

greater than the diameter of wells, sinking shall be taken up on all wells and they shall be sunk alternately so that sinking of all wells proceeds uniformly and together. In sinking dump-bell of double D-shaped wells the excavation in both the dredge holes should be carried out simultaneously and equally to facilitate even sinking. All wells on which sinking is in progress shall be sunk to sufficient depth below the designed scour level before the seasonal floods. Further, they shall be temporarily filled and plugged before the onset of the floods so that they do not suffer any tilt or shift. All necessary precautions shall be taken against any possible damage to the foundations of existing structures in the vicinity of the wells, prior to commencement of dredging from the well. The dredged materials shall not be allowed to, accumulate over the well. It shall be dumped, as far away from the well as possible, and then continuously and simultaneously removed. In case the river stream flows along one edge of the well sunk, the dredged materials shall not be dumped on the dry side of the bank but on the side on which the river current flows. Very deep sump shall not be made below the well curb as it entails risk of jumping (sudden sinking) of the well. Normally the depth of sump shall not exceed 3.0 metres below the level of the cutting edges unless otherwise specially permitted by the Engineer-in-charge. In case a well sinks suddenly and with a jerk, the steining of the well shall be examined to the satisfaction of the Engineer-in-charge to see that no damage has occurred to it.

Tilt and shift of each well shall be measured regularly during the entire sinking operation. Observations to this effect shall be taken at each stage of casting of the steining. Simultaneously, as the sinking proceeds, necessary corrective measures be taken to obtain the lifts and shifts within the permissible limits. Unless otherwise specified, the tilt of any well shall not exceed 1 in 80 and the shift shall not be more than 5% of the outside diameter of the circular well or of the maximum outside dimension of the well for any other shape subject to a maximum of 150 mm. **If the tilt and shift exceed the above limit for any well, that well shall be liable to rejection at the discretion of the Engineer-in-charge at the entire risk and cost of the contractor.** If under any circumstances the Engineer-in-charge allows tilt and / or the shift more than that specified above and which cannot be corrected. **The stresses at the foundation level due to tilt and shift can not be brought within permissible limits the contractor shall rectify the well or reconstruct the same at his own cost.** The cost of the cement and steel supplied to the contractor and used in the rejected well as well as in the new well laid in its place shall be recovered from him. Payment of part or full rate during the process of sinking shall not be considered as part or full acceptance of the work till it is sunk to the designed or required level and satisfies the design requirements in regard to tilts and shifts.

Every well started during any working season must be completed, plugged, filled with sand and sealed with well cap at top within that working season so as to be safe from floods and tides as far as possible. If the sinking of a well upto the designed or required level, plugging it at bottom and top sand filling and concreting the well cap can not be complete in one working season, the following precautionary measures shall be taken by the contractor at his own risk and cost.

- (i) All exposed reinforcing bars shall be carefully bent down along the steining and temporarily be embedded in lean concrete.
- (ii) The dredge holes shall be filled up with sand right upto top of well steining as cast and suitably covered up with adequate wooden planking or by any other method approved by the Engineer-in-charge.
- (iii) All precautionary measures shall also be taken to prevent any damage or shift or tilt to the well due to floods during monsoon.

**D.15.3 Measurement :** Sinking of a well be measured from the water level / ground level at the time of casting the curb or from the level at which the bottom of the cutting edge is laid initially; whichever is lower to the bottom of the cutting edge in the final position. Any scooping of the bottom of the foundation or “Kundi” below the level of the bottom of the cutting edge shall not be measured or paid. If the level at which the bottom of cutting edge is actually laid is lower than the water level at the time of casting the curb, the same shall be recorded by the Ex-Engineer of the work or Assistant Engineer-in-charge of the work and shall be countersigned by the contractor or his authorised representative in token of its acceptance. If for any valid reasons in some very rare case, it becomes impracticable to lay the curb at or below the sub-soil water level, the contractor shall be permitted to lay the curb at level higher than the sub-soil level, but sinking shall be measured from water level only and in such cases, excavation above water level will, however, be payable under the item of open excavation for foundation of the relevant strata. For the purpose of payment the rate of sinking will vary according to range of depths as given in the schedule ‘b’ for this item.

**D.15.4 Payment :** The rate for sinking shall include the cost of all labour, tools and plant and other operations required, such as dewatering, excavation and bailing out materials, providing and placing kentledge on top of well and removing the same and contingencies warranting provision of temporary top plug in the event of floods being expected at site making further sinking not possible and also other incidental works to sink the well to the level shown on the drawings. It shall also include blasting or use divers for removal of obstacles from under the cutting edge of the well. The rate shall be applicable for all types of soil except rock.

## **D.15.5 BOTTOM RAFT FOR WELL**

### **General**

A.1.3.1.1(A) After getting a written permission of the Engineer-in-charge, divers shall be sent down to clean the inside faces of the curbs and to remove any adhering clay or other deposit therefrom, and to remove away any rubbish or loose material that may accumulate in the bottom. Before commencing plugging, all the loose material from the bottom of the well shall be removed. Careful soundings shall be taken and the entire bottom surface shall be brought to uniform grade.

The laying of concrete wherever and whenever possible shall be done in dry condition by pumping out water and where not practicable, concrete shall be laid under still water by tremie or by specially designed water tight collapsible drop bottom buckets or other approved methods as may be decided by the Engineer-in-charge. When laid under water, concreting shall be done with water levels both inside as well as outside the well equal. Concreting under hydrostatic pressure shall not under any circumstances be permitted. No pumping shall be permitted during the course of concreting. The placing operations of concrete for the bottom raft shall be continuous without any break till the full thickness of the raft is formed to effectively seal the interior of the well without any laminations. The concreting by tremie or other method as may be approved by the Engineer-in-charge shall also conform to the requirements as per clause 13.2 of IS. Code of practice for plain and reinforced concrete for general building construction No. IS : 456 (latest edition).

Where tremie is used, it shall be of suitable size having dia of not less than 20 cm and the hopper large enough to hold not less than one entire batch of the mix or the entire contents of the transporting bucket when one is used. Each tremie shall be supported independently in such a manner as to permit free movement of the discharge and over the entire top surface of the work and so as to permit quick lowering when necessary to slow down or stop the flow of concrete. The consistency of concrete shall be got approved from the Engineer-in-charge and shall be laid by the most satisfactory method in proper manner.

After depositing, concrete shall be allowed to set for atleast 14 days during which period water in the well shall not be pumped nor disturbed for any purpose. After the raft concrete has sufficiently set i.e. after 14 days of concreting, it shall be tested for water tightness by dewatering the well to the extent about 4.5 m below the average water level or the tide level in the creek at the site of work. Necessary precautionary measures shall be taken against

buoyancy of the well due to differential head of water acting from below by way of putting kentledge load on the well if so necessary before dewatering.

The well raft shall be considered satisfactory if after dewatering to the extent as above, the rate of leakage through or by the side of the raft is such as not to raise water level in the well by more than 0.3 m. in the first two hours. If the test does not prove successful and much leakage is noticed during the pumping, more concrete shall be deposited at the cost of the contractor until the safe height is reached to effectively seal the leakage of water into the well.

The specifications as laid down under Section of 'Concrete work' of this volume shall be followed except for the above modification and additions.

The rate to be for this item shall be per cubic measurement of raft concrete actually laid. Generally the cubic quantity of concrete shall be calculated on the basis of average foundation level and the actual top level of the raft. For determining average level of the base, sounding shall be taken at different points in this well and levels recorded and signed by the Engineer-in-charge and the contractor before starting the work.

**Measurements :** The methods of measurement may however be changed at the direction of the Engineer-in-charge in case it is difficult to ascertain the correct depth of raft laid, in which case quantity to be paid shall be based on the average yield of the finished concrete under water per bag of cement, which shall be taken as 0.15 cm per bag of cement consumed. This shall include extra 10% cement to be used for concrete to be laid underwater.

**Payment :** Unit rate of the item shall include cost of labour, materials, tools and plant required to complete the work.

#### **D.15.6 M. S. CUTTING EDGE FOR RCC WELL CURBS**

##### **General**

Finished rolled materials shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges and other defects. It shall have a smooth, uniform finish, and shall be straight. It shall be free loose mill scale, rust pits or other defects affecting its strength and durability. The acceptance of any materials on inspection at the mill i.e. rolling mills, foundry or fabricating plant where materials for the work is manufactured, shall not be a bar to its subsequent rejection, if found defective. Mild steel for bolts and nuts shall conform to IS : 226 but have a minimum tensile strength of 44 kg/mm<sup>2</sup> and minimum percentage elongation of 14.

All work shall be in accordance with the drawings. Care shall be taken that all parts of an assembly fit accurately together. All structural steel members and parts shall have straight edges and blunt surface. If necessary, they shall be straightened or flattened by pressure unless they are required to be curvilinear forms. They shall also be free from twist. Pressure applied for straightening or flattening shall be such as would not injure the materials. Adjacent surface



or edges shall be in close contact or at uniform distance throughout. All structural steel parts where required shall be sheared, chopped, sawn or flame cut and ground accurately to the required dimensions and shape. All edges of splice and gusset plates 12 mm thick and over shall be machined and those less than 12 mm thick may be sheared and ground.

The diameter of rivets shown on drawings shall be the size before heating. Each rivet shall be of sufficient length to form a head of the standard dimensions as given in IS Hand book on steel section, Part-I. It shall be free from burrs on the underside of the head. All loose or burnt rivet and rivets with cracked or badly formed defective heads or with heads which are unduly centric with the shanks, shall be removed and replaced. In removing rivets, the head shall be sheared off and the rivet punched out so as not to injure the adjacent metal and if necessary, they shall be drilled out. Recouping and caulking shall not be permitted.

All welding shall be done with the prior approval of the Engineer-in-charge shown on the workmanship shall conform to the specifications of IS : 823. When materials thickness is 20 mm or more special precautions like preheating shall be taken as laid down in IS : 823.

The cutting edge shall be fabricated to the exact shape and dimensions shown on the detailed drawings. The steel sections shall be bent cold to the required shape by making V-cuts in the horizontal portion at not less than eight places for single well at uniform intervals along length. The V-cuts shall then be welded together electrically. Steel cutting edges shall be transported on site and shall be conveyed to the exact location by any means including launching by barges if necessary and shall be placed in true positions as directed by Engineer-in-charge.

**Measurement :** The measurements of this item shall be in tonnes based on the weight of metal in the fabricated structure computed on the basis of nominal weight of materials. No payment shall be made for rivets, bolts, nuts washer and for welding. No deduction shall be made for the hole punched or V-cuts made in the structure.

**Payment :** The unit rate shall include the cost of all materials, labour, tools and plants including setting out on site to complete the work.

#### **D.15.7 CONTROLLED CEMENT CONCRETE (WITH SULPHATE RESISTANT CEMENT) M-30 MIX FOR WELL CURBS**

##### **General :**

Cement shall be procured in accordance with the Standard Specifications and Code of practice prescribed in the relevant Indian Standard Specifications.

The specifications as laid down under Section of concrete work of this volume shall be followed for concrete work further details pertaining to this work are as under:

Well curb shall be laid accurately on level ground or island specifically prepared for the purpose and at the exact position and level as directed by the

Engineer-in-Charge. All reinforcement shall be placed in position, the curbs securely fixed to the M.S. Cutting edge as per detailed drawing before the concreting which shall be commenced only after the same is permitted by the Engineer-in-Charge.

### **Kentledges**

In no case shall any kentledge be put on the well curb within 4 days of the laying of the concreting nor at any stage the permissible stress in the concrete shall be exceeded by putting excessive kentledge at any time during sinking.

The contractor shall be fully responsible for any damage in the curb during progress of sinking and he shall rectify the same at no extra cost and to the entire satisfaction of the Engineer-in-Charge.

**Payment :** The payment for this item shall be on the cu.m. basis of concrete.

## **D.15.8 CONTROLLED CEMENT CONCRETE (WITH SULPHATE RESISTANT CEMENT) M-30 MIX FOR BASE SLAB**

### **General :**

Before concreting, the well shall be dewatered to the extent required, to enable the concrete of the base slab to be laid at the level, as shown on the detailed dewatering or as directed by the Engineer-in-charge.

The specifications as laid down under Section of concrete work of this volume shall be followed except for the above modification and additions.

**Payment :** The rate to be paid for this item shall be per cubic meter of base slab concrete actually laid, and is inclusive of the cost of dewatering where necessary.

Unit rate of the item shall include cost of labour, materials, tools and plant required to complete the work.

## **PLAIN CEMENT CONCRETE (WITH SULPHATE RESISTANT CEMENT) M-30 MIX FOR WELL STEINING**

Providing and casting in situ Plain cement concrete (with sulphate resistant cement) M-30 mix for well steining including necessary shuttering, laying, vibrating and curing etc. complete.

### **General :**

The dimensions and shape of the well shall strictly conform to those shown on the drawings. The steining of the well shall be built on one straight line from bottom to top, the work being checked carefully with the aid of straight edges of lengths approved by the Engineer-in-charge. Plumb bob or spirit level shall not be used. Steining built in the first stage shall not be more than 2 metres

and in subsequent stages, it shall not exceed the diameter of the well or the depth of well sunk below the adjoining bed level a time. As far as possible, the stages of work shall not be kept at the location of joints in the vertical steining bars. The height of steining shall be calibrated by making at least 4 gauges distributed equality on the outer periphery of the well each in the form of a 10 cm wide strip painted on the well. Each in the form of a 10 cm wide strip painted on the well, with every metre mark shown in black paint. The gauges shall start with zero at the bottom or cutting edge. Marking of the gauges shall be done carefully with a steel tape. After sinking of a stage in complete all damaged portions of steining at top of the previous stage shall be properly repaired before constructing the next stage. When dowel bars for foundations are to be provided, 100 mm holes shall be kept in steining itself at regular intervals as shown in drawings or as directed by the Engineer-in-charge.

The specifications as laid down under Section of specifications of concrete work of this volume shall be followed except for the above modification and additions.

**Payment :** The payment shall be made on cubic meter basis.

## **D-16: SPECIFICATIONS FOR PILE FOUNDATION WORKS**

### **SECTION : D-16**

#### **D.16.1 General :**

- 1 These specifications cover reinforced cement concrete driven / bored cast in situ piles including all related items of work like sand filling in the holes left after casting the piles, chipping off a small length at the top, load test on a single and/or groups of piles, taking cores for ascertaining strength of concrete in pile etc. The relevant clauses of the specifications for concrete plain and reinforced as per relevant IS codes, fall within the scope of these specifications.

#### **2 Extent of Contractor's services :**

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

- (a) Furnish all labor, supervision, services, materials, piling equipment, tools, plants, transportation etc. required for the work for pile foundations conforming to the detailed drawings or as may be specified, including all surveying and setting out arrangements necessary for fixing correct locations of piles etc.
- (b) The identification plan showing the proposed sequence of piling will be prepared on the basis of plan furnished by the engineer and get the same approved from the competent authority before commencing pile work.
- (c) Submit in prescribed form detailed daily report of piling work done giving all information as required by the Engineer – in – charge.
- (d) Furnish details of the pile driving boring and casting equipment giving all salient dimensions and loads.
- (e) Carry out tests to the satisfaction of the Engineer-in-charge including casting and dismantling test caps if done and submit the test results in prescribed data sheet as given under Appendix – D in pursuance to provision under Clause 7.13.2 of IS. 2911 (Part I/Sec 2) 1979.
- (f) Make necessary earthwork and approaches for movement of the equipment for execution specified, and cleaning up the works area etc.
- (g) Provide all necessary work mentioned under the “Technical Specifications for concrete, plain and reinforced: as per relevant IS codes as may be applicable.

### **3 Work provided by others :**

No work under these specifications, will be provided by any agency other than the contractor unless specifically mentioned otherwise elsewhere in the contract.

### **4 Codes and specifications applicable :**

The following Indian standard codes and specifications, unless otherwise specified herein, shall be applicable.

- i) IS : 269 - Specifications for ordinary and low heat port land cement.
- ii) IS : 432 - (All parts) Specifications for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
- iii) IS : 455 - Specifications for portland and reinforced concrete.
- iv) IS : 456 - Code of practice for plain and reinforced concrete.
- v) IS : 2720 - Method of tests for soil (Part – I)
- vi) IS : 2911 - Code of practice for design and construction of pile foundations part I (all sections) concrete piles.
- vii) IS : 3385 - Code of practice for management of civil engineering works part I pile foundation.
- viii) IS : 5121 - Safety code for piling and other deep foundations.

Other IS codes pertaining to the items of piling work and not listed above shall also deem to come under the purview of this clause. The provision of special conditions of contract those specified on the execution drawings or other specifications issued in writing by Engineer-in-charge shall also form part of these specifications.

All codes and standards referred to in these specifications shall be of the latest version. Where IS codes are not available, a reference to British Standards / Codes will be made.

### **5 Conformity with designs :**

The contractor will prepare check list in approved Performa which will be called “Pile Installation Card. At each important stage of the work as decided by the Engineer-in-charge for correctness and conformity with the design, specifications and drawings, before allowing the next phase of the work to

commence. These intermediate checks and approval by the Engineer-in-charge will not, however absolve the contractor from his total responsibility to execute the work as per the specifications and drawings and to remove and / or rectify all work which is defective or inaccurate.

**6 Soil Data :**

The information as to the bore hole log details and soil investigation report, are given in good faith and for general guidance only. The client will not be responsible for any discrepancy or inaccuracies therein and shall not entertain any claim whatsoever from the contractor on the basis if the same.

**7 Other Data :**

Nothing contained in this contract documents or these specifications shall relieve the contractor from the responsibility of obtaining the approval from the Engineer-in-charge, the pile installation procedure to be followed by him. During the execution of the work, should any error or inconsistencies appear in any of his contract documents, the contractors shall not proceed with the work before obtaining instructions / clarifications from the Engineer-in-charger.

**8 Site Inspection :**

The contractor is directed to inspect the site and satisfy himself about the working conditions, availability of approach, facilities of water, power utility services etc. and he shall be deemed to be aware of all the site conditions in so far as the requirements of carrying out pile foundations is concerned.

**D.16.2 Materials :**

**1 General :**

All materials whether incorporated in the works or used temporarily for executing will be of the best approved quality conforming to the latest Indian Standard Specifications.

**2 Concrete & Reinforcement :**

The relevant clauses in the specifications for concrete, plain and reinforced, enclosed are applicable. If no specific specifications are enclosed, the relevant IS Codes are deemed to form part of this specifications.

**3 Drilling Mud (Bentonite) :**

**(a) General :**

For soft soils if required drilling mud (bentonite) will be used. The specification of the same are as under.

Drilling mud corresponding to basic properties given under appendix A under Clause – 4.3 of Part I – IS –2911 Sec – 2 shall be used to keep

The sides of the bore holes established Mud shall have THIXOTROPIC Properties i.e. gel forming property. The drilling mud shall have such properties as to permit the formation of filter cake on the sides of the bore holes, the thickness of which would depend on the nature of the subsoil deposit. Sodium based bentonite have ideal properties suitable for use as drilling mud.

**(b) Specification / Properties**

The suspension used for pilling work shall satisfy the following requirements.

Fresh sodium based bentonite shall have :

- (a) The liquid limit of bentonite when tested in accordance with IS 2720 (Part V) shall be more than 300 percent and less than 450 percent.
- (b) The PH value of 5% bentonite suspension shall be between 8 & 11.5%.
- (c) The free water standing after 24 hours of 10% suspension of 100 cc be only a thin veil of water.
- (d) Sand content of bentonite powder to be not more than 7 percent.
- (e) The Marsh viscosity of 5% suspension when tested by Marsh cone should be around 37 seconds.
- (f) The 10 minute gel strength of fresh 5% bentonite to be between 10 to 75 Kg. Sq.m.
- (g) The density of the bentonite solution should be above 1.11.

**(c) Reuse :**

During boring operations fresh suspension gets contaminated with bored soil and gradually becomes heavy. This contaminated bentonite may be reused depending upon the manner of boring, type of strata encountered and the specific gravity of the contaminated bentonite. It is essential to check the specific gravity of the bentonite in the bore holes before concreting. The contaminated bentonite may be collected in a suitable receptacle and allow the heavier practices to settle and the slurry washed before reuse.

**(d) Disposal :**

The drilling mud shall be suitably disposed off without causing any nuisance to the surrounding area in a manner to be approved by the Engineer-in-charge.

#### **4 Storage of Materials :**

The relevant clause pertaining to storage of materials under specification for concrete plain, reinforced and prestressed as per relevant IS Codes will apply.

#### **D.16.3 Installation :**

All Installation requirements for bored pile shall be accordance with IS : 2911 (part I) sec-2 and as supplemented or modified herein or by other best possible standards to the satisfaction of the Engineer-in-charge where the specific requirements mentioned in this section of the specification wherever not covered fully in all aspects.

##### **1. General :**

The tenderer is supplied with details of bore hole log or any other data indicating the probable nature of the soil strata expected at the site. All piles will have to be bored / driven to the required founding level as shown on the drawings or as may be decided by the Engineer-in-charge.

##### **2. Type of pile :**

###### **(i) Type**

All piles shall be driven or bored cast-in-situ concrete piles reinforced as per design requirements.

For any type of pile adopted and in spite of different methods of installations, concreting, etc. the load carrying capacity of single and group of piles shall not be less than the design loads indicated on the drawings.

###### **(ii) Diameter :**

The casing / boring shall be of such diameter as to give the necessary specified nominal diameter of the concrete pile. In general, the measurement of the diameter of the pile shall be as follows :-

- (a) For cast in situ bored piles, employing temporary casing withdrawn during the placing of the concrete, the nominal diameter shall be the outside diameter of the temporary casing.
- (b) For cast in situ bored piles with permanent liner, the nominal diameter shall be the inside diameter of the permanent casing left in place.
- (c) For partly lined or unlined bored cast in situ piles using drilling mud, the nominal diameter shall be the inside diameter of the guide liner (temporary or permanent)



- (d) The size of the cutting tool shall not be less than the diameter of the pile by more than 75 mm.
- (e) The contractor may however be required to demonstrate to the Engineer-in-charge, if so called for by him, that the diameter of the bore hole for its full length is not less than the nominal diameter specified and this may be done by lowering a guide ring having a diameter equal to the nominal diameter of the pile into the bore hole before concreting the pile or lowering the reinforcement cage.

**3. Identification of Pile :**

A plan showing clearly the designation of all piles by identification system shall be filled with the Engineer-in-charge before installation of piles is started, if so desired by the Engineer-in-charge.

**4. Piling Sequence :**

The piles shall be installed in such a sequence that the carrying capacity of previously installed piles is not reduced or there is no appreciable upheaval of ground causing unusual soil resistance to rest of the pile driving or the soil is not flowing laterally during driving operation. The Engineer-in-charge shall decide on the sequence of the groups of piles that the contractor shall undertake for construction and the contractor shall have to follow this sequence.

**D.16.4 Workmanship & Construction of Piles :**

**(a) General :**

- (1) Piles shall be constructed by acceptable method which leaves their strength unimpaired and which develops and retains the required bearing resistance. Equipment and the method of construction of the pile shall be such that the pile is installed in its proper position alignment and truly vertical.
- (2) Piles construction shall be carried out by using standard bored piling process. Piles shall be cased with mild steel liner of required thickness which shall be provided up to depth shown on the detailed working drawing supplied by the Engineer-in-charge.
- (3) For uncased piling for boring beyond the depth of M. S. casing shall be done using bentonite slurry to prevent the subsoil from caving. This shall be of approved quality and standards as prescribed under detailed specification for pile foundation work given in the document. The boring shall start from the level as indicated in the drawings.
- (4) Further, for all types of bored piles including the use of open-end casing, the tenderer shall submit, in view of sub-soil water being present in the bore hole, particulars of concrete placement method so as to reduce to a minimum, the contact of fresh concrete with ground water. It is imperative that the bore hole shall exclude any subsoil

material before placement of reinforcement and concrete inside the casing or bore hole. Details of the concrete placing equipment and/or any other process intended to be used by the tenderer for such conditions, shall be fully described.

- (5) The reinforcements of the pile should project out, above the top level of the pile by a minimum length of 600 mm or as specified, to be later or bent and embedded in the pile cap concrete.
- (6) Concrete shall be placed and compacted at least up to 300 MM above the cut-off level and the ground level shall be filled up with sand so that the next pile does not move out of place during construction.
- (7) To construct the pile cap, the ground will be excavated to expose the top portion of the piles, which will be dismantled neatly up to the cut-off level, removing all cracked, loose and unsound concrete. The top surfaces of the piles will be kept rough and treated by keeping wet and application of Neat cement coat, before concreting of pile cap to ensure bond with the pile cap concrete in which they will be ultimately embedded.
- (8) In case, the casing is directed to be removed, care shall be taken to ensure that there is no gap left in the concrete of the pile and that the reinforcement are not displaced.

#### **D.16.5      Quality control :**

The contractor shall maintain quality control for all items of work including materials and every stage as may be directed by the Engineer, to ensure compliance with contract specifications and shall maintain and submit to the Engineer, records of the same. The quality control requirements stipulated under the specifications for “Concrete Reinforced and Plain” will apply wherever relevant. In addition, the requirements will include but not be limited to the following:

- |                        |   |
|------------------------|---|
| (a) Location & Plumb   | : Control survey for accuracy in plan and check for verticality.  |
| (b) Driving            | : Correlation of weight of hammer, length of strokes, number of strokes per minute and rate of penetration.   |
| (c) Boring             | : Prevention of any cave-in of subsoil.   |
| (d) Casting of piles   | : Check inside casing or boring as the case may be, reinforcement cage, concrete mix, placing, consolidation. |
| (e) Inspection of pile | : Taking core for ascertaining homogeneous and compactness of concrete.                                       |
| (f) Load tests         | : As prescribed under these documents if any.   |

## **D.16.6 Concrete in Piles :**

### **(a) General :**

This shall conform to the specifications for cement concrete- plain and reinforced as per relevant IS codes to the extent it has been referred to or applicable for this purpose. The concrete shall be as per design mix specified & of approved quality. The entire depth of the pile shall be concreted in one operation without stoppage. All concreting operation for piles shall be carried out during day time only. Exposed portions of piles shall be cured for at least 10 days from the date of casting. When installing the piles in groups, sufficient time shall be allowed for freshly poured concrete in pile to set before installing adjacent piles. The Engineer-in-consultation with the contractor shall determine the installation sequence and time schedule to ensure that freshly concreted piles are not damaged due to installation of adjacent piles.

### **(b) Materials :**

Unless otherwise called for on the drawings or in the bills of quantities, the concrete shall be of grade M-30 **and shall have a cement content not less than 410 Kg/Cu.m. for concrete.**

Cement shall be ordinary port land cement conforming to I.S. : 269 unless specified otherwise. Maximum size of aggregate shall be 20 mm.

### **(c) Volume check :**

Concreting shall start as soon as possible after driving is closed and pile tube or completion of boring. Concrete shall be so placed as to fill the entire volume of the hole without segregation and formation of voids caused by faulty consolidation or entrapped air. The volume of concrete placed shall be observed in the initially cast piles and the average figure obtained shall be used to check whether there is undue deviation in concrete consumption and if so the same shall be brought to the notice of the Engineer without further work on piling.

### **(d) Consistency :**

Where the concrete is cast in place in an open-end tube, its consistency shall be suitable to the method of compaction employed in the formation of piles. If necessary concrete shall be as dry as possible to minimize shrinkage and the possibility of cement being washed down by flow is withdrawn. plasticising agents may be used by the contractor to improve the workability but the Engineer may be furnished with proof that the proposed plasticising agent has no adverse effects on the hardened concrete of reinforcement. Care shall be taken against segregation of concrete while passing through the reinforcement cage, and against inflow of soil and water during withdrawal of the tube, if such method is adopted by maintaining sufficient head of concrete inside the tube. The extraction of casing shall not cause any shearing or necking of the poured concrete thereby reducing the capacity of the piles.

If it becomes necessary to place concrete through water, this should be done with special equipment and necessary precaution in conforming with contractor's specification as may be got approved by the Engineer. As per Clause 6.3.4 of IS 2911 (Part I /sec 2) slump of concrete shall range between 100 to 180 mm. depending on the manner of concreting.

**(e) Testing :**

At least one test shall be made for every 15 m<sup>3</sup> of concrete and not less than six cubes shall be cast on each day of concreting of piles. Three of the six cubes constituting one test shall be tested on the 7<sup>th</sup> day from casting the cubes and the remaining three cubes shall be tested on the 28<sup>th</sup> day after casing. Tests of all cubes shall be carried out in presence of Engineer-in-charge or his representative.

**(f) Acceptance**

The Engineer reserves the right to reject any pile of deficient concrete strength. Such rejected piles shall be replaced by the contractor at his own cost who shall also bear the additional cost of widening the pile cap resulting from the grouping if the piles as result of replacement of piles. The Engineer also reserve the right to order a change in the mix design and/or water cement ratio to obtain the specified strength of workability if so considered necessary during execution.

**D.16.7 Reinforcement in Piles**

Reinforcement conforming to IS : 432 , IS : 1139 or IS : 1786 grade suitable for cement concrete as per IS specifications for reinforcement concrete for general building work shall be applicable for this specification to the extent it has been referred to or acceptable.

Reinforcement used in cast in situ piles shall be made up into cages sufficiently well wired or span welded to withstand handling without damage. The bars shall be so spaced as not to offer obstruction in placing concrete. Care shall be taken to preserve correct cover and alignment of reinforcement throughout the operation of placing the concrete. Any distortion or displacement of reinforcement during the compaction of concrete or while extracting the tube, shall be avoided.

Joints in longitudinal reinforcement bars, if unavoidable, shall be made by lapping and the laps shall be tack welded to prevent distortions of the reinforcement cage. The lap length of longitudinal bars beyond the pile cut-off level shall be as shown on the drawings.

Unless otherwise specified in the drawings, the lateral reinforcement shall consist of a helix made from 8 mm. dia. bars at a pitch of 150 mm. through out the length of the reinforcement cage.

Concrete cover over all reinforcement including lateral helical reinforcement shall be 50 mm. unless otherwise specified or shown on the drawings.

Care shall be taken to preserve the correct cover and alignment of reinforcement free from any twist, throughout the whole operation of placing the reinforcement in the bore hole and placing the concrete.

#### **D.16.8 Dowels :**

The contractor shall provide necessary dowels is as directed by the Engineer if so required.

##### **1. Inspection**

For cast in situ, bored, piles, the contractor shall get the bore hole inspected by the Engineer in charge for proper plumb, location, compaction of founding surface, pressure of water and other requisites. The diameter of the hole may also be checked in the case of bentonite slurry bored pile by lowering a guide ring through the depth of the hole. The depth of the bore hole shall be measured by means of a chain to which a plumb bob weighing not less than 250 gm. Is attached. The contractor shall provide all the equipment required for the above inspection and he shall co-ordinate this work with the Engineer in charge. Concreting shall start only after the Engineer has approved the bore hole. All facilities, equipment and labor required for inspection by the Engineer mentioned above shall be provided by the Contractor promptly and free of cost.

##### **2. Record of Installation of Piles :**

A joint record shall be maintained by the contractor in a Performa approved by the Engineer, of the entire penetration for every pile and the behavior of such pile during its entire process of construction as per IS 2711 (part I) Section 2. These records shall be submitted to the Engineer-in-charge regularly as the job progresses. Any sudden change in the rate of penetration which can not be ascribed to the nature of the ground or any deviation from the designed location, alignment or load carrying capacity of any pile or any upheaval or subsidence noticed on any pile driven under this contract or already existing, during construction of other piles, shall be promptly reported to the Engineer-in-charge and adequate corrective measures shall be taken free of any charge as may be decided by the Engineer-in-charge. The records of such additional borings or other subsurface information that were obtained during the process of installation shall also be filed with the Engineer in charge.

##### **3. Pile capacity, quality and tolerances**

###### **(a) Working load on piles**

General specifications of pile foundations and its details are given in the tender for general information.

The capacity of the piles in place shall be verified by conducting “Routine Load Tests” on working pile as describe hereinafter.

For bored piles, the characteristics, thickness and inclination of the subsoil strata under laying the pile points shall be taken into account for estimating the extent of settlement of the pile due to consolidation of the soil below, while evaluating the allowable load on pile.

The contractor shall submit his findings on the allowable carrying capacity of a single pile from the load test. This shall then be reviewed by the Engineer and the allowable carrying capacity of each pile and group piles shall be decided by him in consultation with the contractor. The decision of the Engineer in charge regarding the allowable load on the piles shall be final.

The layout and number of piles and the size and details of the pile caps may have to be revised if the decided allowable loads on each single pile in a group differ from the above value and the contractor shall have to do the work according to the revised design and drawings at no extra cost or expenses to the client.

If the load test results indicate that the piles, already constructed are deficient in load carrying capacity, such deficiencies shall be made good by the contractor in the manner as may be approved by the Engineer, at no extra cost to the client.

**(b) Quality :**

The contractors shall guarantee the full cross section of the pile for its entire length and also guarantee against the occurrence of necking or wasting, bulging, spilling of pile sheaft concrete and similar defects which will impair the strength and durability of the pile.

**(c) Tolerances :**

The pile shall be installed truly vertically as per the detailed design required within the following permissible tolerances. The position of the pile at the level of the bottom of the pile cap shall not vary more than 75 mm in any direction from the positions specified in the drawings. The alignment shall not vary by more than 2% (about 1 degree) from the vertical axis or the specified batter. The above two allowances, however, shall not be cumulative.

**(d) Defective Piles**

Piles that are defective or where the deviation in alignment of the tube or base is more than that tolerance specified, shall be pulled out or left in place as per the directions of the Engineer in charge. Additional pile shall be driven to replace them and/or the pile cap shall be redesigned and built at no extra cost to the client. In case the pile / casing can not be removed. It shall be cut as may be directed by the Engineer in charge. Voids resulting from rejected borings or extraction of the pile or casing shall be filled with gravel or sand

unless other piles are installed in such voids. The contractor shall also not be paid for any expenses incurred by him, in extracting and rejected pile / casing and refilling if so required.

#### **4. Idle period**

The phasing of construction and movement of plant shall be done as may be directed by the Engineer. The phasing may involve some extra movement of the plant or some idle period during test pile operation etc., but the contractor will not be entitled for any claim due to this reason and all rates quoted by him shall include the same. However, during the testing of piles and other holdups, pile driving operation may be allowed on other piles, if considered acceptable and if so decided by the Engineer in charge with a view to minimise idle time. If due to change in loading elevation of any other alternations, modifications become be entitled to any claim whatsoever, for such modifications in the pile layout, during the progress of work including claims for any idle labor or tools and plant on that account.

### **D.16.9 Testing acceptance Criteria :**

#### **1. Static Load Test**

##### **(i) General**

In order to determine the carrying capacity of pile, static load tests shall be undertaken by the contractor on single pile as indicated on drawings. Piles to be tested shall be cast in situ at least 30 days before loading. Before any load test is made, the proposed arrangement of the structure and kentledge to be used in making the load test shall have to be approved by the Engineer in charge. All load tests shall be made under the supervision of the Engineer in charge. All responsibility for conducting the test safety and properly shall rest with the contractor.

##### **(ii) Preparation of pile head for test**

The pile head shall be chipped off carefully till sound concrete is met with and the reinforcement shall either be cut off for initial test or bent sideways and the top shall be capped by means of a suitable RCC cap. A bearing plate may be embedded on the top to receive the loading jack.

#### **Procedure for Load Testing**

- (a) The test shall be carried out by applying a series of vertical load increments on the pile. The load increments shall be equal to about 20% of the estimated working load on the pile.
- (b) The test load may be applied by means of hydraulic jack with pressure gauges, with remote pumps acting against rolled steel joists or suitable load frame obtaining reaction reached from :

- (i) Kentledge heavier than the required test load, placed on a platform supported clear of test pile. Any existing structure of suitable construction may be used as a kentledge. The center of gravity of the kentledge shall generally be on the axis of the pile and the load applied by the jack shall also be concentric with the pile axis.

OR

- (ii) Tension piles or suitable anchors. The center to center distance between the test piles and the anchor piles shall be a minimum of five times the diameter of the test pile. Working piles shall not be used as anchor piles.
- (c) The reaction to be made available for the tests shall be at least 25% more than the final test load proposed to be applied.
  - (d) The settlement shall be recorded at least with three dial gauges for single piles and four dial gauges for group of test piles and positioned at equal distances along the periphery of the pile and held normally by datum bars resting on immovable supporters at least 5 x D (subject to a maximum 2.5 m) away from the test pile periphery where D is the diameter of the test pile shaft.
  - (e) Each stage of loading shall be maintained till the rate of movement of the pile top is less than 0.1 mm per hour in sandy soils and 0.02 mm per hour in clayey soils for this purpose, the soil met with at the tip of the pile shall be considered. The estimated safe working load in the pile shall be kept in position for at least 24 hours and during this period settlement regarding shall be recorded every hour.
  - (f) Each stage of application of the load increment shall be smooth and free from jerks. Time and settlement observations shall be made at the commencement and completion of the load increment. Settlement observations shall be made when each increment of load had been maintained for at least 15 minutes.
  - (g) The loading shall continue for the specified load for the type of test in question or failure of the pile should this occur earlier.
  - (h) After the proposed working load had been applied and from each increment thereafter, the test shall remain in place until there is no settlement in two hours period. The total test load shall remain in place until settlement does not exceed ½ of a millimeter in 48 hours.
  - (i) The total test load shall be removed in decrements not exceeding 1/5 of the total test load. The rebound shall be



recorded after each decrement is effected and the final rebound shall be recorded, 24 hours after the entire test load had been removed.

- (j) A complete record in triplicate shall be filed with the Engineer or the loads and readings obtained, duly verified and countersigned by the Engineer.

**(iii) Costs**

The tested piles will be used as usual foundation piles if it is a routine test. Tenderer shall include cost of all materials, accessories and labor including construction of pile top loading platform and dismantling the same, for the load test.

**(iv) Acceptance Criteria**

**(I) For Initial Load Tests**

- (a) Two thirds of the final load at which the total settlement attains a value of 12 mm unless it is specified that a total settlement different from 12 mm is permissible in any given case taking into consideration the nature and type of the structure. In the latter case, the load corresponding to the actual total permissible settlement of the pile head shall be the safe load.
- (b) Fifty percent of the final load at which the total settlement equals 10% of the diameter of the pile.

**(II) The safe load on a group of piles shall be the least of the following**

- (a) Final load at which a total settlement attains a value of 25 mm unless a total settlement, different from 25 mm is acceptable for a given case on the basis of type and nature of the structure.
- (b) Two thirds of the final load at which the total settlement is 40 mm.

**2. For Routine Load Tests**

The two pile tests shall be considered as successful, provided that –

- (a) The total settlement at the full test load of 1.5 times the proposed design load for the pile is not more than 12 mm.
- (b) The net settlement on removal of entire test load is not more than 6 mm.
- (c) Load settlement curve shall not indicate failure of the pile within the above range of settlement.

The cost of testing of two piles shall be borne by contractor and no payment shall be made.

### **3. Cyclic Load Test**

Cyclic load test may have to be carried on the test pile if directed by the Engineer. This load test shall be carried out as per Cl. 6.3 of IS : 2911 with procedure laid down in Appendix A in the said IS : 2911 (Part IV) 1985. Loading shall be continued till, there is no marked progressive settlement of the pile. The rate for such item shall be decided as may be mutually agreed upon with the Engineer in charge.

### **4. Lateral Load Test**

#### **(i) Procedure for Load Test**

- (a) This test shall be conducted as far as possible at the cut off level of the piles. In case of pile groups the test shall be conducted after providing caps such that the required conditions of actual use fulfilled.
- (b) The test may be conducted by introducing a hydraulic jack, with gauge between two piles or pile groups under test or the reaction may be suitably obtained otherwise these tests may also be done by applying lateral pull, by a suitable set up. If it is conducted by jack located between two piles or groups, the full load imposed by the jack shall be taken as the lateral resistance of each pile or group. The loading should be applied in increments of about 20% of the estimated safe load.
- (c) After applying each increment of load, the next increment of load shall be applied after the rate of settlement of mm. in sandy soil and 0.02 mm. per hour in clayey soil or two hours time whichever is earlier.
- (d) Displacements shall be measured by using at least two dial gauges spaced at 30 cm. and kept horizontally one above the other on each pile. Where it is not possible to locate one of the dial gauges in the line of jack axis, then the two dial gauges may be kept at a distance of 30 cm. at a suitable location from similar triangles.

#### **(ii) Acceptance Criteria**

The safe lateral load on a pile shall be taken as the least of the following:

- (a) Fifty percent of the final load at which total displacement increases to 12 mm.
- (b) The load at which the displacement is equal to 5 mm.

- (c) Load corresponding to any other displacement specified and dictated by performance requirement.

**5. Pull out test :**

Pull out tests may be carried out in special cases, if required to determine friction and ensure that the construction method and equipment used by the contractor produces sound piles of desired depth and specifications.

**(i) Procedure for pull out test :**

- (a) Uplift force on the piles may preferably be applied hydraulic jacks with calibrated gauges and using suitable set up approved by the Engineer.
- (b) The test pile shall have adequate steel reinforcement to withstand pulling loads. Additional reinforcement may be provided in the pile for this purpose.
- (c) Pull out loads shall be applied without shock by suitable mechanical means, in stages of 2 ½ tonnes until a peak value of frictional resistance is reached. A graph of pull out force and corresponding rise of pile top shall be plotted.

**(ii) Acceptance Criteria :**

For initial load, tests, the load applied shall be two times the estimated safe load on the pile. The safe load shall be taken as the least of the following :

- (a) One half the load at which the displacement is 12 mm. or corresponding to a specified displacement.
- (b) One half the load at which the load displacement curve shows a clear break.

Routine test load shall be carried out to 1.5 time the allowable load, pull out load in the pile or the load corresponding to 12 mm. pull whichever is earlier.

**(iii) Defective Piles :**

In case it is observed that the piles cast are not sound and there is doubt about compactness of concrete, reduction in diameter, exposure of steel, undesirable information or any other flaws which the Engineer in charge considered improper, the contractor shall modify or improve his method of construction and ensure by casting and constructing further piles at his own cost before he is permitted to go ahead with the construction.

6. Low strain pile integrity test : On RC bored foundation piles using pile integrity tester equipment manufactured by pile dynamics inc. of USA or TNO of Netherland or equivalent that confirms to ASTM D5882 shall be conducted.

7. High strain dynamic pile test : High strain dynamic pile testing shall be as per ASTM-D4945-1989.

8. **Pile cut off, Excavation & clean up :**

**(i) Pile cut off**

- (a) All piles shall be concreted to a level 150 mm. to 450 mm. above the specified pile cut off elevation which shall be 8 cm. above the bottom of the pile cap. For piles cast by tremie method, in bentonite stabilized bore holes, this level of concreting above pile cut off elevation shall be not less than 600 mm.
- (b) Before casting the pile cap, this excess concrete shall be cut off up to pile cut off elevation. In case sound concrete is not met with at such elevation, the piles shall be cut to such elevation where sound concrete is met.
- (c) Piles shall be cut off at level and true to elevation shown or specified on the drawings. Care shall be taken not to damage the reinforcement or the concrete below cut off elevation during such stripping operations.
- (d) Where stripping has been done to a level lower than the specified cut off elevation to obtain dense and sound concrete, the contractor shall build up the pile up to cut off elevation at his own cost.

**(ii) Excavation**

- (a) Excavation by the Contractor for pile cut off shall be done to the depth specified on the drawings. These excavations shall be coordinated with the Engineer - in – charge so that they will remain open for a minimum possible time and the pile cap concrete is placed as soon as possible thereafter.
- (b) Any additional excavation carried out due to pile stripping being required to be carried out below the cut off elevation to obtain dense concrete and the back filling of all such excavation shall be done by the Contractor at his own cost.

**(iii) Clean up**

- (a) Upon completion of the piling work, all casing equipment, construction tools, protective coverings and debris resulting from the piling operations shall be removed from the works site with the permission of the Engineer - in – charge
- (b) All excavated material and left over drilling mud shall be disposed off, as may directed by the Engineer - in – charge , away from the site and the cost of all such cleanup operations shall be included by the Contractor in his rates for piling work and no separate payment will be made for the same.

9. **Rates and Measurements :**

1. **Rates**

The rate for the item of installation of piles shall include the cost of all materials consumed in the work or incidental to it as well as testing of materials, including the cost of plants and equipment, labour, supervision, transport, taxes, insurance, royalties and revenue expenses, securities and safety measures, approaches, power, fuel, lubricants, services, preliminary and enabling works, camps, stores etc. and overheads and profits etc. complete.

Separate items and rates have been provided for Empty boring, concrete and reinforcement steel work.

2. **Measurements**

- (a) For the purpose of measurements and payments, the length of the pile shall be measured from the tip of the pile to the bottom of the pile cap for each diameter of the pipe installed in position as per these specifications. The 8 cm. length of pile tip projecting into the pile cap shall not be measured and also shall not be deducted from the quantity of the pile cap concrete. The rate shall be based on the assumption that the boring of the pile is done by means of a normal bailer through soft soil such as clay, silt, sand, soft and hard murrum, gravel and boulders not more than 150 mm. in diameter or a mixture thereof. The rate shall include the cost of providing and placing concrete of specified proportions or strength as specified and shall be in cubic meters.
- (b) Measurement of length for payment will be done by letting down a tape with a heavy weight attached at the end, through the hole left by driving, before the reinforcement cage is lowered and concreting commences. The additional depth driven and covered with the show or any other materials like aggregates or concrete will not be considered for payment. Payment will be made for the specified depth below the cut off level as measured as per above procedure, whichever is less.
- (c) Empty boring through overburden and through soils of all types between the tip of piles and the bottom of pile cap shall be paid per meter for empty bore.
- (d) Reinforcement placed in the pile shall be paid for separately for the actual quantity of reinforcement placed in the pile exclusive of wastage, avoidable, overlaps, couplings, and welded joints spaces bars and annealed steel wire for binding as stipulated in the relevant specification for reinforcement.

- (e) Payment for load tests shall be made only for those tests ordered by the Engineer and the payment shall be made only for the completed load test provided the pile tested passes the load test, otherwise the cost shall be borne by the Contractor.

## **D-17 : DRILLING OF HORIZONTAL BOREHOLE FOR LAYING OF PIPELINE BELOW ROAD SECTION – D-17**

### **D.17.1 SCOPE**

The scope of item includes following :

- Preparing the required drawings & to get the permission / approval for lowering, laying & jointing pipeline below Road under the supervision of concerned authority & also obtaining completion certificate from the concerned authority after completion of work. AMC will reimburse all statutory charges & sign the necessary papers related to the work as per requirement. All other charges shall be borne by the contractor.
- Drilling horizontal bore & providing, fixing M.S. casing pipe with jointing.
- Constructing temporary R.C.C. thrust block & base concrete as per requirement for facility of pushing the pipeline and dismantling the same on completion of work
- Fixing of water main pipe.
- Sealing the both ends of pipe with construction of brick work including C.C 1:3:6.

### **D.17.2 GENERAL TECHNICAL REQUIREMENTS:**

Sr. No.	Particulars
1	Casing pipe shall be of mild steel MS pipes shall be fabricated as per IS:3589 from steel plates conforming to IS:2062. The casing pipe shall be designed for MBG loading standard or any other current loading standard as defined in IRS Bridge Rules..
2	For insertion of casing pipe, boring shall be carried out by auger type boring device with cutting head to drill a horizontal bore. The hole drilled shall be of suitable size to accommodate casing pipes. The casing pipe shall be inserted along with boring to keep the formation supported to prevent any settlement of the track. The casing pipes will be installed with even bearing throughout its length. The work will be done under the supervision of concerned authority.
3	The casing pipe will be Deep below the natural ground level As Per concerned authority Requirements. The length of casing pipe shall be upto the end of land boundary.
4	Care shall be taken to isolate the pipeline crossing installation from aerial electrical wires & shall be suitably insulated from underground conduits carrying electrical wires.
5	The pipeline shall be tested for specified test pressure to check for leakage.
6	To protect casing pipes as well as carrier pipe against corrosion, following action will be taken: <ul style="list-style-type: none"> <li>(a) Outer surface of casing pipe will be painted with a coat of zinc rich epoxy primer of thickness 4 mils.</li> <li>(b) Suitably 3 roller support at 4 mts interval of steel pipe shall be welded spacers of high density polyethylene or either similar material shall be installed in between the carrier &amp; casing pipe to prevent carrier pipe forming metallic contact with casing pipe.</li> </ul>

Sr. No.	Particulars
7	The alignment of the pipeline shall be so decided that it crosses track nearest to right angle.
8	These special conditions and the schedule of work shall govern the work to be executed under this contract in addition to and/or in part super session of the General Conditions of Contract & Standard Specifications.

The fixing of water main shall be as per detail specifications in section.

#### **D.17.3 Scope also covers**

- Shifting of service lines and reinstating the same
- Demolishing all types of R. C. C., masonry work
- Pumping / Bailing out water etc.

No extra payment shall be made for dewatering when any work is done below water level.

The rate quoted by the Contractor/s shall be deemed to include diversions, bunds, approach road to the site of work etc. and such other works, necessary for setting out and execution of works in different phases as ordered by the Engineer and / or his representative. No extra payment shall be made for such works or any other phase works carried out which are necessary for satisfactory execution of work. The diversion for traffic shall be made by the agency as per requirement without any extra cost.

Any timbering work required to be done for retaining earth during excavation of foundations will have to be arranged by the contractor which shall conform to the provision laid down in Specification of Timber Shoring.

The working area may be water logged during monsoon or any untimely rains. Contractor should take the special note while preparing the programme schedule for this work. Contractor should also specify the method which they propose to avoid water logging in the working area, however it may be clearly noted that bailing out / pumping out shall not be payable.

The rate is on Rmt. basis for specified length as per detail description in item. However, during execution as per site condition, if the length of pushing is increasing / decreasing the excess / reduce payment will be adjusted accordingly.



## D-18: SPECIFICATIONS FOR MECHANICAL WORKS

### SECTION: D-18

#### GENERAL REQUIREMENTS:-

##### Applicability

The following clauses specify general mechanical requirements and standards of workmanship for equipment and installation and must be read in conjunction with the particular requirements for Contract. These general specifications' clauses shall apply where appropriate, except where redefined in the particular sections of the technical specifications which shall be applicable.

##### List of Standards

Titles of various standards referred to in the specifications are indicated below. This list does not necessarily cover all the standards referred to.

BS 5135	Specification for arc welding of carbon manganese steels
BS 5316 Part-2	Specification for acceptance test for centrifugal, mixed flow and axial pumps – Test for performance and efficiency
BS 6072	Method for magnetic particle flow detection
BS 6405	Specification for non-calibrated short link steel chain (Grade 30) for general engineering purposes: Class 1 & 2
BS 6443	Method for penetrate flow detection
ASTM A-36	Specification for Structural Steel
ASTM A-216	Specification for Steel Castings, Carbon suitable for fusion welding for high temperature service
ASTM A-276	Specification of stainless steel and heat resisting steel bars and shapes
ASTM A-351	Specification for castings, Austenitic – Ferric (Duplex) for Pressure containing parts
ASTM A-743	Specification for castings, Iron – Chromium, Iron – Chromium – Nickel and Nickel Base Corrosion Resistant for general Application
ASTM A-744	Specification for castings, Iron Chromium – Nickel, Corrosion – Resistant
IEC – 189 Part 1 & 2	Low frequency cables and wires with PVC insulation and PVC Sheath
AWWA C 501	Cast Iron Sluice Gates
IS 5	Colours for ready mixed paints and enamels
IS 210	Grey Iron Castings
IS 318	Leaded Tin Bronze Ingots and Castings
IS 325	Three Phase Induction Motors
IS 807	Code of Practice for Design, manufacture, erection and testing (Structural Portion) of cranes and hoists
IS 1239	Mild Steel tubes, tubular and other wrought steel fittings
IS 1536	Centrifugally Cast (Spun) iron pressure pipe for water gas and sewage
IS 1537	Vertically cast-iron pressure pipes for water, gas and sewage
IS 1538	Specification for cast iron fittings for pressure pipes for water, gas and sewage
IS 1554	PVC insulated (Heavy duty) electric cables
IS 2062	Steel for general structural purposes
IS 2147	Degrees of protection provided by enclosures for low voltage switch gear and control gear
IS 3177	Code of practice of electric overhead traveling cranes and gantry cranes other than steel work cranes

IS 3624	Vacuum and Pressure gauges
IS 3815	Point hooks with shank for general engineering purposes
BS 2910	Methods for radiographic examination of fusion welded circumferential butt joints in steel pipes
BS 3017	Specification for mild steel forged ram shorn hooks
BS 3100	Specification for steel castings for general engineering purposes
BS 3923	Methods for ultrasonic examination of welds
BS 4360	Specification for weldable structural steels
BS 4772	Specification for ductile iron pipes and fittings
BS 4870	Specification for approval testing of welding procedures
BS 4871	Specification for approval of the string of welders working to approved welding procedures
BS 4942	Short chain link for lifting purposes
IS 1710	Specification for Pumps – Vertical Turbine Mixed and Axial Flow, for Clear, Cold Water
IS 5120	Technical requirements of roto dynamic special purpose pumps
IS 5600	Horizontal / vertical non clog type centrifugal pump for sludge handling
IS 6595	Horizontal Centrifugal Pumps for Clear, Cold Water
IS 7090	Guidelines for rapid mixing devices
IS 7208	Guidelines for flocculator devices
IS 10261	Requirements for clarifier equipment for wastewater treatment
IS 8413	Requirements for biological treatment and equipment
Part-II	Activated sludge process and its modifications
IS 10037	Requirements for sludge dewatering equipment, sludge
Part-I	Drying beds, sand, gravel and under drains
IS 6280	Specification for Sewage Screens
IS 3938	Electric Wire rope hoists

Further, the following codes and standards unless specified herein shall be referred to for pipe lines, pipe work and fittings.

IS 210	Specification for grey iron casting
IS 290	Specification for coal tar black paint
IS 456	Code of practice for plain and reinforced concrete
IS 458	Specification for precast concrete pipes (with and without reinforcement)
IS 516	Method of test for strength of concrete
IS 638	Specification for sheet rubber jointing and rubber insertion jointing
IS 783	Code of practice for laying of concrete pipes
IS 816	Code of practice for use of metal arc welding for general construction in mild steel
IS 1367	Technical supply conditions for threaded steel fasteners
IS 1387	General requirements for the supply of metallurgical materials
IS 1500	Method for Brinell hardness test for metallic materials
IS 1536	Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage
IS 1537	Specification for vertically cast-iron pressure pipes for water, gas and sewage
IS 1538	Specification for cast iron fittings for pressure pipes for water, gas and sewage
IS 1916	Specification for steel cylinder pipes with concrete lining and coating
IS 2078	Method for tensile testing of grey cast iron

IS 3589	Specification for MS Spirally Welded Pipes
IS 3597	Method of tests for concrete pipes
IS 3658	Code of practice for liquid penetrant flow detection
IS 5382	Specification for rubber sealing rings for gas mains, water mains and sewers
IS 5504	Specification for spiral welded pipes
IS 6587	Specification for spun hemp yarn
IS 7322	Specification for specials for steel cylinder reinforced concrete pipes
IS 8329	Specification for DI pipes
IS 9523	Specifications for DI fittings
IS 4984	Specifications for HDPE pipeline
IS 14846	Specifications for valves
IS 783	Code of practice for laying of concrete pipes
IS 3114	Code of practice for laying of cast iron pipes
IS 3764	Excavation work - Code of Safety
IS 4127	Code of practice for laying of glazed stoneware pipes
IS 5822	Code of practice for laying of electrically welded steel pipes for water supply.
IS 6530	Code of practice for laying of asbestos cement pressure pipes.

## Materials

All materials incorporated in the work shall be the **most suitable for the duty concerned and shall be new and of first-class commercial quality, free from imperfection and selected for long life and minimum maintenance.**

## Design and Construction

- a. The plant design, workmanship and general finish shall be of sound quality in accordance with good engineering practice. Design shall be robust and rated for continuous service, at the specified duties, under the prevailing operational site conditions.
- b. The general design of mechanical and electrical plant particularly that of wearing parts, shall be governed by the need for long periods of service without frequent attention but shall afford ready access for any necessary maintenance.
- c. Similarly, items of Plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same material specification as the originals.
- d. No welding, filling or plugging of defective work will be permitted without the written permission of the Engineer. All welding spatters shall be removed.
- e. It shall be the responsibility of the contractor to ensure that all the equipment selected is fully compatible, mechanically, electrically and also with respect to instrumentation, control and automation.
- f. It shall be the responsibility of the contractor to ensure his equipment interfaces with any existing equipment correctly. Any interfaces must not affect the integrity of the equipment, or invalidate any warranties or guarantees.
- g. Each component or assembly shall have been proven in service in a similar application and under conditions no less than those specified therein.

- h. The equipment shall be compatible with the civil structure, when installed, with sufficient space for operator access and maintenance procedures.
- i. All materials shall be of the best commercial quality and free from any flaws, defects or imperfections.
- j. Materials shall be selected to eradicate or reduce corrosion to a minimum.

### **Tropicalization**

Equipment is to be designed for tropical climate suitable for Indian conditions and the city/location where it is to be installed, and the following shall apply.

- i. Tropical grade materials should be used wherever possible. Some relaxation of these provisions may be permitted where equipment is hermetically sealed.
- ii. Iron and steel and in general to be painted or galvanized as appropriate in accordance with the specification. Small iron and steel parts (other than stainless steel) of all instruments and electrical equipment, the cores of electro-magnets and the metal parts of relays and mechanisms are to be treated in an approved manner to prevent rusting. Cores etc. which are built up of lamination or cannot for any other reasons be anti-rust treated, are to have all exposed parts thoroughly cleaned and heavily enamelled, lacquered or compounded.
- iii. The use of iron and steel is to be avoided in instruments and electrical relays whenever possible. Steel screws, when used, are to be zinc, cadmium or chromium plated or, when plating is not possible owing to tolerance limitations, shall be corrosion resisting steel. Instruments screws, except those forming part of a magnetic circuit, are to be of brass or bronze. Springs are to be of brass, bronze or other non-rusting material. Pivots and other parts for which non-ferrous material is unsuitable are to be of an approved stainless steel.
- iv. Fabrics, cork, paper and similar materials, which are not subsequently to be treated by impregnation, are to be adequately treated with an approved fungicide. Sleeving and fabrics treated with linseed oil or linseed oil varnishes are not to be used.

### **Climate**

- i. All part and materials used shall in all respects be suitable for the climatic conditions of the city/location where it is to be installed. The following maximum conditions shall be used for all design.

<b>Maximum Ambient Temperature for Design Purpose</b>	:	<b>50 °C</b>
Maximum Relative Humidity	:	95%

In damp situations and wherever exposed to the weather, precaution shall be taken against corrosion of metal work, cable armour conduit and the like.

### **De-Rating due to the Climatic Conditions**

- i. All electrical equipment including cables shall be de-rated for continuous operation in an ambient temperature of 50 °C in accordance with the appropriate regulations unless otherwise specified.
- ii. All materials and equipment which are subject to certification by testing authorities etc. shall be certified as being tested at 50 °C ambient unless other higher temperature specified elsewhere for specific equipment/product.

### **Packing and Delivery**

- a. All part and equipment as necessary shall be packed in first quality containers or packing; no second hand timber shall be used. All packing must be suitable for several stages of handling via sea or air freight, inland transport and movement on site.
- b. Flanged pipes are to have their open ends protected by adhesive tape or jointing and are then to be covered with a wooden blank flange secured by service bolts.
- c. The sleeves and flanges of flexible couplings shall be bundled by wire ties. Cases containing rubber rings, bolts and other small items shall not normally weigh more than 500 kg gross.
- d. Precaution is to be taken to protect shafts and journals where they rest on wooden or other supports likely to contain moisture. At such points wrappings impregnated with anti-rust composition or vapour phase inhibitors are to be used of sufficient strength to resist changing and indentation due to movement which is likely to occur in transit. **The form of the protective wrappings and impregnation are to be suitable for a minimum period of twelve months.**
- e. Lids and internal cross battens of all **packing cases are to be fixed by screws and not nails.**

Hoop metal bindings of cases are to be sealed where ends meet and if not of rust less material are to be painted. Contents of cases are to be bolted securely or fastened in position with struts or cross battens and not with wood chocks, unless they are fastened firmly in place. All struts or cross battens are preferably to be supported by cleats fixed to the case above and below to form ledges of which the batten may rest. Cases are to be up-ended after packing to prove that there is no movement of contents.

Where parts are required to be bolted to the sides of the case, large washers are to be used to distribute the pressure and the timber is to be strengthened by means of a pad.

Contents of cases are to be bolted securely or fastened in position with struts or cross battens and not with wood chocks, unless they are fastened firmly in place. All strut or cross battens are preferably to be supported by cleats fixed to the case above and below to form ledges on which the batten may rest. Cases are to be up-ended after packing to prove that there is no movement of contents.

Where parts are required to be bolted to the sides of the case, large washers are to be used to distribute the pressure and the timber is to be strengthened by means of a pad.

All stencil marks on the outside of the casings are to be either of a water proof material or protected by Shellac or varnish to prevent obliteration in transit.

- f. Wood wool is to be avoided as far as possible. Waterproof paper and felt linings are to overlap at seams at least 12mm and the seams secured together in an approved manner, but the enclosure is to be provided with screened openings to obtain ventilation.
- g. Where applicable, indoor items such as electric motors, winch and control gear, instruments and panels, machines components etc. are to be 'cocooned' or covered in polythene sheeting, selected at the joints and the enclosures provided internally with an approved desiccators.
- h. Bright metal parts are to be covered before shipment with an approved protective compound or coating and protected adequately during transport to site. After erection these parts are to be cleaned by the Contractor.

- i. Each crate or package is to contain a packing list in a waterproof envelope and copies in duplicate are to be forward to the Engineer; prior to dispatch. All items of material are to be clearly marked for ready identification against the packing list.

All cases, packages, etc. are to be clearly marked on the outside to indicate the total weight, to show where the weight is bearing and to indicate the correct positions for slings and are to bear an indelible identification mark relating them to the appropriate shipping documents.

- j. Structural steel work, pipes, valves, encased fittings and metal work shall be similarly marked. In addition, one in every ten repeated articles shall bear the dispatch marks in suitable paint or other approved medium. When in the opinion of the Engineer, the dispatch marks can not be applied satisfactorily to any item, they shall be stamped on a metal label attached to the item they shall be stamped on a metal label attached to the item or part by means of a piece of wire passing through holes at either end of the label and secured so that it lies flat with the item.
- k. The Engineer may require inspecting and approving the packing before the items are dispatched but **the contractor is to be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not relieve the Contractor for any loss or damage due to faulty packing.**

## **Finish**

Workmanship and general finish shall be of first class commercial quality and in accordance with best practice. All covers, flanges and joints shall be properly faced, bored, fitted, fixed, hollowed, mounted or chamfered as the case may be, according to the best approved practice and all working parts of the plant and other apparatus, shall similarly be well and accurately fitted, finished, fixed and adjusted.

## **Wrought Steels**

Where not otherwise specified wrought steel shall be selected from the appropriate grade of IS: 1570 and be free from blemishes, short or hammer marks.

The Contractor shall submit for the approval of the Engineer-in-charge, the grade number selected for each component.

## **Castings**

All casting shall have a homogenous structure and be free from blow holes, flaws and cracks. Any casting having a thickness in parts in excess of 3 mm to that which it is purported to be shall be rejected. No repairs or patchwork to castings shall be allowed other than that approved by the Engineer-in-charge.

Castings subject to hydraulic pressure shall be tested to 1.5 times the maximum working pressure. Certified copies of Test Reports shall be forwarded to the Engineer as soon as the test is completed.

## **Steel Castings**

Where not otherwise specified, steel castings shall be selected from the appropriate grade of BS 3100.

## **Grey Iron Castings**

All grey iron castings supplied shall be to the appropriate grade of IS: 210. The Contractor shall replace any casting which the Engineer considers is not of first class appearance or is not in any way the best which can be produced, although such a casting may have passed the necessary hydraulic or other tests. No plugging, filling, welding or “burning on” will be acceptable.

### **Spheroidal Graphite Iron Castings**

All spheroidal graphite or modular graphite iron shall be to the appropriate grade of BS 2789.

### **Bronze**

Where not otherwise specified, the bronze used shall be made of a strong and durable zinc free mixture to IS: 318.

### **Aluminum and Aluminum Alloys**

Bars and extruded sections shall be to designation EN 8 or BS 1474. Aluminum and aluminum alloys shall not be utilized unless alternative materials are considered unacceptable. The use of aluminum requires the approval of the Engineer in all cases.

### **Aluminum and Aluminum alloy Castings**

Castings shall be manufactured from LM5 to BS 1490 and subjected to a chill cast to increase tensile strength. Aluminum and aluminum alloys shall not be utilized unless no other materials is considered suitable. Immersed structures or structures that are periodically immersed shall not be constructed from aluminum or aluminum alloys.

### **Painting and Metal Protection**

All bright metal parts shall be covered before shipment with an approved protective compound and adequately protected during shipment to site. **After erection these parts are to be cleaned.**

All exposed metal parts of the equipment including piping, structures, etc. wherever applicable, after installation unless otherwise surface protected shall be first painted with at least one coat of suitable Zinc rich epoxy primer which matches the shop primer paint used, after thoroughly cleaning all such parts of all dirt, rust, scales, greases, oils and other foreign materials by wire brushing, scraping or sand blasting and the same being inspected and approved by the Engineer for painting. After wards, the above parts shall be finished with two coats of epoxy/coal tar epoxy coating/paint. The quality of the finish paint shall be as per the standards of ISI or equivalent and to be of the colour as approved by the Engineer. The paint shall be suitable for use in industrial corrosive works atmosphere.

All bright metal parts shall be covered before shipment and transportation with approved protective compound and protected adequately during shipment and transportation to the site. After erection, these parts are to be cleaned.

All pipe services wherever applicable are to be painted in accordance with the Owner’s standard colour code scheme, by the Contractor.

MS/GI Hand Rails shall be painted with synthetic enamel paint or as specified in Scope of Work/ process description/Process Design Criteria and detailed Specifications and of shade approved by engineer-in charge.

### **Chromium Plating**

All chromium plating shall comply with IS: 1986.

## **Galvanizing**

Where steel or wrought iron is to be galvanized, it shall be carried out by the hot-dip process and shall conform in all respects with IS: 2629.

Attention shall be paid to the details of members in accordance with BS: 4479. Adequate provision for filling, venting and draining shall be made for assemblies fabricated from hollow section. Vent holes shall be suitably plugged after galvanizing.

All surface defects in the steel including cracks, surface lamination, laps and folds shall be removed in accordance with IS: 6159. All drilling, cutting, welding, forming and final fabrications of unit members and assemblies shall be complete before the structures are galvanized. The surface of the steel work to be galvanized shall be free from welding slag, paint, oil, grease, and similar contaminants. The articles shall be pickled in dilute sulfuric or hydrochloric acid, followed by rinsing in water and pickling in phosphoric acid. They shall be thoroughly washed, stoved and dipped in molten zinc and brushed, so that the whole of the metal shall be less than 610 grams per square meter of surface galvanized, except in the case of tubes to BS 1387 when it shall be 460 grams per square meter.

On removal from the galvanizing bath the resultant coating shall be continuous, adherent, as smooth and evenly distributed as possible, and free from gross imperfections such as bare spots, lumps, blisters and inclusions of flux ash or dross etc. and free from any defect that is detrimental to the stated end use of the coated article. Edges shall be clean and surfaces bright.

Bolts nuts and washers shall be hot dip galvanized and subsequently centrifuged in accordance with IS: 2669. Nuts shall be tapped up to 0.4mm oversize before galvanizing and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of nuts.

During off-loading and erection, the use of nylon slings shall be used. Galvanized work which is to be stored in works or on site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining.

Small areas of the galvanized coat damaged in any way shall be restored by following.

- i. Cleaning the area of any weld slag and thoroughly wire brushing to give a clean surface.
- ii. The application of two coats of zinc-rich paint (not less than 90% zinc dry film), or the application of a low melting point zinc alloy repair rod or power to the damaged area, which is heated at 300 °C.

Where surfaces of galvanized steel work are to be in contact with aggressive solutions and/or atmospheres the galvanizing shall receive further protection by painting.

## **Fasteners**

Bolts, nuts and studs and fasteners with nominal diameters up to and including 39 mm required to be made in carbon steel shall conform to BS 6104 and threaded in accordance with IS: 1363 and 1367. Bright steel washers 3.0mm in thickness shall conform to BS 4320 and shall be provided beneath bolt head and nut.

The above items required to be supplied in stainless steel shall conform to IS: 1570. These items together with holding down bolts and anchor plates required to be supplied in high tensile steel shall conform to BS 970 Ref. Symbol T.

Drilled anchor fixings fasteners for use on concrete structures shall be of an approved type by the Engineer's Representative. The Positions of all drilled anchors shall be approved by the Engineer's



representative and a Contractor proposing to use such fixings shall be deemed to have undertaken to supply, mark off, drill and fit. All exposed bolt heads and nuts shall be hexagonal and the length of all bolts shall be such, that when fitted and tightened down with a nut and washer, the threaded portion shall fill the nut and not protrude from the face thereof by more than a half diameter of the bolt. Rivets shall conform to BS 641 and tested in accordance with BS 1109.

### **Forgings**

Carbon steel forgings shall be manufactured heat treated forgings and tested in accordance with BS 29.

### **Foundation and Settings of Machinery**

The Contractor shall arrange for the provision of all foundation and plinths required for the plant and shall be responsible and setting for ensuring that all foundations and plinths are constructed and boxed out for Machinery holding down bolts in accordance with the approved drawings.

The Contractor shall provide all necessary templates for suspension of the holding down bolts during grouting of same.

The Contractor shall visit the site during the course of construction and check the Civil Works to ensure that the foundation and/or plinths are at correct required location and height for the acceptance of the machinery. When the foundations and/or plinths have been complete and are in a satisfactory condition, the machinery shall be installed as directed by the Engineer's representative.

The machinery shall be mounted on flat steel packing of a thickness selected to take up variations in the level of the correct foundations. The packing shall be bedded by chipping or grinding of the concrete surface.

Only one packing of selected thickness shall be used at each location, which shall be adjacent to each holding down bolt. The number of shims shall not exceed two at each location and the thickness of each shim shall not exceed 3mm.

The machinery shall be alighted, leveled and pulled down by the nuts of the holding down bolts with a spanner of normal length, and no grout shall be applied until the machinery has been run and approved by the Engineer for stability and vibration. The Civil Works Team shall then carry out the grouting and building in of the machinery. However, the Contractor shall take responsibility for the satisfactory nature of this work, and shall have a representative present.

### **Built In Items**

The Contractor shall include in the relevant Schedule of the Specifications, details of all the items of equipment to be "Built in" by the Civil Works Team, together items with details of the period in which these items could be delivered to site.

The Contractor shall provide to the Civil Works Team full details of the box outs and plant fixing and foundation requirements for incorporating in the Civil Work. The Contractor shall liaise closely with the Civil Work and shall obtain from him a program of the civil works, clearly showing the dates when box-out and plant foundation details will be required. The Contractor will be responsible for co-ordinating and program his work schedule with the Civil Work so as to ensure an optimum arrangement with the minimum of disturbance to the progress of the Works as a whole. The Contractor shall deliver all items of equipment that are required to be built in the civil works, as required by the construction program and shall arrange for a representative from the equipment supplier to be in attendance during the progress of such works. The Civil Works team shall grout up and make good when instructed by the Engineer's representative.

## **Location and Alignment**

Where individual items of equipment and mechanically located and coupled, such as alignment motors, gear boxes and similar items depended upon correct alignment for satisfactory operation, each shall be mounted on a common bed plate and when alighted shall be located by means of dowels to ensure that correct re-alignment can be easily achieved when re-assembling the items after removal for overhauls.

## **Coupling**

Flexible couplings shall be couplings rated at not less than the stalling torque load of the motor. Couplings liable to impregnation by oil shall be of the all metal flexible type.

General Service coupling shall be of the flexible multi-pin and resilient bush type, having not less than six bushes and each bush shall have an inner sleeve to allow rotation on the pin (bushes shall not be in direct contact with the pin). All pins shall have shoulders to allow positive location and securing to the half coupling face.

Flexible couplings shall be supplied in matching balanced sets machined, balanced and marked before leaving manufacturer's works. The couplings shall be a tight fit on the shafts and secured with hand fitted keys and fully checked for alignment shall be a tight fit on the shafts and secured the hand fitted keys and fully checked for alignment. All necessary equipment for checking alignment shall be supplied by the Contractor.

Where flexible coupling are used, the Contractor shall fully describe the arrangements proposed for ensuring that the desired freedom of relative movement between the shafts is obtained when transmitting a torques corresponding to the continuous maximum rating of the motor.

Solidly bolted couplings shall be subject to accurate alignment and the Contractor's proposed alignment procedure shall be subject to the approval of the Engineer. In particular, the alignment procedures which involve rotating one half coupling only will not be accepted.

Overload release couplings shall not rely on shear pins. Release torque shall be adjustable over a wide range and preferably without the need to change components. The coupling shall be capable of angular alignment of 1 degree maximum and 1mm displacement of shafts.

Hydraulic couplings shall be oil filled with thermal overload protection device. The coupling shall be fully rated to transmit the motor full load power without exceeding normal working temperature and due regard shall be taken to ambient temperatures. An enclosure around the coupling shall be provided to prevent oil spray in the event of operation of the thermal overload device.

Final alignment of all types of coupling shall be checked by the Contractor in the presence of the Engineer's Representative.

## **Bearings and Lubricators**

The size of bearing shall be not less than that calculated for bearings and a minimum L10 basic rating life in accordance with BS 5512 Lubricators Part 1, taking into account all considerations of reliability materials of manufacture and operating conditions. All bearings shall be rated and sized to ensure satisfactory running without vibration under all conditions of operation for a minimum life of 50,000 hours running.

They shall be efficiently lubricated and adequately protected from ingress of moisture, dust and sand and the particular climatic condition prevalent at the site. All bearings shall be to ISO standard SI unit dimensions where practicable.

All ball or roller bearings, except those supplied and “sealed for life” shall be arranged for grease gun lubrication and a suitable high pressure grease gun shall be supplied.

Adequate “Stauffer” screw top pressure grease lubricator with ‘tell tale’ stems or ‘Tat’ grease nipples shall be provided for all moving parts. The position of all greasing and oiling points shall be arranged so as to be readily accessible for routine servicing. Wherever necessary, suitable access platform shall be provided.

The type of lubricant and intervals of lubrication, which shall be kept to a minimum (not less than nine days), for each individual item of plant shall be entered on a working schedule, which shall form part of the Operation and Maintenance instructions.

A list of recommended Lubricants and their equivalents Bearings shall be entered in the Operation and Maintenance instructions.

### **Gear boxes**

The gear boxes shall be totally enclosed dust, water and hose proof. Suitable lifting lugs shall be provided. They shall be robustly constructed and arduous duty.

The gear case shall be manufactured from grey cast iron to IS: 210 and of a grade to ensure high strength and wear resistance. Inspection covers shall be provided together with protected oil level indication, breather with oil mist preventer and drain plugs.

The gear boxes shall be designed for operation at the ambient temperatures specified without the assistance of a cooling fan.

The **mechanical service factor shall be not less than 1.5** when applied to the rated motor power or higher as recommended by equipment manufacturer.

The gears shall be manufactured from steel to BS 970 of grade selected by the Contractor and entered in the Schedule of Particulars. The teeth shall be profile ground and lapped to a high standard of accuracy and finish.

Rolling bearings shall be adequately rated to ensure a running life of not less than 50,000 hours L10 life.

The input and output shafts shall have oil seals fitted to prevent the ingress of lubricant when the gearbox is mounted in the required orientation. For example, inclined when applied to screw pump installations.

The seals shall also prevent the ingress of dust, sand and moisture.

Lubrication of the gears shall be by a splash or forced system.

An anti-run back device shall be supplied and fitted to all gearboxes involved in screw pump installation.

Each gear unit shall be subjected to a full load test at the inclinations specified for duration of 3.00 hour during which time temperature, vibration and noise levels together with oil tightness shall be recorded in the presence of the Engineer’s representative.

After satisfactory completion of the tests, each unit shall be drained of lubricant. All internal surfaces shall then be coated with suitable preservative.

A metal label shall be securely wired to the gear case to clearly state that the gear case requires to be coated with a suitable preservative.

The gear box shall be securely wired to the gear case to clearly state that the gear case requires to be filled with lubricant, the type and grade of which shall be clearly identifiable.

A metal label shall be securely wired to the gear case to clearly state that the gear case requires to be filled with lubricant, the type and grade of which shall be clearly identifiable.

## **Steelwork General**

The Contractor shall provide and fix all the steel work, including stairways, ladders, hand railing, checkered plate and open mesh flooring frames and curbing as detailed in the specification and/or as shown on the contract drawings or as directed by Engineer.

All steel work shall be constructed in mild steel and shall be galvanized after manufacture or shall be provided with finish as specified in the specifications of specific equipment/work.

For all pre-fabricated metal work, including multiple duct covers, external ladders, open mesh flooring, checkered plating, hand railing, staircase, structural steel work and the like, the Contractor shall submit fabrication drawings for the approval of the Engineer prior to the manufacture of any of these items.

## **Hand Railing and Safety Chains**

### **Hand Railing**

**Hand railing shall be of MS ERW Medium Class of circular hollow section and shall comply with the relevant requirements of BS 1387, BS 6323 Part I or BS 4360. Mild steel toe boards shall be provided, 100mm high by 3mm thick positioned above the platform level and fixed securely to the standards. All items shall be painted with epoxy paint & epoxy primer.**

Standards shall not be less than 38mm external diameter and rails shall not be less than 32mm external diameter.

Horizontal handrails shall be 1000mm high with an intermediate rail at mid height. Handrail height shall be measured vertically from finished floor level to the hand rail centerline.

Handling and fixings shall be designed to withstand a horizontal force of 740 N/m run without permanent distortion or failure of components. When a horizontal force of 360 N/m is applied at handrail level the deflection at any point on the handrail shall not exceed 1/125 of the distance between the center lines of adjacent standards or 10mm whichever is the least.

All mounting flanges shall be of substantial construction, with horizontal flanges drilled for not less than three bolts with two bolts on a line parallel to and on the walkway side of the line of the hand railing and vertical flanges drilled for less than two bolts and line through the bolts being vertical. Fittings shall be screwed or secured with grub screws. The standards shall be set at not more than 1.5 m. centers. When provided in sections, hand railing shall be joined together with purpose made fittings secured by screws or grub screws.

All ladders, stairway or other openings shall be guarded on three sides by hand railing conforming to the requirements stated above.

The Contractor shall ensure that unless specified hereinafter to the contrary, all hand railing shall be of uniform appearance and manufacture.

### **Safety Chain**

Mild steel safety chain shall be 8mm nominal size grade (M 4) non calibrated chain Type 1, complying with BS 4942 Part 2. After manufacture, mild steel safety chains shall be hot dipped galvanized in accordance with BS 729.

Stainless steel safety chains shall be manufactured from grade 316S31 steel complying with ISO 570 Part 1. Chain links shall be welded and have an internal length not exceeding 45 mm and an internal width of between 12mm and 18mm. The fins caused by welding shall be removed and the weld shall be smoothly finished all round. When tested in accordance with clause 7.3 of BS 4972 Part 2, each chain shall with stand a breaking force of 30kN and a proof force of 15kN.

### **Open Mesh and Chequer Plate Flooring**

Open mesh flooring and gratings shall generally comply with BS 4592 except where otherwise specified hereinafter. Such flooring and gratings shall be of rectangular mesh and non-slip and shall be mild steel galvanized.

Flooring shall be provided to span between the supporting members as shown on the Contract Drawings.

Where necessary intermediate support members shall be provided and fixed.

Galvanized mild steel toe plates 100 mm high and not less than 3mm thick shall be provided and fixed at all cut-outs except where otherwise shown on the approved drawings.

Both the load bearing and transverse bars in rectangular flooring panels shall be obtained systemically around the centre lines of the panels in both directions, so that when the panels are fixed in extensive areas or in long runs, the bars of all panels are in line.

Chequer plate flooring shall be galvanized and of the non-slip type, not less than 10mm thick measured excluding the raised pattern. The flooring shall be secured to its frame by stainless steel countersunk set screws.

All flooring shall be designed to carry a loading of 750 kg/sq. meter and the deflection shall not exceed 1/200 of the span or 10mm whichever is the least.

All flooring shall be removable and set flush in mild steel galvanized frames. All frames shall be provided with lugs for building in.

Flooring shall be provided in sizes suitable for lifting and removal by one man and with the appropriate cutouts to permits its removal without disturbing or dismantling spindles, supporting brackets, cables or pipe work. Flooring spanning wide openings shall be supported on removable bearers and fixings to provide the required rigidity and these shall be supplied and fitted by the Contractor. These members shall be removable to afford clear access to the openings which includes ducts.

Lifting keys shall be supplied for each location and the type of key shall be such that inadvertent release is avoided.

### **Stairways**

**Stairways shall be detailed, fabricated and erected to the dimensions shown on the drawings and in accordance with BS : 449 Part 2 to carry a load of 750 kg/sq. meter. Treads shall be rectangular open mesh fixed to the stringers, not directly to concrete. Sloping hand railing shall be as specified for horizontal hand railing but with the top rail 850mm vertically above the line of pitch and standards vertical and spaced at not more than 1500mm., measured parallel to the line of pitch.**

Staircases shall be constructed to the size and position shown on the drawings or as instructed by the Engineer. They shall be steel galvanized at works after manufacture and shall comprise stringers supporting the open mesh stair treads and shall be supplied complete with handrails and stanchions conforming to the above except the height which shall be 900mm above the pitch line.

### **Ladders**

**Ladders shall conform to BS 4211 except where the specified here after. They shall be in mild steel galvanized as specified in. The stringers shall be flat section not less than 65mm x 10mm spaced 380mm apart and shall be flanged and drilled for wall fixing at both ends. The stringers shall be radiuses over the top where they shall be not less than 600mm apart. Ladders over 3.0 m long shall have additional intermediate stays at not more than 2.5 m centers.**

**Rungs shall be 20mm diameter round bar at 250 mm c-c distance shouldered at each end and securely riveted into countersunk holes. Rungs shall be not less than 225mm from the wall.**

All ladders shall have safety cages which shall be constructed of three flat vertical strips supported by flat hoops, with a diameter of 750mm. The hoops shall be at approximately 70mm centers and the first hoop shall be 2400mm. above ground or lower platform level.

Where the rise exceeds 6000mm, an intermediate landing shall be provided.

### **Multiple Duct Covers and Frames**

Multiple duct covers and frames shall be of cast iron, water proof, non-rocking and recessed for filling with concrete or similar material.

They shall be of the type incorporating integral, removable, intermediate beams to given the required clear pit opening as shown on the approved drawings.

A heavy grease seal is to be formed between the cover and frame to prevent ingress of grit.

### **General Requirements for Pipe work**

The Contractor shall supply, deliver and erect all pipe work and fittings within the structures and externally to the limits indicated on the approved drawings and in accordance with each section of specification.

Pipe work and fittings shall be suitable for a safe working pressure equivalent to the maximum working pressure of the system. The safe working pressure of the pumping mains shall be the closed valve head of the pump plus the maximum suction static head. The maximum surge pressure shall be limited to 125% of the maximum working pressure. All pipe work and fittings shall be of adequate strength to accommodate the maximum surge pressure of the system.

The minimum pressure rating of pipe work and fittings shall be 10 Bar or higher as per process requirement.

There shall be a sufficient number of mechanical joints to enable mechanical plant and valves to be disconnected from built-in pipe work. Such joints shall be tied and shall not be allowed to sustain the weight of any pipe work.

All pipe work and fittings shall be sized for the required capacity at a velocity limits depending on the nature of the fluid or substance to be conveyed.

All pipe work shall be adequately supported by purpose made fixings. Support shall not be provided by plant or equipment.

The position of any thrust blocks required shall be indicated on the Contractor's details drawing together with the position of any sleeping required through partition walls in buildings. Puddle flanges shall be provided for building at locations in which pipes 80mm diameter and above pass through structural concrete below ground level.

Where pipe work is connected to plant and equipment readily demountable fittings in the form of unions or flanged adapters shall be provided. The flanged adapter on the delivery pipe of pumps shall be located upstream of the reflux valve where appropriate.

Flexible joints shall be provided in all pipe work subjected to linear constraint.

All jointing work including the provision of suitable full face gasket not less than 5mm in thickness and galvanized fastenings or fastening as specified shall be included.

Pump suction bell mouths shall be standard castings in either cast iron or ductile iron.

Unless otherwise specified, the pieces shall have a radial branch to enable a more streamlined flow from branch to body. Due allowance shall be made for reinforcement in the vicinity of the branch.

Prior to dispatch, each item of pipe work or associated fitting shall be clearly identified in paint with the plant item number indicated on the Contractor's arrangement drawing.

Puddle flanges shall be provided on all pipes where they pass through pumping station walls/water retaining structure walls. Each puddle flange shall be continuously welded to the pipe on both sides of the flange.

Pipe jointing surfaces and components shall be kept clean and free from extraneous matter until the joints have been made or assembled. Care shall be taken to ensure that there is no ingress of grout of other extraneous material into the joint annulus after the joint has been made.

The dimensions of gaskets shall comply with BS 4865 Part I. Gaskets shall be manufactured from material complying with BS 2494 for Type 1 rings.

Pump suction and delivery manifolds shall be provided with a drain valve where natural drainage does not occur.

Hydraulic testing shall not be carried out until all fabrication has been completed. When the pressure applied and sustained without further pumping shall be twice the working pressure.

The Contractor shall be responsible for cleaning the internal surface of all pipes prior to erection particularly the removal of weld deposits. Initial capping of the ends for protection during transport and storage shall not be removed until erection takes place.

### **Grey Iron Pipe work and Fittings**

Grey Iron flanged pipe work shall conform to BS 4622 – not less than Class 3 with flanges to BS 4504 Part 1 – table 16.

### **Spheroidal Graphite Cast Iron Pipe work and Fittings**

All spheroidal graphite or modular graphite cast iron pipe work and fittings shall be to the appropriate grade of BS 4772.

### **Carbon Steel Pipe Work**

Carbon Steel Pipe work for pressure purposes shall be to BS 3601 and assemblies shall be manufactured from pipe to this specification. The type of pipe shall be hot finished seamless steel. The wall thickness shall be not less than that required in BS 534 Table – 1.

### **ABS Pipe Work**

ABS Pipe work shall be provided and installed for special purposes where hereinafter specified. The pipe work shall conform to BS 5391 and the fittings to BS 5392.

### **Fabrication of Carbon Steel Pipe Work and Fittings**

The Contractor shall fabricate the pipeline by butt-welding without utilizing a backing ring in accordance with BS 2971 Class II metal arc welding of carbon steel pipe work. Branches shall be formed in accordance with BS 2971 (Class I or Class II, depending on operating conditions) and shall be welded before so that at any point along the bend, ovality will not reduce the bore by more than 21%. Radii of hot bends for all pipes shall not be less than five times the outside diameter. Gusseted “Cut and Shut” and wrinkle. All pipe flanges shall be of the wrought steel slip on type conforming to BS 4504 PN 16, welded on in accordance with BS 2971 (Class I or Class II, depending on operating conditions). No flanged joints shall be located within a backfilled trench. Flexible joints shall be bolted gland or Victaulic coupling as necessary.

### **Welder Qualification**

Before welding work commences on pipe work, the Contractor shall satisfy the Engineer’s representative that the welders have previously carried out similar welding work within recent months. When instructed by the Engineer’s representative, the Contractor shall arrange for the welder to produce test welds in accordance with the provisions of BS 2971.

### **Pipe Work Installation**

All pipe work, pipe fittings, jointing materials etc. shall be of the best quality free from defects and obtained from a supplier approved by the Engineer. The installation of the pipe work shall be carried out using skilled personnel and pipe work shall be installed according to the drawing approved by the Engineer. Where valves are incorporated in pipe work, the valves shall be provided with their own supports, such that no excess loading is exerted on pipe work. All pipe work materials shall have no excess loading is exerted on pipe work. All pipe work materials shall be off-loaded, stored on site and handled thereafter in such a manner that they are adequately protected for damage or deterioration.

### **Underground Pipes**

Unless otherwise state all underground pipes shall be buried in trenches which have been excavated in accordance with the relevant section of the specification.

### **Examining Pipes**



Before being used, each pipe casting or fitting shall be properly examined and should appear defective in any way, it shall be set apart and not used until it has been examined and passed by the Engineer. All metal pipes which shall be buried in the ground shall, prior to their installation, be slung and sounded in an approved manner. Any pipe found to be faulty by this method, shall be set aside for examination by the Engineer.

### **Cutting Pipe Work**

All pipe work shall be cut with proper pipe cutting tools. The use of hammer and chisel for this purpose shall not be permitted. Great care shall be exercised when cutting concrete/bitumen lined spun iron and ductile iron pipes, to ensure that there is no damage to the lining. Should any damage to the lining take place which is to an extent which the Engineer deems to be undesirable, then the pipe shall be rejected. The Contractor shall then prepare another pipe for incorporation into the works. All pipes which have been cut shall have the edges dressed and deburred.

### **Labels**

The Contractor shall arrange for the supply and fitting of engraved identification labels to all valves and items/equipment of plant. The reference numbers of all valves shall be as indicated on the schematic diagram to be supplied under the Contract.

All warning labels shall comply with BS 5378 parts 1, 2 and 3 and screw fixed rigid construction.

Designation labels shall be of 5mm trefoil with black lettering on white background. Embossed materials and techniques shall not be accepted.

The Contractor shall provide 2 nos. enameled iron plates worked "Men Working of Plant". The plates shall be 200mm x 75mm with red lettering on a white background.

N. B.: All identification and warning labels shall be in ("Hindi Language") and English.

### **Guards**

Adequate guards shall be supplied and installed throughout the installation to cover drive mechanisms. All rotating and reciprocating parts, drive belts, etc. shall be securely shrouded to the satisfaction of the Engineer to ensure the complete safety for both maintenance and operating personnel. However, whilst all such guards shall be of adequate and substantial construction, they shall also be readily removable for gaining access to the plant, with out the need for first removing or displacing any major item of plant. The guards shall be of the open mesh type except where retention of fluid spray is required.

### **Suppression of Noise**

All plant equipment offered shall be quiet in operation. The noise level within the building shall not be more than 85 dB (+5 percent on this over the audible frequency spectrum measured at mid-band), "A" scale when measured along a contour 3 meters from any single item of plant during starting, running and stopping. The noise level outside the building shall not be more than 60 dB (+5 % on this over the audible frequency spectrum measured at mid-band), "A" scales when measured along a contour 3 meters from the external wall. Noise test measurement shall be made on completion of the installation of the plant at Site to verify that it complies with this Clause. Plant which fails to comply with the noise level limits when tested which render it liable for rejection unless it is satisfactorily modified at the Contractors expense by the programmed commissioning date.

### **Trolley and Chain Pulley Block**

- a. The chain pulley block shall be operated on the lower flange of the bridge girder.
- b. The load chain shall be made of alloy steel as per IS: 3109. It shall be heat treated to give ductility and toughness so that it will stretch before breaking. It shall be of welded construction with a factor of safety not less than 5.
- c. The hand chains for the hoisting and traverse mechanism shall hang well clear of the hook and both the chains shall be on the same side. The hand chain wheel shall be made from pressed sheet and shall be provided with roller type guarding to prevent snagging and fouling of the chain.
- d. All the gearing shall be totally encased. Proper lubricating arrangements shall be provided for bearings and pinions. Gears shall be cut from forged steel Blanks. Pinions shall be of heat treated alloy steel. Gears shall be as per BS 436/IS: 4460.
- e. The trolley track wheel shall be rim toughened, heat treated carbon steel or low alloy steel or CI and shall be single flanged and shall have antifriction ball bearings. The wheels shall be machined on their treads to match the flanges of the track joints.
- f. The traveling trolley frame shall be made of rolled steel conforming to IS: 2062. The side plate of trolley frame shall extend beyond wheel flanges, thus providing bumper protection for the wheels. The two side plates shall be connected by means of an equalizing pin.
- g. Axles and shafts shall be made of carbon steel and shall be accurately machined and properly supported.
- h. The lifting hooks shall be forged, heat treated alloy or carbon steel of rugged construction. They shall be of single hook type provided with a standard depressed type safety latch. They shall swivel and operate on antifriction bearings with hardened races. Locks to prevent hooks from swiveling shall be provided. Hook shall be as per BS 2903/IS: 3815.
- i. The brake for the lifting gear shall be automatic and always in action. It shall be of screw and friction disc type self-actuating load pressure brake. Brakes shall offer no resistance during hoisting.
- j. If the weight of offered pump set/equipment is more than the craned capacity specified, the contractor shall offer the crane capacity 1.5 times higher than the weight of the pump set/equipment or as per latest IS.

### **Pipes and Fittings**

- a. The cast iron pipes shall generally conform to class B IS: 1537/IS: 1536/IS: 7181 and pipe fittings shall conform to IS: 1538. Ductile Iron pipes shall conform to IS 8329/BS: 4772.
- b. The material for cast iron pipes and fittings shall be of grey cast iron conforming to IS: 210, Gr. FG 200.
- c. The pipes shall be of uniform bore and straight in axis. Length of the straight double flanged pipes shall be within a tolerance as specified in IS standard.
- d. The flanges of the straight pipes shall be square to the axis of the pipe. The faces of the flanges shall be parallel. The bolt holes in one flange shall be located in line with those in order.
- e. The faces of the flanges of the fittings shall be square to the directional axes. The holes shall be located symmetrically off the centerline. The intersecting axes of the tees shall be perpendicular to each other.
- f. The bolt holes on flanged pipes and fittings shall be drilled with the help of drilling jig. The blank flanges are to be machined and drilled.
- g. The dismantling joints shall be of cast iron with EPDM seal ring.

### **Ventilation Systems**

These specifications are common to all dry well/wet well effluent, sewage and water pumping stations and treatment plants. The scope of ventilation system includes following.

- a. Supply Air Fans
- b. Exhaust Fans

### c. Associated Ducting

Wherever the drawings provided for ventilation system, indicate proposed ventilation fans and the routing of ducting. It is the responsibility of the contractor to study and analyse the adequacy of the system and suggest any improvement at the same time taking into consideration all the requirements of the public authorities including safety orders and Fire Protection Rules & Regulations and IS Codes. The necessary permits shall be obtained by the contractor and all payments towards license inspections etc. paid before starting the work.

### **Supply Air Fans**

Air fans shall be of centrifugal type and fan housing shall be hot-rolled steel of thickness 3/8". End flanged shall be fixed to the casing by continuously welding over the entire circumference. The flanges shall have bolt holes for bolting to inlet bell, companion flanges or ducts as the case may be. Housing shall be continuously welded and shall be expanded by suitable mechanical means to insure concentricity. Motor support shall not be less than 3/9" thick steel plate. Support ring shall be continuously welded to the support plate.

Fan rotor and blades shall be made from cast aluminum with suitable corrosion resistant coating. Belt driven fans shall have multi V belts on pulleys with suitable guards. V belts shall be 150% of rated HP duty.

The fan rotor shall be whirl-tested to 125% of operating speed and shall be statically and dynamically balanced on fan motor shaper to maximum tolerance in one (1) mil double amplitude at design operating speed.

The fans shall have inlet screen at inlet bell cone and carbon steel bolts for existing discharges cone with flanges on both ends attachment to fan and to discharge ducting.

Fan motor supports shall be of adequate strength, constructed from 1/4" carbon steel angles. All the external fasteners shall be stainless steel.

### **Motors**

Motors selected for the fan shall be of adequate rating with a safety factor of 1.5 or greater. If the fans are belt-driven the motor shall be mounted on slide rails for belt tension and adjustment. The complete assembly shall be mounted on Neoprene Vibration Isolators. The motor shall conform to the relevant latest Indian Standards or British Standards. It shall have permanently lubricated ball bearings. The motor shall be suitable for 415 V, 3 Phase 50 Hz supply.

The bearing life shall not be less than 20,000 hours at design conditions and motor shall be of class 'F' insulation to allow for operation up to 95 °C rise over the ambient temperature of 45 °C. External copper grease leads for lubrication of motor bearings shall be provided by the manufacturer.

Fan motor shall be standard totally enclosed fan cooled (TEFC) foot mounted squirrel cage induction motor with single speed, single winding, continuous duty variable torques.

A conduit box shall be mounted on the exterior of fan casing and lead wires from the motor conduit box shall be protected from the air stream by being encased in a tight metal conduit pipe.

The belt drives shall have stainless steel wire cage guards.

Supply of air fans in dry well shall have air flow switches and pressure switches fitted in the ducting. The selection of these switches is left to the contractor to suit the fan units being supplied.

## **Exhaust Fans**

Exhaust fans shall be of direct drive, impeller propeller type, having maximum speed of 1450 rpm.

All the exposed parts shall be of aluminum, with transparent anodic, anti-salt spray coating. All external fasteners shall be of stainless steel. Hood shall be hinged for accessibility and servicing. Fans shall be complete with aluminum bird screens, Plastic or light weight aluminum back draft compels and electrical disconnecting means beneath the hood and protective grid guard below fan motor.

Motors shall be of relevant Indian Standards or British standards and shall have permanently lubricated ball bearings. The rating shall be adequate with service factor of 1.50 based on rated horsepower. All motor shall be TEFC and be suitable for continuous operation without exceeding a temperature rise of 50<sup>0</sup>C over ambient.

The motor shall be of constant speed and squirrel cage type, operating on 415 V, 3 phase, 50 Hz supply. Roof mounted motors shall have electrical disconnects.

Contractor shall submit all catalogues showing the sizing and rating of fans with the size of openings to be provided for approval before proceeding with the work.

## **Dampers**

All dampers shall be of louver type, robust construction, and tightly fitted suitable for the location and service required.

Dampers shall have suitable links, levers and quadrants as required for the proper operations, control or setting in any desired position. Dampers and these operating devices shall be made robust, easily operable and accessible through access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all items.

Dampers shall be placed in ducts and every branch supply or return air duct connection whether or not indicated on the drawings for the proper volume control and balancing the system.

## **Grilles and Diffusers**

All grilles shall have vertical and horizontal adjustable bars and controlled from the front of the grill.

## **Installation**

The duct fabrication and installation shall generally conform to IS: 655 latest. It is the responsibility of the Contractor to provide and neatly erect all the sheet metal work as shown on the drawings or as required at site to the satisfaction of the Engineer.

All necessary allowances and provisions shall be made by the contractor for beams, pipes or other obstructions in the building, whether or not the same are shown on the drawings. All necessary modifications as required shall be carried out by the Contractor, however maintaining the same area.

All co-ordination with other agencies/contractor working simultaneously at the site to avoid repetition of work shall be the responsibility of the Contractor.

The ducting shall never be hung from the ceiling and only support of beams and columns shall be taken. The ducts shall be rigid and adequately supported and braced with beams or columns. All joints shall be made tight and all interior surfaces smooth bends shall be made with radius not less than one half the width of the duct. All the sheet metal connections, partitions and required to confine

the flow of air and through the filters and fans shall be constructed from No. 18 galvanized iron thoroughly stiffened with 25mm x 25mm angle iron braces and fitted all necessary doors, to give access to all parts of the equipment. Doors shall be set conveniently where required. At the connection of ducting and inlet/outlet of fans, a double-fiber glass reinforced canvas sleeve shall be used.

All fans shall be protected and painted to avoid corrosion.

### **Lubrication**

All blower bearings shall be provided with adequate facilities for lubrication. Exhaust fan unit bearings shall be sealed lubricated type. All oiling devices, grease fittings shall be readily accessible. All bearings shall be lubricated upon completion of the work using lubricants specified by the manufacturer.

### **Testing**

The Contractor shall adjust, test and air balance the ventilating and exhaust systems and shall submit a report after final adjustments to 5% of designed air quantities.

### **Operating Instruction**

Three (3) copies of an Instruction book giving complete service data on all equipment and system shall be furnished.

### **SPECIFICATIONS FOR MECHANICAL ITEMS / EQUIPMENT**

See the "GENERAL REQUIREMENT FOR MECHANICAL ITEMS / EQUIPMENT" at end of equipment specifications for painting, min. documentation requirement for approval during execution & prior to manufacturing and inspection requirements.

### **NOTES / PROVISIONS**

Bidder to take note of the following provisions applicable for specifications for various mechanical equipment.

1. See the "GENERAL REQUIREMENT FOR MECHANICAL ITEMS/EQUIPMENT" at end of equipment specifications for painting/coating, minimum documentation requirement for approval during execution and prior to manufacturing and inspection requirements.
2. For all imported equipment, the motors, gearbox, switchgear, PLC controls, etc. items and components as per manufacturers' standards and makes shall be acceptable.
3. For items like mechanical screens, grinding screens, belt filter press, turbo/centrifugal blowers, centrifuge/decanter, SBR decanter, electric actuator, floating / slant mixers (anaerobic, anoxic, aerobic), etc. the motors, gearbox as per manufacturers' standards and makes shall be acceptable.
4. For items like screw pumps, dosing pumps, valves, gates, EOT Cranes/Hoist/Material handling equipment etc. the gear box as per manufacturers' standards and makes shall be acceptable.
5. Make of Crane Duty (S4) motor of small capacity ( $\leq 5.5\text{kW}$ ) for EOT Crane/Electric Hoist as per manufacturers' standards shall be acceptable.
6. The construction and general requirements for starter/control panel supplied by vendor along with equipment (applicable for equipment with max. motor rated  $\leq 15\text{kW}$ ) can be accepted as under.
  - The control panel shall be generally free standing, floor / wall mounting type, totally enclosed and dust, damp and vermin proof. Enclosure shall have IP-42/IP-52 or better degree of protection to be mounted indoor or under shed with suitable protection unless better protection class specified in specifications of respective equipment or in BOQ or in tender specifications elsewhere (such as Scope of Work or Process Description or Process Design Criteria and Detail Specifications etc.). Cubicle sheet steel shall be CRCA minimum 1.6mm for load bearing and non-load bearing members. Gland plate shall be CRCA sheet minimum

2.0mm thick unless higher thickness or better MOC (SS 304 or such better MOC enclosure) specified in specifications of respective equipment or in BOQ or in tender specifications elsewhere (such as Scope of Work or Process Description or Process Design Criteria and Detail Specifications etc.). For motors rated  $\leq 15 \text{ kW}$ , the common equipment panel with multiple starters up to 6 numbers within single cubicle can be accepted. However, for motor rated  $>15 \text{ kW}$ , individual starter cubicle only shall be provided. For panel offered with multiple starters, the main incomer breaker shall be MCCB of suitable rating.

- Starter shall be fuse less type. Incomer shall be with ammeter, voltmeter, indicating lamps etc. Start/Stop (Mushroom head stay put type with padlocking facility)/Overload Reset Push Button and Auto-Off-Manual, local-remote selector switches etc. shall be provided. Ammeter with Y-Phase CT shall be provided for all starters with motors rating **ranging from 7.5 kW to  $< 30 \text{ kW}$** , and ammeter with selector switches shall be provided for all starters with motors rating of  $\geq 30 \text{ kW}$ . Control and power wiring shall be with minimum 1.5 sq. mm. FRLS Copper flexible. CTs, wherever provided shall be resin cast.

The breaker (MCCB/MCB) and other switchgear (MPCB, contactor etc.) shall be as per approved makes specified in tender/specifications for electrical works except for panels imported from outside the country for which makes as per manufacturer standard shall be accepted. However, makes of rest all items like wires, selector switches, push buttons, CT/PT, etc. as per manufacturers' standards are acceptable.

- For equipment starter required with/provided with VFD based starting or with Soft Starter based starting following to be noted:
  - ✓ VFD shall be selected such that the de-rated current of VFD/Soft Starter for  $50^\circ\text{C}$  continuous operating temperature shall be equal to or greater than 110% of the rated current of driven motor. Alternatively, VFD shall be provided of at least one rating higher than the motor rating.
  - ✓ The VFD for sewage/STP and industrial effluent or such applications shall be with 3C3 conformal coating and for raw/drinking water or rest applications shall be with 3C2 conformal coating.
  - ✓ The Fast Acting (Semi-conductor) fuse for VFD/Soft Starter protection are not required for motors rated less than **75 kW**.
  - ✓ The series contactor in line of VFD/Soft Starter after breaker is not required for motors rated less than **75 kW**.
  - ✓ VFD shall be with communication port (RS 485 Modbus or suitable) and shall be connected with plant PLC/SCADA for remote data, power monitoring and diagnostic data.
- Shall be suitable for remote monitoring and control from PLC/SCADA system. Required potential free contacts shall be provided for On/Off, Trip and L/R selector switch status as a minimum. In case of PLC based control offered, the PLC shall be with communication port (Modbus protocol or suitable) to communicate with plant/main PLC/SCADA for remote monitoring and control.
- For PLC based control provided in control panel supplied along with equipment by vendor, the PLC with specification and make as per manufacturers' standards are acceptable.
- Bidder to refer the specifications for electrical works and instrumentation works for rest all requirements.

7. The detail specifications for various mechanical equipment provided below are general specifications/general requirements. Operation philosophy and construction methodology may vary for each manufacturer and for the type of equipment offered and can be accepted

keeping the design philosophy/application requirement as specified in tender or as per process requirement and such minor variation in specifications can be accepted subject to review (if required with justification/supporting documents) and Client's approval.

8. First Fill of Lubricants for all mechanical equipment's shall be provided by bidder / respective equipment manufacturer.

## **DETAILED MECHANICAL SPECIFICATIONS FOR VARIOUS EQUIPMENT**

### **❖ SPECIFICATIONS FOR SUBMERSIBLE NON-CLOG PUMP SET**

#### **A. General**

The Pump shall be submersible, non-clog, single stage, centrifugal, wear resistance with vertical shaft suitable for permanent installation in wet-pit/sump along with submersible motor and submersible cable of specified length. The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor.

The pump shall be designed to pump sewage/wastewater or sludge or such fluids having impurities / solids and operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required Head-Capacity range. The head-capacity curve of the pump shall have continuously rising head characteristics with decreasing capacity over the whole performance range of pump. The shut off head of the pump shall be at least 120% of the total head.

The pump shall be selected in such a way so that the operating point shall lie on best efficiency point (BEP) or within 15% of BEP flow on either side meeting minimum submergence requirement.

Each pump must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitation or overload under all operating conditions within the system resistance indicated. All pumps shall have identical performance.

The pump shall be designed to start with the delivery valve fully open to the extent possible.

The pump shall be designed to operate safely at the maximum speed attainable in the reverse direction of rotation due to liquid returning through the pump at times when the power supply to the motor is interrupted and the discharge valve fails to close.

Pumps' rotating parts and assembly shall be statically and dynamically balanced as per ISO 10816/ latest IS standards and shall run smooth without undue noise and vibration.

The auto coupling unit with foundation plate shall be grouted with the RCC foundation with the help of "J" type foundation bolts or as per manufacturer's recommendation/approved size. Minimum height of RCC foundation height shall be "Pockets" Height (Depth) and additional 50 mm".

The power rating of motor to drive pump shall be suitable to meet maximum requirement of power for the rated impeller throughout its performance range and specific gravity of the liquid.

#### **B. Features of Construction**

##### **PUMP**

Pump shall be vertical submersible centrifugal, single stage, non-clog suitable for permanent installation in wet-pit/sump. The pump shall have bottom suction and side discharge nozzle. The pump and motor shall be as one unit together with impeller mounted on extended shaft of motor.

The pump having delivery size of 50mm, shall be designed to handle solids of minimum 35-40 mm, for pump having delivery size 100mm shall be designed to handle solids of up to 80 mm size, for pump having delivery size above 100mm shall be designed to handle solids of up to 100 mm size.

##### **Casing**



Pump casing shall be volute type of robust construction and designed for high efficiency. Liquid passages shall be designed to allow free passage and finished smooth. The tongue shall be straight across and filed to a smooth rounded edge. Casing can be provided with wearing rings/wear plates.

Casing shall have facility for removal of clogged material from impeller vanes without dismantling the whole pump.

### **Impeller**

Impeller shall be semi-open or suitable as per manufacturers' design, single suction with smooth and large ways so as to allow free passage to the fluid being pumped. Impeller shall have two/three vanes maximum and be capable to handle solids of specified size. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials. Typical sewage has high content of sand, silt and ash, hence the pump design shall be of wear resistant type.

Impeller shall be statically and dynamically balanced preferably at rated speed as per applicable standard so as to avoid vibration. The Impeller shall have back vanes or suitable features to balance axial thrust.

Suitable mechanisms should be provided to avoid accumulation of grit/silt for enhanced life of mechanical seal.

### **Impeller Nut**

Impeller shall be fixed on rotating shaft with the help of SS 316 impeller screw or cap top type impeller nut with helicoil insert and washer in such a way that impeller doesn't get loose during rotation of pump in either direction.

### **Shaft Seal / Mechanical Seals**

Double mechanical seals shall be provided to protect the motor from ingress of water along the shaft. The preliminary and secondary seals shall be oil-lubricated. The seal faces of the preliminary seal shall be of either tungsten carbide or silicon-carbide faces while the secondary seal can be of carbon versus chrome steel or tungsten carbide. Pumps shall be equipped with moisture detection sensor for seal failure detection. Use of Lip seals or back to back seals is not allowed. The mechanical seals shall be bi-directional.

### **Bearings**

The pump set shall have double anti friction grease lubricated bearings. The bearings life shall be minimum 40,000 hours of operation. Bearings shall be greased for life i.e. shall not require any re-greasing.

### **Auto Coupling/Guide Pipe/Lifting Chain**

Each pump shall be supplied with pump connector unit in order to connect connector unit to pump support bracket & provide leak proof joint and fixing it to the concrete floor of the suction well. The design of the automatic coupling system shall be such that the joint between the pump discharge flange and the delivery piping shall be made by merely lowering the pump into guide rails/wire rope from access level. The pedestal of the automatic coupling system shall be integrally cast with the delivery bend thereby obviating the need of separately bolted CI duck foot bend. It shall be provided with all necessary fixtures like guide wire/guide pipe for guiding the pumps during lifting/lowering.

Each pump shall be provided with stainless steel lifting chain in conforming to relevant standards. The lifting chain shall be provided with dual 'O' rings/shackles in SS 304 at every about 1.5m C-C for intermediate level support of pump and changeover of hoist hook during lowering and lifting.

Pump Rated 7.5kW & above must be with Double Guide Pipe. For Pump with Motor Rating less than 7.5 kW Guide Pipe can be single / double as per Pump Manufacturer Standard.

For Pump Rating 15kW and above Guide Pipe shall be min. 50mm Dia. or higher as required as per pump load / vendor requirements. For pump with motor rated less than 15kW Guide Pipe shall be as per manufacturer standard / as pump design requirements.

### **Lifting Hook**

To "fish out" a vertical submerged pump set from the wet well (even if a chain has not been attached to the lifting hook prior to the pump set being lowered) the pump shall have a self-centering lifting hook. Its design shall be such that the lifting chain's hook can be engaged to the pump's lifting hook without the need for man to enter the wet well.

### **INDUCTION MOTOR (Submersible)**

The submersible motor shall be induction, squirrel cage and dry type, designed for continuous operation (S1 duty) capable of working satisfactorily in water immersion. Motor shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following electric supply conditions:

Supply voltage	:	415 Volts, 3 Phase, 50 Hz AC supply
Voltage variation	:	± 10%
Frequency variation	:	± 5%
Combined variation of Voltage and Frequency	:	± 10%

The motor shall be generally designed to have performance characteristics like nominal efficiency, locked rotor current etc. in line with IS:12615 (2018) (Efficiency Equivalent to IE2 of IS:12615)

Degree of protection of motor shall be IP 68. The power rating of the motor shall be minimum 110% of power required by the rated impeller on its entire performance range. Further, the minimum power ratings for motors to drive pump should be selected as per table of multiplying safety factor provided for squirrel cage induction motors under electrical specifications and higher of the two ratings shall be provided.

Motor shall be suitable for full voltage & DOL/Star-delta/Soft Starter/VFD starting. Motor shall be capable to start and accelerate the load with the applicable method of starting, without exceeding acceptable winding temperature, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation. The motor vibration shall be within the limit specified in applicable standard unless otherwise specified for the driven equipment. Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standards.

Any joints in the motor insulation such as at coil connection or between slot and end winding section, shall have strength equivalent to that of the slot section of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropical treatment shall be as per the applicable standard.

The stator winding shall be made from high conductivity annealed copper conductor, super enameled insulated winding wires conforming to IS:8783 (1978) for dry type motors. The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS 4800 Part VII (1970) for dry type motors. The corresponding class of insulation shall be class F with temperature rise limited to class B. However, for motors to be operated on VFDs, only class H insulation with temperature rise limited to class F is allowed and motor shall be inverter duty type and to suit for speed variation from 50% to 100% or higher.

As the cable resistance method, due care is taken to account for the correct hot and cold resistance of windings.

If these pump's motors are to be used with Variable Speed Frequency Drives than:

- ❖ The motor insulation shall be vacuum varnish impregnated instead of dip varnishing or trickle varnishing with double insulation coating.
- ❖ The motor insulation is to be of class H only with temperature rise limited to class F.
- ❖ Current insulated bearings (preferably NDE) required for motor ratings above 200kW.
- ❖ The motor shall be suitable for speed variation from 50% to 100% or higher.

Terminal chamber shall be of IP 68 type construction to eliminate entry of storm water and dust. The Terminal chamber should be isolated from the motor chamber to prevent entry of liquid/moisture in the motor chamber through the terminal chamber. The terminal shall be the stud type with necessary plain washer, spring washers and check nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase to ground clearance.

### **Protection**

Protection against increase in bearing & stator winding temperature shall be provided. Thermostats/bimetallic switches shall be provided to sense the stator winding temperature.

Sensors are to be provided to detect if leakage of water into the oil housing. Bimetallic thermal switch to trip the motor against increase in temperature shall be provided.

The required control unit to process these safety signals and with potential free contact o/p for alarm/trip shall be provided by pump vendor for suitable interlocking in starter circuit and/or PLC.

Manufacturer shall provide Pump Monitoring Unit (PMU) & temperature scanner (as per electrical specification requirements) with each pump set.

### **Submersible Cable**

A watertight cable junction box sealed from the motor shall be provided for the motor power and signaling cables. The cable shall be of sufficient length and shall be brought out of the submerged motor without joint to terminate in junction box/control panel, located in LV panel room/outside the wet well.

Power as well as control cables shall be of dual sheathed EPRS/PVC, armoured type with required numbers. of Copper core, round type and of required size as per design requirement.

The power cable shall be PVC insulated and PVC sheathed, flexible, copper 3.5/4.0 core round type. The size of the conductor shall be adequate for continuous use under water and air. Cable half/full core as per design to be provided for earthing. The size of the conductor considering length of cable shall be suitably selected so that the voltage drop at motor terminals does not exceed 3 percent of the rated voltage.

The control cable shall be PVC insulated PVC sheathed, flexible, copper, round type and shall be adequate for continuous use under water and air. The control cable for stator winding temperature sensor, bearing temperature sensor, sensor for leakage of water into the oil, level sensor (thermostats/bimetallic switches/RTD) of 1.5/2.5 sq. mm, multi strand copper conductor of required number shall be provided or as required as per design. Control cable shall be with minimum 1 number of spare core.

The cable connection to the motor entry should be such that cable fitment should be possible at the site. Control cable termination details as per pump design / requirements shall be provided by manufacturer.

Earthing of the motor & pump set shall be done in accordance with the relevant provisions of IS:3043:(2018) for the purpose of earthing the motor & pump set. Earthing connection may be made to discharge pipe.

### **Motor Cooling**

The motor cooling shall be normally by surrounding water. However jacket cooling with in-built overflow or such suitable design of other method of jacket cooling shall be provide as specified in process data sheet/scope of work or if specified in BOQ.

### **C. Materials of Construction**

The specific requirement shall be considered as under:

Pump Casing	: CI IS 210 Gr. FG 260
Casing Wear Ring / Wear Plate	: CI IS 210 Gr. FG 260
Suction cover/Oil Chamber/Motor Casing	: CI IS 210 Gr. FG 260
Shaft	: AISI 410
Shaft Sleeve	: AISI 316 (if applicable)
Impeller/Impeller Nut	: CF8M
Auto Coupling Unit	: CI / WCB
Hardware (Nuts, Bolts, Fasteners, etc.)	: SS 304
Motor Jacket (if applicable)	: SS 304
Guide Rail Pipe	: SS 304 of suitable length & size as specified above in pump specifications.
Lifting Chain	: SS 304, Minimum equivalent to sump depth + 3m, with dual 'O' rings/shackles at every about 1.5m center to center.
Bolts, Nuts, Fasteners etc.	: SS 304 (All, Wetted and Non-wetted)
Cable length (each run)	: As per BOQ or Minimum equivalent to sump depth + 10 m, whichever is higher.
Maximum Permissible Solid Size	: As specified above in pump specifications

**The above MOC is minimum requirement and if process requirement is higher as indicated in process data sheet the stringent MOC to be provided.**

**NOTE (For installation in Existing Sump):** For Pumps to be installed / mounted in existing sump / tank where in it is not possible to take shutdown and empty the sump or provide new foundation or such site condition, the pump shall be provided with pre-cast RCC foundation with duck foot, guide pipe mounting, etc. arrangement for installing direct in sump and having arrangement for lowering and lifting the pump.

## ❖ SPECIFICATIONS FOR VARIOUS VALVES & ELECTRIC ACTUATOR

### General

Valves shall be as per internationally recognized standards. Flanges shall be machined on faces and edges to ISO 7005, IS: 6392 or BS 4504. Flange drilling should confirm to IS: 1538.

Valves shall be double flanged type (unless the end connection is permitted otherwise as specified in specifications for each valve below/in process data sheet) and the face shall be parallel to each other and flange face should be at right angles to the valve centerline. Back side of valve flanges shall be machined or spot faced for proper seating of the head and nut.

Generally, valves shall be rated for nominal pressure of PN 1.0 as a minimum or PN 1.6 if required as per process application or as specified in tender specifications/SOQ/BOQ. Further, higher pressure rating valves shall be offered if required as per process application and in MOC as specified in specifications elsewhere for such applications or suitable for such pressure ratings if not specified explicitly. The CI/DI MOC specified are generally for water/sewage/sewage sludge applications. However for industrial effluent and certain chemical applications the valve MOC shall be offered to suit to the process fluid.

Valve buried or installed in underground chamber, where access to a hand wheel would be impractical, shall be operated by means of extension spindle and/or keys.

Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position. For all type of valves/gates (including open channel, thimble mounted, etc.) gear mechanism design and makes shall be as per manufacturer standard

The valve stem, thrust washers, screws, nuts and all other components exposed to water/sewage shall be of a corrosion resistant grade of stainless steel.

Valves shall be free from sharp projections.

For valves with extended spindle/shaft following shall be considered/provided.

- Extended spindle MOC and size to be confirmed by valve manufacturer.
- Head stock/bracket supply shall be in valve vendor scope only. Valve manufacturer also to provide details and MOC of the same in GAD.
- For extended spindle the coupling and guide bracket details shall be provided by manufacturer. Generally it is desired to have two numbers universal couplings (one on top/below headstock and one in bottom above gear box/valve body). In case of long spindle lengths muff couplings at about every 3m distance. Shaft guide bracket/support shall be provided if extension spindle is more than 3m long.

### ➤ SLUICE/GATE VALVES

#### Design Requirements and construction Features

Sluice valve shall be non-rising spindle type resilient seated (Manually operated) confirming to IS: 14846/BS 5163 having PN 1.0/PN 1.6 rating free from sharp projections which are likely to catch and hold stringy materials.

Sluice valve shall be rising/non-rising spindle type when operated through electric actuators confirming to IS: 14846/ BS 5163 having PN 1.0/PN 1.6 rating.

For valve size 50mm and above end connection shall be flanged and for sizes below 50mm shall be flanged/threaded type.

Body of the valve shall be designed for 1.5 times the rating of the valve.

Valve flange face shall be parallel to each other and flange face should be at right angle to the valve centerline.

Back side of valve flange shall be machined or spot faced for proper seating of bolt head and nut.

Wherever extension spindle is provided, the valve shall also be provided with suitable headstock.

Valve shall close with clockwise rotation of the hand wheel. The direction of closing shall be marked on the hand wheel.

Valve shall be non-rising or rising spindle type and rated for nominal pressure of PN 1.0/PN 1.6 as per SOQ/BOQ or as specified in tender specification or as per application requirement.

Stem sealing shall be done with NBR wiper ring in case of resilient seated and bonnet gasket shall be of EPDM. Valve shall be powder coated electrostatically internally as well as externally by RAL blue colour.

Accessories shall be provided as under.

1. Valves 300mm and above size shall be provided with repacking arrangement as per IS: 14846.
2. The valves 600mm and above size shall have channel and shoe arrangement as per IS: 14846.
3. The valves 350mm size and above shall have spur/bevel gear arrangement as per IS: 14846.
4. All valves shall have valve's OPEN/CLOSE indicator arrangement as per IS: 14846.

### **Materials of Construction**

Body and Bonnet	: CI IS: 210 FG 200 <b>OR</b> DI IS: 1865 Gr. 500/7
Wedge	: CI IS: 210 FG 200 <b>OR</b> DI IS: 1865 Gr. 500/7 and core fully Encapsulated with EPDM rubber with integral wedge nut (For non-rising resilient seated valves)
Spindle Nut	: Bronze IS: 318 Gr. LTB2
Spindle	: SS BS 970 Gr. 304 S16
Seat Rings	: SS BS 970 Gr. 304 S16
Back Seat Bush	: Bronze IS: 318 Gr. LTB2
Shoe and Channel Linings	: SS to BS 970 Gr. 304 S16

For valve size 50mm and above end connection shall be flanged and for sizes below 50mm shall be flanged/threaded type.

However, valves 15mm to 40mm size shall be generally as per API 6D/API 602 and having Carbon Steel Body (Body: forged carbon steel A105/cast carbon steel Gr WCB, Trim: 13% Cr) in class 150 or higher rating and shall be screwed/flanged ended.

### **➤ SWING CHECK TYPE REFLUX VALVES (NON-RETURN VALVES)**

### **Design Requirements and Construction Features**

Non return valve i.e. reflux valve swing check type confirming to IS: 5312 having PN 1.0/PN 1.6 rating free from sharp projections which are likely to catch and hold stringy materials.

For valve size 50mm and above end connection shall be flanged and for sizes below 50mm shall be flanged/threaded type. The valve shall be suitable for mounting on horizontal pipeline.

The internal parts shall be easily accessible for inspection through inspection hole.

Hydraulic passages and doors shall be designed to avoid cavitation.

The valve body shall be designed for 1.5 times the rated pressure.

Valve shall be of swing type or ball type. Ball type valve must house a freely moving ball in such a way that return flow is effectively prevented.

Valve shall be quick closing type with non-slam characteristics in case of swing type. The non-slam characteristics shall be achieved by providing suitable combination of door and hydraulic passages without any external lever/dampening arrangement.

Flow direction shall be clearly embossed on the valve body.

Valve flange faces shall be parallel to each other and shall be at right angles to valve centerline. Flange back shall be machined or spot faced for proper seating of bolt head and nut.

Valve shall be rated for nominal pressure of PN 1.0/PN 1.6 as per SOQ/BOQ or as specified in tender specification or as per application requirement.

Accessories shall be provided as under.

1. Valves 300mm and above size shall be provided with by-pass arrangement as per process requirement as per IS: 5312.
2. Valves 300mm and above size shall be provided with drain plugs as per IS: 5312.
3. Valves 450mm size and above shall have support foot as per IS: 5312.

### **Materials of Construction**

Body, Cover, Doors and Hinge	: CI IS: 210 FG 200 <b>OR</b> DI IS: 1865 Gr. 500/7
Body Ring	: SS BS 970 Gr. 304 S16
Disc Ring	: SS BS 970 Gr. 304 S16
Bearing Bushes	: Bronze IS: 318 Gr. LTB2 / SS BS 970 Gr. 304 S16
Gasket	: Grafoil Filler SS 304 Spiral Wound
Ball (if applicable)	: To Be with EPDM Rubber

However, valves 15mm to 40mm size shall generally as per API 6D/API 602 and having carbon steel body (Body: forged carbon steel A105/cast carbon steel Gr WCB, Trim: 13% Cr) in class 150 or higher rating and shall be screwed/flanged ended

Note: For non-return valves with a diameter exceeding 600 mm, a dual plate check valve shall be provided.

### **➤ DUAL PLATE CHECK VALVES**

#### **General**

All double flanged dual plate check valves shall conform to API 594 (1997) and API 598 or its latest amendment for pressure rating PN1.0/PN 1.6/Class 300 as specified in technical data sheet/BOQ. All the parts of the valve shall be designed so as to withstand the test pressure as specified in the standard. Valve shall be free from sharp projections which are likely to get clogged with stringy materials. The internal dimensions and shape of the body, plates etc. shall ensure that the area for flow passage at any cross section in the valve is not less than the area of the nominal bore of the valve as per manufacturing standard.

The designs of the plates, hinge pin, stop pins etc. shall ensure free swinging of the plates. The spring action shall optimize the equal closing rates of each plate. The dual plates face shall have close face contact with the body seat ring in close position. Valves shall be designed for horizontal and vertical mounting position. The plates shall not vibrate under full or partial flow condition.

Valve shall be quick closing type with non-slam characteristics. The non-slam characteristics shall be achieved by providing suitable combination of plates, springs and hydraulic passages.

### **Features of Construction**

#### **Body**

Valve body shall be double flanged. The minimum thickness of metal for body shall be as per directives given in the API 594 and shall be maintained throughout any section uniform. The flange to flange dimensions shall be in accordance with manufacturing standard (Tables 2A and 2B).

Body of the valve shall be fitted with removable seat ring securely fixed in machined recesses by proper engineering practice. Rear side of valve flanges shall be machined or spot faced for proper seating of bolt head, washer and nut.

Each check valve shall carry an embossed ARROW to indicate the direction of flow.

#### **Flanges**

Valve flange faces shall be parallel to each other and shall be at right angle to the valve centerline. The finish on facing shall comply with MSS SP-6/ASME B 16.5. The flanges and their dimensions of drilling shall be in accordance with the requirements of IS: 1538, Table IV and VI.

#### **Plates and Hinges**

Plates and hinges shall be designed so as to withstand satisfactorily the repeated impacts likely to occur during service. Plates shall be securely positioned on body seat face with the assistance of required nos. of spring or other devices. Plate seating face shall be renewable or uniformly deposited weld metal machined and lapped using good manufacturing process so as to provide leak less seating on body face ring.

The spring action shall optimize the equal closing rates of each plate. The plates shall be totally vibration free under full or partial flow condition.

#### **Internal Wetted Parts**

Internal wetted parts shall be suitable for the specified service conditions. The term shall include but not be limited to hinges, pins, bolts, bearings and any other part in contact with the fluid medium other than the body, plates, trim, springs and pipe plugs.

#### **Optional Items**



1. Valves 150mm and above size shall have lifting eyebolts.
2. Valves 600mm and above size shall have support foot.
3. Valves 600mm and above size shall have bypass arrangement as per process requirement.

### Materials of Construction

Body	: CI IS: 210 FG 200 <b>OR</b> DI IS: 1865 Gr. 500/7
Disc (Closure Plate)	: Cast Steel (ASTM A216 Gr. WCB)
Seat	: Nitrile
Spring	: Spring Steel
Stop/Hinge Pin and Space Washers	: SS 304

### ➤ BUTTERFLY VALVE

Butterfly valve shall be as per IS: 13095/BS 5155. Valve shall be suitable for mounting in any position. Valve shall be rated for nominal pressure as specified above in general requirements.

For valve size 150mm and above end connection shall be flanged and for sizes up to and including 125mm shall be flanged/full lug wafer type.

The valve seat shall be of integrally cast or replaceable design. When the valve is fully closed, the seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.

All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.

Valve shall be suitable for throttling purpose.

All valve, spindles and hand wheels shall be positioned to give good access for operational personnel.

Valve of diameter 200mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

Butterfly valve where specified shall be electrically operated.

### Materials of Construction

Sr. No.	Component	Material
(a)	Body	Cast Iron IS: 210 FG 260 <b>OR</b> Ductile Iron IS: 1865 Gr. 500/7
(b)	Body Ring	Stainless Steel BS 970 Gr. 431 S29
(c)	Disc	Ductile Iron IS: 1865 Gr. 500/7
(d)	Shaft	Stainless Steel BS 970 Gr. 431 S29
(e)	Disc Ring	EPDM Rubber
(f)	Bearing	Teflon

### ➤ ELECTRIC ACTUATOR (APPLICABLE FOR VALVES/GATES)

All local controls shall be protected by a lockable cover.

Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gear box shall be oil or grease filled and capable of installation in any position. All operating spindles, gears and headstocks shall be provided with adequate points for lubrication.

The valve actuator shall be suitable for ON-OFF type of service and duty shall be S-2 minimum 15 minutes of continuous operation. It should be capable of producing not less than 1½ times the required valve torque i.e. selected actuator rating in Kgm (Nm) shall always be 1.5 times the maximum valve torque in Kgm (Nm).

The operating speed shall be such as to give valve closing and opening within 120 seconds maximum up to 400 mm dia./height of SV/KGV/slucice gates. However for SV/KGV/SG exceeding 400 mm dia./height shall be maximum within 300 seconds or as per manufacturers' standards subject to fulfilment of actuator torque rating be 1.5 times that of maximum valve torque. Moreover number of turns for valve close to valve open shall be less be preferably less than 200 for sizes up to 400 mm dia. Only in higher sizes the same may be permitted beyond 200 or as per manufacturers' design & standards. The operating speed shown here are for ready reference only. Care must be taken by the valve manufacturer to choose such model of actuator so as to keep the opening & closing time to as low as possible.

The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weather proof housing of IP 68. The motor starter shall be capable of starting the motor under the most severe conditions.

The starter housing shall be fitted with contacts and terminals for power supply, remote control and remote positional indication, and shall also be fitted with internal heaters so as to provide protection against damage due to condensation. Heaters shall be suitable for single-phase operation. The heaters shall be switched "ON" when the starters are "OFF" and shall be switched "OFF" when the starters are "ON".

The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel irrespective of the connection sequence of the power supply.

Each starter shall be equipped as follows as a minimum.

- a) AC electric motor.
- b) Reduction gear unit (with thrust bearing if required).
- c) Torque switch mechanism complete with set of torque switches for "Open" and "Close" position.
- d) Limit switch mechanism complete with set of limit switches for "Open" and "Close" position.
- e) 2 numbers of Intermediate limit switches to be provided for each direction in the switch mechanism in addition to the torque/limit switch for travel termination (if specified for any application in scope of work/process description & specifications).
- f) Hand wheel for manual operation.
- g) Hand-auto changeover lever with suitable locking arrangement.
- h) Local control switch/push buttons.
- i) Forward/Reverse integral starter.
- l) 1 Set "Open", "close" and "Stop" buttons as applicable.
- m) 1 number Local – Off –Remote switch with padlocking facilities as applicable.
- n) Space heater, internally powered. No external power supply for space heater
- o) Local Mechanical Position indicator.
- p) Position Feedback / transmitter with 4-20 mA analogue output for valve open/close position if requirement specified elsewhere in tender as per application.

The following relays/potential free contact shall be provided.

- Full open
- Full close
- Torque switch open
- Torque switch closed
- Thermo-switch/thermal overload relay tripped
- Selector switch position local-remote-off
- Single phasing power supply failure.
- Remote position feedback in the form of 4-20 mA (if required/specified).

The actuator shall be suitable for operation in the climate conditions and power supply conditions given in the specification.

### **AC Electric Motor**

Each motor shall be fully tropicalized and suitable for operation in the prevailing climate conditions. They shall also be suitable for operating satisfactorily under variations of electric supply specified.

The motors shall be of appropriate rating for 3 phase, 50 Hz AC electric supply of required speed (RPM) of minimum class 'F' insulated with temperature limited to that of class B, high torque low inertia motors of 15 minutes rating, squirrel cage induction type with 'O' ring seal to provide complete environmental protection during long period of inactivity. The winding shall be impregnated to render them non-hygroscopic and oil resistant. All internal metal parts shall be painted. Motor shall be capable of at least 60 starts per hour. Make of electric motor shall be as per latest governing standards and manufacturers' standards.

### **Motor Protection**

Following motor protection shall be provided.

- a) The motor shall be de-energized in the event of a stall when attempting to unseat a jammed valve.
- b) Motor temperature shall be sensed by a thermostat to protect against overheating.
- c) Single phasing protection.

### **Motor Controls**

The reversing contactor starter and local controls shall be integral for actuator. The starters shall comprise mechanically and electrically interlocked reversing contactor of appropriate rating fed from a internal control transformer (220V AC/120V AC/24VAC) for energization of contactors and 24V DC rectifier supply for local control for integral starter is also acceptable). The common connection of the contactor coils at the transformer shall be grounded. HRC type primary and secondary fuses shall be provided.

Local control shall comprise push buttons for open close and stop operations, and a local/remote selector switch lockable in the three positions as below.

Local control only,  
Remote control only,  
Locked off - No electrical operation.

Vendor should also make a provision for transmitting the mode selected to control panel and control panel will have corresponding indication lamps.

### **Wiring and Terminals**

Internal wiring shall be of grade PVC insulated stranded cable of 650V and of minimum 1.5 mm<sup>2</sup> copper for control circuits and of minimum 4 mm<sup>2</sup> for the power circuit. Each wire shall be number identified at each end. The terminals shall be of stud type and they shall also be identified by numbers. Cable entries shall be suitable for suitably sized PVC cables.

### **Enclosure**

Actuators shall be O-ring sealed IP 68. The motor and all other internal electrical elements of the actuator shall be protected from ingress of moisture and dust when the terminal cover is removed for site for cabling, the terminal compartment having the same ingress protection rating as the actuator with the terminal cover removed.

Enclosure must allow for temporary site storage without the need for electrical supply connection.

### **Reduction Gear Unit**

Reduction gear unit shall be of the totally enclosed oil bath/grease lubricated type. The gear box shall be provided with the first charge of oil lubricants and appropriate filling and drain connections. Gearing shall be adequate to open and close the sluice gates under full indicated maximum operating pressure differential at a speed sufficient to cover the full extent of travel.

The sluice gate operating equipment shall have a hammer-blow device to loosen stuck sluice gate or retrieve jammed sluice gate position.

The gearbox shall have suitable stops to prevent movement of shaft beyond fully open/close position.

The gearbox shall also be designed for 15% more torque than maximum sluice gate/valve torque.

### **Torque and Position Limit Switch Mechanism**

Each actuator shall be provided with both open and close torque limit switches, open and close (end position) limit switches for remote indication and interlocking plus two sets of Intermediate limit switches in each direction for intermediate position indication and interlocking if specified above for minimum provision in starter. Means shall be provided to prevent the open torque switch tripping during initial hammer blow effect. Torque protection reset shall not allow repeated starting in same direction when the control signal is maintained.

The torque switch mechanism shall function as follows to stop the motor on closing or opening of the sluice gate, upon actuation by the torque when the sluice gate disc is restricted in its attempt to open or close.

The torque switch in the closing direction shall interrupt the control circuit if mechanical overload occurs during the closing cycle or when the sluice valve is fully closed. The torque switch in the opening direction shall interrupt the control circuit if mechanical overload occurs during opening cycle or when the valve is fully open.

The mechanism shall facilitate adjustment of the torque at which the switches are required to operate.

### **Hand Wheel**

A hand-wheel shall be provided for emergency operation. The hand-wheel drive shall be mechanically independent of the motor drive and any gearing should be such as to permit emergency.

### **❖ SPECIFICATIONS FOR METALLIC EXPANSION BELLOWS**

Expansion bellow shall be fabricated in accordance with the EJMA/ASME standard.

The bellows shall be metallic corrugated design of MOC as specified and shall have flanged ends on both sides with liner/internal sleeve. The fatigue life expectancy considered for EB shall be minimum 3000 cycles. The drilling standard of EB flange shall be matched on piping side to ensure proper alignment and bellows is not subjected to torsional forces due to misalignment. It shall be single bellow design and suitable for axial movement of up to total 30mm (20mm axial compression and 10mm axial extension). Further it shall be suitable accommodate angular misalignment of piping for up to minimum 5mm/3 degrees for installation. The overall length of expansion joint for up to 300mm dia. size shall be 250mm, for above 300mm and up to 1000mm it shall be 300mm and for above 1000mm the same shall be 350mm. The austenitic stainless steel shall be welded using the TIG welding method. The shipping bracket of bellows shall be removed only after installation of the bellows at site.

To achieve maximum flexibility coupled with required resistance to pressure, bellows shall be formed with single or multiple walls using a number of concentric cylinders (multi-ply construction) of specified MOC, each longitudinally welded. However for the blower application the bellows shall be of multi-ply construction only.

Generally the expansion joint is provided of single bellow design as a dismantling/disassembly joint in piping near valve or pump or flow meter or such device or equipment for ease of removal and jointing. Tie rods/threaded draw bars attached to expansion joint assembly shall be provided for this application.

In case of bellows used for air piping application/in air blower discharge piping or such application witnessing vibration and temperature variations the expansion joint shall be single bellow with or without limit rods as recommended by manufacturer suitable to absorb axial movement and to suit this requirement. In case of bellows used for diaphragm type dosing pump or such pulsating service the expansion joint shall be single bellow with or without limit rods as recommended by manufacturer suitable to absorb axial movement and to suit this requirement.

The weld end pipe shall be suitable for design pressure (Minimum PN 10 or higher as per design) and for CS/MS weld end pipe shall be with minimum corrosion allowance of 3mm for water/waste water application. However for blower application the bellows shall be designed for a working pressure of minimum 1 Bar or higher as per design and for a temperature of minimum 115<sup>0</sup>C or higher as per design and for velocity of minimum 25 m/sec or higher as per design and the liner thickness shall be suitable for the same.

During installation the bellows as a practice shall always to be placed between two fixed points. Thrust block or saddle welded to pipe to make it fixed must be provided on both sides of EB.

The shipping bracket of bellows shall be removed only after installation of the bellows at site.

For blower application generally after the bellow the first support (saddle or suitable) shall be provided at 4D distance and second support 14D distance from bellows to dampen the vibrations.

### **Materials of Construction**

<b>Component Description</b>	<b>Water / Sewage / Sec. Treated Indl. Effluent / Air Application</b>
Bellows	SS 304 (ASTM A 240 Tp. 304)
Internal Sleeves / Liners	SS 304 (ASTM A 240 Tp. 304)
Weld End Pipe	CS / MS
Flanges	IS:2062 with drilling as per IS:1538, PN10
Tie / Limit Rods	Carbon Steel (CS) as per IS 1367
Nut, Bolt, Hardware	CS as per IS 1367

**Note:** For Chemical (Alum, polyelectrolyte, etc.) or Corrosive application the above specified MOC are minimum and higher / better / suitable MOC shall be provided as per the nature of chemical / fluid.

### **❖ SPECIFICATIONS FOR PIPES & FITTINGS**

#### **Pipe Work**

The pipe works for the plant involves manufacturing, supplying, laying and jointing of suitable size cast iron, ductile iron pipes along with matching special etc as required. All piping inside the plant shall be cast iron/ductile iron except for chemical house and chlorine piping. The specifications for

manufacturing, supplying, laying and jointing of pipes shall generally conform to the standard specification.

All pipe work and fitting shall be of class rating in excess of the maximum pressure attained in service including any surge pressure.

The pipe work installation shall be so arranged to offer ease of dismantling and removal of pumps or other major items of equipments. CI dismantling joints which can take radial and axial misalignment of minimum 1 percent of valve nominal size with tie bolts shall be provided. All pipe work shall be adequately supported with purpose-made fittings. When passing through walls, pipe work shall incorporate a puddle flange. Flange adapters and unions shall be fitted in pipe work runs, wherever necessary, to permit the simple disconnection of flanges, valves and equipment.

The Contractor shall be responsible for ensuring that the internal surface of all pipe work is thoroughly clean before and during erection and before commissioning. Cleaning shall include removal of all dirt, rust, scale and welding slag due to site welding. Before dispatch from the manufacturers' works, the ends of the pipe, branch pipe etc., shall be suitably be removed until immediately prior to connecting adjacent pipes, valves or pumps. All small bore pipes shall be blown through with compressed air before connection is made to instrumental and other equipment. No point of passage of pipes through floors or walls shall be used as a point of support, except with the approval of the Engineer-in-charge.

### **Materials for Pipelines**

Each pipeline shall be constructed in a material compatible with the fluid conveyed through that pipeline i.e. the materials used in the pipes which are or can be in contact with the untreated sewage, suitable additive for mortar protection shall be provided.

Pipework and valve materials for the following duties shall be as follows or equivalent to the approval of the Employer's Representative:

#### **➤ DUCTILE IRON PIPES and FITTINGS:**

### **Pipes and Fittings**

#### **(a) General**

Ductile iron pressure pipes (up to Class K9) shall comply with IS: 8329. For flanged pipe flanged end shall be welded on flanged pipe and pipe shall be min. K9 class.

Ductile iron pressure fittings (up to Class K12) shall comply with IS: 9523. For flanged fittings flanged end shall be welded on flanged fitting.

All fittings shall be socketed unless specified except for incoming and outgoing below unit shall be flanged.

#### **(b) Materials**

The materials used in the manufacture pipes shall comply as per IS:8329 and for fittings shall comply as per IS: 9523.

#### **(c) Tests**

Tests on pipes shall be carried out in accordance with IS:8329 and on fittings shall be carried out in accordance with IS: 9523.

## **Testing of Pipe**

The main test among others to be conducted shall be as per IS: 8329 (2000) or with its latest revision/amendments.

### **(A) Mechanical Tests**

Mechanical tests shall be carried out during manufacture of pipes as specified in the Standards. The frequency and sampling of tests for each batch of pipes shall be in accordance with IS: 11606 (1986). The test results so obtained for all the pipes and fittings of different sizes shall be submitted to Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per IS: 8329/EN 545 for pipes and IS: 9523/EN 545 for fittings.

### **(B) Brinell Hardness Test**

For checking the Brinell hardness the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS:1500. The test shall comply with the requirements specified in IS: 1500/ISO 6506.

### **(C) Re-tests**

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in the standard for a period of minimum 15 seconds during which the pipes shall be struck moderately with a 700gms hammer for conformation of satisfactory sound. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before surface coating and lining.

## **Quality Assurance**

The manufacturer shall have a laid down Quality Assurance Plan for the manufacture of the products offered which shall be submitted along with the tenders.

The Employer's representative shall be permitted free access to the place of manufacture for the purpose of examining and witnessing the testing of pipes and fittings.

## **Joints**

### **(a) Spigot and Socket Joints**

These shall have sockets which are integral with the pipe and incorporate an elastomeric rubber ring gasket conforming to IS:12820 suitable for carrying raw sewage with high septicity.

### **EPDM Rubber Gasket**

Rubber Gasket shall be suitable for Push-on-Joint on lines carrying septic sewage.

The spigot ends shall be suitably chamfered or rounded off to facilitate smooth entry of pipe in the socket fitted with the rubber gasket. Rubber Gasket shall conform to IS: 5382 and ISO 4633-1996 or its latest revision or amendments if any. Rubber ring bundles from every lot shall carry with them manufacturers test certificate for the following mechanical properties

- ☐ Hardness
- ☐ Tensile strength
- ☐ Compression set
- ☐ Accelerated aging test
- ☐ Water absorption test
- ☐ Stress relaxation test

Rubber rings shall be clearly labeled in bundles to indicate the type of ring, the type of joint, the size of the pipe with which they are to be used, the manufacturer's name and trade mark, etc. such other required details.

#### **(b) Flanged Joints**

The flanges shall comply with dimensions and drilling details in IS: 8329 of min. PN 1.0 rating or higher applicable rating. All flanged joints between steel and ductile iron pipe work shall be electrically isolated joints.

These shall have isolation gaskets between the flanges, isolation sleeves around all bolts and isolation washers under all bolt heads and nuts.

#### **Linings**

Ductile iron pipes and fittings shall have a cement mortar lining, in accordance with IS: 11906 or ISO 4179.

Pipe linings shall be inspected on site and any damage or defective areas made good to the satisfaction of the Employer's representative. The Contractor may use specialist mortars, mortar additives or curing agents only with the approval of the Employer's representative.

Certain sections are amplified as follow:

For sewage & industrial effluent application Sulphate Resistant Cement shall be used as specified below for internal lining requirement and no other additive shall be used without the written approval of the Employer's representative, and shall be used strictly in accordance with the manufacturer's recommendations.

The minimum thickness of the lining at one point shall not be less than 4mm.

#### **Internal Lining**

Internally pipe shall be Cement mortar lined as per IS: 8329 / IS: 11906. Ductile iron pipes and fittings shall normally have a portland cement mortar lining. However, for Sewage and Industrial effluent lining shall be Sulphate Resisting Cement Mortar Lining.

Cement mortar lining shall be applied at the pipe manufacturing shop in conformity with the aforesaid standards.

Pipe lining shall be inspected on site and any damage or defective areas shall be made good to the satisfaction of the Engineer. Lining shall be uniform in thickness all along the pipe. The minimum thickness of factory applied cement mortar lining shall be as per IS: 8329 Annexure-B or ISO 4179. This is given below.

<b>Nominal Pipe Size (mm)</b>	<b>Nominal lining thickness (mm)</b>
Up to 300	3
350-600	5



Nominal Pipe Size (mm)	Nominal lining thickness (mm)
700-1200	6
1400-2000	9

## **Coating**

Pipe shall be delivered internally and externally coated.

### **External Coating**

Pipe shall be metallic zinc coated and after that it shall be given a finishing layer of bituminous paint as per IS: 8329 (2000). Zinc coating shall comply with IS: 8329/EN 545/ ISO 8179. Only molten zinc spray coating shall be acceptable. The average mass of sprayed metal shall not be less than 130 g/sq. m with a local minimum of 110 g/sq. m.

Bitumen overcoat shall be of normal thickness of 70 microns unless otherwise specified. It shall be a cold applied compound complying with the requirements of BS 3416 Type II suitable for tropical climates factory applied preferably through an automatic process.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

#### **(a) General**

Ductile iron pipes and fittings shall be zinc coated with a bitumen over coating, all in accordance with the following Specifications. Buried pipes and fittings shall also have a site or factory applied polythene sleeving. Pipe coatings shall be inspected on site and any damage or defective areas made good to the satisfaction of the Employer's representative.

#### **(b) Zinc Coating**

Zinc coating shall comply with ISO 8179 and shall be applied as a spray coating. The mass of sprayed metal shall not be less than 130 g/m<sup>2</sup> as described in Clause 5.2 of ISO 8179.

#### **(c) Bitumen Coating**

Bitumen coating shall be of normal thickness 0.07mm unless otherwise specified. It shall be a cold applied compound complying with the requirements of BS 3416 Type II, suitable for tropical climates, factory applied in accordance with the manufacturer's instructions.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

#### **(d) Polythene Sleeving**

Where polythene sleeving is specified to be applied in addition to bitumen coating it shall comply with ISO 8180. Site applied sleeving shall be stored under cover, out of direct sunlight, and its exposure to sunlight shall be kept to a minimum. Pipes having a factory applied sleeving must be stored in the same conditions.

## **❖ SPECIFICATIONS FOR MATERIAL HANDLING SYSTEMS (CRANE / HOIST / CHAIN PULLEY BLOCKS)**

### **General**

Appropriate and suitable material handling arrangements shall be provided for all equipment included in Contractor's scope to transfer the equipment to maintenance area within the building and/or to transfer the equipment outside the building up to ground level for further transportation by the Employer. For this purpose contractor shall provide monorails and hoist blocks with cross travel facility or cranes with 3D movement (vertical i.e. hoisting motion, longitudinal i.e. long travel motion LT, Cross travel motion CT) where specified.

### **Codes and Standards**

The design, manufacture, inspection and testing of monorails and hoists shall comply with all the currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The monorails and hoists shall conform to the latest edition of the following standards and codes. Other internationally acceptable standards/codes, which ensure equal or higher performance than those specified, are also acceptable. Nothing in this specification shall be construed to relieve the contractor of the required statutory responsibility. In case of any conflict in the standard and this specification, the decision of the Employer shall be final and binding.

IS: 807	:	Design, Erection and Testing of Cranes and Hoists
IS: 3177	:	Electric Overhead Travelling Cranes
IS: 3938	:	Specification for Electric Wire Rope Hoists
IS: 3832	:	Chain Pulley Blocks
IS 2429	:	Round Steel Short Link Hand Chain
IS: 6216	:	Short Link Load Chain Grade 80 Alloy Steel
IS: 2266	:	Steel Wire Ropes
IS: 15560	:	Points Hooks with Shank and Safety Latch
IS: 210	:	Cast Iron Castings

### **Design Requirements**

If not specified elsewhere in specific requirement of tender specifications/BOQ, then generally for the hoists with more than 1.0 metric ton lifting capacity or more than 06 meters lift, motor operated hoist blocks for both long travel and lift shall be provided where rest other hoist blocks shall be of manually operated type for both, longitudinal travel and lift. Minimum 1.5 to 3 meter length of cantilever from edge of building/cladding shall be provided in monorails coming out of the building to lower the equipment to ground level clearing the building sidewalls/cladding and any other facilities beneath the floor up to ground level.

The exact lift/travel and capacity of the hoisting mechanisms and the mode of lifting equipment shall be as per approved GA drawings of building/concerned civil unit.

Clear height shall be maintained when handling one equipment over other, in such case dismantling of any equipment shall not be permitted. The center line of monorail shall not deviate by more than 500 mm from the center of gravity of any equipment that is to be lifted.

Monorails shall be extended outside the building to handle the equipment to ground level. For monorail/hoist routed inside the buildings, suitable machinery well and removable handrail and grating shall be provided on various floors of buildings, as necessary to handle the equipment.

### **➤ ELECTRIC CHAIN HOIST AND TRAVELLING TROLLEY**

The design, manufacture, inspection and testing of monorail, electric chain hoist and electrically operated traveling trolley shall comply with all the currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. Electrically operated chain hoist shall confirm to IS: 6547 (1972) and shall be designed for duty service Class II. Other internationally acceptable standards/codes, which ensure equal or higher performance than those

specified, are also acceptable.

IS: 6547 (1972)	:	Electric Chain Hoist
IS: 2429	:	Round Steel Short Hand Link Chain
IS: 6216	:	Short Link Load Chain Grade 80, Alloy Steel
IS: 15560	:	Points Hooks with Shank and Safety Latch
IS: 808	:	Indian Standard Medium Weight Beam
IS: 210	:	Cast Iron Castings

Electrically operated chain pulley hoist shall consist of following major components.

- a) Electrically operated chain hoist, motor with motor cable, hoisting block and hooks complete.
- b) Limit switch to prevent over hoisting and over lowering.
- c) Erection hardware.
- d) Pendant control station suspended from hoist.
- e) Control panel mounted on wall or crane/hoist as applicable.

Load chain shall be Grade 80 alloy steel chain as per IS: 6216 (1982). Chain wheel shall be made from malleable/SG iron cast confirming to IS: 1865, accurately shaped pockets ensuring smooth operation of load chain.

Length of hoist rope/chain shall be sufficient to ensure descent of hook to the bottom of suction pit/sump or up to ground level, whichever is more.

Chain hoist shall be suitable to fix with supporting/monorail girder at fixed location at the top/bottom flange of beam (for fixed installation) and bottom hook shall be so designed that it shall be free to swivel in the loaded conditions without twisting the load chain. Hook shall be forged as per IS: 15560 or its latest amendment.

All running shafts and wheels running on fixed axles/pins shall be fitted with antifriction bearings. Necessary provision shall be made for lubrication of all moving parts and bearings. All exposed bearings shall be suitably sealed or shielded.

Electric chain hoist shall be with limit switch, pendant push button control switch and over load relay.

Drive motors shall be suitable for crane duty (S4) application and generally conforming to latest IS: 12615/IEC 60034-1 standards as applicable. Make of Crane Duty (S4) Motors for EOT Crane / electric hoist as per manufacturer standards shall be acceptable.

Hoist shall be designed into two separate independent units, i.e. motor and hoist for easy maintenance.

The load hook shall be swiveling type forged circular shank section and shall be as per IS: 15560 with antifriction/thrust bearing.

Further, suitable local brake shall be provided as per IS to arrest and sustain loads in all working positions.

The velocity rates, effort on chain required to raise the safe working load and travel and speed shall be within the limit as per IS. Proof load test shall be carried out as per IS: 6547.

Cast iron parts, wherever used, shall be of minimum grade 30, IS: 210.

Trolley for manual/electric cross travel shall be designed to accommodate a wide range of "T" beams and shall be capable of traveling on straight as well as curved monorails with the design being such to maintain uniform distribution of pressure on the flanges.

All gears and pinions shall be case hardened and tempered steel with machine cut teeth in metric modules and shall conform to relevant Indian standard. Surface hardening of steel is not acceptable.

All running shafts and wheels shall be fitted with ball/roller bearings with a rated life not less than 20 years based on equivalent running time as per IS: 3938.

Monorail 'I' beam shall be medium weight beams (ISMB) as per IS: 808 (1989) (Reaffirmed 1999) for steel beam in case of providing the same.

Clear height of the monorail shall be maintained to handle one equipment over other.

Monorails shall be extended outside the building to handle the equipment to ground level. For monorail/hoist routed inside the buildings, suitable machinery well and removable handrail and grating shall be provided on various floors of buildings as necessary to handle the equipment.

## ❖ SPECIFICATIONS FOR WALL THIMBLE MOUNTED CAST IRON SLUICE GATES

### **General**

The construction of cast iron sluice gates shall be strictly in accordance with the specifications mentioned hereunder. The sluice gates shall be capable of performing the isolation duties in water/waste water treatment plant and pumping stations for isolation of flow in and out of a closed conduit as well as in those applications where water head is more than the height of shutter/opening. They shall be so constructed that there is no undue wear or deterioration during its operative life and so designed that the maintenance is kept to a minimum.

The Sluice gates shall be wall thimble mounted only except for shallow channels. For shallow channels of up to 3.5 meter depth with water head not exceeding 2.0meter and Gate/Shutter area not exceeding 1.5 m<sup>2</sup> wall mounted gates can be accepted instead of wall thimble.

The gates shall be so selected that effective area (shutter area) of each gate does not exceed 1.5m<sup>2</sup> and if effective area of gate exceeds 1.5m<sup>2</sup> then multiple gates shall be provided such that effective (shutter) area of each gate is less than 1.5m<sup>2</sup> unless otherwise specified in SOQ / Price Bid / Scope of Work / Process Design Criteria of tender.

The gate shall be designed for seating and unseating head of minimum 5m liquid depth or as per design requirement (except for shallow channels/units < 5m total height for which it shall be subject to top of channel/unit and accordingly head shall be as per actual full height).

### **Design and Construction**

The sluice gates shall be manufactured generally as per IS: 13349 (1992). The constructional features and details of components of the required gates are to be as under:

### **Gate Frame**

- a) The gate frame will be made from cast iron and shall be sufficiently rigid to withstand the designated water head. The gate frame shall either be flat back type or flange back type to suit the designed head and site condition.
- b) Back flange of the gate aperture frame to be precisely machined flat and drilled to engage with the Cast iron wall thimble mounted on the wall. A rubber gasket will be provided between the wall

thimble and the gate for ease in future dismounting of the gate for repairs/replacement and seal any leakage between the flange of frame and wall thimble.

- c) The gate frame of these sluice gates shall either be self contained type or non self contained type depending upon site requirement. In case of non self contained gates the frames shall have short length extension guides and shall be without yoke at their top. The length of extension guides in such cases shall be sufficient to engage at least half the overall vertical height of door when the gate is full open and shall be in accordance with the relevant provisions of IS: 13349. In case of self contained gates the frames shall have full length extension guides and shall be provided with a yoke at their top. The length of extension guides in such cases shall be sufficient to engage the overall vertical height of door when the gate is full open position.

#### **Wall Thimble**

- a) The wall thimble will be made from cast iron for placement in the concrete wall. Its front flange will be machined, drilled and tapped to match with the frame flange.
- b) The cross section of the thimble shall be F shaped and the depth of thimble shall be minimum 200mm long or more as per manufacturer's standards. Gates subjected to high unseating heads shall have thimble cross section shaped E.
- c) To permit entrapped air to escape as the thimble is being encased in concrete, cast holes of 40mm diameter shall be provided at the bottom of wall thimble in each entrapment zone.

#### **Gate Slide/Shutter/Door**

- a) The gate slide/shutter/door will be made from cast iron and shall be sufficiently ribbed to withstand the designated water head.
- b) The gate slide/shutter will be provided with integral pocket to house the thrust nut used to connect the stem with the slide.

#### **Seating/Sealing Faces**

- a) Materials: These should be of Stainless steel or Bronze or as specified.
- b) Fitment: The facings shall be attached to flat/rectangular/dovetailed machined faces of gate frame and door, depending upon the applicable water head, and be secured in place using taper screws. The taper screws adopted for facings shall be of same material as that of the seat facings.
- c) The front faces of integral extension guides which can come in contact with the sealing faces of door while opening, shall also be fitted with sealing faces of the same material as that of the sealing faces on door. This is required to offer non corroding smooth sliding surfaces to the sealing faces of door/shutter during its vertical travel for opening and enhance the effective life of gate.
- d) Finish: The mating seating/sealing faces on the gate frame and door shall be precisely finished for proper contact. They should be so finished that the clearance or gap, if any, between the mating sealing faces, in gate closed position, does not exceed 0.1mm.

#### **Wedging Devices**

- a) The sluice gates shall be provided with individually adjustable wedging devices to ensure forced contact between frame and shutter seat facings, when the gate is in closed position.

- b) The gates meant for seating head shall be provided only with side wedging devices. Gates meant for unseating head of sizes larger than 600mm, shall be provided with side, top and bottom wedging devices or with side and top wedging devices and flush bottom closing arrangement as required.
- c) The wedging devices comprise of wedge brackets fitted on gate aperture frame and door. The wedge bracket on frame shall remain in fixed position and those on door shall be adjustable or vice versa. A sort of slot and tannen arrangement shall be provided on base of wedge brackets to prevent any tendency to shift. Provision shall be made to clamp the adjustable brackets firmly in adjusted position.
- d) The wedging devices shall be made of cast iron. If the wedges/wedge blocks of wedging devices are of cast iron, then these are to be lined with contacting faces of the same material as that of sealing faces attached to the gate frame and door.

### **Conventional OR Flush Bottom Closing**

The sluice gates shall be provided with conventional or flush bottom closure arrangement as required.

Generally as a standard the **gates shall be provided with flush bottom closing only especially for gates mounted on bottom of channel** etc. Only the gates mounted above the floor level and having required clearance below for applications like inlet pipe isolation at elevated level, etc. shall be with conventional bottom closing.

The sluice gates provided with conventional bottom closing arrangement involve corrosion resistant metallic contacting sealing faces at the bottom sill of gate. In such cases, the invert of the gate is required to be kept above the floor of the channel/chamber by at least 150mm to 250mm depending upon the size and type of gate. The contractor should verify whether this clearance is available at the site of installation for fitting a conventional bottom closure gate.

In case of conventional closing gate, if the invert of the gate is kept at the same level as that of the channel/chamber floor, then there remains a slot or a groove at the invert of the gate. Debris, dirt etc. which may settle in this slot and may not allow the gate to close properly and this may give rise to heavy leakages while in operation. With a view to avoid this, in situations where the invert of the gate is to remain at the same level as that of the channel/floor, a flush bottom closing gate instead of conventional bottom closing gate should be provided.

Flush bottom closing shall involve a flexible rubber seal at the bottom of the gate, mounted either on the shutter or on the frame, ensuring that the sealing face remains flush with the floor. The cast iron bar fitted at the bottom of the frame is required to be embedded in the channel/chamber floor and for this a cut out/recess of ample dimensions is required to be provided beneath the waterway opening along the gate invert, while constructing the floor. The dimensions of this cut out shall be provided depending upon the feasibility to do so as per actual site conditions.

This cut out/recess is to be later on filled up with removable asphalt or loose concrete mixed with sand dust or vermiculate after putting the gate in position so that it is possible to break open this second stage grout for removal of the gate in future.

The rubber seal employed shall be made of EPDM or Neoprene rubber and the rubber seal retainer bar as well as the fasteners for fitting the rubber seal and the retainer bar are of stainless steel.

### **Gate Operating Head Stock/Lift Mechanism**

- a) The operating head stocks shall be designed in such a manner as to permit the gate operation by a single person under the specified maximum operating head with an effort of less than 18kgs on

the crank or hand wheel with a radius not exceeding 375mm. Vendor shall provide torque calculations in support of same.

- b) The headstock may be ungeared or geared type and the geared headstock may be either of single speed or of double speed, as might be necessary to make it convenient for one person to open or close the gate as fast as practicable. Two speed headstocks shall be supplied with gates requiring higher hoisting capacities. In this type of headstock the low speed is meant for crack opening the gate when the effort required to open the gate is maximum and the high speed is meant for further faster opening after the gate is crack opened.
- c) Geared headstock shall be supplied with easily removable crank handle or handwheel with a radius not exceeding 375mm.
- d) All the gears of geared headstock shall be kept completely encased in cast iron housing to protect them from damage, dirt, dust, water etc. and other atmospheric effects and thus ensure their smooth operation. Grease nipples shall be provided at proper places for lubricating with grease.
- e) Headstock meant for mounting on operating platform shall be supplied with a pedestal/floor stand to provide a convenient operating height of approximately 900mm. The pedestal of the headstock shall be provided with a covered window opening to enable cleaning and greasing of stem threads.

### **Lifting Spindle/Stem**

The sluice gates shall be supplied with rising type lifting spindles/stems. The stem shall be provided with acme/square threading, length of threaded portion being about 400mm more than the height of waterway opening. This much extra length is required to allow for a minor variation of approximately 100mm on either side of the specified height of operating platform.

The design of stem will be done as per the provision in IS: 13349.

### **Stem Block/Connecting Block/Thrust Nut**

The rising type stem shall be connected to the door through a stem block/thrust nut housed in a ribbed pocket cast integral with the door. The bottom end of stem shall thread into the stem block and is locked in place by a set screw to prevent the stem from unscrewing. The stem block shall be cast Bronze or Gunmetal.

### **Safety Stop Nut**

The stem shall be provided with a safety stop nut to prevent the chances of over closing of gate which may otherwise damage either the stem or the lifting platform. The stop nut shall be furnished with a set screw for setting it in a fixed position after the gate is installed. Upon installation the safety stop nut should be set in such a way that its bottom remains about 1mm to 2mm away from the top of headstock, in gate closed position.

In case of stainless steel stem, the stop nut shall also be of stainless steel material of the same grade.

### **Stem/Spindle Couplings**

For ease in transportation and handling, maximum length of one piece stem shall be restricted within 5 meter length. Where the stem are required to be furnished in more than one piece, threaded stem

couplings shall be furnished to interconnect different sections of the stem. The couplings shall have provision for pinning after inserting in the threaded end of the stem.

In case of stainless steel stem, the couplings shall also be of stainless steel material of the same grade.

### **Stem Guide Brackets**

Longer stems shall be provided with sufficient number of stem guides to prevent buckling of stem. The stem guide bracket to be provided shall be adjustable center type - wherein a separate stem guide is bolted on to the wall bracket. The stem guide shall be adjustable in the slots on wall bracket in a direction perpendicular to the face of wall. Wall bracket should also offer minor adjustment in the direction parallel to the wall.

The stem guides shall have machine bored split journals to facilitate erection. The journal shall be lined with Brass/Gunmetal bush.

### **Pipe Hood for Stem**

A pipe hood shall be provided on the top of headstock in case of rising spindle/stem gates to cover the spindle threads for protection against damage, dirt, dust, water etc. It shall be made of transparent fracture resistant polycarbonate material. The pipe hood shall have vent holes to prevent condensation.

### **Gate Opening Indicating Arrangement**

Gate opening indicating arrangement shall be provided to indicate the position of the shutter. This shall comprise of scale mounted on the pipehood and an indicator nut mounted on the rising spindle to show the extent of the opening and closing. The minimum scale graduation shall be 25mm.

### **Materials of Construction**

The materials of construction for various components shall be as under.

Gate Frame, Shutter, Thimble	Plain Cast Iron IS: 210 FG 200
Headstock, Wedges, Stem Guides	Plain Cast Iron IS: 210 FG 200 Stem Guide shall be with LTB-2 Lining
Seating/Sealing Faces and Wedge Lining	Stainless Steel ASTM A 240 Type 304
Rubber Seals (If Applicable)	EPDM Rubber to ASTM D 2000
Rubber Seal Retainer Bar (If Applicable)	Plain Cast Iron IS: 210 FG 200/Stainless Steel ASTM A 240 Type 304
Stem, Stem Guide Brackets, Coupling and Stop Nut	Stainless Steel ASTM A 276 Type 304
Assembly Bolts, Nuts and Fasteners	Stainless Steel ASTM A 276 Type 304
Yoke (If Applicable)	Mild Steel to IS: 2062 Grade A, Epoxy Painted
Stem Block	Leaded Tin bronze to IS: 318 Type LTB2
Lift Nut for Manual Ungear	Leaded Tin bronze to IS: 318 Type LTB2
Pipe Hood for Stem	Transparent Fracture Resistant Polycarbonate Material
Operation	
Lift Nut for Manual Geared/Actuator Operation	As per Gear Box/Actuator Manufacturers' Standards



## ❖ SPECIFICATIONS FOR REMOVABLE BOX TYPE COARSE MESH SCREEN

Manual removable type box screen is to be installed vertically in guide channel in the screen chamber for performing the screening duties in storm water / waste water pumping stations/ water intake structure and in water and waste water treatment plants for arresting floating or similar material entering into the plant/pumping station..

The Removable Box type manual coarse Mesh Screen shall be fabricated from SS 304 mesh made of 10 mm dia. SS 304 round bar materials & having opening as specified in tender specifications elsewhere / in process design criteria and details specifications (shall be 50mm x 50mm opening if not specified elsewhere in tender) and welded / fixed in SS rectangular Box frame made of SS equal angles. The screen width shall match the channel width as a minimum and the height of the screen shall be 300mm above the design liquid depth and having min. 300mm depth. The portion of channel / chamber above the screen up to top of screen chamber shall be closed with RCC wall or 10mm thk MS plate with 10-15mm dia. perforations with required perforation area (not exceeding 25-30% perforation area) or with precast RCC jali sliding in guide channel to prevent any overflow of sewage. Refer attached typical drawing of the box screen.

Screen shall be of two part - (1) Bar Mesh Screen with Box frame & (2) Solids Collection Box.

The screen shall be welded to a common frame as fabricated from min. 50mm X 50mm x 5 mm thick or higher as require equal angle throughout its perimeter of SS-304 to provide sufficient strength with intermediate supports.

Screening / Grit collection box shall be cubical in shape of min. 300mm Ht. with 10mm perforations on all sides to drain fluid and fabricated from min. 3 mm thk SS 304 sheet, covered from all three side & bottom and welded on common frame of screen. Screening / Solids Collection Box shall be framed in min. 50mm X 50mm x 5 mm thick or higher as require of SS-304 equal angle. Both the side of cubical frame of box screen also shall be covered together with top of screen using 3 mm SS 304 sheets. The Side & Bottom surfaces of solid collection box shall be suitably perforated (10 mm dia holes with maximum 10% perforation area) to drain the sewage / water.

The screen shall have min. two lifting hooks, spaced sufficiently apart from the center at the top of the screen frame along with pair of SS chain with lifting rings of min. 300 mm long each at a distance of 1.5 mt. of required length up to 1 m above top to facilitate easy removal of screen from sump. The side of the screen shall have replaceable wear shoes of SS/gunmetal plate at top & bottom edge. The screen shall be rectangular in shape and shall be capable of being lifted by means of mechanical / manual lifting arrangement (electric chain hoist) and raised above the operating platform, as and when necessary.

The Box screen shall be lowered in screen wet pit, suitable to slide complete screen through rollers between guide passage made through C- channel of MCP-400 as per IS-808, grouted / anchored/welded with equally long insert plates of 10 mm thk and securely fixed providing required support vertically throughout the depth of sump on both RCC side wall.

Screen shall be supplied with 1 sets of cleaning rakes / shovels with required long wooden / FRP arm for collecting/removing screenings gathered/collected on screen.

## **GENERAL REQUIREMENT FOR MECHANICAL ITEMS/EQUIPMENTS**

### **PAINTING/COATING OF MECHANICAL ITEMS/EQUIPMENTS**

#### **MS/CI/DI BODY OR PARTS OR STRUCTURE (GENERAL FOR PIPING AND PUMP/ BLOWER/ PROCESS OR SUH OTHER EQUIPMENT IF NOT PROVIDED AS SPECIFIC)**

Painting shall be carried out with one coat of ~~red oxide~~/epoxy primer followed by two coats of epoxy paint after proper surface preparation as recommended by paint manufacturer/shot blasting prior to dispatch, to a total DFT of minimum 150 microns inclusive of priming (for equipment/gate/valves, etc. at manufacturer works before delivery).

Zinc rich epoxy primer and epoxy paint of approved quality shall be used for external and internal painting as applicable. The mix of zinc rich epoxy primer shall be prepared at work site not earlier than 15 minutes before applying the same on pipes and special surfaces. One coat of zinc rich epoxy primer of DFT 75 micron shall be applied along with two coats of epoxy paint DFT 40-45 micron and DFT 30-35 micron respectively. No thinner shall be added to ready mix paint without previous approval of the Employer's representative and the finishing coats on top of the primer coat shall only be applied after allowing the film to cure for at least 48 hours.

After application of zinc rich epoxy primer the surface should be cleaned by duster and inspected. If during inspection, any portion is found rusting the same shall be removed by emery paper and coated with zinc rich epoxy primer.

Mixed paint should be used within 3 to 4 hours of mixing or as recommended by manufacturer and fresh mixing shall be done for every new application. Every successive coat of paint shall be applied only after 48 hours of previous coat. Before applying the next coat, the surface should be properly cleaned by duster.

**CED Coating i.e. Cathode electro deposition coating which is the latest technology for corrosion resistance with uniform coating is also permissible and preferable over conventional painting.**

#### **OPEN CHANNEL GATES/SLUICE GATES (THIMBLE MOUNTED GATES) / STOP LOGS**

The following painting procedure shall be adopted for the Gates, Stop Logs (CI/DI/MS MOC):

Surface Preparation	: Blast clean to near white metal finish using shot blasting.
Priming	: One coat of red oxide primer.
Finish Painting	: Black bituminous paint for gate assembly. Minimum DFT 200 microns inclusive of priming. Yoke and Headstock to be provided with <del>red oxide</del> / epoxy primer and epoxy grey or such suitable shade of paint having minimum DFT 150 microns inclusive of priming.

For Stainless steel gates, SS gate assembly shall be shot/grit blasted, pickled and passivated before delivery.

#### **EOT CRANE**

Painting shall be carried out as specified above for MS/CI/DI parts or structure before delivery. However, the final coat shall be golden yellow color with black zebra marking wherever applicable.

#### **SS BODY OR PARTS OR STRUCTURE OR ENCLOSURE OR PIPING**

Shall be shot/grit blasted, pickled and passivated before delivery / before erection at site (as applicable).

#### **NOTE:**

1. For equipment (including valves, gates, etc.) if paint surface is observed to be damaged/deteriorated during storage or erection of such at site, an additional coat/touch up of paint shall be provided at site as directed by engineer-in-charge prior to commissioning/acceptance of site by client.
2. The paint shade as per manufacturers' standards' can be accepted.

## **DOCUMENTS SUBMISISON OF MECHANICAL ITEMS/EQUIPMENT**

In general, the minimum document submission for various equipment/items shall be as described below or additional as required for review to be submitted by manufacturers'/vendors' (duly stamped by manufacturers'/vendors') for review and approval during detailed engineering/execution and prior to manufacturing.

Manufacturing shall be carried out as per approved drawings and documents only and after complying comments as applicable.

### **PUMP AND PUMP-MOTOR SET (CENTRIFUGAL/POSITIVE DISPLACEMENT/ PROGRESSIVE CAVITY (SCREW)/RECIPROCATING (DOSING), ETC.)**

1. Product technical data sheet.
2. Preliminary outline dimensional drawing (GA Drawing) showing the details of pump and motor, suction, discharge connections and foundation details.
3. Performance curves showing capacity v/s total head, efficiency, NPSH required and power requirements ranging from run out to pump shut off for minimum, maximum and rated impeller diameter of the offered pump.
4. ISO efficiency curve (as applicable).
5. Typical cross sectional drawing showing internal features of pump, parts and their materials.
6. Torque – Speed curve of the pump (as applicable).
7. Quality Assurance Plan.

### **VALVES (SV/NRV/DPCV/BFV/KGV/BALL/AIR VALVE, ETC.), SLUICE GATES, OPEN CHANNEL GATES, STOP LOGS**

1. Product technical data sheet (valve torque shall be provided for electric/pneumatic actuator operated valve)
2. General outline dimensional drawings.
3. Cross sectional drawing showing constructional details with part list with their quantity and MOC confirming to relevant standards.
4. QAP of the product.

### **ADDITIONAL DOCUMENTS FOR ELECTRIC ACTUATOR OPERATED VALVES**

1. Actuator data sheet (shall include opening & closing time and actuator torque selection with required safety factor over valve torque).
2. GA and wiring drawing of electric actuator.
3. Valve torque calculations.
4. Product catalogue.

### **MECHANICAL/MANUAL TYPE COARSE AND FINE SCREENS**

1. Product technical data sheet.
2. GA drawing.
3. Hydraulic calculation for head drop across screen for design/peak flow @ 50% clogging.
4. GAD, wiring and schematic diagram with BOM for control panel or recommended schematic and wiring diagram (as applicable).
5. Recommended cable schedule (as applicable).
6. QAP of the product.

### **EXPANSION BELLOWS**

1. Product technical data sheet.
2. GA Drawings.
3. QAP of the product.

#### **PIPES (METALLIC: CI/DI/MS, ETC. and NON-METALLIC: HDPE/uPVC/RPVC/PP ETC.)**

1. Bill of materials.
2. QAP of the product.

#### **MATERIAL HANDLING EQUIPMENT Viz. EOT/HOT CRANE/CPB/HOT-MONORAIL**

1. Product technical data sheet.
2. Preliminary outline dimensional drawings.
3. Requirement of Girders/ISMB including minimum required size with all calculations.
4. Wiring diagram of panel.
5. QAP of the product.

**Note:** The data sheet and GAD as specified for equipment/item shall also be considered to include coupled items like electrical drives/motor including its performance curves, electric actuators including its wiring diagram, pneumatic actuators etc. as applicable.

#### **INSPECTION AND TESTING**

**Inspection of offered equipment/items at manufacturers' works shall be done by the Client/PMC/TPI representatives as specified here in / as per approved inspection plan. Inspection shall be carried out as per relevant and applicable inspection and testing standards viz IS/BS/API etc. and as per approved quality assurance plans, technical data sheets, documents and drawings.**

#### **Inspection Criteria of Various Major Equipment/Items at Manufacturers' Works:**

The Manufacturers'/OEM/Vendors' shall provide all instrument and equipment required to carry out applicable tests. The instruments shall be calibrated and certified by an approved independent testing authority preferably NABL accredited with valid calibration certificates as on date of inspection.

The inspection category and brief description of tests to be carried out for various equipment is as follows.

#### **➤ PUMP AND PUMP-MOTOR SET**

##### **HYDROSTATIC TEST**

- A standard hydrostatic test shall be conducted on the pump casing with water at 1½ times the maximum discharge pressure on the head characteristic curve or 2 times the rated pressure whichever is higher.
- Unless otherwise stated in data sheet, the hydrostatic test on casing shall be conducted for minimum duration of 30 minutes.
- Manufacturer shall provide internal test certificates of hydrostatic test for review and acceptance by PMC and Client.

##### **MECHANICAL BALANCING**

- Major rotating components of the pumps like impellers, shaft, shaft sleeve etc. shall be individually statically as well as dynamically balanced preferably at rated speed.
- Vendor for PMC/Client's approval shall provide necessary test certificates.

#### **MATERIAL TEST CERTIFICATES**

- Material test certificates for the various pumps components shall be furnished for PMC/Client's review and approval as stated in the data sheet.

### **VISUAL INSPECTION**

- Entire lot as per tender/BOQ shall be offered for visual inspection. The pumps shall not be painted before visual inspection and carrying out performance testing.

### **PERFORMANCE TESTING**

Pump shall be tested for its full operating flow and head range.

Test shall be carried out for rated discharge and maximum discharge. Each pump shall be tested at its rated speed with preferably with **JOB** or shop motor of required rating and speed for its entire working range.

During pump testing, readings to the extent possible shall be taken to correspond to the net effective lift specified in the data sheet, and cover its full working range from its closed valve condition to run out condition i.e. when delivery valve is fully opened. Flow-Head, Flow-Power and Flow-Efficiency curves shall be drawn based on readings of tests carried out. The curves produced shall be used to determine the capacity of pump sets to meet guaranteed performance at site at rated speed.

### **PERFORMANCE WITNESS**

#### **CENTRIFUGAL PUMPS – ANY TYPE (HSCF/VT/SCF/HNC-VNC SEWAGE/ SEWEAGE SUBMERSIBLE/POLDER/MONO BLOCK/MONO SUBMERSIBLE ETC.)**

<b>Pump (Based on Drive Motor Rating)</b>	<b>Pump Performance Test to be Witnessed/Reviewed for each duty and type preferably with JOB MOTOR (Also see notes below)</b>
Up to 30kW motors	Visual/Performance test witnessing not required. Vendor to submit internal test certificates for review, approval and dispatch clearance as per note given below prior to dispatch.
> 30kW up to 160 kW motors	25% quantity or minimum 1 No. whichever is higher per duty/type.
> 160kW	50% quantity or minimum 1 No. whichever is higher per duty/type.
<b>Notes:</b> (1) Manufacturer shall test all the pumps internally and shall provide their internal test records along with dynamic balancing, material test certificates for all major parts as per tender. Hydrostatic test certificate, dimensional check certificates etc. as per approved QAPs and data sheet, of each pump for review, record and dispatch clearance prior to dispatch of pumps. (2) Vendor shall provide certified parallel operation curve for pumps where more than two pumps are incorporated in BOQ along with individual pumps performance test witnessing. (3) <b>HSCF/VT/HNC-VNC Pumps with drive motor ratings &gt; 75 kW &amp; above to &lt; 160 kW, ONE JOB motor</b> of each type and rating, out of the project (tender) lot, shall be sent to the pump manufacturers' works for performance testing of pump-motor assembly set. In case of testing of pump(s) with job motor(s), witnessing of inspection test of motors @ motor manufacturers' works shall stand waived and if pump(s) are to be performance tested with shop motor(s), inspection tests of motors shall be witnessed by the Client/PMC/TPI @ manufacturers' works as specified in technical specifications of electrical works.	

#### **➤ VALVES (SV/NRV/DPCV/MD-NRV/BFV/KGV/BALL VALVE/AIR VALVE)**

### **HYDROSTATIC TEST**

- A standard hydrostatic test shall be conducted on the body and seat (with water) of valves at

required test pressure depending on PN ratings/design pressure rating(s) of valves for minimum duration of 2 minutes or as specified in applicable testing standards.

- Manufacturer shall provide internal test certificates of hydrostatic test for review and acceptance by PMC and Client.

#### **MATERIAL TEST CERTIFICATES**

- Material test certificates for the various components of valves shall be furnished for PMC/Client's review and approval as stated in the data sheets.

#### **VISUAL INSPECTION & VERIFICATION of DIMENSIONS**

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of dimensions. The valves shall not be painted before visual inspection and carrying out performance testing.

#### **PERFORMANCE TESTING**

- Valves shall be tested for operation as per applicable standards.
- Electric actuator operated valves shall be tested only on job electric actuator and shall verify operation time (Full open to full close in one cycle).

#### **PERFORMANCE WITNESS**

<b>Size of Valves</b>	<b>Performance Test to be Witnessed/Reviewed for each size/rating and type (Also see note below)</b>
Up to 300mm diameter	Visual/Performance witnessing is not required. Vendor to submit test certificates for review/approval and dispatch clearance as per notes given below prior to dispatch.
> 300mm diameter	10% quantity or minimum 1 number whichever is higher per size/rating and type for hydro test and rest shall be review of internal documents.
<b>Note:</b> Manufacturer shall test all the valves internally and shall provide their internal test records for hydrostatic test along with material test certificates for all major parts as per tender, dimensional check certificates, actuator internal test records for valve etc. as per approved QAP and data sheets of valve type for review, record and dispatch clearance prior to dispatch of materials.	

#### **➤ EXPANSION BELLOWS**

##### **HYDROSTATIC TEST**

- A standard hydrostatic test shall be conducted on bellows at required test pressure depending on PN ratings/design pressure rating(s) of bellows for minimum duration of 15 minutes or as specified in applicable testing standards.
- Manufacturer shall provide internal test certificates of hydrostatic test for review and acceptance by PMC and Client.

##### **MATERIAL TEST CERTIFICATES**

- Material test certificates for the various components of bellows shall be furnished for PMC/Client's review and approval as stated in the data sheets.

##### **VISUAL INSPECTION & VERIFICATION of DIMENSIONS**

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of dimensions. The bellows shall not be painted before visual inspection and carrying out performance testing.

#### **PERFORMANCE TESTING**

- Bellows shall be tested for axial expansion and compression test as per applicable standards.
- Dye penetration test (DPT) shall be carried out for weld joints on expansion bellows exceeding size of 1 meter (NB Dia.) selected randomly from entire project (tender) lot.

#### **PERFORMANCE WITNESS**

<b>Size of Expansion Bellows</b>	<b>Performance Test to be Witnessed/Reviewed for each size/rating and type (Also see note below)</b>
Up to <b>500mm</b> diameter	Visual/Performance test witnessing is not required. Vendor to submit test certificates for review/approval and dispatch clearance as per notes given below prior to dispatch.
> <b>500mm</b> diameter	10% quantity or minimum 1 number whichever is higher per size/rating and type for hydro test, axial expansion and compression test & and rest shall be review of internal documents.
<b>Note:</b> Manufacturer shall test all the expansion bellows internally and shall provide their internal test records for hydrostatic test along with material test certificates for all major parts as per tender, dimensional check certificates, actuator internal test records for valve etc. as per approved QAP and data sheets of expansion bellows for review, record and dispatch clearance prior to dispatch of materials.	

#### **➤ SLUICE GATE**

#### **MATERIAL TEST CERTIFICATES**

- Material tests certificates for all important components of gates such as thimble, frame, shutter, seat facings, spindle and rubber seals etc. to be furnished at the time of inspection.

#### **VISUAL INSPECTION & VERIFICATION of DIMENSIONS**

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of important dimensions.

#### **OTHER TESTS**

- **Movement Test**

Movement test shall be conducted in horizontal/vertical assembled condition using stems and headstock. The gate should be operated once from full close to full open and back to full close condition with a maximum force of 135 Newton-meter on the crank or hand wheel.

- **Shop Leakage Test**

Shop leakage test by applying unseating hydraulic pressure will be conducted with gate mounted vertically on a test bench. A hydrostatic pressure equal to maximum seating/ unseating head shall be applied to gate at centerline of gate opening from the back, i.e. unseating face of the gate in closed position, through pump. A suitable scaled calibrated pressure gauge put on the unseating face of the gate shall indicate reading equal to unseating pressure head. Water leakage through the gate under above condition shall be collected in a collection pan and measured.

The leakage so measured should not exceed the limit of 2.5, 3.5 and 4.5 LPM per meter sealing perimeter for class I, class II and class III sluice gates as stated in the IS: 13349 (1992).

No alternate testing arrangement will be permitted in place of above method. Gates can be applied with a coat of primer to prevent rusting due to water exposure during testing.

- **Hydrostatic Body Test**

After the leakage test, hydrostatic body test will be conducted by applying hydrostatic pressure equal to 1.5 times the maximum operating head on the gate for 5 minutes continuously. No permanent deformation in casting should be observed.

- **Torque Testing at Operating Head**

Torque test at operating head would be conducted at applicable head at manufacturer's shop for gates up to 2000mm x 2000mm size.

- **Seat Clearance Check**

With the gate in closed condition, 0.1mm thick feeler gauge should not pass through between seat facings.

- **PMI Test**

Positive Material Identification (PMI) test to be conducted for sealing/seating faces, rubber seal retainer bar (if applicable) and stem/spindle during the inspection.

- Electric actuator operated valves shall be tested only on job electric actuator and shall verify operation time (Full open to full close in one cycle).

## **PERFORMANCE WITNESS**

<b>Size, Class and Type of Sluice Gate</b>	<b>Performance Test to be Witnessed/Reviewed for each size, type and class of Sluice Gate (Also see Note below)</b>
Up to 1000mm dia./square (up to 1 m <sup>2</sup> area)	Visual/Performance witnessing is not required. Vendor to submit test certificates for review/approval and dispatch clearance as per note given Below prior to dispatch.
> 1000 mm diameter/square (> 1 m <sup>2</sup> area)	10% quantity or minimum 1 number whichever is higher per size/class and type.
<b>Note:</b> Manufacturer shall test all the sluice gates internally and shall provide their internal test records for hydrostatic test along with material test certificates for all major parts as per tender, clearance check test, leakage test, movement test, dimensional check certificates, actuator internal test records for gates etc. as per approved QAP and data sheet of sluice gate for review, record and dispatch clearance prior to dispatch of material.	

## **➤ MECHANICAL/MANUAL TYPE COARSE AND FINE SCREENS**

### **MATERIAL TEST CERTIFICATES**

- Material tests certificates for all important components of the equipment to be furnished at the time of inspection.

### **VISUAL INSPECTION & VERIFICATION OF DIMENSIONS**

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of important dimensions.

### **PMI Test**



- Positive Material Identification (PMI) test to be conducted for MOC during the inspection.

#### DPT

- Dye penetration test (DPT) shall be carried out for checking of soundness of weld joints on mechanical screens.

#### PERFORMANCE WITNESS

Type of Screen	Performance Test to be Witnessed/Reviewed for each type and size
Manual Screen – Any Type	Visual/Performance witnessing is not required. Manufacturer shall check all manual screens internally and shall provide their internal test records for dimensional check certificates along with material test certificates for all major parts as per tender and approved QAP and data sheet for review, record and dispatch clearance, prior to dispatch of materials.
Mechanical Screen – Any Type	10% quantity or minimum 1 No. whichever is higher per size of Mechanical screen shall be witnessed at manufacturers' works for DPT, PMI and other required tests as per approved QAP and data sheet etc.

#### ➤ PIPES (METALLIC: CI/DI/MS, ETC. and NON-METALLIC: HDPE/uPVC/RPVC/PP ETC.) AND CI/DI FITTINGS

#### VISUAL INSPECTION & VERIFICATION of DIMENSIONS

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of dimensions.
- Mass/Weight check and thickness check shall be carried out as per approved QAPs and applicable standards.

#### HYDROSTATIC TEST

- A standard hydrostatic test shall be conducted on pipes at random at required test pressure for minimum specified duration in applicable testing standards.
- All other tests shall be carried out as per applicable standards.

#### PERFORMANCE WITNESS

Size, Class and Type of Pipes and Fittings	Performance test to be Witnessed/Reviewed for each size/class and type of pipe and fittings (Also see notes below)
Up to 300mm diameter	Performance witnessing is not required.
> 300mm diameter and up to 900mm diameter	10 % quantity or minimum 1 number whichever is higher per type size/class/length and type.
> 900mm diameter	25% quantity to be witnessed.
<b>Notes:</b> 1) Manufacturer shall test all the pipes & fittings internally and shall provide their internal test records for hydrostatic test along with material test certificates, mass/weight check statement, dimensional check certificates etc. as per BOM and as per approved QAP for review, record and dispatch clearance prior to dispatch of materials. 2) For pipes <b>above 300mm dia. and up to 900mm dia.</b> size, if the total quantity required for any particular size of pipe for entire pumping system / plant / project is <b>less than 100meters</b> , performance test is not to be witnessed for the particular applicable size of pipe/s. However, conditions mentioned at serial number 1) here in must be adhered to and complied with to the satisfaction of Engineer in	

charge/ PMC.

**3)** For pipes **above 900mm dia.** size, , if the total quantity required for any particular size of pipe for entire pumping system / plant / project is **less than 50meters**, performance test is not to be witnessed for the particular applicable size of pipe/s. However, conditions mentioned at serial number 1) here in must be adhered to and complied with to the satisfaction of Engineer in charge/ PMC.

**4)** For all fittings of all sizes if the total weight of total quantity required for entire pumping system / plant / project is less than **5000kg**, performance test is not to be witnessed. However, conditions mentioned at serial number 1) here in must be adhered to and complied with to the satisfaction of Engineer in charge/PMC.

➤ **MATERIAL HANDLING EQUIPMENT Viz. EOT/HOT CRANE/CPB/HOT-MONORAIL**

**MATERIAL TEST CERTIFICATES**

- Material tests certificates for all important components of the equipment hook, wire rope, brakes etc. to be furnished at the time of inspection.

**VISUAL INSPECTION & VERIFICATION of DIMENSIONS**

- Entire lot as per tender/BOQ shall be offered for visual inspection and verification check of important dimensions.

**OTHER TESTS**

- All motorized material handling equipment shall be tested for overload tests at 125% of the rated load.
- All manual chain pulley blocks/HOT etc. shall be tested for overload tests at 150% of the rated load.
- Speed of lifting, long and cross travel as well as and deflection check shall be conducted as per governing standards.

**PERFORMANCE WITNESS**

<b>Type &amp; Capacity of Material Handling Equipment</b>	<b>Performance Test to be Witnessed/Reviewed for each type and capacity</b>
(Electric/Manual) CPB/HOIST/HOT-Monorail/ Chain Hoist – Any capacity  EOT/HOT Crane - <b>Up to 3MT</b>	Visual/Performance witnessing is not required. Manufacturer shall test all the CPB/Hoist, HOT/EOT (up to 3 MT) internally and shall provide their internal test records along with material test certificates for all major parts as per tender, dimensional check certificates etc. as per approved QAP and data sheet of CPB/Hoist, HOT/EOT (up to 3 MT) for review, record and dispatch clearance prior to dispatch of materials.
EOT/HOT Crane > <b>3MT</b>	10% Quantity or Minimum 1 No. whichever is higher per size (capacity) and type shall be witnessed at manufacturers' works for performance test as per approved QAP and data sheet.

**NOTES:**

For all major equipment/items specified above, where factory inspections are exempted as clearly specified above, all tests as per relevant and applicable standards as well as approved QAPs, data sheets, documents and drawings must be carried out by the manufacturers'/vendors etc. and test certificates, MTCs etc. shall be submitted to the PMC/TPI prior to dispatch for getting dispatch clearance of the Client/PMC/TPI.

All other items not explicitly mentioned here but are in the scope of the tender (project) are exempted from performance tests @ manufacturers' works' to be witnessed by Client/PMC/TPI. However, all tests as per applicable governing standards should be carried out by the manufacturers' and such test reports along with MTCs, dimensional verification certificates (if and as applicable) shall be submitted to the Client/PMC/TPI for review and acceptance for getting get dispatch clearance.

All expenditure pertaining to inspection including to and fro travel, local conveyance, lodging and boarding etc. shall be borne by the Contractor for minimum 2 representatives of Client/PMC/TPI Agency.

The Client or his authorized representative may visit the works during manufacture of various mechanical equipment/materials to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given full assistance to carry out stage inspection. Client's representative shall be given minimum two weeks advance notice for witnessing the final testing.

Field tests as per approved procedures/procedures available with Engineer-in-charge or his authorized representative shall be performed on the mechanical system/equipment before it is being put into service. All test equipment and instruments shall be arranged by the Vendor/Contractor. Test reports shall be approved by the Engineer-in-charge before acceptance of the equipment and complete plant.

## **TESTING, ERECTION AND COMMISSIONING**

Tests of the plant at the manufacturer's premises will be required in accordance with the conditions of contract. All inspection, examination and testing shall be carried out in accordance with appropriate standards.

Testing & inspection at manufacture works of all major items viz.: pumps, motors, valves, EOT crane shall be conducted at manufacturer's work in presence of PMC/third party inspection agency appointed by Client/or Engineer-in-charge representatives of Client/PMC/TPI.

All the charges for third party inspection shall be included under the scope of Contractor. All instruments used for such tests shall be calibrated and certified by an approved independent testing authority not more than 12 months prior the test in which they are used. The Engineer's representative reserves the right to impound any instrument immediately after test for independent testing. A certificate shall be produced by the Contractor prior to carrying out every test showing the readings obtained, calculations and full details of the calibration certificates referred to.

If the Engineer's representative witnesses a test he shall be given a copy of the test results and certificates immediately. Whether he witnesses a test or not, copies of test certificate shall be sent to the Engineer's representative. No item of the plant shall be forwarded to the site until its test certificate has been approved writing by the Engineer's representative. Six copies of the test certificates shall be supplied in suitable folders with proper index.

Certificates shall be clearly identified by serial or reference number where possible to the material being certified and shall include information required by the relevant reference standard or specification clause.

## **INSPECTION AT MANUFACTURER'S PREMISES**

The inspection of all equipment required to be supplied to complete the works shall be done as detailed in this specification. Only defect free and sound material meeting the technical requirements of this specification and in accordance with a high standard of engineering would be acceptable to the engineer's representative.

For meeting these requirements of inspection, testing (including testing for chemical analysis and physical properties) shall be carried out by the Contractor and certificates submitted to the Engineer's representative who will have the right to witness or inspect the above mentioned testing/inspection at any stage desired by him. Calibration certificates or test instruments shall be produced for the Engineer's consent in advance of testing and if necessary instruments shall be recalibrated or substituted before the commencement of the test. Items of plant or control systems not covered by standards shall be tested in accordance with the details and program agreed between the Engineer and Contractor.

If during or after testing, any item of the plant fails to achieve its intended duty or otherwise prove defective it shall be modified or altered as necessary, retested and re-inspected as required by the Engineer.

At least 21 days' notice shall be given to the Engineer before the specified tests are carried out.

No material is to be delivered to site without the above described inspection having been carried out or officially waived in writing by the Engineer's representative.

## **ERECTION-GENERAL**

The Contractor's staff shall include at least one competent Erection Engineer with proven suitable, previous experience on similar contract to supervise the erection of the works and sufficient skilled, semiskilled and unskilled labour to ensure completion of the works in time. The Contractor shall not remove any representative, erector or skilled labour from the site without the prior approval of the Engineer's representative.

One Erection Engineer who shall be deemed to be the Contractor's representative shall be conversant with the erection and commissioning of the complete works. Should there be more than one erector, one shall be in charge and the Contractor shall inform the Engineer's representative in writing which erector is designated as his representative and is in charge. Erection engineer is to report to Project Manager.

The Contractor's erection staff shall arrive on the site on date to be agreed by the Engineer's representative before they proceed to the site, however, the Contractor shall first satisfy himself, as necessary, that sufficient plant of his (or his sub-contractor's) supply has arrived on site so that there will be no delay on this account.

The Contractor shall be responsible for setting up and erecting the plant to the line and levels of reference given by the Engineer in writing, and for the correctness (subject as above mentioned) of the positions, levels dimensions and alignment of all parts of the works and for provision of all necessary instruments, appliances and labour in connection therewith. The checking of setting out of any line or level by the Engineer or Engineer's representative shall not in any way relieve the Contractor of his responsibility for the correctness thereof.

Erection of plant shall be phased in such a manner so as to obstruct the work being done by other Contractors or operating staff who may be present at the time. Before commencing any erection work, the Contractor shall check the dimensions of structures where the various items of plant are to be installed and shall bring any deviations from the required positions, lines or dimensions to the notice of the engineer. Plant shall be erected in a neat and workmanlike manner on the foundations and at the locations shown on the approved drawings. Unless otherwise directed by the Engineer, the Contractor shall adhere strictly to the aforesaid approved drawings. If any damage is caused by the Contractor during the course of erection to new or existing plant or buildings or any part thereof, the Contractor shall, at no additional cost to the Employer, make good, repair or replace the damage, promptly and effectively as directed by the Engineer and to the Engineer's satisfaction.

During erection of the plant the Engineer will inspect the installation from time to time in the presence of the Contractor's site representative to establish conformity with the requirements of the specification. Any deviations and deficiencies found or evidence of unsatisfactory workmanship shall be corrected as instructed by the Engineer.

## **RECORD, PROCEDURES AND REPORTS**

The Contractor shall maintain records pertaining to the quality of installation/erection work and inspection, testing, compliance with all technical requirements in respect of all his works as described in the previous paragraphs. The reporting formats shall be in the approved formats. The Contractor shall submit such records to the Engineer after the completion of any particular work before submitting the bill of supply/progress of work. Such report shall comprise of shop inspection reports, shop testing reports, material test reports, based on which dispatch clearances are provided, all the quality control reports of welding, erection and alignment records.

All the above mentioned records shall be submitted in the final form duly countersigned by the engineer's representative attesting conformity to specifications and is approval of installation and duly incorporating all the additions, alternations and information as required by the engineer, on the basis of preliminary reports giving the progress of the work. Such records notwithstanding any records

submitted earlier with bill of supply/progress etc. shall be duly bound and submitted to the Engineer in six copies by the contractor on his notification of the mechanical completion of erection.

## **COMPLETION OF ERECTION**

The completion of plant under erection by the Contractor shall be deemed to occur, if all the units of the plant are structurally and mechanically complete and will include among other such responsibilities the following:

- (a) Plant in the scope of the contractor has been erected, installed and grouted as per specifications.
- (b) Installation checks are completed and approved by the Engineer.
- (c) The erected plant are totally ready for commissioning checks.

At the stage of completion of erection, the Contractor shall ensure that all the physical, aesthetic and workmanship aspects are totally complete and the plant is fit and bound to undergo commissioning checks/tests on completion.

Upon achieving the completion as described above, the Contractor shall notify the Engineer by a written notice intimating such mechanical completion of units and notify the Engineer for inspection and acceptance of mechanical completion. The Engineer/Engineer's representative shall proceed with the inspection of such units within 14 days of such a notice.

Thereafter,

- (a) The Engineer shall certify completion when there are no defaults in the works and the plant is acceptable, or
- (b) The Engineer shall inform the contractor list of deficiencies for rectification hereinafter referred as Punch List and the Contractor shall complete the rectification work within a jointly agreed period before tests on or approval of the same before proceeding with the Tests on Completion, or
- (c) The Engineer may inform the Contractor that the works are accepted with the 'punch' list (Items which do not hamper operability, safety or maintainability) and allow the Contractor to proceed with the pre-commissioning checks followed by Test on Completion when the Contractor undertakes to complete such outstanding works within an agreed during Defects Liability Period.

Taking over shall be based on rectification of all deficiencies as advised by punch lists.

The erection period indicated by the Contractor would be deemed to cover all the activities up to completion as stipulated in previous paragraphs, notice of completion by the Contractor, inspection by the Engineer for completion, and Contractor rectification of all deficiencies as noticed by the deficiency/punch list, and acceptance by the Engineer of such rectification, prior to Test on Completion.

Minor defects, which in the opinion of Engineer which do not hamper operability and maintainability will not be taken in to account for deciding mechanical completion. Such defects shall be rectified concurrent to commissioning checks before Test on Completion. However, the Engineer's decision in this regard is final.

The commissioning period as notified by the Contractor shall be deemed to occur beyond the date of completion and shall include all period of pre-commissioning, trials and Test on Completion.

It is in the Contractor's interest to offer the sections/units/systems, progressively under identified milestones within overall erection period, duly completed for inspection by the Engineer's representative, obtain his 'punch' list, for rectification of any deficiencies pointed out by the Engineer

and to achieve mechanical completion before undertaking the Test on Completion within the specified erection period. The Engineer also reserves a right to withhold the cost as estimated, to be equivalent to the rectification of deficiencies pointed out to the Contractor until such a time such deficiencies are rectified to the satisfaction of the Engineer.

## **SETTING TO WORK**

On completion of erection the Contractor shall request the Engineer's representative to carry out the installation inspection.

After the plant has been set to work the Contractor shall continue to operate the plant for a period of one week.

## **INSTALLATION INSPECTION**

In addition to the progressive supervision and inspection by the Client/Employer the Contractor shall offer for inspection to Engineer, the completely erected plant/part of plant on which tests are to be carried out. After such inspection by Engineer, each equipment/sub-system shall be tested by the contractor in accordance with the applicable standards in the presence of Engineer. Such tests shall include but not be limited to the tests specified in following clauses.

## **PUMPS, PIPING AND VALVES**

- (a) The erected pipe work shall be subjected to a hydraulic test at 1.5 times the maximum pressure or twice the working pressure whichever is higher to test the soundness of the joints. Provision of the necessary pumps, gauges, blank flanges, tapings etc. for carrying out these tests shall be include in the contract.
- (b) Leakage tests shall be carried out on all erected pipe work, pumps and valves immediately after erection and where possible before being built in.
- (c) Operating tests shall be conducted on valves.
- (d) The pump set shall be tested for satisfactory operation. The vibration and noise level shall be checked to be within the specified limits.

## **PUMP MOTORS**

Condition of winding insulation be tested and insulation values shall be restored to required level by suitable heating arrangements locally.

## **HOISTS**

The hoist and lifting tackle shall be tested to 125 % of the safe working load. The contractor shall arrange the test load.

## **SLUICE GATE**

- (a) Leakage test shall be performed by the contractor after installation of the sluice gates.
- (b) Under the design seating head and unseating head the leakage shall not exceed the limit specified in AWWA C501/IS: 13349, class 1 for shop testing.

## **INSTRUMENTATION**

Performance of the instrumentation shall be checked as per the design requirements.

## **MISCELLANEOUS**

Completion checks and commissioning tests on items not covered under above, shall be carried out by the contractor as per the instructions of the Engineer's representative.

## **COMMISSIONING**

### **SCOPE**

~~At the time of commissioning, the Engineer will appoint his representative as commissioning Engineer.~~ The Contractor shall carry out commissioning tests in the presence of the representative of AMC. Though the mechanical completion may have been checked and clarified by the site Engineers, the representative of AMC may verify any mechanical completion checks to satisfy himself that the plant is fit and sound, if such checks had not been witnessed by him. It will be the responsibility of the contractor to make all arrangements for carrying out these tests. The evaluation of test results and decision passed by the AMC representative regarding the test results will be final and binding on the contractor. Any additional tests or repetition of tests to establish satisfactory operation of any equipment shall be carried out by the Contractor at no extra cost.

### **MISCELLANEOUS**

Completion checks and commissioning tests on items not covered under above, shall be carried out by the Contractor as per the instructions of the Engineer's representative.

### **HANDING OVER WORK**

No item of Plant/Equipment will be certified for taking over by the Client's Engineer-in-charge unless it has successfully passed all the tests, requirements as mentioned in tender documents. Contractor has to handover phase wise work to client and after completing all kinds of SITC work and upon fulfilling all checks/tests/reports as mentioned in tender the Handing Over will be taken by Client. Defect Liability Period will start from date from Completion and Handing-Over Entire work under this tender scope.

### **TAKING OVER**

No item of plant will be certified for taking over by the Client/Employer unless it has successfully passed all the tests called for under the contract. If nevertheless the employer uses any part of the works, that part which is used shall be deemed to have been taken over at the date of such use.

Taking-Over Certificate for plant shall not be issued unless the following documentation are duly compiled and submitted in final formats in duly bound volumes.

- (a) A compilation of all shop inspection results/reports of the plant/machinery with due attestation that the plants have been manufactured to specified standards (5 copies).
- (b) All erection/construction quality control checks in appropriate approved formats for all installation works with attestation that installation has been carried out as per acceptable/stipulated standards (6 copies).



**TECHNICAL DATA SHEET FOR  
MECHANICAL EQUIPMENT**

**(TO BE SUBMITTED DURING EXECUTION STAGE)**

### GENERAL NOTES/GUIDELINES FOR BIDDERS/VENDORS

1. The technical vendor data sheets for various electro-mechanical equipment and items shall be submitted by contractor during execution/respective equipment approval stage as per provided format as a minimum (and with additional details as required separately) for review and approval.
2. The design ambient temperature shall be considered as 5 °C minimum and 50 °C maximum.
3. The specific gravity of various service fluids shall be considered as under:

Service Fluid	Specific Gravity
Clear/Potable Water, Tertiary Treated Sewage	1.00
Raw Water (River, Canal etc., Secondary Treated Sewage)	1.01
Sewage	1.02
Secondary / Return Activated Sludge	1.03
Primary / Thickened / Digester Sludge	1.05
Any Other	As per fluid properties and concentration

4. For painting, document submission and inspection and testing requirements bidder/vendor to refer the “GENERAL REQUIREMENT FOR MECHANICAL ITEMS/EQUIPMENT” section provided with specifications or other as specified elsewhere in tender.
5. The selection of motor operating characteristics and its mounting to suit the equipment shall be responsibility of contractor/vendor.
6. The data sheet shall be submitted separately for each type/capacity of pump, for each size/type of valves and gates and its type of operation for each equipment etc. as applicable.

## DATA SHEET OF NON-CLOG SEWAGE SUBMERSIBLE PUMP-MOTOR SET

Sr. No.	Particulars	Data To Fill by Contractor/ Vendor
<b>1.0</b>	<b>Liquid Data</b>	
1.1	Liquid Handled	Sewage
1.2	Specific Gravity	1.02
1.3	Temperature °C (Ambient)	
<b>2.0</b>	<b>Pump Data</b>	
2.1	Make	
2.2	Pump Type	Sewage Submersible CF pump with Dry Type Motor
2.3	Pump Model	
2.4	Quantity (Nos.)	
2.5	Type of Duty	Continuous
2.6	Design Capacity (m³/hr.)	
2.7	Head (m)	
2.8	Shut Off Head (m)	
2.9	Rated Speed of Pump (RPM)	
2.10	Pump Efficiency at Duty Point (%)	
2.11	Pump Input (Max. BkW) for Rated Impeller (kW)	
2.12	Recommended Drive Motor Rating (kW)	
2.13	Efficiency of Pump Set (%) @ Duty Point (Without Coating & Without Negative Tolerance)	
2.14	Full Load Motor Efficiency (%)	
2.15	Guaranteed Overall Efficiency of Pump-Motor Set @ Duty Point	
2.16	Full Load Speed of Motor (RPM)	
2.17	Minimum Submergence Required (m) (Measured from bottom to impeller for cavitation free operation of pumps (m) <b>1.</b> for Solo Operation and <b>2.</b> for Parallel Operation	
2.18	Maximum Permissible Size of Solids (mm)	
2.19	Guide Pipe, Size and Thickness/Schedule	
2.20	Length of Each Guide Pipe (m)	
2.21	Lifting Chain: Construction Details	
2.22	Lifting Chain: Length (m)	
2.23	Weight of Pump Motor Set (kg)	
2.24	GD² value of Pump-Motor Set	
<b>3.0</b>	<b>Constructional Features</b>	
3.1	Number of Stage	Single
3.2	Casing Type	Volute Type
3.3	Impeller Type (Enclosed/Semi Open)	Non-Clog Single Suction
3.4	Impeller Diameter (mm) Max./Rated/ Minimum	
3.5	Shaft/Drive Transmission	Direct Uni-Built (On Common Shaft)
3.6	Shaft Seal	Double Mechanical Seal
3.7	Mechanical Seals: Make, Type and Size Faces: Pump Side Motor Side	
3.8	Mounting Orientation	Vertical
3.9	Nozzle Orientation and Size (mm) Suction (Bottom/As per Application)	

	Discharge (Side/As per Application)	
3.10	Flange Drilling	As per IS: 1538, FF with off center bolt holes/IS: 6392/BS EN 1092 FF
3.11	Direction of Rotation	CW when viewed from Top
3.12	Type of Starter (DOL/Star-Delta/Soft/VFD)	
<b>4.0</b>	<b>Motor Data</b>	
4.1	Motor Rating (kW)	
4.2	Voltage/Phase/Frequency and % Variation	
4.3	Combined Voltage and Frequency Variation	
4.4	Design Ambient Temperature/Temperature Rise °C	
4.5	Insulation Class	
4.6	Duty	
4.7	Full Load Speed (RPM)	
4.8	Full Load Torque (FLT) (kgm)	
4.9	Starting Torque as Percentage of FLT (%)	
4.10	Full Load Current (FLC) (Amps.)	
4.11	Locked Rotor Current (Amps.)	
4.12	Starting Current as % of FLC	
4.13	Break Down Torque (POT) as % of FLT	
4.14	Starting Time at 80% V/100% V (Seconds) with Load Coupled	
4.15	No Load Starting Time	
4.16	Locked Rotor Withstand Time Hot/Cold (Seconds)	
4.17	Overload Capacity (%)	
4.18	Number of Permissible Cold/Hot Starts	
4.19	Starting Power Factor	
4.20	Motor Power Factor @ 50%, 75% and 100% Load	
4.21	Motor Efficiency @ 50%, 75% & 100% Load (%)	
4.22	Protection Class	
4.23	Provision of Thermistors	Yes
4.24	Winding and Moisture Protection Details	
4.25	Bearing Type/Number DE: NDE:	
4.26	Winding Insulation Class	
4.27	Motor Seal Cooling Details	
4.28	Winding Temperature Detector	
4.29	Seal Leakage (Moisture) Detector	
4.30	Cable Type	Dual PVC Sheathed, Round, Copper Conductor
4.31	Details of Power Cable: Run, Core & Size	
4.32	Details of Control Cable: Run, Core & Size	
4.33	Length of Pair of Cables offered with Pump Set (Power and Control) (m)	
<b>5.0</b>	<b>Materials Of Construction</b>	
5.1	Pump Casing (M)	
5.2	Casing Wear Ring (if provided)	
5.3	Suction Cover/Oil Chamber/Motor Casing	
5.4	Shaft (M)	
5.5	Shaft Sleeve (if required) (M)	
5.6	Impeller (M)	
5.7	Impeller Wear Rings (M)	

5.8	Impeller Nut (M)	
5.9	Mechanical Seal Faces: Pump Side Motor Side	
5.10	Stator Housing	
5.11	Stator	
5.12	Rotor	
5.13	Auto Coupling Unit (Pump Connector Unit)	
5.14	Guide Pipe	
5.15	Lifting Chain	
5.16	T Bracket	
5.17	Hardware – Bolts, Nuts, Anchor Fasteners etc.	
<b>6.0</b>	<b>Accessories Required</b>	
6.1	Auto Coupling Unit	Yes
6.2	Dual Guide Pipe with Support (SS)	Yes
6.3	Lifting Chain (SS)	Yes
6.4	Set of Foundation Bolts and Nuts	Yes
6.5	SS Suction Strainer with Details of Size and Area of Opening	Yes
6.6	PMU/Pump Monitoring-Safety Unit	Yes
6.7	Non-Standard/Special Tools	Yes
<b>7.0</b>	<b>Drawings and Documents Submission</b>	As per Specifications
7.1	Performance Curves (Capacity i.e. Flow Vs Head, Capacity Vs Efficiency and Capacity Vs Power)	
7.2	GA Drawing of Pump	
7.3	Cross Sectional Drawing of Pump	
7.4	Catalogue of Products	
7.5	QAP	
<b>8.0</b>	<b>Painting</b>	Refer General Requirement for Mechanical Items/Equipment Section /Tender Specifications
<b>9.0</b>	<b>Testing</b>	As Specified in Inspection-Testing

**Notes:** 1. Manufacturer/Supplier shall submit separate data sheet for each duty.

2. For components (marked-M) MTC (**of Laboratory accredited with NABL**) as per relevant standards shall be furnished.

3. Test certificates for hydrostatic test, static and dynamic balancing of impeller and rotating assembly are required for review and acceptance.

4. Bidder shall refer electrical specifications for motor requirement and shall offer accordingly.

5. Bidder shall have to submit completely filled data sheet in above format certified by approved pump manufacturer along with certified pump characteristic curves and offer pump model with guaranteed minimum acceptable pump and overall (pump and motor combined) acceptable efficiency.

**ANNEXURE – X-1**  
**FORMAT OF UNDERTAKING BY PUMP MANUFACTURER**  
**(To be made on Rs. 300 stamp paper and notarized to be submitted)**

**(For HSCF/VT/HNC and VNC NON-CLOG SEWAGE/SEWAGE SUBMERSIBLE/ SUMBERGED CENTRIFUGAL etc. type of PUMPS as applicable)**

**To,**  
**Additional City Engineer (\_\_\_\_\_)**  
Ahmedabad Municipal Corporation  
Ahmedabad – 380 001.Gujarat.

**Name of Work: (Bidder/Vendor to specify as applicable)**

We, the pump manufacturer, M/s. \_\_\_\_\_ (Name of Company) (Hereinafter referred as '\_\_\_\_\_) a company incorporated under the Companies Act 1956 with Registered Office at \_\_\_\_\_, One of the approved vendors for \_\_\_\_\_ Pumps **(Bidder/Vendor to specify type of Pump as per BOQ)** as per tender and have agreed to offer our pumps of following capacity.

- (1) Discharge \_\_\_\_\_ m<sup>3</sup>/hr at \_\_\_\_\_ metre Head as per tender Price Bid/Specifications,  
(2) Discharge \_\_\_\_\_ m<sup>3</sup>/hr at \_\_\_\_\_ metre Head as per tender Price Bid/Specifications,

**(Bidder/vendor to specify each type and capacity of pumps as offered by Vendor for said work)**

for above referred Work to the Bidder M/s. \_\_\_\_\_, a company incorporated under the Companies Act 1956 (or a Partnership or Proprietor Firm as applicable) with a Registered Office at \_\_\_\_\_, (herein referred as '\_\_\_\_\_').

In this regards we confirm/undertake to offer services to the Bidder M/s. \_\_\_\_\_ as under.

1. We undertake to supply pumps of rated capacity and head as per tender with pump/overall pump set efficiency of (1) \_\_\_\_\_%, (2) \_\_\_\_\_% etc. **(Bidder/Vendor to include and specify as applicable)** without negative tolerance which is equal to/better than the minimum efficiency specified in financial bid/tender and meeting the tender specifications in general.
2. We have understood the requirement for pumping fluid as specified in tender/application for onwards supply with working pumps as indicated in tender/drawings and confirm to provide parallel operation performance curve of the selected pump that will be observed while running all working pumps in parallel discharging flow in the system and same shall be sum of all pumps discharge (i.e. duty point flow x number of working pumps as per tested curves) maintaining the design total head and proportionate power consumption during execution stage for review and approval in line with this and other tender requirements.
3. We confirm to provide supervision/assistance during erection, commissioning, performance testing and trial runs of the pump sets at site at no extra cost.
4. We confirm to provide backup guarantee for the offered pump set during entire **24 months or at least till defect liability period gets over**. We understand and confirm that offered pumps shall be suitable for continuous operation on round the clock basis.
5. We also confirm the availability of the offered pump model and any spare of the offered pump model during entire O and M period as well as during service life of pump of minimum 15 years from the date of successful commissioning and acceptance of these pump sets at site.
6. We also confirm to depute our engineer to carryout periodical operation and maintenance check of pump at least once during each year of O and M at no extra cost to the Bidder/contractor and shall ensure operating rated flow, head and power consumptions are maintained throughout its working life during defect liability/O and M period. If pump flow reduces by more than 10% of rated flow at any point of time during defect liability/O and M period then we along with contractor shall carry out

corrective measures including replacement of required parts by original parts and shall regain the rated performance without any extra cost to AMC.

7. For the sake of correspondence following addresses and the persons concerned are to be contacted.

**For M/s. .... (Bidder)**  
**(Authorized Signatory)**

**Name:**

**Designation:**

**Address for Correspondence:**

**For M/s. .... (Pump Manufacturer)**  
**(Authorized Signatory)**

**Name:**

**Designation:**

**Address for Correspondence:**

**Remarks: Further the Bidder shall also take note of below mentioned points and consider them in their scope of work.**

- (1) Bidder shall provide parallel operation performance curve of the selected pumps that will be observed while running all the working pumps in parallel discharging flow in the system and same shall be sum of all pumps discharge (i.e. duty point flow x number of working pumps as per tested curves) maintaining the design Total head and proportionate power consumption during detailed engineering for review and approval. Bidders shall note that all the total nos. of pumps to be supplied as per price bid/as indicated in tender.
- (2) Bidder shall submit guaranteed pump efficiency without negative tolerance as per tender along with supporting backup documents of pump manufacturer. The pump set offered during detailed engineering shall be equivalent or of higher efficiency during execution stage of any approved make specified in tender and subject to meeting flow, head and all other requirements as per tender including required undertaking of pump manufacturer of approved make and any other requirement specified in tender & addendum (if applicable).
- (3) The pump manufacturer shall provide supervision/assistance during erection, commissioning, performance testing and trial runs of the pump sets at site at no extra cost. The pump sets/pumping station shall be taken up for trial run and commissioning by contractor only after obtaining necessary certification from pump manufacturer regarding satisfactory installation of all pump sets.
- (4) Contractor shall carryout yearly corrective maintenance check of pumps and shall ensure operating rated flow, head and power consumptions are maintained during entire backup/O and M period. If pumps flow reduces by more than 10% of rated flow then contractor shall carry out corrective measures including replacement of required parts by original parts and shall regain the rated performance without any extra cost to AMC.

## DATA SHEET FOR SLUICE VALVE (MANUAL/GEAR BOX OPERATED)

Particulars	Data To Fill by Contractor/Vendor
Make	
Manufacturing and Testing Standards	IS: 14846
Size (mm)	
Quantity	
Pressure Rating	
Type (Rising / Non-Rising)	
Type of Operation: By Hand Wheel/Gear Box	
Ends (Flanged)	Flanged, FF as per IS: 1538 having off center bolt holes
Body/Bonnet	Bolted
Disc	
Maximum Valve Torque (Nm)	
Seat Body and Disc	Renewable
Type of Gear Box (For size $\geq 350$ mm)	
Direction of Closing	CW Marked on Hand Wheel
Repacking/Back Seat Bush Arrangement	Required for size $\geq 300$ mm
Channel and Shoe in Arrangement	Required for size $\geq 600$ mm
Gear Box Arrangement	Required for size $\geq 350$ mm
Maximum Valve Torque (Kgm)	
Gear Box Model and Rating (Kgm)	
Input Torque to Gear Box (Kgm)	
Gear Box Ratio/M. A.	
Number of Turns for Valve Close to Open	
<b>Materials Of Construction</b>	
Body, Bonnet (M)	
Wedge (M)	
Stem/Spindle (M)	
Stem Nut/Spindle Nut	
Body Seat Ring/Wedge Face Ring (M)	
Stuffing Box and Gland	
Back Seat Bush	
Bearings	
Stem Sealing	
Bonnet Gasket	
Channel and Shoe Lining	
Gland Packing	
Bolts, Studs and Nuts	
Hand Wheel/Cap	
<b>Painting/Coating</b>	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
<b>Drawings and Document Submission</b>	As per Specifications
GA Drawings of Valve and QAP	
<b>Testing</b>	As Specified in Inspection-Testing

**Notes:** 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.

2. For components (marked-M) MTC (of **Laboratory accredited with NABL**) as per relevant standards shall be furnished.



## DATA SHEET FOR DUAL PLATE CHECK VALVE

Particulars	Data To Fill by Contractor/Vendor
Make	
Manufacturing Standards	API 594
Testing Standards	API 598
Size (mm)	
Quantity	
Pressure Rating	
Ends	Flanged, FF as per IS: 1538 having off center bolt holes
<b>Materials of Construction</b>	
Body (M)	
Door (Disc/Closure Plate) (M)	
Door Face (Body/ Plate Seat) (M)	
Bearing Bush	
Hinge Pin and Stop pin (M)	
Springs (M)	
Body Seat Ring	
Bolts, Studs and Nuts	
<b>Accessories Required</b>	
Lifting Eye Bolts	Required for size $\geq 150$ mm
Support Foot	Required for size $\geq 600$ mm
Bypass Arrangement	Required for size $\geq 600$ mm
<b>Painting/Coating</b>	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
<b>Drawings and Document Submission</b>	As per Specifications
GA Drawings of Valve	
QAP	
<b>Testing</b>	As Specified in Inspection-Testing

**Notes:** 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.  
2. For components (marked-M) MTC (of Laboratory accredited with NABL) as per relevant standards shall be furnished.

## DATA SHEET OF METALLIC EXPANSION BELLOWS

Particulars	Data To Fill By Contractor/Vendor
Make	
Manufacturing Standards (EJMA/ASME)	
Type	Corrugated Design Single Metallic
Size Range and Quantity	
Overall Length (mm)	
Pressure Rating	
Axial Expansion (mm)	Minimum 20 mm
Axial Compression (mm)	Minimum 10 mm
Fatigue Life Expectancy	Minimum 3000 Cycles
Overall Length of EB	
Mode of Installation (Horizontal)	
Ends Flanged, FF as per IS: 1538 having off	

center bolt holes	
Number of Convolutions	
Thickness of Weld End	
Thickness of Internal Sleeve	
Quantity and Position of Rods Minimum 2 Nos. up to 200 NB Minimum 3 Nos. from 250 to 450 NB Minimum 4 Nos. from 500 to 900 NB Minimum 6 Nos. above 1000 NB	
<b>Materials of Construction</b>	
Bellows (M)	
Internal Sleeves (M)	
Flanges (M)	
Lugs	
Rods	
Hardware	
<b>Painting</b>	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
<b>Drawings and Document Submission</b>	As per Specifications
GA Drawings of Bellows	
QAP	
<b>Testing</b>	As Specified in Inspection-Testing

**Notes:** 1. Manufacturer/Supplier shall submit separate data sheet for each size and rating.  
2. For components (marked-M) MTC (of Laboratory accredited with NABL) as per relevant standards shall be furnished.

#### DATA SHEET FOR ELECTRIC CHAIN HOIST and ELECTRIC TROLLEY

Particulars	Data To Fill By Contractor/Vendor
<b>General</b>	
Make	
Model	
Capacity in Metric Ton (MT)	
Location	Indoor
Quantity	
<b>Chain Hoist</b>	
Design and Construction Standards	
Class and Duty	
Mono Rail Girder	
Type	Electrically Operated
Maximum Lift (meters)	As per Actual Requirement
Number of Falls	
Operating Speed (meter/minute)	
Type of Gear Box	
Type of Hook	
Brakes For Hoisting	
Brake Type	
Brake Size (mm)	
Load Chain Size	
DSL	

<b>Electric Travelling Trolley</b>	
Design and Construction Standards	
Class and Duty	
Operating Speed (meter/minute)	
Type of Gear Box	
Bay Length	As per Actual Requirement
Lubrication	
<b>Materials of Construction</b>	
Main Girder (Mono Rail Beam)	
Gears and Pinions (M)	
Wire Rope (M)	
Hook (M)	
Load Chain (M)	
Trolley Wheels (M)	
Trolley Shaft (M)	
Bearings	
Plates	
<b>Electrical Details</b>	
Power Supply	
Motor Standard	
Control Voltage	
Class of Insulation/Degree of Protection	
Ambient Temperature	50 °C
Type of Motor (Hoist Duty)	
Make	
Motor Ratings (kW) For <ul style="list-style-type: none"> <li>• Chain Hoist</li> <li>• Trolley</li> </ul>	
Method of Starting	
<b>Accessories Required</b>	
P. B. Station	
Festoon Cable System	
Control Panel	
<b>Weight</b>	
Weight of Hoist (kg)	
Weight of Trolley (kg)	
<b>Painting</b>	Refer General Requirement for Mechanical Items/Equipment Section/Tender Specs.
<b>Drawings and Document Submission</b>	As per Specifications
GA Drawings showing complete details of span, lift, power and control diagram etc.	
BOM	
QAP	
<b>Testing</b>	As Specified in Inspection-Testing

Notes: 1. Manufacturer/supplier shall submit separate data sheet for each size.

2. For components (marked-M) MTC (of Laboratory accredited with NABL) as per relevant standards shall be furnished.

3. Contractor shall visit the site(s) and obtain accurate data for span, lift etc. suitable for proposed/existing pump house or location of installation as applicable and shall furnish all details accurately in data sheet.

**APPROVED VENDOR LIST FOR MECHANICAL EQUIPMENT**  
(as applicable)

ITEM	APPROVED MAKES
SUBMERSIBLE NON-CLOG PUMP-SET	AQUA / KIRLOSKAR / KSB / ABS / GRUNDFOSS / XYLEM / MATHER & PLATT (WILO) / EBARA
VALVES (SLUICE VALVES / NON RETURN VALVES / DPCV / BUTTERFLY VALVES / AIR VALVES)	KIRLOSKAR / IVC / IVI / AUDCO / R&D MULTIPLE / KEYSTONE / FOURESS / VAG / AVK / DURGA / UPADHAYA
ELECTRIC ACTUATOR	AUMA / ROTORK / EMERSON
METALLIC EXPANSION BELLOWS	DHRUV / PRECISION / TECHNOFLEX / PRECISE ENGG. / FLEXICAN BELLOWS & HOSES / FLEXPART BELLOWS / SUR INDUSTRIES (SURFLEX) / ATHULYA BELLOWS
HOT/EOT CRANE, HOIST AND CHAIN PULLEY BLOCK	MORRIS / INDEF / SAFEX / W H BRADY / ANKER / JAPS
BEARING	SKF / NBC / FAG / NTN
CI PIPE AND FITTINGS	ORIENTAL CASTINGS / ELECTRO STEEL / UPADHYAYA / BIC / KEJRIWAL / NJMW
D.I. PIPES	ELECTRO STEEL / KEJRIWAL / LANCO / JINDAL / ELECTROTHERM / SRIKALAHASTHI
D.I. DOUBLE FLANGED (DI DF) PIPES & FITTINGS.	ELECTRO STEEL / KEJRIWAL / LANCO / JINDAL / ELECTROTHERM / SRIKALAHASTHI / KISWOK / TRUFORM / CHANDRANCHAL (DI PIPE FOR DI DF PIPE MANUFACTURING SHALL BE AS PER APPROVED MAKE OF DI PIPES ONLY)
MS / GI PIPES	ARCELOR MITTAL (ESSAR) / TATA / JINDAL / SAIL / ZENITH / ASIAN / ANY REPUTED MFG. USING APPROVED MAKE OF MS OR GI PLATES & SHEETS
MS / GI PLATES AND SHEETS	ARCELOR MITTAL (ESSAR) / TATA / JINDAL / SAIL / ASIAN
uPVC/cPVC PIPE	ASTRAL / ASHIRWAD / DUTRON / SUPREME / PRINCE
MECHANICAL SEALS	EAGLE BURGMAN / FLOWSERVE / AESSEAL / CHESTERTON / FLEXASEAL / JOHN CRANE
OFFICE FURNITURE	BLIND MEN'S ASSOCIATION / GODREJ
TOOLS	EVEREST / GEDOR / JHALANI / MEKASTER / TAPARIA
SLUICE GATES / OPEN CHANNEL GATES	JASH / IVC / IVI / R&D MULTIPLE / PARCHURE ENGINEERS
MANUAL BAR / BOX SCREEN	JASH / JAPS / HDO / TRIVENI / AURIC / SHIVPAD / APOLLO SCREEN / PARCHURE ENGINEERS / HNB

The contractor shall distinctly understand that it will not be their prerogative to insist on a particular brand from the list, final selection will be done with the approval of Engineer in charge.

## **D-19 : SPECIFICATIONS FOR ELECTRICAL WORK**

### **SECTION : D-19**

#### **(A) GENERAL REQUIREMENTS**

##### **General**

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian and International Standards except where modified and/or supplemented by this specification. Only in absence of Indian standards, International standards shall be followed.

The equipment shall meet the requirements of Indian Electricity Rules, CEA Notification, CPWD guidelines as amended up to date and relevant IS Codes of Practice. In addition, other rules and regulations as applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.

##### **Completeness of Supply**

It is not the intent to specify completely herein all details of the equipment. Nevertheless, the equipment shall be complete and operative in all aspects and shall conform to highest standard of engineering, design and workmanship. The following shall be considered in the scope of work as a minimum.

Any material or accessory which may not have been specifically mentioned but which is necessary or usual for satisfactory and trouble free operation and maintenance of the equipment shall be furnished without any extra charge.

SITC of Electrical Equipment with all necessary erection accessories and materials, all steel members (angle, channel, plate, steel sheet etc.) for installation of electrical equipment, GI pipes, GI/PVC conduits, bends, clamps, nut, bolts, hot dipped GI/FRP ladder type cable trays, tray installation materials and accessories, cable supporting structures, flexible metallic hoses, sealing materials for openings/conduits, single/double compression cable glands, cable lugs, cable tags, cable fasteners, insulating tapes, ferrules, RCC slabs/checker plates, GI/RCC pipes for protection of cables at road crossings and other places, cable markers, cable jointing and termination kits and materials, earthing strips of different sizes, junction boxes, pull boxes, epoxy paints and all consumable materials for complete laying and termination of cables, earthing system and erection of electrical equipment etc.

Obtaining license/certificates/clearances etc. from appropriate Govt. statutory authority/body for installation and energizing the complete electrical system and necessary liasoning work for the same (Necessary statutory fees only shall be paid by client).

**The quantity/number of items, weight and length of cables/earthing strips etc. mentioned in tender documents are tentatively taken, however the payment will be given as per items installed, works done and actual length of cable/earthing strips etc. actually used and installed.**

Submission of all engineering documents, drawings, data sheets, earthing system, layout etc. for review and approval. All manuals, catalogues, characteristic curves etc. for various electrical equipment/components shall be submitted.

**Contractor shall verify the quantity of cable or such material required as per site condition against quantity specified in BOQ/SOQ and for procurement and place order as per actual site requirement.**

**All Drawings/Datasheets/Technical Catalogues/Documents for various electrical works/items shall be submitted by bidder as under.**

**Number of copies for Submission for various Drawings/Documents shall be as under.**

- a) In four sets by successful bidder in hard copy for review and approval including revisions, if any. The approved drawings for execution purpose shall be retained in Two Sets by Client, One Set by Client's Consultant and One Set shall be returned to Contractor. The contractor must ensure that copy of approved drawings are kept readily available at site.
- b) In four sets by successful bidder in hard copy and two sets in soft copy (on two separate CD) of as-built drawings.
- c) In three sets by successful bidder in hard copy and two sets in soft copy (on two separate CD) of Operation and Maintenance (O and M) manual including manufacturers' O and M and preventive maintenance schedule, recommended spares list etc.

All above final documents and drawings incorporating modifications, if any, done during erection/commissioning shall be furnished.

### **Site/Ambient Conditions**

All electrical equipment and installation shall be for the tropical climatic conditions and be suitable continuous operation under the site conditions as described below.

Maximum Ambient Temperature :	47 °C
Minimum Ambient Temperature :	5 °C
<b>Design Ambient temperature :</b>	<b>50 °C (Unless otherwise specified for Specific Components/equipment in the Tender)</b>
Relative Humidity :	95 %
Climate :	Tropical, Dusty, Corrosive

If not specifically mentioned, an altitude not exceeding 1000m above mean sea level shall be taken into consideration for design purpose.

Where the equipment is installed outside and exposed to direct sun, these shall be suitable for operation at higher ambient temperature and rigorous weather conditions under which they are required to operate.

### **Codes and Standards**

The electrical equipment and complete installation offered shall comply with the relevant Indian Standards/Codes of Practices, this specification, statutory regulations and sound engineering practices.

The complete system shall conform to the latest revisions of the following.

- The Indian Electricity Act & Rules 2003
- The Indian Electricity (Supply) Act, 1948
- Regulations laid down by local statutory authorities and CEA, CPWD, Electrical Inspectorate.
- The requirement of GETCO/Power Utility Companies ie Discoms viz UGVCL, PGVCL etc.
- Fire advisory Committee Insurance Act/Fire Insurance Regulations
- Indian Petroleum rules and any other regulations laid down by the Chief Controller of Explosives
- The factory act and any other regulations laid down by factory inspectorate.

Wherever Indian Standards do not exist, the relevant IEC, British or German (VDE)/IEEE/NEMA standards shall apply. Any other Standard which is considered equivalent to or superior than

applicable Indian Standards may also be acceptable. The bidder however, shall have to substantiate equivalence or superiority.

- Applicable standards govern the materials and workmanship in the manufacture of all Equipment/ items of Electrical Equipment.

<b>Codes</b>	<b>Description</b>
IS: 731, BS 137, IEC 383	Pin & Disc Insulator
IS: 2544, IS: 5350, BS 3297, IEC 168	Porcelain post insulators for systems with nominal voltage greater than 1000V
IS: 5621	Hollow insulators for use in electrical equipment
IS: 398 Part I and II (1996)	ACSR conductor
IS: 9920 Part 1 to 4 (2002)	Specification for High Voltage Switches for rated voltage above 1kV and less than 52kV (First Revision)
IS: 9921	Alternating current disconnectors (isolators) and earthing switches for voltages above 1000V
IS: 9385 (1983)	Governing specifications for GOAB switch
IS: 3070	Lighting arresters for alternating current systems
IS: 15086	Surge arresters
IS: 8828	Electrical Accessories -Circuit Breakers for Over Current Protection for Household and Similar Installations
IEC 60529	Enclosure degree of protection IP 5X
IS: 3231	Electrical relays for power system protection
IS: 4047, IEC 408	Air Break Switches
IS: 2208, IEC 259-1	Fuses
IS: 1248	Direct acting indicating analogue electrical measuring instruments and their accessories
IS: 2419	Dimensions for panel mounted indicating and recording electrical instruments
IS: 2705	Current transformers
IS: 3156	Voltage transformers
IS: 2026, IEC 60076	Power transformers
IS: 11171	Specification for Dry-Type Power Transformers.
IS: 335	New insulating oils
IS: 1180 Part 1 (2021)	Outdoor Type Oil Immersed Distribution Transformers Up to and including 2500kVA, 33kV Specification
IS: 8468	On-load tap changers
IS: 2099	Bushings for alternating voltages above 1000V
IS: 6600	Guide for loading of oil immersed transformers
IS: 4237	Switchgear General Requirements
IS: 13947 IEC 60947-1 and IEC 60947-2	Low-voltage switchgear and control gear
IS: 375	Panel Wiring
IS: 3427	AC Metal Enclosed Switchgear and Control gear for Rated Voltages

	Above 1kV and Up to and Including 52kV
IS: 2516	Moulded Case Circuit Breakers
IS: 3842	Application guide for electrical relays for ac systems
IS: 13925	Shunt capacitors for ac power systems having a rated voltage above 1000 V
IEC 60831 (1 and 2)	Shunt capacitor of the self- healing type for AC systems having rated voltage up-to and including 1000V
IEC 61921	Power capacitors –Low voltage power factor correction banks
IS: 16636	Automatic Power Factor Correction (APFC panels for voltage rating up to and including 1000V)
IS: 2959, IEC 158-1	Contactors
IS: 1822, IEC 292	Starters
EN 50081-1, 50082-2 and 60204-1	Microprocessor Soft Starter
IEC 61800 and/or IEEE 519	Harmonics Control & Reactive Compensation Of Static Power Converters
IEC 721-3-3, Class 3C1	Maximum Corrosion Level of the Cooling Air
IEC 721-3-3 Class 3C2	Maximum Corrosion Level of the Chemical Gases
UL 508C	Solid state thermal protection of AC Drive
IS: 722	Specification for AC Electricity Meters
IS: 12615 (2018)	Energy efficient induction motors-three phase squirrel cage
IS: 15999 (Part 1)	Rotating electrical machines: Part 1 Rating and performance
IS: 15999 (Part 2)	Rotating electrical machines: Part 2 Method of tests, standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 2253	Designation types of construction and mounting arrangement of rotating electrical machines
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 9283	Motors for submersible pump sets
IS: 9334	Electric motor operated actuators
IS 8130	Conductors for insulated electric cables and flexible cords
IEC 228	Conductors of Insulated Cables
IEC 230	Impulse tests on cables and their accessories
IEC 502	Extruded solid dielectric-insulated power cables for rated voltage from 1kV up to 30kV.
IEC 540	Test methods for insulations and sheaths of electric cables and chords
IEC 229	Test on cable over sheaths which have special protective functions and are applied by extrusion.
IEC 287	Calculations of continuous current rating of cables (100% load factor).
IEC 60751	Industrial platinum resistance thermometers and platinum temperature sensors
IEC 61537	Cable management -Cable tray systems and cable ladder systems
IS: 1554 Part1	PVC insulated (heavy duty) LT electric cables up to 1.1kV



IS: 7098 Part I	XLPE Insulated LT Electric cables (heavy duty) up to 1.1kV
IS: 7098 Part II	XLPE insulated PVC sheathed cable for voltage from 3.3kV up to 33kV
IS: 5831 (1984)	PVC insulation & sheath of electrical cables
IS: 694	PVC Insulated cables for working voltage up to and including 1100 V
IS: 1255	Code of practice for installation and maintenance of power cables up to and including 33kV rating
IS: 3975	Mild steel wires, formed wires and tapes for armouring of cables
IEC 885(2) – 1987 Part-I)	Electrical test methods for electric cables partial discharge test
IS: 10810	Methods of test for cables
IEC 811	Common test methods for insulating and sheathing materials of electric cables
IEC 230	Impulse test on cables & other accessories
IEC 859	Cable termination for gas insulated switchgear
IS: 3961	Recommended current ratings for cables
IS: 3043	Code of practice for earthing
IS: 2629	Recommended Practice for Hot-Dip Galvanizing of Iron and Steel
IS: 2633	Methods for testing uniformity of coating of zinc coated articles
IS: 1897	Copper strip for electrical purposes – Specification
IEC 62305 / IS: 2309	Designing for Protection Against Lightning / Code of practice for protection of buildings and allied structures against lightning
IS: 732	Code of practice for electrical wiring installations
IS: 1646	Code of practice for fire safety of buildings (General) Electrical installation
IS: 2509	Rigid non-metallic conduits for electrical wiring
IS: 6946	Flexible (Pliable) non-metallic conduits for electrical installation
IS: 9537	Conduits for electrical installations
IS: 3854	Switches for domestic purpose
IS : 3415	Fittings for rigid non-metallic conduits
IS: 3837	Accessories for rigid steel conduits for electrical wiring
IS: 14927	Cable trunking and ducting systems for electrical installation
IS: 4648	Guide for electrical layout in residential building Indian electricity act and rules
IS: 1293	3 pin plugs and sockets
IS: 4795	Holders for Indicator Lamps for Electronic and Telecommunication Equipment
IS: 3646	Code of practice for interior illumination
IS: 1913	1969 General and Safety requirements for Electric lighting fittings
IS: 1239, IS: 2713	GI Lighting Poles
IS: 1944	Code of practice for lighting of public thoroughfare
IS: 374	Electric ceiling type fans and regulators
IS: 1293	Plugs and socket-outlets of rated voltage up to and including 250 volts and rated current up to 16 amperes – Specification

IS: 6665	Code of practice for industrial lighting
IS: 8224	Electric lighting fittings for division 2 areas
IS: 9583	Emergency lighting units
IS: 9974	High pressure sodium vapour lamps
IEC 62305	Protection against lightning -Part 4: Electrical and electronic systems within structures
IS: 1271	Thermal evaluation and classification of electrical insulation
IS: 1544	Cotton calico
IS: 1868	Anodic Coatings on Aluminium and its Alloys – Specification
IS: 2190	Selection, Installation and Maintenance of First-aid Fire Extinguishers — code of practice
IS: 2546	Specification for galvanized mild steel fire bucket
IS: 5572	Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installation
IS: 9677	Guide for limits of temperature-rise of the windings of electrical equipment when tested by different methods
IS: 9678	Methods of measuring temperature rise of electrical equipment
IS: 10118	Code of practice for selection, installation and maintenance of switchgear and control gear
IS: 15652	Insulating mats for electrical purposes – Specification
IS: 5424	Rubber mat
IS: 4770	Rubber Gloves -Electrical Purposes – Specification
IS: 2551	Danger notice plates
ISO 3046	Diesel Engine
IS: 4722, BS 2613	Alternator
IS: 16101	General lighting LED and LED modules
IS: 16102 (Part 1)	Self ballasted LED lamps for general lighting service-Safety Requirement
IS: 16102 (Part 2)	Self ballasted LED lamps for general lighting service-Performance Requirement
IS: 16103 (Part 1)	LED modules for General lighting-Safety Requirement
IS: 16103 (Part 2)	LED modules for General lighting-Performance Requirement
IS: 16107 (Part-10)	Luminaries Performance-General Requirement
IS: 16108	Photo biological safety of lamps and lamp systems
IS: 10601	Dimensions of terminals of HV switchgear and control gear
IS: 12729	General requirements of switchgear and control gear for voltages exceeding 1000V
IEC 1330	High voltage/low voltage prefabricated substations
IEC 60694	Common clauses for MV switchgear standards
IEC 6081	Monitoring and control
IS: 8686	Specification for static protective relays
IEC 376	Filling of SF6 gas in RMU

## Design Basis

The Electrical equipment system shall be in accordance with project specifications and shall ensure continuity/reliability of supply, flexibility of operation and safety.

The Basic Design Data to be considered as follows.

Incoming Supply Conditions	11kV $\pm$ 10%
Frequency	50 Hz $\pm$ 5%
Voltage and Frequency Combined Variation	$\pm$ 10%
Fault Level at 11kV	500 MVA symmetrical (1 second) or higher as per Statutory requirement
System Grounding	Solidly Earthed
Fault Level at 415V (Design)	50kA Symmetrical (1 second)
Control Circuit Voltage	230V AC via Constant Voltage Transformer for LV Panels and 110V DC for HV Panel via Power Pack
HV Cabling	3C XLPE, 11 kV (E), Extruded Inner Sheath
LV Cabling	Copper/Aluminium Stranded Conductor XLPE/PVC insulated, Extruded Inner Sheath
Earthing	Earth Pit: Cu Plate/GI Pipe electrode (Maintenance free Chemical Type) as per IS: 3043/Specifications/ Drawings
Induction Motor	Energy Efficient Design of IE3 Class as per IS:12615 (2018) amended up to date
Soft Starter	DOL starting, Soft Starter De-rated current for 50 <sup>0</sup> C operating conditions $\geq$ Minimum 110% of rated motor current as per IS: 12615/BOQ, with in-built or external bypass contactor, with in-line contactor and semi-conductor (fast acting) fuse protection, required protection parameters etc. as per SLD/SOQ /Specifications
Variable Frequency Drive (VFD)	VFD De-rated current for 50 <sup>0</sup> C operating conditions $\geq$ Minimum 110% of rated motor current as per IS: 12615/SOQ with in-line contactor and semi-conductor (fast acting) fuse protection, required protection parameters etc. as per SLD/SOQ/Specifications

The proposed scope of work is outlined in the Scope of Work chapter. The scope of work also includes liasoning work for obtaining power from power supply company (PSC) on behalf of client.

The proposed transformers are connected by LV cables/Bus duct (as per SOQ) to the main 415V over Motor Control Centre (PMCC/PCC/MCC LV panels). Fuse less design shall be used in PMCC/APFC/MCC as per CPWD Guidelines/Specifications.

This LV panel shall in turn feed downstream APFC/MCC/LDB/PDBs etc. for feeding various loads.

Motors shall be started and stopped by push buttons at Local Control Stations located near respective motors as per specifications/SLD/SOQ. Starters shall be housed in MCCs with STOP/START (where ever LCS is not applicable)/RESET Push Button.

In outdoor areas cables shall be mostly buried directly underground with mechanical protection wherever applicable. In indoor areas, cables shall be laid in trenches through Hot Dip Galvanized Iron (GI) Strip/ FRP cable trays as per BOQ/SOQ.

Earthing system design and installation shall be generally as per IS: 3043. Earthing system shall be carried out by pipe-in-pipe technology and maintenance free UL listed chemical earthing system as per SOQ/BOQ by hot dip galvanized GI strips, Cu strips, maintenance free UL listed Cu bonded earthing electrodes, GI pipes, earth enhancement materials ie back filling compounds for chemical earthing etc. as per actual requirement of the entire Plant. All equipment shall have two separate and distinct earth points. Earth resistance shall not exceed one ohm at any point.

Notwithstanding anything mentioned in this tender specifications and Schedule of Quantities (SOQ)/Bill of Quantities (BOQ), contractor shall be responsible to provide all equipment and material to complete the electrical installation in all respects at no extra cost. Bidder is responsible to study the technical specifications/SOQ in entirety and understand the requirements prior to bid submission and shall bid/quote accordingly.

## **General Instructions**

### **Unit Rate**

The unit rate of all the item of works as per SOQ shall include the following job as a minimum.

- Delivery of the Equipment at site.
- Unloading at site store/proposed area.
- Storage and security of supplied materials and equipment till installation at site and handing over to Client.
- Power and Control cabling work between equipment.
- Assembling various item as per requirement.
- Checking of operation and wiring before commissioning.
- Testing and commissioning of equipment.
- Supply of necessary spares required for commissioning.

### **Drawings/Documents**

Successful Bidder shall submit documents, **Technical data sheets in the formats given in the tender**, all manuals, catalogues, characteristic curves etc. for various electrical equipment/components for review and approval.

Detailed documents to be prepared in line with recommended specifications/details and submitted to Client in a timely manner to allow for review and approval.

The Bidder shall furnish following required drawings/**documents** for each item for review and approval as a minimum.

- a) List of Drives/Loads with Quantity/Ratings/Specifications along with power load statement.
- b) Transformer, DG Set and Capacitor Sizing Calculations.
- c) SLD and control diagram of complete electrical system.
- d) GA drawing, SLD, Sectional drawings, BOM, Wiring/Schematic Drawings etc. as applicable for complete electrical system (HV and LV Panels, LVDB, Lighting Panels, PDBs etc.)
- e) Overall Cable Layout and Unit Wise Cable Tray layout.
- f) Earthing Layout with Earthing Calculations.
- g) Internal Lighting Layout with Calculations.
- h) External Lighting Layout.
- i) Cable Schedule with voltage drop calculation/sizing calculations.
- j) Interconnection Schedule.

- k) GA Drawings for all equipment including sectional drawing wherever necessary and specifying recommended installation, weight, clearances requirements etc.
- l) Filled in Data Sheets.
- m) Schedule of quantities along with brief specifications.
- n) Design/sizing calculations for equipment as applicable.
- o) O and M manual for all equipment.

### Vendor Data Requirement

Following minimum documents shall be submitted by contractor along with the bid/offer for review and approval during detailed engineering, as indicated.

Sr. No.	Description	With Bid/ Offer	For Review/ Approval	As Built
1	Technical Details for Major Equipment		*	*
2	List of Recommended Spares		*	*
3	Data Sheet/GA drawing/BOM/SLD/Wiring and Schematic Diagram for Power and Control Circuit/Data sheet of Relay for 11 kV HV VCB Panel/Transformers/Motor/Bus Duct/DP Structure as applicable		*	*
4	GA Drawings with sectional view, door open view, top and bottom view, Rear view, Mounting plate details etc./BOM/SLD/ Wiring and Schematic Diagram for Power and Control circuit for LV Panel/Starter/ APFC Panel/Bus Duct		*	*
5	Technical Data Sheet/ Catalogue of ACB, MFM, Soft Starter, VFD, APFC Relay, Detuned Reactor		*	
6	GA Drawing/BOM/Technical Details for LCS/Indoor and Outdoor Light Fixtures /LDB/Switch Board/Safety Equipment		*	*
7	Data Sheet and BOM for Cable Tray		*	*
8	Cable Schedule/Data Sheet/Make and Type for HV/LV Power and Control Cables.		*	*
9	Earthing (Grounding) System Calculation and Details		*	*
10	Lightening Protection System for Buildings and Structures (If and as Applicable)			
11	RCC Foundation Details for various Electric Equipment.		*	*
12	Inspection Schedule and QAPs for Major Equipment		*	
13	Test Certificates		*	*
14	O and M Manual (If and As Applicable)		*	*

## **(B) DETAILS TECHNICAL SPECIFICATIONS**

### **❖ LV PANELS: PCC/PMCC/MCC/APFC/LVDB/OTHER SWITCH BOARDS**

Panel shall conform to Indian Electricity Act and rules CEA Notification/Guidelines, CPWD guidelines 2019 as amended up to date and shall be as a minimum.

The LV switchboard panels shall be floor mounting, free standing, compartmentalized, extensible, Modular type suitable for indoor installation. The panel shall be totally enclosed and dust, damp & vermin proof. Enclosure shall have IP 52 or better degree of protection for indoor unit and IP 55 or better degree of protection for outdoor unit as a minimum. Outdoor unit shall be double door and additionally provided with canopy or weather shed for protection.

Panel construction shall be complying to Form 3b type as per IS/IEC 61439 (i.e. separation of bus bars, all functional units and of terminals and external conductors etc. shall be as per Form 3b type as per IS/IEC 61439). Only metallic sheet shall be used for compartment separations/partitions. Hylam/PVC sheets shall not be allowed.

LV panels/switch boards sheet steel shall be CRCA minimum 2 mm for load bearing members, mounting plate, partition, doors/covers, canopy. Gland plate shall be CRCA sheet minimum 3 mm thick. All the doors and others openings shall be provided with neoprene rubber gaskets or of durable material gaskets.

All hardware shall be corrosion resistant. Star washers shall be used for effective continuity.

Suitable lifting arrangement with L angle welded at top for PMCC/MCC/APFC etc. shall be provided on each panel or on each shipping section for ease of lifting of switchboard.

A base channel of 100 mm x 50 mm x 5 mm thick shall be provided at the bottom of the panel on all four sides of each shipping section.

Overall height of panel shall not exceed 2300 mm (For VFD/Soft starter panel height up to maximum 2500 mm can be accepted) including minimum 100 mm ISMC base frame. However, in case of panel mounted on floor without cable trench shall be mounted at least 500 mm above the floor level on structure steel or suitable support base / stand to provide adequate bending radius for in and out cables (elevated stand to be covered suitably from all sides). **Operational height of starters and control switch gear shall not exceed 1800/1900 mm above FFL (irrespective of overall height of panel) for ease of operation.**

Shipping section length shall be maximum 2500 mm. Each shipping section shall have full side sheets of 2 mm thick on both the sides. Vertical partition of incomer/bus coupler/outgoing feeders etc. shall be of full depth of the panel. Detachable gland plate shall be provided at the top on both the ends of the shipping sections for connecting/joining of bus bars.

PCC/PMCC panel shall have 2 numbers outgoing MCCB/ACB power feeders, one number on each side of BUS to feed power to downstream MCC panel or shall be as per tender SLD/BOQ.

All MCC feeders will have two incomers (one incomer as stand by) with electrical and mechanical interlocking between the two such that only one incomer is ON at a time or shall be as per tender SLD/BOQ.

**Electrical interlocking mechanism shall operate in both Manual and Auto Operational mode without fail. Panel builder must ensure that proper fail safe interlocking in both modes is provided. It is absolute responsibility of panel builder/integrator to design the panel and ensure proper & satisfactory operation & performance of the offered panels and for satisfactory**

**operation of plant / pumping station. The SLD where furnished along with tender shall be considered as an indicative SLD for adhering to minimum requirements as specified there in and panel vendor shall be responsible for desing and arrangement of incomer or any outgoing feeders and other additional requirements for satisfactory and reliable operation of panel and for meeting the stated objective of electrical system in tender / BOQ / Tender drawings.**

Minimum dimension of incomer, bus coupler, starter, MCCB cubical compartment shall be as per the Table. Height of main horizontal bus bar chamber shall be minimum 300mm up to 630A rating and 350 mm or higher for 800 A and above. Vertical bus bar shall be minimum 300mm or higher as per kA level and temperature rise required. Minimum width of cable alley shall be 350mm or higher as per number of cables.

Control MCB shall be provided for control wiring circuit. Panel shall be of fuse less design.

All type of meters shall be digital type. Voltmeter shall be provided for all incomer feeders. Ammeter / MFM shall be provided as under:

- Incomer Feeders: 3Nos. CTs with ammeter with selector switch shall be provided
- Incomer Feeders of PCC/PMCC: Digital multi function meters shall be provided in addition to Ammeter and Voltmeter
- Outgoing Power Feeders less than 100A: 3Nos. CTs with ammeter with selector switch shall be provided
- Outgoing Power Feeders rated 100A and above: Digital multi function meters shall be provided
- Motor Starters rated 7.5 kW to less than 15 kW: CT on Y phase with digital ammeter shall be provided
- Motor starters rated 15 kW and above and less than 30 kW: 3Nos. CTs with ammeter with selector switch shall be provided
- Motor starters rated 30 kW and above: Digital multi function meters shall be provided
- For motor starters and outgoing power feeders provided with MFM, separate ammeter/voltmeter/PF meter is not required.

RS 485 of all meters/MFMs shall be looped together inside the panel and brought out in the cable alley.

LV panel shall be of fixed type, single/double front. LV panel shall be single tier for incomers and bus coupler feeders rated 500A and above. Panels with VFD and soft starter feeders rated 22 kW and above shall be in single tier only while the same shall be in single tier or two tier for less than 22 kW VFD/soft starter feeders.

Outgoing ACB feeder of 1000 A and above ratings shall be in single tier only.

Vacant space on incomer and bus coupler panel shall not be used for mounting the starter, switch gear modules, MCB feeder, control transformer. Fixed capacitor/reactor feeder may be housed below bus coupler with steel sheet separation/barrier.

VFD starter panel shall be stand alone panel in case of VFD for motors rating  $\geq 75\text{kW}$ . This provision does not apply in case of VFD panel bundled along with / housed within equipment housing or enclosure for equipment like turbo blowers, etc.

All auxiliary devices for control, metering, protection, indication and measurement such as push buttons, control and selector switches, indicating lamps, ammeters, voltmeters, kWh meters and protective relays shall be mounted on the front side of respective compartment, for easy operation without opening the door. Metering cubicle shall be separate/independent of ACB/MCCB incomer feeders.

Circuit breakers of required capability/suitability to interrupt applicable capacitive current shall be specifically verified/supported by manufacturers' recommendations.

The switch board components, bus bars etc. shall be designed to withstand the maximum designed short circuit level for minimum 1 second.

MCCB shall be TPN/4P, microprocessor based release/thermal magnetic release as specified elsewhere. All MCCBs shall be suitable for  $I_{cs} = 100\% I_{cu}$ . The rated service short circuit breaking capacity ( $I_{cs}$ ) of MCCBs shall be more than or equal to the specified fault level. MCCB shall be supplied with extended rotary handle, terminal spreader, auxiliary C/O + trip contact as applicable.

Rating of MCCB/MPCB, contactors, relay etc. of motor feeders as recommended by equipment manufacturers' and shall comply with Type 2 Coordination as per IS: 60947.

Panel shall have main horizontal and riser bus bars, air insulated with coloured heat shrinkable PVC sleeves, housed in a separate compartment, segregated from all other compartments, with sheet steel barriers, sufficient louvers with wire mesh for air circulation.

The LV panels shall be provided with a continuous earth bus having sufficient cross section to carry the specified fault current for specified duration without exceeding the safe temperature throughout its entire length.

All control wiring except CT secondary wiring shall be carried out with minimum 1.0 mm<sup>2</sup> FRLS PVC copper flexible wires (Grey). CT secondary wiring shall be carried out with 2.5 mm<sup>2</sup> FRLS PVC copper flexible wires (Color coded).

Adequately rated anti condensation heater with porcelain connectors shall be provided in each breaker panel and in cable alley to maintain inside temperature 5 °C above outside ambient temperature. It shall be supplied from 240V AC auxiliary bus for space heater. The space heater shall be provided with a thermostat having variable setting of 30-70 °C and manually operated switch fuse and link for phase and neutral respectively.

All starters shall be provided with Auto-Off-Manual and Local-Remote selector switches (where start PB provided at panel end) to monitor and operate MCC or LCS, ICP/PLC.

All ACBs, MFM, VFD, Soft Starters where provided shall have inbuilt RS 485 port to communicate with PLC/SCADA for monitoring and control. RS 485 terminal shall be wired upto external TB with shielded wire.

240V AC control supply shall be fed from 415/230V AC constant voltage/control voltage transformer (with  $\pm 2.5\%$  and  $\pm 5.0\%$  tapings on both primary and secondary sides) one number on each bus of minimum 1.5 kVA rating (for less than 630 Amps connected load), and higher kVA rating depending on total connected working load. Suitable control logic through contactors shall be provided such that control supply is available to all feeders based on incomer 1 and incomer 2 status. Only one control transformer shall be ON at a time. **Separate control transformer 415/230V of suitable VA rating shall be provided for incomers. DP MCB of suitable rating shall be provided on both incoming as well as outgoing side of control transformer.** All CTs, PTs and constant voltage/control transformer shall be cast resin type with terminals. CT shorting link type control terminal shall be provided. Only Ring type lugs shall be used for CT termination.

2 Nos. auxiliary contactors to be considered for PLC interface.

All capacitors generally shall be at 440V or 525V if provided with detuned reactor or as specified in BOQ. Capacitors shall be heavy duty type with discharge resistors and with dielectric losses  $\leq 0.2\text{w/kVAR}$ .



Adequate number of spare outgoing breaker/power feeders shall be provided in all panels/switchboards. At least one number of power feeder with highest rated outgoing breaker shall be provided as spare in PCC/PMCC and at least two numbers of 4 pole 63A rating (or higher rating or higher nos. as per Bidder's design requirement) shall be provided as spare power feeders in all panels/switchboards (PCC/PMCC/MCCs) as applicable (For PCC/PMCC the 2 numbers spare feeders shall be provided on each side of bus as a minimum). For PDB/LDB, minimum 2 numbers outgoing feeders of highest rating (for each phase) shall be provided as spare.

Following communication RS 485 Modbus, DI, AI and DO, AO to be considered for various type of feeder for PLC/SCADA interface.

	<b>INCOMER (ACB/ MCCB)</b>	<b>SOFT/VFD/SD STARTER (MPR)</b>	<b>MOV</b>
<b>Communication</b>	Inbuilt Modbus RS 485 for control and monitoring metering, energy and protection parameters (Applicable only for ACB)	Modbus RS 485 monitoring and control (SS and VFD) & MPR Only monitoring & Trip. In VFD: PF, energy saving also to be monitored.	-
<b>Digital Input (DI)</b>	Breaker ON/OFF	Motor Run	Valve Open
	Breaker Trip	Motor Trip	Valve Close
	Auto / Manual (For ACB)	Auto / Manual	Local/Remote
		Local / Remote	Trip/Fault
<b>Digital Output (DO)</b>	Breaker ON/OFF (latched type)	Start/Stop (latched type)	Valve Open
			Valve Close
<b>Analog Input (AI)</b>		Speed Feedback (Only for VFD)	Valve Position Feedback
<b>Analog Output (AO)</b>		Speed Reference (Only for VFD)	Valve Position Reference (Only for VFD)

**In addition to above MFM and Temperature scanner with RS 485 Communication MODBUS shall be taken for interfacing with PLC/SCADA for monitoring and for controlling further as required.**

#### **Bus Bar**

Bus bars shall be of high conductivity, electrolytic Aluminium (E91E) suitable for carrying the rated and short time current without overheating supported on insulators made of non hygroscopic, non flammable material to ensure free thermal expansion with tracking index equal to or more than that defined in IS.

Aluminium bus bars shall be sized for maximum 0.8 A/mm<sup>2</sup> current density only.

Whenever incoming supply is through bus duct, incoming bus bar of incomer shall be extended till the top end of panel and phase positioning/orientation of bus bars shall be suitable for transformer LV terminal arrangement to avoid additional phase cross over chamber.

Bus bars for risers shall be rated to carry minimum 80% or higher of the rated current of all feeders connected to the risers as per the design of the system/loading.

The current rating of neutral shall be minimum half that of phase bus bars. For LDB neutral rating shall be equal to that of phase bus bar.

Both horizontal and vertical TP and N, bus bars, bus joints and supports shall be capable of withstanding dynamic and thermal stresses of the specified short circuit currents for 1 second.

Only high tensile steel bolts, nuts and washers duly zinc passivated or cadmium shall be used for all bus bars joints and supports.

The hot spot temperature of bus bars including joints at design temperature shall not exceed 85 °C for normal operating conditions.

All bus bars shall be insulated with heat shrunk PVC sleeves of 1100V grade.

The bus bars shall be arranged such that minimum clearance between the bus bar for 50kA fault current shall be maintained as below.

- Between phases : 27mm minimum
- Between Phase and Neutral : 25mm minimum
- Between phase and Earth : 25mm minimum

**To fulfill the requirement of 65kA for 1 second, necessary clearance as per relevant IS shall be maintained.**

#### **Auxiliary Supply Bus Bars**

Auxiliary bus bar of **Tinned Copper EC grade** of suitable size shall run throughout the length of main busbar/vertical bus bar alley and supply shall be tapped to individual feeder directly from the bus and shall not be looped between the feeders. Control MCB shall be provided for individual feeder. Exact size/capacity of bus bar shall depend on various controls, metering and auxiliary power distribution requirement. Auxiliary bus shall be provided for following applications:

- Panel space heater supply and motor space heater supply,
- Control supply for breaker tripping, closing and indication circuits,
- Control supply for breaker spring charging motors, motor starter control and indication circuits and
- AC potential supply for MFM, meters, starter and voltage operated relays etc.

#### **Power and Control Wiring and Terminal Blocks**

All wiring shall be done with FRLS PVC copper flexible wires with IS marks. The insulation grade for these wires shall be 660V grade. The control wiring shall be enclosed in plastic channels/Race way and neatly bunched together.

Control circuit wiring shall be FRLS PVC copper flexible wire of minimum 1.0 mm<sup>2</sup> size and CT circuit wiring shall be minimum 2.5 mm<sup>2</sup> size. CT wiring shall be R Y B colour coded and terminals shall be CT shorting link type only. Power wiring inside the starter module/MCCB/MCB shall be rated for full current rating of feeder MCCB/MCB.

All feeder modules shall be provided with neutral link. Suitable size and rating terminal blocks shall be provided for all outgoing feeders in the cable alley for connecting power and control cables. Cable shall never be connected directly to MCCB/MCB terminals.

Flexible wire shall be used only up to and including 100 A MCB/MCCB. For above 100 A MCCBs bus bar shall be used. Minimum size of FRLS Copper wire shall be up to and including 16A: 2.5 mm<sup>2</sup>; 20A: 4 mm<sup>2</sup>; 32A: 6 mm<sup>2</sup>; 40A: 10 mm<sup>2</sup>; 50A: 16 mm<sup>2</sup>; 63A: 25 mm<sup>2</sup>. and 100A: 35 mm<sup>2</sup>.

Each wire shall be identified at both ends by PVC ferrules. Inter panel wiring shall be done through rubber grommets. A minimum of 2 numbers or 20%, whichever is higher, spare terminals shall be provided on each terminal block.

Marking on the terminal strips shall correspond to wire numbers on the wiring diagrams. All spare contacts and terminal of panel mounted equipment and devices shall be wired to terminal blocks.

### **Earthing**

The minimum earth bus size shall be minimum **65mm x10mm (hot dip galvanised strip) or 40mm x 10mm (Aluminium) or** higher to suit the fault level/kA requirement.

All doors and movable parts shall be earthed using minimum 1.5 mm<sup>2</sup> FRLS Copper flexible wires (Green colour) to the fixed frame of the switch board. Provision shall be made to connect the earthing bus bar to the plant earthing grid at two ends. All non-current carrying metallic parts of the mounted equipment shall be earthed. Minimum 4 numbers, 10 mm dia. hole shall be provided on the earth bus for termination of earth strip/wire.

### **Name Plate**

Name plates shall be provided as per standards.

LV panel shall be with details like name of Client (on first row/top row), Project name (second row), name of Contractor (third row) and Panel builder/manufacture (in fourth row), Panel Manufacturing month & year all with equal of descending order letters size on top of front side of panel.

LV panel shall be with name plate (on front side of door of incomer) having minimum details like (1) Project name (2) Client name (3) Contractor name (4) Panel manufacturer name (5) Panel Manufacturing month & year (6) Incomer rating (7) Power supply voltage, (8) Control supply voltage, (9) Frequency, (10) Panel fault level, (11) Panel protection class and (12) Panel manufacturing IS standards considered etc. details.

### **Painting**

The LV panel shall be treated with seven tank/nine tank process with degreasing, water rinsing, De-rusting, water rinsing, phosphating, water rinsing, passivation.

After seven tank process the panel shall be powder coated with Siemens grey RAL 7035 / 7032 or such other suitable shade with kliknet approval for inside and outside of LV panel.

Mounting plate shall be painted / powder coated with white or suitable shade.

Thickness of paint shall be between 80 to 100 Microns.

### **Switchgear Modules**

#### **Air Circuit Breakers**

Circuit breakers shall be air break, electrical draw out type for feeders 630A and above. All ACB shall be with microprocessor based release with overload, short circuit and inbuilt earth fault protection. Only for APFC incomer thermal magnetic type can be accepted.

The ACB shall be minimum 50kA (1 Second) or higher as per fault rating,  $I_{CS} = 100\% I_{CU} = I_{cw}$ . All ACBs shall comply and tested as per IS: 13947/IEC 60947-1 and IEC 60947-2 standards.

ACB for all incoming, Bus coupler should be Four Pole Type. PCC outgoing feeders shall be Four Pole/Three Pole + Solid Neutral (TPN) Type.

ACB for incoming and bus coupler shall be identical and interchangeable.

ACB models shall be: **Schneider: Master pact NW, Siemens: 3WT<sup>PLUS</sup> / 3WA , LK-E&A (Formerly L&T E&A): Omega U-Power, ABB: E-Max2; or Equivalent** model from Approved Vendor list. Data sheet with parameter comparison shall be submitted for approval. However, in case of change in models / introduction of new model by vendor in due course, the latest model equivalent or better than specified model shall be offered / considered.

ACB shall be with **inbuilt Communication Module** RS 485 for MODBUS for communication with SCADA/PLC for both control and monitoring.

Electrical and mechanical interlocking shall be provided between ACB incomers and bus coupler with required key locks, under voltage coil etc. as per the system requirement. Only ACB auxiliary built-in contact shall be used for interlocking i.e. auxiliary contactor/plug-in relay shall not be used.

ACB Trip Release LSIG (Micro Processor based) should have minimum as following:

- Overload with time delay
- S/C with time delay and instantaneous trip setting
- Earth fault with time delay
- Under/over voltage for incomer
- LSIG fault record display (Only For Incomer and Bus coupler)
- Metering and Energy display (Only For Incomer and Bus coupler)
- Ammeter display (For Outgoing feeders)

ACB shall be fitted with following:

- Auxiliary built-in contacts having not less than 4 NO + 4NC contacts
- Built in resin cast current transformer
- Shunt and under voltage tripping device
- The ACB shall be suitable for locking the breaker in various positions. Interlocks shall be provided to: Prevent the breaker from being isolated unless it is in the 'OFF' Position; Prevent the breaker from being racked in to the service position unless it is in the 'OFF' position; Prevent the breaker from being accidentally pulled completely 'OFF' the guide rail.
- Safety shutters of an insulation material shall be provided to prevent access to all live contacts, when the breaker is in the inspection position or completely withdrawn.

### **Moulded Case Circuit Breakers (MCCB)**

All MCCBs shall be comply and tested as per IS: 2516/IEC 60947-1 and IEC 60947-2 standards.

Incomer MCCBs shall be 4 P, 50kA or higher (and  $I_{cs} = 100\% I_{cu}$ ) with micro-processor based release with in built O/C, S/C and E/F protection.

Outgoing MCCB TPN for power feeders up to and including 200A shall be with thermal magnetic release with adjustable O/L and Adjustable/Fixed S/C protection. Outgoing MCCBs from 250 A and above shall be with microprocessor based release with in built Adjustable O/C, Adjustable S/C and Adjustable E/F protection.

All MCCBs shall be 50 kA or higher,  $I_{cs} = 100\% I_{cu}$  and with extended rotary handle and terminal spreader. Auxiliary change over contact 1 No + 1 NC and trip contact shall be provided as per the requirement.

MCCB of Soft Starter/VFD feeder shall be TPN with microprocessor release with overload/short circuit and inbuilt earth fault release.

MCCB as part of DOL/Start Delta motor starter module shall be current limiting type, TPN, (rating and protection type as indicated above) and type tested for Type 2 Coordination as per IS: 13947 / IS/IEC: 60947.

MCCB models shall be: **Schneider: NSX/CVS** or **Siemens: 3VA/3VJ** or **LK-E&A (Formerly L&T E&A): D Sine** or **ABB: T-Max**; or **Equivalent model** from approved vendor list. However, in case of change in models / introduction of new model by vendor in due course, the latest model equivalent or better than specified model shall be offered / considered.

Electrical interlocking shall be provided between MCCB incomers and bus coupler with required under voltage coil, auxiliary contactors as per the system requirement.

On & trip indication of MCCB shall be provided for starter feeders having MCCB breaker.

### **Switches/Fuses**

The switches or fuse switches shall be load break, heavy duty/motor duty, air break type provided with quick make/break manual operating mechanism. The operating handle shall be mounted on the door of the compartment having the switch. Fuses shall be non-deteriorating HRC cartridge link type. Rating of heavy duty switches or motor duty starter modules shall meet the requirement of AC23 duty as per IS: 13947.

### **Contactors**

The contactors shall be air break type, equipped with three main contacts and minimum (2 NO + 2 NC) auxiliary contacts. All contactors shall be 3 Pole, AC3 duty except for lighting feeder where in the contactor shall be 4 P and AC1 duty. External bypass contactor used for soft starter shall be AC1 or AC3 as recommended by soft starter manufacturer.

Unless otherwise specified, the coil of the contactor shall be suitable for operation on 240V, 1 Phase AC supply and shall work satisfactorily between 65 to 110% of the rated value.

Contactor used for capacitor feeder shall be capacitor duty contactor with inbuilt leading contact with wiper function for limiting/damping the capacitor inrush current with NO NC Auxiliary contact.

### **Bimetal Relay**

All bimetal overload relays shall be with in-built single phasing prevention and with Manual/Auto reset type (selectable) with at least 1 NO and 1 NC contact with reset type push buttons in the front, mounted on door such that it shall be possible to reset the O/L relay without opening the compartment door.

### **Motor Protection Relay (MPR)**

Motor Protection Relay (MPR) shall be provided for starters rated 30kW and above. MPR is not required for VFD/Soft starter motor feeders.

Motor protection relay (MPR) shall be numerical type with over load, short circuit, earth fault, under current, unbalance, phase loss/reversal, stall, locked rotor, no load running.

Single phasing prevention with adjustable under/over voltage protection shall be provided separately if the same is not inbuilt feature in MPR.

**MPR shall be Numerical with adjustable parameter with inbuilt MODBUS over RS 485 interface (for item rate tender will be as specified in SOQ/Tender drawings). MPR shall be DIN rail mountable base module and LCD display module shall be panel door mountable. ZCT/CBCT shall be provided for earth fault / leakage protection (range 0.1A to 2A). It shall have programmable 2 DI and 2 DO.**

MPR shall display 3 phase current, unbalance 9% as minimum and earth current monitoring. MPR shall store fault records/Start- Stop records/motor run hours/maximum starting current etc.

For motors 30kW and above external CT (3 nos) 5A, Resin cast of suitable VA shall be used.

Make: **C & S mPRO 200 with ZCT or equivalent model** of other approved makes. Data sheet with parameters comparison shall be submitted for approval. However, in case of change in models / introduction of new model by vendor in due course, the latest model equivalent or better than specified model shall be offered / considered.

#### **Motor Starter**

DOL starter to be considered for rating less than 7.5kW rating. Star-delta starter is to be considered from 7.5kW rating and upto less than 75kW rating. Soft starter to be considered for 75kW and above ratings.

VFD shall be provided for any rating if specifically asked for/as per the requirement/application. Soft starter shall be provided for lower ratings also if specifically asked for/as per the requirement.

MCCB rating upto 800A as incomer for Soft starter and VFD starter is acceptable.

MPCB with overload protection, short circuit protection and single phasing/phase loss protection, AC3 duty contactor for DOL feeders and Start Delta feeders up to and including 15kW.

All MPCB shall be with rotary switch.

MCCB (with adjustable overload, adjustable short circuit, earth fault) microprocessor release or thermal magnetic release (with adjustable overload, adjustable/fixed short circuit) as per MCCB rating, AC3 duty contactor, numerical motor protection relay as applicable, A/M switch, L/R switch, indicating lamps, push button etc. shall be provided.

Provision for door mounting PMU shall be provided in the starter cubicle of submersible pump motor. Wiring shall be done up to terminal connector for PMU input from field. Alternately PMU mounted within enclosure can be permitted to be installed outside the panel within LT room or outdoor near the pump as per contractor's design.

Minimum 8 channel or higher, temperature scanner shall be provided in starter feeder for 90kW and above rated motor feeders wherever motor is supplied with RTD and BTM.

Temperature scanner/Thermistor and PMU (as applicable) shall be interlocked with starter feeder with control/tripping circuit of starter feeder. Temperature scanner shall be door mounted. Soft starter/VFD shall be with input terminal for RTD (PT 100) and Thermistor for motor temperature (winding and bearing) monitoring/protection.

#### **Temperature Scanner**

Temperature scanner of required channels with minimum 2 spare channels shall be provided to detect high winding, and bearing temperature in order to generate tripping signals. The input signals to temperature scanner shall be derived from the motor. Industrial type PT 100 resistance temperature detectors shall be provided in the motor windings and bearings.

1	Service and type	Motor winding and bearing temperature measurements – microprocessor based
2	Range	0 to 200 °C
3	Alarm Contacts	Adjustable 4 Nos. (high temperature and very high temperature) for motor winding and bearing
4	Type of Relay contacts	One Single Pole Double Throw per set point (Relay)
5	Input Signal	From RTDs for each Motor winding and bearing winding
6	No. of channels	6 Nos. for Winding + 2 nos. Bearing + 2 Spare
7	Accuracy	± 1 °C

8	Communication	RS 485 for Instrumentation panel interface if specified to be provided in SOQ/elsewhere in the tender.
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### **Instrument Transformers (CTs/PTs)**

Current transformer and potential transformer shall generally conform to IS: 2705, IS/IEC: 60044-122 and any special requirement with reference to numerical relay shall be taken care of by contractor. All CTs shall be resin cast type and secondary 5 A. APFC feedback CTs, MFM CTs, MPR CTs shall be of Class 0.5 and 10 VA. CTs (80A and above) of digital ammeter, APFC panel metering shall be Cl. 1 and 5 VA. CTs less than 80A shall be Cl 1.0 and 2.5 VA.

The current transformers in breaker feeders shall be capable of withstanding the applicable peak momentary short circuit and the symmetrical short circuit current for 1 second.

### **Indicating/Measuring Instruments**

The meters shall be digital type and generally of square pattern type of 96mm x 96mm suitable for flush mounting. Instrument shall generally conform to IS: 1248 and shall have accuracy class of 1.0 or better. Digital meters shall have 3½ digit LCD display as a minimum.

All auxiliary equipment such as shunt transducers, CTs, PTs etc. as required shall be included in the supply of panel/switch board.

The current coil of ammeters and potential coils of voltmeters shall continuously withstand 120% of rated current and voltage, respectively, without the loss of accuracy.

Digital ammeter and voltmeter shall be with in-built or separate selector switches.

Voltmeter for three phase shall be provided with three line display.

Multi function meter shall be with 3 line display, accuracy class: 0.5 suitable for measuring and displaying the following parameters: A, V, F, PF, kW, kWh, kVA, KVAR, KVARh, Md (Md for PCC/PMCC incomer feeder only), Harmonic and with inbuilt RS 485 communication port. (**Schneider**: EM 6400NG; **LK-E&A (Formerly L&T E&A)**: MFM 4420 (for Incomer) & MFM 4410 (for Starter&Outgoing); **Secure**: Elite 444 (for Incomer) & Elite 443 (for Starter & Outgoing); equivalent model of other approved make). Data sheet with parameter comparison shall be submitted for approval. However, in case of change in models / introduction of new model by vendor in due course, the latest model equivalent or better than specified model shall be offered / considered.

### **Push Buttons**

Push buttons shall have rated operational current of not less than 4A (AC 11).

Push buttons for START, OPEN, CLOSE, LEFT, RIGHT, FORWARD, REVERSE etc. shall be flush type with spring aided self reset contacts.

Push buttons for STOP/EMERGENCY STOP shall be mushroom headed type with stay put contacts and shall be coloured red. The operation of the button shall be press to lock and twist to release.

The stop PB for each outgoing feeder/starter at MCC and for field LCS shall be EMERGENCY STOP push button.

Push buttons shall be in compliance with IEC 60947-5-5.

Illuminated PB is also acceptable.

Colour of push buttons shall be as follows:

Stop/Open/Emergency	:	Red
Start/Close	:	Green
Reset/Test	:	Yellow/White

### **Indicating Lamps**

Indicating lamps shall be LED type and colour shade for the indicating lamps shall be as below:

ON indicating lamp	:	Red
OFF indicating lamp	:	Green
TRIP indicating lamp	:	Amber
PHASE indicating lamp	:	Red, Yellow and Blue
TRIP circuit healthy lamp	:	Milky

### Fixed Compensation

Fixed capacitor banks for transformer compensation (for no load as well as leakage reactance) shall be provided. MCCB 50kA or higher as per specifications along with ammeter, CT 3 nos, capacitor duty contactors, ON delay timer, heavy duty multiple capacitor units (in smaller kVAR ratings viz 10,5,2,1) totaling to 3% value of transformer rating. Capacitor shall not be mounted below incomer feeder. Capacitor, if provided below bus coupler, capacitor housing/compartment shall be fully separated with steel sheet. Proper ventilation shall be provided.

7% detuned reactor with thermostat, 440V shall be provided in series with 525V capacitor or as per SOQ, if working VFD load is more than 50% of total load or if specified in SOQ. kVAR rating of capacitor shall be suitable for reactor rating.

For Capacitor banks of ratings > 50 kVAR for transformer fixed compensation, separate enclosure shall be provided. Fixed capacitor banks meant for transformer compensation for ratings > 50 kVAR shall not be permitted to house in main LV PMCC/PCC panels. Only 4P MCCB power feeder shall be provided in PCC/PMCC panel for the same.

### Danger Notice Plates

The danger notice plate shall be affixed in permanent manner on operating side of the panels. The danger notice plate shall indicate danger notice both in Hindi and English and local language with a sign of skull and bones as per IS: 2551.

### Cubicle/Feeder Size Criteria For LV Panels

**ACB cubicle** shall be min. 1800mm height and minimum compartment size as under:

ACB Rating	Width of Compartment (I/C or O/G) (mm)	Width of Compartment (Bus Coupler) (mm)	Depth (mm)	Remark
630 A – 1250 A 4P	800	900	1000	Cable entry
1600 A 4P	900	1000	1000	Cable entry
2000 A - 2500 A 4P	900	1000	1200	Bus duct entry
3200 A – 4000 A 4P	1100	1200	1300	Bus duct entry

NOTE: Dimension mentioned above is minimum. Height of ACB feeder shall be 1800 mm excluding main Bus bar chamber. Above 1000A ACB outgoing feeders shall be in single tier. Up to and including 1000A ACB outgoing breaker feeder shall be in single/double tier.

**MCCB cubicle** minimum compartment size shall be as under:

MCCB Rating	Minimum Compartment Width (mm)	Minimum Compartment Height (mm)	Depth (mm)	Remark
Up to 100A	350	250	250	Copper flexible shall be used
125A – 200A	400	350(3P)/400(4P)	300	Bus bar/strip
Above 200A to 400A	500	450	400	Bus bar/strip
Above 400A to 550A	600	500	500	Bus bar/strip
Above 550A	600	600	500	Bus bar/strip

NOTE:



1. Dimension mentioned above is Minimum. Depth of panel as per required depending on cable size/ site condition and for ease of maintenance.
2. The minimum height provided is for horizontal mounting of MCCB. However, in case vendor provides vertical mounting of MCCB, then vendor shall provide higher height of compartment then specified above and in this case the cubicle height shall be equal to specified width of compartment as a minimum or higher as required.

**VFD and SOFT Starter cubicle** shall be minimum 1800mm height and minimum cubicle compartment size as under:

<b>Motor Rating</b>	<b>Minimum Width of Compartment (For VFD and for Soft Starter with External Bypass Contactor)</b>	<b>Minimum Width of Compartment (For Soft Starter with Built in Bypass Contactor)</b>	<b>Depth of Compartment</b>
Less than 75 kW	700	700	800
75 kW to $\leq 132$ kW	800	750	900
Above $132 \leq 250$ kW	900	800	900
Above 250 kW	1000	900	1000

NOTE: Dimension mentioned above is minimum. S/S and VFD feeder for 22 kW and above shall be in single tier only.

#### TECHNICAL DATA SHEET FOR LOW/MEDIUM VOLTAGE PANEL BOARD

<b>Sr. No.</b>	<b>PARTICULAR</b>	<b>DETAILS</b>
1.0	<b>SITE CONDITIONS</b>	
1.1	Type/Make	Indoor/As per Tender BOQ
1.2	Mounting	Floor/Stand mounted as per BOQ/Site Conditions
1.3	Design Ambient Temperature	50 °C
1.4	Atmosphere	Corrosive, Humid and Dusty
2.0	<b>CONSTRUCTION</b>	
2.1	Housing	2.0 mm thick CRCA sheet for Body, Partition, Cover/Door
2.2	Protection Class	IP 52 (Indoor)
2.4	Base Channel	100mm x 50mm x 5mm Channel
2.5	Shipping Section Length	2500mm (Maximum)
2.6	Side Sheets for Shipping Section	Full side sheet on both side of shipping section
3.0	<b>OPERATING CONDITIONS</b>	
3.1	Voltage	415V $\pm$ 10%
3.2	Number of Phase	3
3.3	System	3 Phase, 4 Wire
3.4	Frequency	50 $\pm$ 5% Hz
3.5	Fault Current	50 kA as per SLD

3.6	Neutral Grounding	Solid
4.0	<b>CONTROL SYSTEM</b>	
4.1	Voltage	
	For Indication	240V AC
	For Metering	240V AC
	For Protection	240V AC
4.2	Control Supply Through Control Transformer/ Constant Voltage Transformer	240V AC for PMCC
4.3	Wiring	Control Wiring: 1.0 mm <sup>2</sup> FRLS PVC Cu Flexible Wire (Grey); CT Wiring: 2.5 mm <sup>2</sup> FRLS, Color Coded: Door Earthing: 1.5 mm <sup>2</sup> FRLS (Green)
5.0	<b>BUS BAR</b>	
5.1	Phase Bus Bar Material	EC Grade Aluminium
5.2	Neutral Bus Bar Material	Same as Phase Bus Bar
5.3	Earth Bus Bar Material	65 x 10 mm (Hot Dip Galvanised Strip) or 40mm x 10mm (EC grade Al)
5.4	Current Density	1 sq. mm = 0.8 A. Size of bus bar based on design temperature, kA level and current density
5.5	Hard Ware	High Tensile Steel Bolts, Nuts and Washers duly Zinc/Cd Passivated shall be used for all bus bars joints and supports
6.0	PLC Based System	As per SLD/SOQ
7.0	<b>ACB</b>	
7.1	Type, Rating, Number of Poles	EDO, 50kA Rating and Pole as per SLD
7.2	Protection	LSIG with Display and Fault Record Display Control and Monitoring from Remote Location
7.3	Display of Metering	Basic (A,V,F) and Energy for I/C and Only Current Display of Outgoing
7.4	Communication port	Inbuilt RS 485 (on MODBUS/Ethernet)
7.5	Model	<b>Schneider: Master pact NW, Siemens: 3WT<sup>PLUS</sup> / 3WA, LK-E&amp;A (Formly L&amp;T E&amp;A): Omega U-Power, ABB: E-Max2; or Equivalent</b> model from Approved Vendor List
8.0	<b>MCCB (Ics= 100% Icu)</b>	
8.1	Incomer and Bus Coupler MCCB	Microprocessor based Release with Adjustable O/L, Adjustable S/C, Inbuilt Adjustable E/F, 50kA, 4 Pole

8.2	Outgoing MCCB	
8.2.1	For Rating Above 200 A	Microprocessor based Release with Adjustable O/L, Adjustable S/C, Inbuilt Adjustable E/F, 50kA, 3/4 Pole as Specified in SLD
8.2.2	For Rating Up to and including 200 A	Thermal Magnetic based Release with Adjustable O/L, Adjustable/Fixed S/C, 50kA, 3/4 Pole
8.2.3	For SS/VFD Starter Feeder MCCB	Microprocessor based Release with Adjustable O/L, Adjustable S/C, Inbuilt Adjustable E/F, 50kA, 4 Pole
8.2.4	Accessories	Extended Rotary Handle, Terminal Spreader, Auxiliary Change Over Contact + Trip Contact to be provided
9.0	<b>Electronic Motor Protection Relay</b>	
9.1	Type	Electronic MPR with LCD display (3 Phase Current), Record Storage, DI/DO Interface etc. as per Detailed Specifications
9.2	Protection/Interface	Confirm the Following
		1) Over Current 2) Short Circuit 3) Earth Fault 4) Current Unbalance 5) Phase Loss/Reversal 6) Under Current (Dry Run) 7) Stall (Bearing Broken) 8) Locked Rotor 9) Ground/Earth Fault/Leakage (ZCT) 10) Single Phasing with Under voltage and Over Voltage 11) Over temperature (with PTC Thermister) 12) 3 Programmable DI and 2 Programmable DO 13) Fault Record, Start/Stop, Run Hrs. Maximum Starting Current Record
10.0	<b>PAINTING</b>	
10.1	7 Tank Processed Sheet	Required
10.2	Colour and Shade and Thickness: Panel Exterior and Interior	RAL 7035 80 Micron – 100 micron
10.3	Mounting Plate	Glossy White
11.0	<b>Current Transformer</b>	
11.1	Type	Resin Cast
11.2	Class of Accuracy	Cl 0.5 for MFM, APFC Load Sensing, Summation, MPR Cl: 1 for Ammeter
11.3	Burden (VA)	As per Specifications
12.0	<b>Hardware</b>	For Bus Bar Joints High Tensile With Zinc Passivation/Cd Plated

13.0	<b>Space Heater</b>	230V AC with Thermostat
14.0	<b>Pocket for Drawings at</b>	Yes
15.0	<b>Instrumentation Compartment</b>	Separate Compartment for Energy Meter, Hour Meter, Level Controller etc. with Necessary Internal Wiring
16.0	<b>Panel Internal Lighting</b>	250mm Long LED Panel Light 3/4W or Higher with Auto NO Contact/Switch with Panel Door and control MCB for VFD/SS/Starter Feeder/Incomer/Cable Alley

**Note: Other specifications not mentioned in datasheet shall be considered as per tender specifications/SLD.**

#### ❖ **AUTOMATIC POWER FACTOR CONTROL PANEL (APFC PANEL)**

The design, engineering and construction of APFC panel shall be such that, it improves power factor (up to 0.999 maximum) on LAGGING side only. Under no circumstances power factor improvement shall be on LEADING side. Further power factor improvement system shall adequately function during water supply time i.e. (during pumping) while in LOAD as well as under PART/MINISCULE and NO LOAD conditions during entire day.

APFC panel shall be floor mounting, free standing, compartmentalized, extensible, modular type suitable for indoor installation.

The panel shall be IP 52 for metering and switchgear module and shall be IP 42 for reactor/capacitor section. Full partition shall be provided between switchgear components and capacitor section. Each feeder module shall be fully compartmentalised. Capacitor/reactor shall be mounted in separate vertical section/cubicle adjacent to switchgear cubicle instead of mounting at the rear end/backside of switchgear module as per availability of space.

The control equipment including capacitors shall be mounted in panel made of 2mm CRCA sheet. Panel shall be fully compartmentalised, extensible and with main bus bars in horizontal bus bar alley. Capacitor feeder rating shall not exceed 100 kVAr rating.

Ammeter, ammeter selector switch and CT shall be provided in 50 kVAr and above rated feeders to measure capacitor current.

APFC panel control logic shall be such that when DG is ON, APFC panel shall be OFF and shall become automatically ON when the Grid power/utility power is restored.

**The fixed capacitor bank will be provided on each incomer, as applicable, on upstream side of incomer breaker. Adequate arrangement of interlocking between APFC panel and transformer fixed compensation power capacitor bank for no load power factor improvement must be made in such a way that during load condition i.e. when associated incomer breaker is ON and downstream load is working (load / current is being sensed above certain threshold), the fixed compensation capacitor bank shall be switched off. Similarly, when incomer breaker is OFF or the downstream load are OFF (load / current is zero / below certain threshold), the fixed capacitor banks shall be ON i.e. in functional/working mode. The objective of this interlocking arrangement is to compensate for p.f. during no load condition and it shall also be ensured that power factor does not go into leading side when pumping system is not running / plant under no load condition. For this purpose the fixed capacitor bank shall be adjusted / fine tuned at site to decide the required kVAR to be kept ON out of total and same will be reviewed and set from time to time periodically.**

APFC panel shall be operated on AUTO and MANUAL mode. Individual capacitor feeder shall be possible to be operated on AUTO/MANUAL mode even when A/M switch in incomer feeder is on AUTO Mode.

All capacitors shall be heavy duty MPP/Heavy duty Gas filled with discharge resistor and as per the technical data sheet provided here in. However in case of only smaller capacity ie < 5 kVAr, APP type capacitors are also acceptable.

Heavy duty exhaust fan 6"/8" (shall be continuous duty, metal housing with metal impeller) with canopy shall be provided at the top. Louvers with wire mesh (up to maximum 1mm opening) shall be provided at the bottom end of capacitor section. Minimum 1 number of fan shall be provided per meter length of panel or part thereof or more numbers as required.

Minimum distance between two capacitors and from all sides of panel enclosure (including terminal) shall be 25mm.

Earthing terminal of capacitor shall be connected to earth bus bar.

Automatic Control Panel and Fixed Capacitor Panel (for Transformer Compensation) shall comprise following.

MCCB for protection of each capacitor bank (MCCB should be suitable for capacitor switching and kA rating shall be as per main panel kA rating). For smaller ratings of capacitors ie < 10 kVAr only D curve MCBs of appropriate ampere ratings are acceptable.

Incomer MCCB shall be TPN, microprocessor based/thermal magnetic (adjustable O/L and Adjustable S/C) as per LV panel specifications.

APFC relay shall be microprocessor based with inbuilt RS 485 for sensing and correcting the power factor of the system with required number of steps to achieve the specified power factor. Minimum steps of power factor relay shall be 10 or as per SOQ. Minimum operating current/sensing current shall be 10 mA/10% of load. Minimum 2 numbers additional spare relay contact shall be available for future use.

Two numbers vacant feeders with mounting plate and cutouts shall be provided for future use.

A/M switch with Auto/Manual indicating lamps shall be provided in addition to R Y B indicating lamps.

Each outgoing capacitor feeder shall be provided with suitably rated MCCB, capacitor duty contactor with inrush damping resistor, A/M switch, 'ON' and 'OFF' push with ON, TRIP, AUTO indication lamp, ON delay timer (only for Manual mode of individual feeder), 440V capacitor unit with discharge resistor.

Control circuit of individual feeder shall have control MCB for protection and indicating lamp shall be only through auxiliary contact.

All outgoing MCCB feeders shall be 50kA,  $I_{cs} = 100\% I_{cu}$ , with trip indication/fault signal contact, with extended rotary operating handle, any other components required for satisfactory and safe operation shall be provided.

Capacitor shall be compact in size and hermetically sealed. In built fuses and surge suppressors shall be provided for protection of each capacitor element.

Capacitor banks shall comprise identical delta connected three phase units. Capacitor banks shall be non-flammable, non-toxic, non-PCB, dry technology, inert gas (N<sub>2</sub>)/PU resin impregnated, MPP heavy duty type/Gas filled.

Only one wire shall be connected to each contactor terminal i.e. whenever more than one capacitor is controlled from contactor suitable size bus bar strip shall be provided and power shall be tapped. Else separate contactors shall be used for each capacitor unit.

**If load is VFD driven and working VFD driven load is more than 50% of total load, or if required or specified in SOQ, APFC panel shall be with detuned reactors. 7% detuned reactor, 440V, Al. wound with thermostat shall be provided in series with capacitor unit. Capacitor voltage shall be 525V or as specified in SOQ and kVAr rating suitable for reactor kVAr rating. Filter rating (Reactor + Capacitor) shall be rating of APFC panel.**

Except for the specific requirements of APFC panel specified here in, rest all specifications shall be as per LV panel/switchboard specifications specified herein.

Capacitor rating generally shall be at 525V if provided with detuned reactor or as specified in SOQ and APFC Panel shall conform to IS: 16636 (2017).

### **Three Phase Filter Reactor**

Anti resonance three phase filter reactor, Aluminium wound, 440V detuned reactors (5.67% or 7%) as required are to be used in series with shunt capacitors to prevent harmonic resonance and harmonic overloading of capacitors, transformers, whenever power electronic equipment (Drives, UPS etc.) producing nonlinear currents are used. Detuned systems shall be such that the self resonant frequency is below the lowest line harmonic.

### **Features of Reactors**

- High linearity, low losses and noise level
- High over loading capability
- Inbuilt temperature micro switch

Micro switch potential free contact shall be used in control circuit of respective capacitor feeder to trip the contactor in case of high temperature.

Reactor shall be kept in independent cubicle and adequate ventilation shall be provided.

### **Power Factor Correction Thyristor Switch Module**

Thyristor switching instead of contactor switching shall be used when load variation is rapid. Semi conductor fuses shall be used for protection of Thyristor switches in addition to MCC, BHRC fuses shall not be used. Discharge reactors shall be used for fast discharge for fast reconnection of capacitor.

### **Technical Features**

- Suitable for real time power factor correction
- Switching time less than 5 milli seconds
- PIV: 2200
- Permanent self controlling of voltage parameter, capacitor current, temperature of the thyristor switch
- Suitable for manual operation also
- Automatic switch off in case of over current and over temperature

- Display of: Operation, Faults, Activation.

#### APFC Controller with RS 485

Microprocessor based intelligent control, menu driven, single/3 CT sensing, 5A CT selectable with RS 485 communication port and features as below.

- Display: LCD illumination, large and multi functional characters.
- Parameters: Voltage, monitoring of individual capacitor currents, Real time PF, Power kW, kVA, kVAR, Temperature, Energy KWh, KVAh, KVARh
- Steps: 4, 6, 8, 12,16 as required
- Mounting: Panel mounting (size: 144mm x 144mm)
- Current input: 1 A or 5 A selectable
- Operating temperature: 0 to 60 °C
- Supply voltage: 230V AC
- Target PF: 0.8 inductive - 0.8 capacitive.
- Minimum operating current: 10 / 50 mA
- Sensing: Single/3 CT, 3 CT sensing for unbalanced load.
- Dual target power factor setting: for utility and DG mode operation.
- Facility of including “Fixed capacitor bank” for purpose of transformer compensation. This can be set such that the controller doesn’t ‘see’ this capacitor.
- Potential free contacts/alarm output: Insufficient compensation, over compensation, under current, over current, over temperature, harmonics exceeded.
- Suitable for Thyristor switching if Thyristors are used instead of contactor.

**Minimum rating of MCCB & flexible FRLS copper wire size for capacitor feeder shall be as below.**

TABLE-A			TABLE-B	
Sr. No.	Capacitor Rating (KVAR)	Min. FRLS Copper Wire size (mm <sup>2</sup> )	Capacitor Rating (KVAR)	Min. MCCB Rating (Amps)
1	Up to and ≤ 5	2.5	Up to and ≤ 5	16
2	10	4	10	32
3	12.5	6	12.5	32
4	15	6	15	63
5	20	10	20	63
6	25	16	25	63
7	30	25	30	100
8	40	35 mm <sup>2</sup>	40	125
9	50/60	50 mm <sup>2</sup>	50/60	160
10	75	70 mm <sup>2</sup>	75	200

#### CAPACITOR DATA SHEET

Sr. No.	PARAMETER	Unit	
	Capacitor Type		Heavy duty MPP/Heavy duty Gas

			Filled
1	Conformance to Standards		IS: 13340/IEC 60831
2	Rated Voltage	V	440/525 as required/Applicable
3	Inrush Current	A	Up to 200 Ir
4	Maximum Permissible Current/ Over Current	A (Imax)	1.5 Ir
5	Maximum permissible Voltage/ Over Voltage	V (Vmax)	1.1 Vr
6	Temperature Class	<sup>0</sup> C	60
7	Losses (per phase)	W/kVAr	Dielectric: less than 0.2 Total : less than 0.5
8	Capacitance Tolerance		-5% / + 10%
9	Dielectric		Poly Propylene
10	Impregnation		Non-PCB PU Resin/Inert Gas Nitrogen
11	Number of Switching Operation		5000 as per IEC 60832
11	Useful Life	Hours	125000 Minimum
12	Maximum THD in Voltage		3%
13	Maximum THD in Current		15%

**Note: Rest all construction features and other requirements shall be as per specifications of LV Panel.**

### **Test and Test Reports**

All tests shall be conducted in accordance with the latest edition of IS: 2834 and as applicable for controls.

Type test certificates for similar capacitor units shall be furnished for review and acceptance.

### **Drawings to be submitted for the approval of the Client/PMC/TPI**

- GAD with elevation, side view, sectional view and foundation details.
- Complete schematic and wiring diagrams.
- Detailed BOM and GTP.
- Manufacturers' technical data sheet of capacitors and APFC relay.

### **❖ INDUCTION MOTOR (LOW VOLTAGE)**

#### **Scope**

This specification covers the design, manufacture, inspection, testing at works, supply, delivery to site, installation, testing at a site and commissioning of TEFC, squirrel cage, solid shaft induction motors with all accessories for driving various pumps/equipment working on three phase LV AC supply required for the complete operation of the plant as per the scope of this work.

All motors shall be as per these specifications unless for any other more stringent requirements mentioned elsewhere.



## Codes and Standards

The design, material, construction, manufacture, inspection, testing and performance of induction motors shall comply with all currently applicable status, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also confirm to the IS: 12615 (2018)/IEC 60034 amended up to date.

## General Design and Constructional Requirements

Motors shall be continuous maximum rated as per IS: 12615 (2018) and IS: 4722 (latest edition) and preferably be designed for low starting current and smooth acceleration except for cases where the driven equipment characteristic demand otherwise. Motors shall be of 4/6/8 pole design as required and provided with terminal box large enough to accommodate armoured PVC/XLPE insulated Aluminium conductor cable of required/specified size/ratings. Motors shall be of energy efficiency class IE3 as per IS: 12615 (2018).

All motors shall be foot/flange mounted or as per pump/driven equipment coupling requirements.

The minimum power rating for motors to drive pump / sub. Pump / driven equipment should be selected as per table below to meet the power demanded over its duty point of operation:

Required BkW of Pump/Submersible Pump/Driven Equipment	Minimum multiplying factor to arrive at motor rating
Below 7.5 kW	1.3
7.5 kW and above but below 15 kW	1.2
15 kW and above but below 75 kW	1.15
75 kW and above	1.10

## Operating Conditions

### 1) Frequency and Voltage Variation

All LV motors shall be TEFC squirrel cage motor and the motor shall be suitable for the following.

Design Temperature	:	50 °C
Supply Voltage	:	415 Volts, 3 Phase, 50 Hz AC supply
Voltage Variation	:	± 10%
Frequency Variation	:	± 5%
Combined Variation of Voltage and Frequency	:	± 10%

### 2) Starting

- Unless otherwise specified, motors shall be designed for direct-on-line starting.
- Motors shall be designed for re-acceleration under full load after momentary loss of voltage with the residual voltage being 100% and is in phase opposition to the applied voltage.
- Minimum locked rotor thermal withstand time at rated voltage shall be 10 seconds under cold conditions and 8 seconds under hot conditions. The starting time of motor shall be less than the hot thermal withstand time to permit application of conventional bimetal relays or thermal release against locked rotor and overload conditions.
- The motors shall be suitable for starting under specified load conditions with 75% of rated voltage at the motor terminals.

### 3) Direction of Rotation

Motors shall be suitable for either direction of rotation. In case unidirectional fan is provided for motors, direction of rotation for which the motor is designed shall be permanently indicated by means of an arrow. When a motor is provided with bi-directional fans, a double headed arrow should be provided.

Normally clockwise rotation is desired as observed from driving (coupling) end. Ample space shall be provided in terminal box for interchanging any two external leads for obtaining reverse phase sequence.

### **Performance**

Motors shall be rated for continuous duty S1 unless otherwise specified. For hoist/crane it shall be S4 duty.

All performance characteristics shall be as per IS: 12615 (2018) or latest revision and the torque and other specific requirement shall be selected by the concerned equipment vendor to suit the application.

### **Construction Details**

#### **Motor Casing and Type of Enclosure**

Motors for use in safe area shall be of industrial type meeting the specified ambient conditions, starting and operating requirements. Motors for use in hazardous areas shall have type of protection Ex-d or other as per area classification and to meet requirement of applicable Indian Standards.

The motor enclosure including terminal boxes and bearing housing shall have IP 55 degree of protection.

Motor casing shall be provided with a suitable drain for removal of condensed moisture for motors operating in safe area.

All vertical motors shall be provided with suitable canopies covering the motors fully.

Motors designed to handle external thrust from the driven equipment shall be supplied with a thrust bearing at the NDE.

Motors shall have standard frame sizes for various output ratings as per relevant IS.

Motors installed in outdoor areas shall be provided with FRP type canopies/covers of 2mm thick. All external surfaces of the motor and its canopy shall be given coat of epoxy based paint shade 632 as per IS.

### **Insulation and bracing**

Unless otherwise specified, motors shall be provided with class F insulation with the permissible temperature rise above the specified ambient temperature shall be limited to that of class class B. **VFD operated motor shall be with Class H insulation ONLY with temperature rise limited to Class F.**

The winding shall be tropicalized. The windings shall preferably be vacuum impregnated. Alternately the windings shall be suitably varnished, baked and treated with epoxy gel for operating satisfactorily in humid and corrosive atmosphere.

Windings shall be adequately braced to prevent any relative movement during operation.

Overhung of winding shall be double coated with epoxy gel.

**However, motors operating with Variable Frequency Drive** shall have winding and other features as follows.

- Winding shall be double insulated, vacuum impregnated.
- Winding shall have class H insulation with temperature rise limited to Class F.
- Motors shall have adequate and suitable cooling arrangement and frame size shall be suitably selected for effective heat dissipation unless otherwise specified in SOQ.
- Motors shall be suitable to continuously operate within 30% to 100% speed range variation.

### **Phase Connections and Terminal Box**

The windings shall be connected in Delta. The ends of the windings shall be brought out into a terminal box.

All motors shall be with six terminals and suitable links to connect them in star or in delta. Motors rated up to and including 2.2kW which may be accepted with three terminals.

The terminal box shall be located on the RHS as viewed from driving (coupling) end (for motors above 3.7kW).

The terminal box shall be rotatable in steps of 90 degree to allow cable entry from any direction.

Adequately sized earth terminal shall be provided in the motor terminal box. Terminal box shall be provided at the side of the motor.

### **Bearing and Lubrication**

Motors shall have grease lubricated ball or roller bearings with minimum L 10 rating life of 5 years (40,000 hours) at rated operating condition.

Bearings shall be capable of grease injection from outside without removal of covers with motors in running condition.

Necessary seal to prevent entry of dust/moisture and loss of grease shall be provided. Grease nipples shall be provided with appropriately located relief devices which ensure passage of grease through the bearings.

VFD operated motor shall be considered with insulated bearings for motor rating 90kW and above (not applicable for package product like turbo blower etc.).

### **Cooling System**

All motors shall be self-ventilated, fan cooled. VFD operated motors shall be VFD duty and shall be fully compliant to VFD drive conditions.

### **Rotor**

The motor shall be squirrel cage type, dynamically balanced to provide a low vibration level and long service life of the bearings.

### **Shaft Extension**

Motors shall be provided with a single shaft extension with key-way and full key. Motor shaft shall be sized to withstand 10 times the rated design torque.

### **Lifting Hook**

All motors weighing more than 30kg shall be provided with lifting hook of adequate capacity.

### **Earth Terminals**

Two earth terminals of adequate size, located preferably on diametrically opposite sides shall be provided for each motor. Necessary nuts and spring washers shall be provided for earth connection.

## Accessories

- Anti condensation heaters of 240V, single phase, shall be provided for motors rated 30kW and above. Heaters shall remain ON when the motor is not in service and as such shall not cause damage to the windings. Heaters shall be metal encased with a low surface temperature.
- RTD/BTD: 2 number per phase RTD and 2 numbers BTD for bearings both drive and non driven ends shall be provided for motors rated 90kW and above, suitably terminated in auxiliary terminal box. Separate terminal box shall be considered for space heater and RTD/BTD.
- Name plates shall be provided on each motor as per IEC/IS.
- Noise level and motor vibrations shall be within the limits as laid down in IS.
- **Special application motor for higher pump RPM than motor:** For special applications like high pressure RO pumps etc. where in the pump RPM selected are more than motor RPM, such motors shall be driven by VFD only to achieve higher motor RPM as per pump RPM and the de-rated motor torque at such higher RPM shall be more than pump torque requirement with minimum 10% safety margin or higher as recommended by pump manufacturer/vendor. The motor for such application shall be de-rated and offered with required higher frame size/rating as recommended by motor manufacturer/vendor and shall be suitable for VFD duty requirements specified.

## Notes:

The motor and make of motor as per manufacturers' standards' shall be acceptable for following

- The TEFC squirrel cage induction type drive (motor) for imported equipment coming as part of equipment from foreign country. However same shall be generally meeting IE3 efficiency class requirements.
- DC motors (e.g. Turbo Blowers etc.)
- Motor for special applications viz. Braking applications like mechanical screens, EOT Crane Hoist/Electric Hoist, Electric Actuators, SBR Decanter etc.
- **For 2 pole motor :**
  - 2 pole Motor can be accepted for specific application only on case to case basis with required technical justification (i.e Tri-lobe blower, Centrifuge or such applications).
  - Non-standard rating of motors shall not be accepted.
  - Motor for submersible pump application shall be as per manufacturer standard but generally shall follow the efficiency class IE2 or better. However, the above specifications shall be referred / followed for major requirement i.e S1 Duty requirement, Multiplying factor / safety factor for selection of motor rating over BkW power, Freq. & Voltage Variation, MOC, VFD duty requirement, etc. as applicable.

## Motor Testing

Testing of motors shall comply with the requirements of IS: 4029/IS: 15999.

Motor shall be subjected to all routine tests as per IS: 12615 (2018)/IS: 15999 applicable standard with latest amendments, shall be carried on the motors in OEM factory, in witness of Client/PMC/TPI agency.

All type tests certificates shall be furnished during factory test. Generated values of efficiency and power factors at full load, ½ load and ¾ load shall be furnished by the Bidder.

Testing and inspection plan, methodology and applicability for various ratings of motors is specified in details in the Inspection & Testing Chapter provided in this specifications.

## Drawings

The contractor shall submit the following documents of motors obtained from motor manufacturer /vendor for review and approval.

- GAD and Preliminary outline dimensional drawings showing details of motor, terminal box etc.
- Typical cross sectional drawing showing constructional details with complete bill of materials and relevant standards.
- QAP, Performance Curves, Marking and labeling plate details.
- Data Sheets/Guaranteed Technical Parameters.

### ❖ HV and LV CABLES WITH LAYING DETAILS

All power and control cables for use on low/medium/high voltage shall be heavy duty type, multi strand Aluminum/Copper conductor, PVC/XLPE insulated, extruded inner sheathed, armoured and overall PVC sheathed as described below.

The medium voltage power and control cables have following minimum overall cross sectional areas.

- |    |                 |   |  |
|----|-----------------|---|--|
| a. | Power Cables    | : | 6 sq mm and above (Aluminium)/Up to 4.0 sq mm (Copper) |
| b. | Control Cables  | : | Up to 2.5 sq mm (Copper)                               |
| c. | Lighting Cables | : | Up to 2.5 sq mm (Copper)/6 sq mm and above Aluminium   |

Cables shall be sized based on maximum continuous load current and permissible voltage drop. The derating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other etc. as per applicable standards have be taken into account.

Below ground cables in paved areas shall be in concrete lined trenches with pre-cast concrete covers having proper slope and suitable drainage arrangement to avoid water collection. In unpaved areas cables shall be in lined trenches or directly buried in the ground.

In hazardous areas and transformer bays, trenches shall be completely filled up with sand. Concrete lined cable trenches shall be sealed against ingress of liquids or gases wherever the trenches are in hazardous area or enter into control room or substation area.

Cable trenches shall be sized depending upon the number and voltage grade of cables to be lined. Where underground cables cross roadways, pipe sleepers at grade etc., they shall be protected by being drawn through PVC sleeves/ducts or suitable RCC Pipes/DWC to provide permanent crossing. Pipes laid shall be sealed at both ends for mechanical protection.

High voltage, medium voltage power, control and signal cables shall be separated from one another/each other by adequate spacing or running through independent pipes, trenches or cable trays as applicable. Cable trays, racks and trenches shall be sized to allow for laying 20% cables in future. Cable installation shall provide minimum cable bending radii as recommended by cable manufacturers'.

Cable route markers shall be installed at every 30meter interval all along the routes of directly buried cable trench and also at locations where the direction of cable trench changes.

All power and control cables shall be of continuous length without intermediate joints. Where joints are unavoidable, these shall be provided with the permission of Engineer-in-charge. All cables shall carry tag numbers for easy identification. In case of control cables all cores shall be identified at both sides by their terminal numbers using PVC ferrules as per interconnection diagrams.

Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every meter. The embossing/engraving shall be legible and indelible.

Control cables having 6 cores and above shall be identified with prominent and indelible Arabic numerals on the outer surface of the insulation. Colour of the numbers shall contrast with the colour of insulation with a spacing of maximum 50mm between two consecutive numbers. Colour coding for cables up to 5 cores shall be as per IS.

**A Deleted**

**B LV Power and Control Cables**

The scope shall cover supply, laying, testing and commissioning of low and medium voltage XLPE cables.

All cables shall carry tag numbers for easy identification. In case of control cables all cores shall be identified at both sides by their terminal numbers using PVC ferrules as per interconnection diagrams.

**XLPE Insulated Power/Control Cables (Medium Voltage)**

1.1 kV grade stranded Aluminium/Copper conductor, XLPE insulated, extruded inner sheath, GI strip/ wire armoured (Aluminium armoured for single core cable) LV XLPE cable as per IS: 7098 Part 1 with latest amendment.

**RTD/BTD/Signal Cables**

Contractor/Vendor is responsible for sizing of all cables considering factors like maximum distance between panel/control room and the units/motors.

Specifications for cables for RTD/BTD/Analog signals shall be as follows.

Cables shall be of 660V/1100V grade, single/multi-pair/triad/core cables as per requirement. Triad/multi core signal cables shall be annealed, tinned, high conductivity 0.5/1.0/1.5 sq mm stranded Copper conductor, polyester tapped PVC insulated number of cores twisted into pair, laid up collectively, individual pair/triad shielded and overall shielded with aluminum mylar tape, armoured with galvanized steel wire/strip, overall sheathed with PVC conforming to IS: 1554 and IEC 189 Part II.

**Splicing and Termination**

Branch circuit wiring shall be spliced only in switch boxes, panel switch socket outlet boxes light fixtures outlets and circular junction boxes. They shall be made only with approved polycarbonate type connectors. No joints shall be allowed within the conduit pipes, cable entry pipes or ducts for cable laying and wire pulling.

**Testing**

Cables shall be tested in accordance with IS: 7098.

**Finished Cable Tests at Manufacturers' Works**

The finished cables shall be tested at manufacturers' works. Following routine tests for each and every length of cable and copy of test results shall be furnished for each length of cable along with supply. If specified, the cables shall be tested in presence of Client/PMC/TPI.

#### **1. Voltage Test**

Each core of cable shall be tested at room temperature at 3 kV AC RMS for duration of 5 minutes.

#### **2. Conductor Resistance Test**

The DC resistance of each conductor shall be measured at room temperature and the results shall be corrected to 20 °C to check the compliance with the values specified in IS: 8130 (1976).

**Testing and inspection plan, methodology and applicability for various types, sizes and ampere ratings of cables is specified in details in the Inspection & Testing Chapter provided in this specifications.**

#### **Cable Test before and after laying of cables at site.**

1. Insulation resistance test between phases, phase to neutral and phase to earth.
2. Continuity test of all the phases, neutral and earth continuity conductor.
3. Sheathing continuity test.
4. Earth resistance test of all the phases and neutral.

#### **Sealing and Drumming**

Cable shall be supplied in non returnable drums as per IS: 10418 standard. Cable identification details like voltage, size, name etc. shall be written on drums also as per IS.

### **C Cable Accessories**

All accessories like cable glands, lugs and terminal markings etc. shall be used conforming to relevant standards/as specified.

The end termination for HV cables shall be heat shrinkable type.

For 1100V grade cables, Ni-Plated Brass Double Compression type glands weather protection of IP 65 as minimum.

Crimping type lugs of Copper/Aluminium (as applicable) of required sizes shall be used.

### **D Cable Laying**

HV power, MV power and control cables shall be separated from one another/each other by adequate spacing or by running through independent pipes, trenches or cable trays. Cable laying and termination shall be such that chances of cable getting damaged are eliminated.

LV cable shall be laid in cable tunnel or tray racks or buried underground with appropriate protection. Black shall indicate the neutral, while red, yellow and blue for three different phases. All LV cables when laid on the cable racks shall be properly dressed and clamped as required without criss crossing and unnecessary overlapping. Cables shall be properly dressed and clamped.

#### **Laying of HV and LV underground cables**

Minimum depth of cable trench shall be 750mm for LV cables and 900mm for HV cables from finished ground level (FFL/FGL). Before placing of cables in the excavated trench, bottom shall be cleared from all rocks, stones and sharp objects. The cables shall be protected by filling bottom of the trench with a layer of sand. This sand layer shall be leveled prior to laying of cables over it. Such laid

cables shall be covered with 150mm of sand on top of the largest diameter cable and sand shall be lightly compacted. A flat protective cover of 75mm thick second class red bricks shall then be laid properly in alignment followed by backfilling of the remaining portion of trench with soil, duly rammed and leveled.

While routing, necessary barriers and spacing shall be maintained for cables of different voltages in case they are laid side by side (in adjacency).

Telephone/Telecommunication cables shall cross the power cables only at about right angles and these two shall not run in close proximity.

LV cables shall be bent in radius not less than 12 times their individual overall diameters, while HV cable shall have bends not less than 15 times their individual overall diameters.

Cable routing between cable trench and equipment/motors shall preferably be taken through GI/DWC pipe sleeves of adequate size. Pipe sleeves shall be laid at angle of maximum 45 degree to the trench wall. Bending radii of pipes shall not be less than 8 times their individual overall diameters.

It shall be ensured that both ends of the pipe sleeves are sealed with approved WP sealing compound after cabling. In places where it is not possible, cables shall be laid on smaller branch trays.

All cable shall be identified close to their termination point by cable tag numbers as per cable schedule. Cable tags shall be punched on aluminium straps (2mm thick, 20mm wide of sufficient length) securely fastened to the cable and wrapped around it.

Routes of these cables shall be arrived at on the basis of relevant drawings and with due consultation with the Engineer-in-charge.

## **E Drawings and Schedules**

Size of cables shall be given in single line power diagrams. Cable schedule shall be prepared on the basis of relevant drawings. All cables and wires shall be adequately sized to carry continuously the normal currents expected on the relative circuits. All trenches for electrical cables shall be separate from water or sewage pipe line trenches.

## **F Splicing and Termination**

Straight through joints shall be avoided. In case, these are absolutely necessary they shall be made at convenient locations suitably protected as approved and sanctioned by the Engineer-in-charge but in no case within the conduit pipes or ducts.

Branch circuit wiring shall be spliced only in switch boxes, panel switch socket outlet boxes light fixtures outlets and circular junction boxes. They shall be made only with approved porcelain connectors.

## **❖ CABLE ACCESSORIES AND MISCELLANEOUS ITEMS**

This defines specifications and requirements mainly for miscellaneous items and accessories, which are generally supplied by the erection contractor/agency.

All materials, accessories and consumables to be supplied by the contractor shall be selected from the list of specified makes and shall conform to the specifications given here under.



The accessories shall be manufactured in accordance with prevailing latest IS specifications wherever they exist or with the BS or NEC specifications, if no such IS standards are available. In the absence of any specification, the materials shall be as approved by the Client/PMC/TPI.

All similar materials and removable parts shall be uniform and interchangeable with one another. Makes of bought out items selected by the contractor must be from the approved vendor list of tender.

### **Cable Trays**

These shall be channel type, fabricated from structural steel, hot dip galvanised complete with all accessories such as bends, tees and reducers.

MS/Aluminium flat clamps with GI/Chrome plated bolts, nuts/screws to be used for clamping cables.

Sizes of these trays shall be as specified in bill of quantities/drawings approved by Client/PMC/TPI.

Size 150mm and above shall be ladder type and below 150 mm shall be perforated type. Collar size of the ladder type cable tray shall be 100 mm and 50 mm for perforated type.

Alternatively **FRP cable trays** manufactured as per applicable/relevant standards of required thickness and sizes are also acceptable with prior approval by the Client/PMC/TPI

### **Cable Glands**

Cable glands shall be heavy duty double compression type of Ni-Plated brass. These shall be suitable for armoured/unarmoured cables, which are being used.

### **Cable Connectors**

Cable connectors, lugs/sockets, shall be of Copper/Aluminium alloy, suitably tinned, solder less, crimping type.

These shall be suitable for the cable being connected and type of function (such as power, control or connection to instruments etc.).

### **Cable Indicators**

All cables shall be identified by cable tag of 2mm thick, 15mm wide of enough length of Aluminium straps securely fastened to the cable. PVC identification number, ferrules shall be used for each wire.

### **Conduits for Cables**

For laying of cables under floor, medium duty GI/UPVC/DWC/RCC pipes shall be used.

Pipe shall be laid at an angle of maximum 45 degree to trench wall. Both ends of pipe shall be sealed with approved water proof sealing compound after cabling work.

Size of pipe shall depend upon the overall outer diameter of cable to be drawn through pipe.

To determine the size of pipe, minimum 40% area of selected pipe shall be free after drawing of cable.

### **❖ LOCAL PUSH BUTTON STATION**

Each motor shall be provided with a local control station in the vicinity (area) of the motor.

### **Construction Features**

Push button and related control switches shall be as per IS: 6875.

The local push button station/local control station (LCS) shall have Polycarbonate/FRP/die cast Aluminium enclosure or as specified in BOQ of IP 65 with gland plate with knock out holes suitable for outdoor application.

All control stations shall be suitable for 10A continuous current rating 240V AC as well as 110 V/220 V DC control supply.

All push buttons shall be fitted with 2 NO + 2 NC rated to carry and break 6A at 415V (10A at 240V AC).

The open/close/start push buttons shall be of the momentary contact push to actuate type and shall be green in colour.

The stop push buttons shall be stay put type with mushroom knob and lockable in pressed position and shall be red in colour.

All ammeters shall be of moving iron type having an accuracy class of 1.0 and suitable for 1A CT secondary. The size of ammeter shall be 72mm x 72mm or minimum 65mm dia. The ammeter front glass shall be toughened/transparent Acrylic.

20% spare or minimum 2 number spare terminals shall be considered.

### **Type of Push Button Stations**

Type of LCS	Application	Features Required
Type A	Motor without VFD	Start and Stop PB
Type B	Motor with VFD	Start, Stop, Speed Increment and Speed Decrement. Ammeter if specified in BOQ/Scope of work for motor rated above 30kW
Type C	Motor above 30kW	Start, Stop PB, Ammeter if specified in BOQ/Scope of work
Type D	MOV	Open, Close and Stop PB
Type E	Reversible Motor	Forward, Reverse and Stop PB

### **❖ JUNCTION BOX**

#### **Construction Features**

Junction box shall be with sheet steel enclosure of minimum 2mm thick (14 SWG) and shall be with canopy of 2mm for outdoor application. The enclosures shall be painted with two coats of epoxy paint with final colour shade (both internal and external) of Siemens grey shade RAL 7035 with minimum paint thickness 100 micron.

Separate junction box shall be provided for power and control cable termination.

The boxes shall have Aluminium bus bars supported on insulators suitable for termination of power cables and terminal connectors of required size for termination of control cables.

The bus bar connections shall be suitable for terminations of submersible pump motor flat cable/PVC/XLPE Copper cables and armoured cable from PMCC/MCC as per requirement.

Double compression gland and Aluminium/Copper lugs shall be used for termination.

Minimum 20% or minimum 2 number (whichever is higher) of spare terminals shall be supplied in junction boxes for each size of terminals.

JB shall be wall/stand mounting with zinc passivated bolts and nuts and earth terminals as per IS and name plate as required.

Junction box shall be mounted on required steel structure.

## ❖ INTERNAL AND EXTERNAL ILLUMINATION

### General

The illumination system shall consist of lighting poles, lighting distribution boards, lighting panels/power panels complete with FSU/ELCB/MCB, fixtures, cables, junction boxes, terminal blocks, cable glands, 3 pin 5 A/15 A convenience socket outlets, conduits and accessories and supporting and anchoring materials, lighting fixtures with LED lamps/tubes, sodim vapour lamps, wires etc. All materials, fittings and appliances use in electrical installation shall conform to the relevant IS specifications, required area classification and environmental conditions and shall be anticorrosive painted/FRP enclosures.

The wiring for lighting circuits shall be done by wires run in PVC conduits for indoor areas. For outdoor lighting, wiring shall be done by armoured cables.

### Illumination Level

The following minimum levels of illumination (average lux level) shall be provided in the respective areas.

Sr. No.	Area/Building	Illumination Level
1	Pump House/Centrifuge or Press Area/Sheds/Blower Room	150 Lux
2	Control Room/Laboratory	300 Lux
3	Office	200 Lux
4	Switchgear/MCC Rooms	200 Lux
5	Sub Station (Switchyard)	50 Lux
6	Toilet Block/Wash Room etc.	100 Lux
7	Roads/Walkways	10 Lux
8	Yard/Outdoor Area	10 Lux
9	General Process/Outdoor Equipment Area	100 Lux

The lighting fixtures offered shall comply with the following requirements.

- Luminaries shall have high efficiency Lumen Output/Watts.
- Enclosures shall preferably be FRP/Cast Aluminium with corrosion resistance paints.
- All indoor and outdoor lighting fixtures shall be power saving long life LED type only.

All lighting fixtures shall be supplied complete with control gear and lamps. Special fixtures, wherever required to meet operational requirements, aesthetics etc. shall also be provided by the Bidder. Make of lighting fixture shall be embossed on each lighting fixture.

Lighting wiring for indoor applications between LDB to SB shall be done by FRLS PVC insulated, 3/4Core x 4/2.5 sq mm, 660/1100V grade, Copper conductor flexible wire (phase, neutral and earth).

Lighting wiring for indoor applications between SB to lighting fixtures shall be done by FRLS PVC insulated, 3/4Core x 1.5/2.5 sq mm, 660/1100V grade, Copper conductor flexible wire (phase, neutral and earth).

**Wiring in the Admin Building, Office, Control room, Laboratory Building shall run through concealed conduit only. While lighting wiring for all plant buildings/structures shall be surface conduit type.**

All lighting cables for outdoor application shall be armoured type only.

Conduit wiring shall be done in 25mm dia. minimum 16 gauge black enameled steel structure conduit or PVC concealed conduit with 1100V grade PVC insulated copper wire of minimum size 1.5/2.5 sqmm for fixtures/5A receptacles and 4sq mm for power sockets. Not more than 7 wires shall be accommodated in each conduit. All lighting fittings/convenience outlets shall be earthed through the third wire/separate core in conduit/cable.

On walkway, platforms and other outdoor areas, lighting fixtures shall be nearer to landing of stairs or ladders, gauges, flow meters, panel boards or other equipment requiring good illumination.

In outdoor equipment area at ground level, lighting fixtures shall be mounted preferably 4 meter above floor level. Where this is impractical, the minimum height of any lighting fixture shall not be less than 2.5meter. Socket outlets in process plant areas shall be approximately 1200mm above floor level and 300mm above floor level in office area.

Lighting/power panels shall be mounted such that the top of the panel ie 1800mm above finished grade. Control gears of lighting fixtures with separate control gear shall be mounted at suitable height from ground/platform for easy access/maintenance.

All lighting circuits and convenience receptacles shall be fed from lighting/power panels. Main/Lighting Distribution Board (MDB/LDB) shall be dust and vermin proof and shall be provided with SFUs (HRC)/MCCB as incomer and outgoing feeders where fault level is more than 9kA.

### **Main and Branch Distribution Boards**

Each main DB should be provided with 4 pole isolator as incomer and DP ELCB+MCB as outgoing circuit in each phase and all sub DBs should be with Isolator + ELCB as in comer and MCB as outgoing to control and for protection of lighting circuits.

All DBs should be double door type. Hinged door to cover the operations knobs shall be provided. MCBs shall not be loaded beyond 80% of rated capacity. Minimum of 20% MCB in each panel shall be kept as spare. Power and lighting panel shall be of 16 gauge sheet steel construction and shall be suitable for surface or flush mounting.

All outdoor lighting shall be automatically controlled by means of synchronous timers with manual override control. Normally about 8-10 fixtures shall be wired in each circuit. Lighting feeders requiring automatic control shall be provided with contactors of suitable rating.

Sufficient number of three pin type 5A/15A receptacles as per IS: 1293 shall be provided. Flush mounting type receptacle shall be used where concealed wiring has been adopted and surface type shall be used for other areas. For exhaust fans and wall mounted air circulators, socket and switch

enclosure shall be separate whereas for rest receptacle and controlling on/off switch shall be mounted in the same enclosure.

In building such as sub station, DG shed, workshop, maintenance shop etc. industrial type metal clad socket outlets and plugs shall be provided. The sockets shall be supplied complete with plugs.

Adequate number of ceiling fans of 1200mm sweep (with double ball bearing and regulator) shall be provided in offices and rooms allocated to operating and maintenance personnel etc. In places where ceiling fans are provided, lighting fixtures shall be suspended below fan level with the help of conduits/chains to avoid shadows on the floor.

Minimum 2 number or sufficient exhaust fans as required during detailed engineering/ recommended by equipment manufacturer shall be provided at battery room, laboratory room, sub station/switchgear-MCC room, DG room, all pump houses, filter house etc.

The exhaust fans shall be provided with louvers/net to prevent insects. For pump house below ground level, suitable GI ducts for exhaust shall be provided as decided during detailed engineering and instructed by Engineer-in-charge.

Lux levels shall be maintained at various locations as indicated above and shall be backed up by calculations from manufacturer.

### **Switch Box**

Switch Box shall be made of metal on all sides, except on the front.

In the case of cast boxes, wall thickness shall be at least 3mm and in case of welded mild steel sheet boxes the wall thickness shall not be less than 18 gauge for boxes, up to a size of 20cm x 30cm and above this MS boxes having minimum sheet thickness of 1.6mm shall be used. Switch boxes shall be galvanized after fabrication. Except where otherwise stated 3mm thick phenolic laminated sheets like summica shall be fixed on the front with brass screws. Clear depth of the box shall not be less than 60mm and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern. All fittings shall be flush pattern. It shall be provided with adequate number of knock outs on all sides for ease of wiring either with conduits or without conduits.

Modular type switch boxes are also acceptable.

### **Wiring/Conduit System**

#### **Surface Conduit Wiring System**

PVC conduits pipes of approved minimum 1.6mm wall thickness shall be used. The minimum PVC conduit diameter shall not be less than 25mm. Maximum number of wires permissible in a conduit shall be seven/nine for wire size of 2.5sq mm/1.5sq mm respectively.

In long distance straight run of conduit, inspection type junction box at reasonable intervals shall be provided.

#### **Fixing of Conduit**

Conduit pipes shall be fixed by heavy duty GI pressure saddle with screws in an approved manner at an interval of not more than one metre but on either side of the couplers bends, or similar fittings, saddles shall be fixed at a distance of 30cm from the centre of such fittings. The saddle should not be less than 20 gauge for conduits.

Where conduit pipes are to be laid along the trusses, steel joints etc. the same shall be secured by means of ordinary clips or girder lips as required by the Engineer-in-charge. Where it is not possible to drill holes in the truss members, suitable clamps with bolts and nuts shall be used. The width and the thickness of the ordinary clips or girders clips and clamps shall not be less than as stated below.

### **Recessed Conduit Wiring System**

Recessed PVC conduit wiring system shall comply with all the requirements of surface conduit wiring system specified in clauses above and in addition to the requirements specified in the following clauses.

The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired. In the case of buildings under construction, fixed work, special care shall be taken to fix the conduit and accessories in position along within the building work, to avoid damage to the finished wall etc.

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

The outlet box shall be same as above and shall be mounted flush with the wall. The metal box shall be efficiently earthed with conduit by an approved means of each attachment.

To facilitate drawings of wire in the conduit. GI mesh wire of 10 SWG shall be provided while laying of recessed conduit.

### **Lighting Poles**

#### **Steel Tubular Swaged Type**

Street light poles shall be steel tubular swaged type made from GI pipe conforming to IS: 1239 medium class and made as per IS: 2713.

Street light pole, steel tubular swaged type, 9/7.5/6 meter long (6/4.5/3.0m x 1.5m x 1.5m) 139.7mm, 114.3mm, 88.9mm dia. respectively and 4.85mm, 3.65mm, 3.25mm thick respectively, with MS base plate.

#### **Steel Octagonal Type**

Steel octagonal pole with base plate made from CR sheet steel. The pole should be made as per IS and shall be coated with hot dip galvanizing as per IS: 2629/4759 with required base plate and suitable to sustain local wind speed.

Lighting poles shall be of octagonal poles made from sheet steel conforming to BSEN 10025. Internal and external surface of octagonal pole shall be hot dip galvanized to minimum 65 micron DFT. Octagonal poles shall be provided with base plate and provision for fixing foundation bolts. Base plate shall be as per IS: 2062. All poles are tapered octagonal and shall be in single section.

The street light poles shall have minimum 6meter height, Top dia. – 70mm, Bottom dia. – 130mm and 3mm thickness sheet with bracket for mounting the light fittings and all required accessories. Base plate of minimum dimension 200mm x 200mm x 12mm.

The Flood light poles shall have minimum 9meter height, Top dia. – 70mm, Bottom dia. – 155mm and 3mm thickness sheet with bracket for mounting the light fittings and all required accessories. Base plate of minimum dimension 260mm x 260mm x 16mm.

All poles shall be supplied along with pipe cap, single/double arm of 1m/0.5m height and over hung 1m/1.5m long GI pipe having dia. to suit the socket of 250/150/70W etc. 240V, HPSV/LED/MH/HPMV lighting fixture as applicable and with following.

1. PVC junction boxes on pole with 8 way connector and 1 no. 4A SP MCB.
2. Street light pole shall be as per approved drawings.
3. Internal pole wiring with 3 core 1.5/2.5sq mm flexible stranded copper conductor, FRLS insulated wire from junction box to up to Street light/Flood light/fixture as required.

### **Balancing of Circuits**

The balancing of circuits in three phase installations shall be arranged before hand to the satisfaction of Engineer in charge.

### **Drawings**

All wiring diagrams shall indicate clearly in plan, the main switch board, the distribution fuse board, the run of various mains and sub mains and the position of all points with their classification.

### **Rating of Lamp, Fans, Socket Outlet Points and Exhaust Fans**

Lamps installed in pump house and other means shall be LED Type only.

Table fans and ceiling fans shall be rated at 60watts. Exhaust fans shall be rated according to their capacity.

5A socket outlet points and 15A socket outlet points shall be rated at 100watts and 1000watts respectively, unless the actual values of load are known or specified.

### **Capacity of Circuits**

Lights and fans may be wired on a common circuits, such circuit shall not have more than a total of ten points of light, fan and socket outlet or a load or 800watts whichever is less.

Power circuits on buildings shall be designed with a maximum of two outlets per circuit, based on the loading.

Where, not specified the load shall be taken as 1kW per outlet. Wherever the load to be fed is more than 1kW it shall be controlled by an isolator switch or miniature circuit breaker.

### **Indoor and Outdoor Light Fixtures/Lightings (LED LIGHTING)**

LED fixtures shall be generally having following.

- |                                      |   |
|--------------------------------------|---|
| • LED luminous Efficacy lumens/watt: | 100% minimum  |
| • Efficiency of Electronics System   | : 80% - 85% minimum   |
| • LED Lamp/Light Efficiency          | : 85% - 90% minimum   |
| • Total Harmonic Distortion          | : For Outdoor Fittings: $\leq 20\%$<br>For Indoor Fittings: $\leq 20\%$ |
| • Power Factor                       | : $\geq 0.85$   |
| • Colour Rendering Index (CRI)       | : $\geq 70$   |
| • Colour Temperature/Apparent        | : $\geq 5700K$ (Cool day light)   |
| • Radiation                          | : No Ultra-Violet (UV) or Infra-Red                                     |

(IR) No RF to interfere with radio equipment

- LED Life : Long Life, generally 50,000 Hrs.
- RoHS compliant, Eco Friendly green technology, Mercury free.
- Outdoor LED fixtures must be fully enclosed with minimum IP Rating of IP 66/65 (Weatherproof). LED optical system must be gasketed (enclosed) to minimize light dirt depreciation.
- Electrical safety for outdoor LED Lights shall be of Class I.
- Luminaries must be clearly marked with manufacturer name, model number, electrical rating and agency approval (If applicable - CSA, UL etc.).

### **Industrial Luminaire**

Indoor LED wall mounting Industrial Luminaire shall be LED type minimum 10watt to 48watt.

Each fitting shall be required LM 79 and LM 80 Certificates.

Tube light shall be 20watt or higher wattage with integral/non integral driver, surge 4kV, IP 20, 4 feet with LEDs of wattage 0.2watt to 0.5watt assembled on single MCPCB with housing used as a heat sink shall be made of thick sheet steel conforming to IS: 513/CRCA polyester powder coated and high UV and corrosion resistance with diffuser and/or Polycarbonate optics with company mark/name.

120 to 300V, Power Factor more than 0.9, THD < 20%

CCT 4000 K to 6500K, Uniformity Ratio > 0.7,

Luminaire Efficacy > 85 lumens/watt ,

LED Driver Efficiency > 85 %

Fixtures shall be with earthing arrangement facility suitable for ceiling or pendant mounting suitable for 19 mm conduit with stove enameled reflector gray outside and white inside which can be installed without aid of any tools, complete in all respects and ready for use.

### **Emergency Light**

Emergency light unit working on 230V AC supply shall be self containing LED type of minimum with 20watts 600mm long type 'SWITCH ON MAIN FAILURE. It shall be electronic automatic type which incorporates a unit trickle charge circuit, which shall prevent over charging or battery The battery shall be maintenance free. The unit shall provide 4 hours illumination following power failure. The units shall generally conform to IS: 9583.

### **Gate Lights**

The gate lights shall be post top lantern LED type, weather proof and shall be suitable for use with one number 40watt LED and aesthetics appearance shall be as approved by Client/PMC/TPI.

Post Top Lantern LED fitting comprises of Copper dust finish cast aluminum spigot and spun aluminum canopy fixed with opal polycarbonate, pipe arrangement for vertical mounting, open construction driver and accessories wired upto terminal block.

The post top lantern shall be suitable for use with one number 40watt LED.



GI pipes of suitable dia. shall be provided at gate concrete pillar as conduit for wiring and fixing post top lantern luminaire.

## **Outdoor Yard/Road Lighting**

### **Outdoor Luminaire**

The luminaire shall be LED type with minimum 40watt to 240watt LED complete with all accessories and each street light/flood light industrial luminaire shall be IP 65 and Surge 4kV and shall be required LM 79 and LM 80 certificates.

LED outdoor street light/flood light/well glass industrial luminaire shall be with high power white LEDs wattage of 1watt and above assembled on single MCPCB, efficiency more than 130 lm/w and corrosion free high pressure die cast aluminum housing with smooth finish powder coated and heat sink extruded aluminium with diffuser and Polycarbonate optics/lenses with company mark/name engraved or embossed.

120 to 300V,  
Power Factor more than 0.95,  
THD < 20%,  
CCT 5000 K to 5700 K,  
Uniformity Ratio > 0.45,  
Luminaire Efficacy > 85 lumens/watt,  
LED Driver Efficiency > 85 %.

The required parameters of LED fixtures have been enumerated above.

### **❖ EARTHING SYSTEM**

Earthing system design and installation shall generally be as per IS: 3043. All metallic non current carrying parts of electrical apparatus, current and potential transformer secondaries, columns, vessels, towers, stacks, storage tanks etc. shall be earthed at least by two distinct separate earth conductors from the earth plate connected to main earthing loop.

The main grid conductor shall be hot dip galvanized MS flat. The amount of galvanizing shall be minimum 610 gm per sqm. The main earth loop shall be laid at a depth of 500mm below grade level.

Earthing conductor shall be laid around the battery limit of the plant. Horizontal conductors shall be laid in both longitudinal and transverse direction to facilitate earthing of various equipment in most economical and reliable manner.

Cable trays in process areas shall be earthed with the help of risers emerging from main earthing conductors laid below/adjacent to structures carrying cable trays. Trays shall be earthed at an interval of approximately 30meter and in any case shall be connected to the earthing grid at minimum two points.

Joints and tappings in the main loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and suitably protected by giving two coats of bitumen and covered with hessian tape.

Adequate number of minimum 65mm dia. or higher size as per IS: 3043, 3meter long GI pipe earth electrodes with earth pit shall be provided. All earth electrodes shall preferably be driven to a sufficient depth to reach permanently moist soil.

Multiple earth connection shall be taken from suitably located earth plates connected to earth loop. All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections of equipment. Unless otherwise specified, earthing connections to individual equipment shall be done in accordance with standard equipment earthing schedule.

Lightening protection shall be provided for equipment, structures and buildings as per IS/IEC 62305. Self conducting structures may not be provided with aerial rod and down conductors but shall be connected to the earthing grid at minimum two points of the base. An independent earthing network shall be provided for lightening protection and this shall be bonded with the main earthing network minimum at two points at the buried electrodes.

The resistance value of an earthing system to the general mass of earth for the electrical system and equipment shall be as follows.

- a) For the electrical system and equipment a value that ensure the operation of the protective device in the electrical circuit but not in excess of 5ohms. However, for generating stations and sub stations this value shall not be more than 1ohm.
- b) For lightening protection, the value of 5ohms as earth resistance shall be desirable, but in no case it shall be more than 10ohms.

## **Connection**

The earth system connection shall generally cover the following.

- Equipment earthing for personnel safety
- System neutral earthing
- Static and lightning protection
- System neutral
- Current and potential transformer secondary neutral
- Metallic non current carrying parts of all electrical apparatus such as transformers, switchboards, bus ducts, motors, neutral earthing resistors, capacitors, UPS, battery charger panels, welding receptacles, power sockets, lighting/power panels, control stations, lighting fixtures etc.
- Steel structures/columns etc.
- Cable trays and racks, lighting mast and poles
- Storage tanks, vessels, and all other process equipment
- Fence and Gate for electrical apparatus (e.g. transformer, yard etc.)
- Cable shields and armour
- Shield wire

All main earthing shall be used for earthing of equipment to protect against static electricity.

All LV, medium and high voltage (HV) equipment (above 250V) shall be earthed by two separate and distinct connections with earth.

Plant instrument system clean earthing, UPS system clean/safety earth shall be separate from the electrical earthing system.

All earthing connections for equipment earthing shall preferably from the earth plate mounted above ground wherever provided. Equipment foundation bolts shall not be used for earthing.

Earth connections shall be made through compression type cable lugs/by welded lugs.

All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections and all connections adequately locked against loosening.

Lighting fixtures and receptacles shall be earthed through the extra core provided in the lighting circuit/cable for this purpose.

The reinforcements of sub station building and sub-station floor shall be connected to main earth grid.

The earth electrodes shall be situated at a distance not less than 3meter from the building fencing structure and equipment foundations. The surrounding the electrodes, soil shall be treated up with salt, coke and charcoal. The distance between two electrodes shall not be less than twice the depth of electrode.

Minimum requirement of earth pits as per IE rules are as under.

- Two numbers independent for transformer body.
- Two numbers independent for transformer neutral.
- Two numbers independent for two/four pole structure.
- One number for lightning arrestors.
- Two numbers for LV panel at sub station and at pump house.

The main earth electrodes after being driven into the ground shall be protected at the top by constructing concrete or block masonry chamber or pre-cast chambers of size 300mm x 300mm x height 300mm with CI cover. The resistance of any point in the earth continuity system of the installation to the main earth electrode shall preferably not exceed 1ohm. The remaining space in the bore hole shall be filled with bentonite. The bentonite will hold the earth rod in position. The neutral conductor shall be insulated throughout and shall not be connected at any point to the consumers earthing system.

It shall not be allowed to use the armour of the incoming feeders cable to the sub-distribution board as the only earthing system.

Sheathed lugs of ample capacities and size shall be used for all underground conductors for sizes above 3 mm<sup>2</sup> whenever they are to be fitted on equipment of flat copper conductor.

The lugs shall be fitted on equipment body to be grounded or flat copper only after the portion on which it is to be fixed is scrubbed, cleaned or paint or any oily substance on a subsequently tinned.

No strands shall be allowed to be cut in case of stranded ground round conductors. GI embedded conduits shall be made electrically continuous by means of good continuity fixing and also rounding copper wires and approved copper clamps.

### **Earthing of Lighting Poles**

All external poles are to be looped together with continuous 8 SWG GI earth wire clamped a dollies provided on every fuse box of poles and looped onwards to the other pole. Every fifth pole shall be connected to earth through an earth electrode.

### **Recommended Size of Earthing Conductors**

Below mentioned are the recommended minimum sizes of earth conductors. However, Earthing strips/conductors, if required of higher size as per Ground Fault Calculations, should be laid as per SOQ or as per site requirement.

Type of Equipment	Earth Conductor (See Note)
Motors upto 3.7kW	8 SWG solid GI wire
Motors from 5.5kW to 30kW and welding receptacles	10mm dia GI wire rope
Motors above 37 kW	16mm dia GI wire rope OR 40mm x 5mm GI strip
Building columns, fencing	40mm x 5mm GI strip
Storage Tanks (Vertical/Horizontal)/Vessels	40mm x 5mm GI strip
Small equipment and instrument	8 SWG GI solid wire
Lighting, Power and Instrument Panels	10mm dia GI wire rope
Main Earth Bus/LV and HV Switchgear Interconnections	75mm x 8mm GI strip
Power Transformer/HV Sub stations	50mm x 6mm Cu for Neutral 75mm x 8mm GI strip for rest
Push Button Stations (LCS)	8 SWG GI solid wire
Street Light Poles	8 SWG GI solid wire
Lighting Transformer	16mm dia. GI rope
Pipe Rack	40mm x 5mm GI strip
Bonding of pipe	25sq mm insulated flexible Cu cable

**Notes:**

- 1) Earth connection to individual equipment from nearest earth plate/grid may also be done alternately using aluminium/copper conductor PVC insulated core of size not less than half the cross section of the respective power cable to equipment (motor, panel etc.). Connections shall be made using crimp type lugs.
- 2) Number of runs of Cu/GI earthing strips shall be as per ground fault calculations.
- 3) The size of strip mentioned may be changed as per availability meeting the minimum area requirement of specified size of strip/conductor.

**Maintenance Free Safe (Chemical Type) Earthing System**

Chemical type earthing electrode shall be used for equipment body earthing. It shall be made with steel core and a copper exterior to provide increased conductivity and corrosion resistance. The electrodes shall be minimum 3meter length, 17mm diameter with 99.9% pure electrolyte copper coating of minimum 250 microns and ANSI/UL 467 approved. Adherence of copper to steel rod is achieved through a pioneered bright acid copper plating process using 14 stations using proper current densities, temperature and brightener additives to achieve copper plating with finer grain structure and a smoother, harder and more uniform surface. It shall have minimum tensile strength of 80,000 PSI and straightness tolerance 0.01" per linear foot and shall meet the requirement of ANSI/UL 467, CSA and ANSI/ NEMA. UL logo and control number where applicable shall be stamped on each rod for easy inspection after installation. The rod shall be tested according to IEC 62561-2 and comply to the requirements of IEC 60364-5-54. The rods also should withstand short circuit currents. All fasteners used should confirm to the requirements of the above standards.

Back filling compound used shall have resistivity less than 20ohm-cm in its set form. Earth resistance shall be remained same over a wide temperature variation of -60 °C to + 60 °C. It shall be suitable to absorb and retain moisture for long time and shall reduce soil resistivity, Dissipate fault current very fast, Eliminate needs of salt and chemical around electrode and maintain compatibility of soil and rod contact. Earth enhancing compound (Soil conductivity improver) used should be tested according to IEC 62561 – 7 from an NABL accredited laboratory. Exothermic welding material used shall be tested as per IEEE 837

**Construction Procedure of Chemical Type Earth Pit**

A hole of 100 to 125mm dia. shall be augured/dug to a depth of about more than 3meters or as per instruction of Engineer-in-charge.

Earth electrode of minimum 3meter length shall be placed into this hole.

It will be penetrated into the soil by gently driving on the top of the rod. Here natural soil is assumed to be available at the bottom of the electrode so that min 150mm of the electrode shall be inserted in the natural soil.

Earth Enhancing material (minimum 20 kg) shall be filled in to the augured/dug hole in slurry form and allowed to set. After the material gets set, the diameter of the composite structure (earth electrode + Earth Enhancing material) shall be of minimum 100mm dia. covering entire length of the hole.

Remaining portion of the hole is filled with backfill soil which is taken out during auguring/ digging.

Construction of masonry earth chamber and cast iron cover with earth resistance result with date or as per instruction of Engineer-in-charge.

For interconnection to the main earthing grid, 40mm X 5mm thick copper clamp shall be provided.

#### **A) PIPE-IN-PIPE Technology Safe earthing**

Two pipes of coaxial diameters joined together for enhancing the service life and performance of the overall earthing system.

The cavity in between the electrodes shall be filled with crystalline conductive compounds for current dissipation and anti corrosive properties.

The electrode cross section shall be circular for the uniform distribution of fault current all around from electrode to earth.

Inner pipe of length 3meter shall be hot dip galvanized/zinc coated with minimum galvanizing thickness 80 - 100 micron or Copper plated (minimum 250mm) as per Drawing/SOQ. Minimum size of pipe as per Drawing/BOQ.

Outer pipe of length 3meter shall be hot dip galvanized/zinc coated (minimum 150 micron) or Copper plated (minimum 250mm) as per Drawing/SOQ. Minimum Size of pipe as per Drawing/SOQ.

A hole of 200mm - 225mm dia. shall be augured/dug to a depth of about more than 3meters or as per instruction of Engineer-in-charge.

Earth enhancing compound of minimum 50kg shall be filled. **Earth enhancing compound shall be filled till top of Earthing Pipe electrode.**

#### **B) Plate Type Earthing Stations**

The earthing station shall be as per drawing/IS: 3043. The equipment neutral earthing shall be with Copper plate earthing station.

The plate electrode shall be 600mm x 600mm x 3.15mm Copper plate for neutral earthing.

The earthing conductors shall be of Copper strip in plate type earthing.

GI pipe with funnel of good quality shall be used for watering the earthing electrodes/stations.

The brick masonry or pre case CC chamber with cover/chequered plate shall be provided for housing the above referred funnel and pipe.

#### **Earthing Unit Measurement**

Earthing station/pit complete with excavation, electrode, watering pipe, soil treatment, masonry chamber with cast iron cover etc. as per tender specifications/drawings shall be treated as one unit.

Different sizes of strips/wires per unit length covering/including cost of interconnection the earthing station to earthing grid, and to respective equipment with fixing accessories like earthing clamps, saddle, labour etc. shall be traded as unit length.

The earth system connection shall generally cover the following.

1. Equipment earthing for personnel safety
2. Transformer, DG and System neutral earthing
3. Static and lightning protection
4. Current and potential transformer secondary neutral
5. Metallic non current carrying parts of all electrical apparatus such as transformers, switchboards, bus ducts, motors, neutral earthing resistors, capacitors, UPS, battery charger panels, welding receptacles, power sockets, lighting/power panels, control stations, lighting fixtures ceiling fan and exhaust fan, street light, flood light pole circuit/cable.
6. Fence and Gate for electrical apparatus (e.g. transformer, yard etc.)
7. Cable shields armour and shield wire.

The scope of work shall also cover supply, laying, installation, connecting, testing and commissioning of following.

Plate (600mm x 600mm x 3.15mm Copper plate) type/Pipe type (Chemical type) earthing station with Copper bonded earth electrode/Copper plate of size as per tender/IS.

Earthing Copper strips from Plate earthing station and hot dipped GI strip for pipe earth to equipotential bar/earth grid.

Earthing GI/Copper strips/wires from earth grid/equipotential bar to power panels, DBs, motors, indoor/outdoor lighting systems etc.

Bonding of non current carrying parts and metallic parts of the electrical installation.

Quantity of pits mentioned are minimum or higher as per soil resistivity. Measurement of soil resistivity to be carried out by contractor at no extra cost.

All the earthing material and installation and construction of earth pit, chamber etc. shall be as per IS: 3043 and tender.

Galvanising thickness shall be 86 micron and 610 g/m<sup>2</sup> as a minimum.

### ❖ SAFETY EQUIPMENT

The contractor shall provide safety equipment and accessories for HV panels, DG panels, LV control panels etc. as per statutory requirement.

Generally following shall be provided as a minimum (forming part of scope of this work).

- Supply and spreading synthetic rubber mat, 1meter wide, 2mm thick, conforming to IS: 15652 Class A for 1.1kV LV voltage in front of LV PMCC/MCC/LVDB/APFC etc.
- Supply and spreading 1meter wide 2.5mm thick synthetic insulating mat as per IS: 15652 Class B suitable for operation of 11kV equipment in front of all HV panels for their entire length. The insulating mat should have ISI mark on every one meter.
- Pairs of electrically tested 22kV rubber gloves. These are to be kept in a suitable wooden box.
- A shock treatment instruction chart in English and local language duly framed as detailed in IS: 1355. Details of the nearest medical facility available with phone number shall also be kept.
- First aid box containing first aid kit for treatment of electrical burns in the main switch room.
- ABC powder type 'Ceasefire' portable type Fire Extinguishers as per IS: 13849 of minimum 4.5 Kg capacity with necessary clamps for erection on wall for individual substation, HV and LV panel/control rooms as required and as per fire safety guidelines and norms.

- Danger/Caution notices in English shall be fixed permanently on the equipment, LV, HV panel room, switch yard etc to comply the requirement of IE rules.
- Safety posters for vigilance against electrical accidents as detailed in IS: 1255.
- Fire buckets with MS angle stand and with 4 number round bottom fire buckets marked fire shall be provided in the LV panel room, HV sub station and at transformer yard. Stand shall be with canopy. Stand shall be grouted in RCC.
- 3meter and 6meter long folding Aluminium ladders for safe maintenance of lighting system etc.
- SLD and earthing layout of suitable size duly framed/laminated shall be fixed on the wall near the entrance.
- Any other as per statutory norms / requirement shall also be provided.

### **(C) INSPECTION AND TESTING**

**Inspection of offered equipment/items at manufacturers' works' shall be done by the Client/PMC/TPI as specified here in as per relevant inspection and testing standards and as per approved, quality assurance plans, technical data sheets, SLD, documents and drawings.**

#### **Inspection Criteria of Various Major Equipment/Items at Manufacturers' Works:**

Major electrical equipment/items as specified below, shall be tested and inspected at vendor manufacturers' works as narrated, prior to dispatch to ensure compliance with the specifications, requirements and applicable codes and standards and approved quality assurance and testing plans by the Client/PMC/TPI.

#### ○ **HV Panels/RMU**

100% quantity of HV breaker panels and RMU, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

100% quantity of **HV FCMA/HFSR/VFD starter panels**, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

#### ○ **LV Panels**

100% quantity of LV panels irrespective of **Amperes Ratings** tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

#### ○ **VFD Stand Alone and MCC Panels with VFD**

100% quantity of VFD stand alone panels and all LV panels with VFD starters irrespective of **Amperes Ratings**, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

#### ○ **APFC Panels**

100% quantity of APFC panels for **KVAr Ratings  $\geq$  100 KVAr**, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

#### ○ **Transformers**

100% quantity of transformers for **kVA Ratings  $\geq$  500 KVAr**, routine tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

#### ○ **DG Sets**

1 No. of each for kVA Ratings  $\geq 500$  kVA, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

- **HV Cable**

For all types, ratings and sizes of HV cables, if the quantity of each size, type and where length of cable is  $\geq 250$  meters, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

- **LV Cables**

For all types, ratings and sizes of LV cables, if the quantity of each type and size  $\leq 120$  sq. mm and where length of cable is  $\geq 1000$  meters, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

Similarly For all types, ratings and sizes of LV cables, if the quantity of each type and sizes  $> 120$  sq. mm and where length of cable is  $\geq 500$  meters, tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

- **HV Motors**

**100%** quantity of motors of each type and rating of entire lot, routine tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI. Type test of one motor of each type and rating out of entire lot, shall also be witnessed @ Manufacturers' works by the Client/PMC/TPI.

- **LV Motors**

**Motors  $\leq 45$  kW:** Routine tests carried out internally and type test certificate of identically rated motor  $\leq 45$  kW shall be submitted for review and acceptance by the Client/PMC/TPI.

**Motors  $> 45$  kW to  $< 160$  kW:** For motor ratings  $> 45$  kW, **one motor** of each type and rating out of the lot shall be sent to pump manufacturer for performance testing of pump-motor assembly set, while all other motors in the lot shall be subjected to internal routine tests. Routine test certificates and type test certificate of identically rated motor shall be submitted for review and acceptance @ the time of pump-motor assembly performance test.

**OR**

Out of all motors rated  $> 45$  kW to  $< 160$  kW, **25% quantity of motors of each type and rating or one number (whichever is higher)** out of entire lot, routine tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI and routine tests of all other motors carried out internally and type test certificate of identically rated motor shall be submitted for review and acceptance.

**Motors  $\geq 160$  kW:** For motors rating  $\geq 160$  kW, **25% quantity of motors of each type and rating or one number (whichever is higher)** out of entire lot, routine tests shall be witnessed @ Manufacturers' works by the Client/PMC/TPI. **Type test of one motor of each rating** out of entire lot, shall also be witnessed @ Manufacturers' works by the Client/PMC/TPI. Routine tests of all other motors carried out internally shall be submitted for review and acceptance.

- For all major equipment/items specified above, where factory inspections are exempted as clearly specified above, all tests as per relevant and applicable standards as well as approved QAPs, data sheets, SLD, documents and drawings must be carried out by the manufacturers'/vendors/panel builders etc. and test certificates, As built drawings and BOM, MTCs etc. shall be submitted to the PMC/TPI prior to dispatch for getting dispatch clearance of the Client/PMC/TPI.



- All other items shall be cleared for dispatch based on review of material test certificates/manufacturers' test reports' by the Client/PMC/TPI.

All expenditure pertaining to inspection including to and fro travel, local conveyance, lodging and boarding etc. shall be borne by the Contractor for minimum 2 representatives of Client/PMC/TPI Agency.

The Client or his authorized representative may visit the works during manufacture of various electrical equipment/materials to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given full assistance to carry out stage inspection. Client's representative shall be given minimum two weeks advance notice for witnessing the final testing.

Field tests as per approved procedures/procedures available with Engineer-in-charge or his authorized representative shall be performed on the electrical system/equipment before it is being put into service. All test equipment shall be arranged by the Vendor/Contractor. Test reports shall be approved by the Engineer-in-charge before acceptance of the equipment and complete plant.

#### **(D) ELECTRICAL INSTALLATION**

This specification covers the technical requirements for equipment, materials and installation methods, testing and commissioning of electrical system.

The contractor shall possess a valid electrical contractor's license for the state in which site is located and shall ensure its validity during the duration of the contract.

The contractor shall employ adequate skilled and unskilled labour to complete all work according to programme of work. Skilled workers shall possess the minimum qualifications stipulated by statutory or competent authorities.

The contractor shall employ adequate numbers of supervisor to control the labour force and to carry out the work as per schedule. Supervisory staff shall also possess the minimum qualifications stipulated by statutory and competent authorities.

Various types of equipment shall be installed in accordance with approved drawings and/or manufacturers' instructions and good engineering practices. Particular attention shall be paid to lubrication of moving parts and bearings, alignment, tightness of all connections (mechanical and electrical) and wiring.

The transformers and DG sets shall be moved to its location and shall be correctly positioned on their bases.

All parts of the transformers, which are supplied loose, such as conservator, radiator banks, buchholz relays, dial thermometers, bushings, etc. shall be fitted onto the transformers.

Transformer oil if supplied in drums shall be filled into the transformer after duly testing/filtering, up to the correct level required. The transformer may have to be dried out and oil filtered.

The contractor shall place the switchgear correctly on the base of foundation prepared for the same. If the switchgear consists of a switchboard with number of panels bolted together, he will place all the sections of the switchboard correctly, align them and bolt the sections together to form one continuous switchboard. The switchgear shall then be secured to the foundation by means of nuts and bolts or foundation bolts grouted in the base. The contractor shall also make inter section bus/wiring connections.

In case of wall/structure mounted equipment, boards, the contractor shall fabricate and install the structural steel frame work suitable for mounting the various equipment boards. The contractor may have to prepare drawing showing the proposed general arrangement, of the structural frame which shall be subject to the approval of the Engineer-in-charge. The fabrication and installation of the framework shall be recommended only after the approval of drawings. Various items of the equipment, board shall be mounted in accordance with the approved drawings.

Motor shall generally be installed by others, along with the driven equipment. The contractor may, however, be asked to install motors in specific instances.

Cable routes and mode of installation shall generally be as shown in the construction drawings.

Identification tags indicating cable designation, shall be affixed to each cable at ends and at an interval not exceeding 15 meters or at the location where cables change direction or elevation. Signboards with necessary indication/arrow mark with necessary structure/foundation shall be also be installed, of adequate size as approved by Engineer-in-charge, for the entire cabling system buried underground.

**HV XLPE/PVC** armoured cables shall be terminated or jointed by means of cold setting epoxy based cast resin jointing system or heat shrinkable or push on type cold setting kit.

All cable glands should be of nickel plated brass, double compression type. All Alu/Cu cables shall be terminated through crimping type Alu/Cu lugs respectively.

All electrical equipment viz. transformers, switchgear, motor control centers, motors, control stations, switches, lighting, fittings and other electrical apparatus shall be connected to the main earth loop by means of two separate and distinct external earth conductors. The material, type and size of earth conductors will be as shown in the drawings or as specified.

Electrical installation in hazardous areas if applicable as defined in IS: 5571 shall be carried out with utmost care and special precautions shall be taken to ensure operational safety.

All personnel, especially supervisory staff, working on such installations shall be fully conversant with the applicable National Standards and Code of Practice and shall have previous experience of such work.

The contractor shall take all reasonable safety precautions during construction and testing of the works. Particular attention shall be paid to the following:

- a) To prevent any conductor or apparatus becoming accidentally or inadvertently charged.
- b) Prior to electrical installation (or part thereof) being connected to the main supply, the Contractor shall ensure that uncommissioned or incomplete circuits cannot be inadvertently energized and completed circuit cannot be used without the Engineer's consent.
- c) No hot work is carried out without work-permit issued by the Engineer in FLP zones (if stipulated by process application).

The tests specified below/elsewhere as part of this tender document shall be carried out on the electrical equipment and installation before commissioning the same. The tests shall be performed by or under the direct supervision of a competent person, qualified to carry out the tests. All tests shall be carried out in the presence of the authorized representative of the Employer/Owner and/or the Engineer, unless this stipulation is waived in writing.

## **PAINTING**

All surfaces of equipment/structural steel shall be sand blasted, degreased and pickled in acid as required to provide a smooth & clean surface, free of rust/scale/grease.

After cleaning the surface shall be given one coat of high quality red oxide or yellow chromate and baking in the oven (for equipment only).

All surfaces shall be then finished with 2 (two) coats of finished epoxy based paint of shade 631 of IS: 5 or with a paint shade of Client's choice unless otherwise specified.

## ❖ DETAILS OF TESTS

### **I POWER and DISTRIBUTION TRANSFORMERS**

- i) Check HV and LV cable terminations, ground connections, fittings and accessories, oil level and oil leaks at various joints. Check breather, thermometers and buchholz relay for proper functioning and operation. Check junction box, marshalling box etc. for correct wiring.

- ii) Oil Test

Crackle test and dielectric test as per Clause 7.11 of IS: 10028. The oil shall withstand at least 40kV with a gap of 4mm.

- iii) Insulation Resistance Test

This may be carried out on new transformer without drying out the transformer, provided the transformer has not been idle or stored for a long period. Otherwise, this test shall be carried out during drying out of transformers. Insulating resistance test shall be carried out between primary & secondary to ground as well as between primary and secondary. Windings not under test shall be grounded during the test.

A megger rated 1000V or higher shall be used for the test.

- iv) Polarity and Phasing Out Test

Check external connection of the transformer in accordance with diagram of connection and phase sequence (anti-clockwise)

### **II HV AND MV SWITCH GEAR**

- i) Check proper mechanical operation of circuit breakers including alignment of trolleys in case of draw out type circuits breakers, smooth operation of all mechanical parts, lubrication, mechanical interlocks etc.

- ii) Check contact alignment and wipe, proper sequence of closing and opening of main and arcing contacts.

- iii) Check electrical relays, instruments and controls for correct wiring.

- iv) Insulating test on bus bars – phase to phase and phase to ground. This test will be carried out with circuit breakers in service position, but contacts remaining open.

- v) Insulation test on relays & control wiring including current and potential transformers and wiring of CT and PT secondaries.

- vi) Insulation test on circuit breakers in withdrawn position – phase to phase and phase to ground with contacts closed.
- vii) Adjust correct settings of relays and/or direct acting trips - as specified.
- viii) Operation test  
  
Energise only control circuits and carry out closing and tripping operations (where AC supply derived from main supply is used for operation, the switch-gear bus may be energised). Check operations of electrical interlocks. Check tripping of circuit breakers by manual operations of protective relays contacts. Check operations of mechanical closing and tripping devices. Check lockout conditions for closing of circuit breakers by simulating the required conditions. Check control, indications, sequence interlocks and alarms.
- ix) Polarity and connections of instrument transformers – Check for correctness of CT and PT connections provided. Check electrical continuity of secondary with ELV tester.
- x) Check operation of instruments, meters, relays and tripping of circuit breakers by primary/secondary injections as specified.
- xi) Check continuity of power circuits and earth continuity of all non current metallic parts with a low voltage a (6 volts or less) continuity tester.

### **III MOTOR CONTROL CENTRES, SWITCHGEARS**

- i) Check equipment, internal wiring, smooth mechanical operation, interlocks etc.
- ii) Check continuity of power circuits and earth continuity of all non current carrying metallic parts with a low voltage continuity tester.
- iii) Insulation test for power and control circuits between phases, between phases and neutral and between phase/neutral and ground.
- iv) Check operation by energizing control circuits (without energizing power circuits) for correct functioning. Simulate external controls and interlocks for the same. Note chatter or humming of contactor and rectify, in necessary.
- v) Check fuse ratings and adjust relay setting (overhead, single phasing preventers etc) in accordance with load ratings.
- vi) Polarity and connections of instrument transformers – Check for correctness of CT and PT connections provided. Check electrical continuity of secondary circuits with ELV tester.

### **IV MOTORS AND ROTATING EQUIPMENT**

- i) Check equipment for free movement of rotor, and play, lubrication and for any other visual checks.
- ii) Insulation test of motors – between winding and ground. Use 500V megger for MV motors and 1000V megger for HV motors.
- iii) Check electrical continuity with ELV tester.
- iv) No load running of motor noting down no load current and voltages in all three phases.

## **V CABLES**

- i) Insulation Test between each phase and neutral and between each phase/neutral and ground.
- ii) DC high voltage test on HV cables in accordance with the relevant Indian Standards and Code of Practice. This test shall be carried out on cables installed in final positions, and all joints and terminations have been made. The cables, however, may not be connected to the equipment, so that the equipment may not be subject to the test voltage.
- iii) In case of lighting wiring, insulating test shall be carried out on lighting feeders with branch circuits open. Branch circuits shall be tested separately with lamp holders, plug receptacles and lighting fittings in position, but without lamps. In case of lighting circuits will lamp ballasts and glow starters, insulation resistance may be measured between phase and ground only.
- iv) In case of directly buried cables, insulate resistance of cables shall be measured before and after the back fillings.
- v) Test all receptacles for correct phase sequence.

## **VI EARTHING SYSTEM**

- i) Measure earth resistance of each electrode separately. If a number of earth electrodes are interconnected with one another, combined earth resistance shall also be measured. The earth resistance of each electrode and/or a group of electrodes shall not exceed the values specified.
- ii) Carry out line earth loop impedance test. The loop comprises the line conductor from the point of fault, back to the supply transformer, the path through transformer winding, the earthed neutral point of the transformer and path for that point to the point of fault through the earthing system.
- iii) Continuity test for earth continuity conductors with ELV tester.

## **STATUTORY APPROVAL**

The Contractor shall be totally responsible for obtaining statutory approval from the electrical inspector or any other statutory authority for the entire installation including DG Set carried out by him unless otherwise specified and agreed. Necessary test reports shall be submitted by him to electrical inspector. This will be an integral part of the contract and shall not be paid for separately. **The contractor shall liaison with local electric supply company for getting power supply and only necessary fees, if any, payable to supply company shall be borne by the Owner.**

## **ACCEPTANCE OF INSTALLATION**

On completion of the work the Engineer-in-charge, together with the Contractor, will carry out an inspection of the Installation. The Engineer-in-charge will issue a completed copy of the Client's Acceptance of Electrical Installation to the Contractor as confirmation that the works have been accepted, subject to any matters noted on the form being attended to.

## **PRICE BREAKDOWN**

- 1.1 Whenever requested by the Engineer-in-charge, the contractor shall furnish detailed price breakdown for supply and installation of each of the items of electrical works including for each type/size of applicable cable/light fitting/earth pit/earth stations.
- 1.2 This breakdown prices are required for the purpose of justification for progress payment and also for working out addition and deletion, if any, in the scope of work at a later date.

**(E) TECHNICAL DATA SHEETS (TO BE SUBMITTED AT THE TIME OF DRAWINGS APPROVAL)**

Data sheets duly filled and certified by the Bidder/Vendor for various major equipment are to be submitted by the Bidder/Vendor along with all other required documents/drawings etc. as narrated above are to be submitted for approval by the Client/PMC/TPI prior to execution.

**DATA SHEET FOR LOW VOLTAGE PANEL BOARD**

<b>Sr. No.</b>	<b>Particular</b>	<b>Details</b>	<b>Confirm/Data to fill by the vendor &amp; be submitted at the time of Drawings</b>
<b>1.0</b>	<b>Site Conditions</b>		
1.1	Type/Make	Indoor/As per tender	
1.2	Mounting	Floor	
1.3	Design Ambient Temperature	50 °C	
1.4	Atmosphere	Corrosive, Humid and Dusty	
<b>2.0</b>	<b>Construction</b>		
2.1	Housing	2.0 mm thick CRCA sheet for Body, Partition, Cover/Door	
2.2	Protection Class	IP 5X	
2.4	Base Channel	100mm x 50mm x 5mm	
2.5	Shipping Section Length	2500mm (Max)	
2.6	Side Sheets for Shipping Section	Full side sheet on both side of shipping section	
<b>3.0</b>	<b>Operating Conditions</b>		
3.1	Voltage	415V $\pm$ 10%	
3.2	Number of phase	3	
3.3	System	3 Phase, 4 wire	
3.4	Frequency	50Hz $\pm$ 5%	
3.5	Fault Current	50kA as per SLD	
3.6	Neutral Grounding	Solid	
<b>4.0</b>	<b>Control System</b>		
4.1	Voltage		
	For Indication	230V AC	
	For Metering	230V AC	
	For Protection	230V AC	
4.2	Control Supply Through Constant Voltage Transformer	230VAC for PMCC and APFC only	

4.3	Wiring	Control Wiring: 1.0 mm <sup>2</sup> FRLS PVC Cu flexible Wire (Grey); CT wiring 2.5 mm <sup>2</sup> Color Coded	
<b>5.0</b>	<b>Bus Bar</b>		
5.1	Phase Bus Bar Material	EC Grade Aluminium	
5.2	Neutral Bus Bar Material	Same as Phase Bus Bar	
5.3	Earth Bus Bar Material	65mm x 10mm (Hot Dip Galvanised Strip) Or 40mm x 10mm (EC Grade Al)	
5.4	Current Density	1 sq. mm = 0.8 A Maximum. Size of Bus Bar based on Design Temperature, kA Level and Minimum Current Density	
5.5	Hard Ware	High Tensile Steel Bolts, Nuts and Washers duly Zinc/Cd Passivated shall be used for all Bus Bar Joints and Supports.	
6.0	PLC Based System	As per SLD/SOQ	
<b>7.0</b>	<b>ACB</b>		
7.1	Type, Rating, Number of Poles	EDO, 50kA Rating and Pole as per SLD	
7.2	Protection	LSIG with Display and Fault Record Display	
7.3	Display of Metering	Basic (A,V,F) and Energy for I/Cand and Only Current Display of Outgoing	
7.4	Communication Port	Inbuilt RS 485 (on MODBUS/ Ethernet)	
7.5	Model	Schneider: Master pact NW, Siemens: 3WT <sup>PLUS</sup> / 3WA, LK-E&A (Formerly L&T E&A) : Omega U-Power, ABB: E-Max2; or Equivalent Model from Approved Vendor list	
<b>8.0</b>	<b>MCCB (Ics = 100% Icu)</b>		
8.1	Incomer and Bus Coupler MCCB	Microprocessor based Release with O/L, S/C, inbuilt E/F, 50 kA, 4 pole	
8.2	Outgoing MCCB		
8.21	For rating above 200 A	Microprocessor based Release with O/L, S/C, inbuilt E/F, 50kA, 3/4 pole as specified in SLD	
8.22	For rating up to and including 200 A	Thermal Magnetic based Release with Adjustable O/L, Adjustable S/C, 50kA, 3/4 Pole	



8.23	For SS/VFD Starter Feeder MCCB	Microprocessor based Release with O/L, S/C, inbuilt E/F, 50kA, 3/4 Pole as specified in SLD	
8.24	Accessories	Extended Rotary Handle, Terminal Spreader, Auxiliary Change Over Contact + Trip Contact: To be provided	
<b>9.0</b>	<b>Electronic Motor Protection Relay (with RS 485 Port)</b>		
9.1	Type	Electronic MPR with LCD display (3 Phase Current), Record Storage, DI/DO interface etc. as per Detailed Specifications with RS 485	
9.2	Protection/Interface	Confirm the following	
		1) Over Current 2) Short Circuit 3) Earth Fault 4) Current Unbalance 5) Phase Loss/Reversal 6) Under Current (Dry Run) 7) Stall (Bearing Broken) 8) Locked Rotor 9) Ground/Earth Fault/Leakage (ZCT) 10) Single Phasing with Under Voltage and Over Voltage 11) Over Temperature (With PTC Thermister) 12) 3 Programmable DI and 2 Programmable DO 13) Fault Record, Start/Stop, Run Hrs. Maximum Starting Current Record	
<b>10.0</b>	<b>Painting</b>		
10.1	7 Tank Process, 2 Coats of Primer, Oven Baked at 310 °C with Powder Coating	Required	
10.2	Colour and Shade and Thickness: Panel Exterior and Interior	RAL 7035 Thickness: Minimum 100 Micron	
10.3	Mounting Plate	Glossy White	
<b>11.0</b>	<b>Current Transformer</b>		
11.1	Type	Resin Cast	

11.2	Class of Accuracy	Cl: 0.5 for MFM, APFC Load Sensing, Summation, MPR Cl: 1 for Ammeter	
11.3	Burden (VA)	As per Specifications	
12.0	Control Wiring	FRLS PVC Copper Flexible 1.5 sq. mm: control wiring 2.5 sq. mm: CT wiring	
13.0	Hardware	For Bus Bar Joints High Tensile With Zink Passivation/Cd Plated	
14.0	Space Heater	230V AC with Thermostat	
15.0	Pocket For Drawings at Door	Yes	
16.0	Instrumentation Compartment	Separate compartment for Energy Meter, Hour Meter, Level Controller, etc. with necessary Internal Wiring	
17.0	Panel Internal Lighting	LED light 3 W with Auto NO contact/switch with panel door for VFD/SS/Starter feeder. 3 W LED Panel light ½ ft long with Control MCB for internal lighting for incomer/ cable alley	
18.0	Danger Notice Plate	With Sign of Skull and Bones as per IS-2551	
19.0	Technical Name Plate	Power supply voltage, Panel fault level, Panel protection class etc.	
20.0	LT Panel Name Plate	Name of Client (on first row/top row), Project name (second row), name of Contractor (third row) and Panel manufacturer (in fourth row), panel Manufacturing month & year	

**Note: Other specifications not mentioned in datasheet shall be considered as per tender specification/ SLD.**

### **INDUCTION MOTOR**

<b>Sr. No.</b>	<b>Particular</b>	<b>Details</b>	<b>Confirm/Data to fill by the vendor</b>
1.0	Make	Pl. furnish	
2.0	Application	Pl. furnish as applicable	
3.0	Type	TEFC Squirrel Cage Induction	
4.0	Efficiency Class	IE3 as per IS: 12615 (2018)	

<b>Sr. No.</b>	<b>Particular</b>	<b>Details</b>	<b>Confirm/Data to fill by the vendor</b>
5.0	Ambient Temperature	50 °C	
6.0	Degree of protection	IP 55	
7.0	Pump Shaft BkW in kW	Pl. furnish	
8.0	Motor Ratings in kW	Please furnish	
9.0	Number of Units/Quantity	As per BOQ/Tender	
10.0	Supply Neutral	Solidly Earthed	
11.0	Rated Voltage	415 V	
12.0	No. of Phase and Frequency	3 Phase and 50 Hz.	
13.0	Full Load Amperes A	Pl. furnish	
14.0	Supply Conditions	± 10% Voltage Variation ± 5% Frequency Variation ± 10% Combined Variation	
15.0	Synchronous Speed	As per SOQ/Tender	
15.0	Duty Conditions as per IS: 12615 or Equivalent	S1 suitable for continuous operations	
16.0	Method of Starting	DOL/Star Delta /Soft Starter/VFD as applicable	
17.0	Guaranteed Motor Efficiency @ Full Load @ 3/4 load @ ½ load	Motor shall be IE 3 (as per BOQ) as per IS: 12615 (2018)  Pl. furnish	
18.0	Power Factor @ Full Load @ 3/4 load @ ½ load	As per IE 3 as per IS: 12615 (2018)  Pl. furnish	
19.0	Starting Torque % of Full Load Torque	Sufficient starting torque to start maximum full load of driven equipment Pl. furnish.	
20.0	Pull Out Torque % of Full Load Torque	Sufficient to bring the motor to normal speed in min. time. Pl. furnish	
20.1	Starting Time at specified minimum starting voltage (Sec)	Pl. furnish (As per Tender)	
20.2	Permissible Running Time at Full Load at Minimum Allowable Voltage (Min.)	Pl. furnish (As per Tender)	
21.0	Locked Rotor Current withstand Time (Safe Stall Time) at 110% rated voltage	Pl. furnish (As per Tender)	
22.0	At Rated Temperature (Hot)	Pl. furnish (As per Tender)	
23.0	When Cold	Pl. furnish (As per Tender)	
24.0	Class of Insulation and Temp. Rise by Thermometer	Pl. furnish (As per Tender)	
25.0	Design Temperature	50 °C	
26.0	Location	As per Tender	

Sr. No.	Particular	Details	Confirm/Data to fill by the vendor
27.0	Hazardous Area Division	As per Tender	
28.0	Atmosphere	As per Tender	
29.0	a) Type of Cooling b) Type of Enclosure c) Degree of Protection	Pl. furnish Pl. furnish <b>Minimum IP 55</b> <b>For Motor –Pl. Furnish</b> <b>For Terminal Box(TB) –Pl. Furnish</b>	
30.0	Terminal Box: a) Location from Driving end b) Rotatable in steps of 90°.	As per Manufacturers' Standards Pl. furnish Pl. Confirm	
31.0	Earthing Terminals	Required as <b>per IS Minimum 2 nos.</b>	
32.0	External Cable Details	As per the SLD/Tender	
33.0	Shaft: Hollow/Solid	Pl. furnish (As per Tender)	
34.0	Type of Couplings	Pl. furnish (as per Tender)	
35.0	Type of Bearings	Pl. furnish (As per Tender)	
36.0	Colour Shade of Paint	Epoxy Grey shade 632 as per IS: 5	
37.0	Space Heater for Motors	Confirm as per SLD/SOQ/Tender	
38.0	RTD/BTD	For 90kW and above motors (6 nos: for winding temperature, 2 nos. for bearing temperature and 2 nos. Spare)	
39.0	Winding Connections	6 Terminals	
40.0	Marking and Labelling	Marking on Rating plate as per 10 of IS: 15999 (Part 1)	
41.0	Winding	<ul style="list-style-type: none"> <li>• Vacuum impregnated / Varnished, baked and treated with epoxy / double insulated, vacuum impregnated (VFD- As applicable ) – Pl. Furnish.</li> <li>• Overhung of winding shall be double coated with epoxy gel- Pl. Furnish</li> </ul>	
42.0	Applicable Standards to be followed	IS: 12615 (2018), 15999, 8225, 4889, 4772, 4029, 4691 and other relevant IS or Equivalent Standards.	

**❖ APPROVED VENDOR LIST – ELECTRICAL EQUIPMENT AND COMPONENTS**

<b>ITEM DESCRIPTION</b>	<b>APPROVED MAKE</b>
MV SWITCHBOARD & MV SWITCHGEAR -11 / 33kV - INDOOR / OUTDOOR TYPE (VCB/SF6)	ABB / BHEL / CG POWER / GE / JYOTI / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS / AUTH. SYSTEM INTEGRATOR FOR SPECIFIED APPROVED MAKE OF OEM HERE IN
RING MAIN UNIT (RMU) MV - 11 / 33kV - INDOOR / OUTDOOR TYPE (VCB/SF6)	ABB / BHEL / CG POWER / GE / JYOTI / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS
PROTECTIVE RELAYS (NUMERICAL TYPE)	ABB / ALSTOM / CSPC (C&S) / CG POWER / GE / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS
PROTECTIVE / AUXILLARY RELAYS (ELECTROMECHANICAL TYPE)	ABB / ALSTOM / CSPC (C&S) / CG POWER / EASUN REYROLLE / GE / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS
INSTRUMENT TRANSFORMERS (CT / PT / CBCT)	AUTOMATIC ELECTRIC / AEP / ASHMOR / C&S / CG POWER / ECS / GILBERT AND MAXWELL / INDCOIL / JYOTI / KAPPA / PRAGATI / PRECISE / SILKAANS
SURGE SUPPRESSORS	ABB / EMERSON / ERICO / MTL / OBLUM / PEPPERL+FUCHS / PHOENIX / RAYCHEM SCHNEIDER / SIEMENS / WEID MULLER
LIGHTNING ARRESTORS	BIRLA NGK INSULATORS / CG POWER / DHRUVA/ ELPRO / JEF / JAYSHREE / OBLUM / WS
ALARM ANNUNCIATORS (SOLID STATE TYPE WITH LED ILLUMINATION) / FACIA ANNUNCIATOR	APLAB / ALSTOM / DIGICONT / ICA / IICP / MINILEC / PROCON INST. (P) LTD / PROTON ELECTRONICS
BATTERY BACKED POWER PACK	ALAN / BHARANI / GOGATE / G'LEC
BATTERY CHARGER & DCDB	AMARA RAJA / AMCO POWER / AUTOMATIC ELECTRIC / CALDYNE AUTOMATICS / CHHABI ELECTRICALS / EXIDE / ELECTRONIC SYSTEMS / HBL POWER SYSTEMS / HIREL-HITACHI / MASS-TECH CONTROLS / UNIVERSAL INSTRUMENTS / SERVILINK
SMF / VRLA / NI-CD / LEAD ACID (PLANTE / TUBULAR) BATTERY	AUTOMATIC ELECTRIC /AMARA RAJA BATTERIES LTD / AMCO / EXIDE / FUJIYAMA / HBL POWER SYSTEMS LTD / LUMINOUS POWER / OKAYA
ELECTRONIC CIRCUIT RELAY	ALLEN BRADLEY / OEN / OMRON / PLA
CONTROL AND RELAY PANEL	ABB / ALSTOM / GE / EASUN REYROLLE / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS
DISTRIBUTION TRANSFORMERS	ABB / BBL / BHEL / CG POWER / EMCO / GE / KEC / RAYCHEM RPG LTD. / SCHNEIDER / TRANSFORMERS & RECTIFIERS INDIA LIMITED / VOLTAMP
SANDWICH BUS TRUNKING (BUS DUCT)	ABB / C&S / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS
PANEL CRCA / MS / GI PLATES & SHEET	ARCEL OR MITTAL / ASIAN / ESSAR / JINDAL / SAIL / TATA
ALUMINIUM BUSBAR MATERIAL	BANCO / HINDALCO / JINDAL / STERLITE
COPPER BUSBAR MATERIAL	HINDALCO / JINDAL / STERLITE
LV PANEL / SWITCHBOARD -	ABB / ALPHA NIPPON / C&S / CG POWER /

DRAWOUT / FIXED TYPE (PCC-LVDB / PMCC / MCC / MLDB / MPDB / MOVDB / APFC)	ELEMBICA / ELEMECH / HORIZON / INDUSTRIAL CONTROLS / LAURITZ KNUDSEN ELECTRICAL & AUTOMATION / PATEL BROTHERS / POSITRONICS / POWER & INSTRUMENTATION (O) LTD. / SCHNEIDER / SIEMENS / SUN AUTOMAT / SWATI SWITCH GEAR / HIGH VOLT / ALSTOM / JYOTI / G SONS POWER / POWERTECH SWITCHGEARS (I) PVT. LTD. / CORE METAL KRAFTS LTD / EXPEL PROSYS PVT. LTD. / SAMUDRA POWER PRODUCTS / SHIVSHAKTI ENGINEERS / ANY OTHER MANUFACTURER WHO MEETS THE REQUIREMENT SPECIFIED AT NOTE BELOW.
<p><b>NOTE:</b>  <b>Any other LV Panel Manufacturer meeting/possessing the following requirements as a minimum shall also be qualified to supply of LV Panels:</b></p> <ol style="list-style-type: none"> <li><b>For up to &amp; including 400A incomer rating panels:</b> (a) The panel manufacturer should have minimum average manufacturing turnover of 2 (Two) Crores for similar panels manufacturing in last Two (2) financial years (Trading or contracting turnover shall not be considered), duly certified by Chartered Accountant (b) Panel manufacturer must have supplied at least one no. LV Panel having incomer rating of 315A in any Municipal Corporation Body/Urban Local Body/Urban Development Authority/State Government Body or Undertaking/Any Department or Undertaking of Government of India in last two years.</li> <li><b>For up to &amp; including 1000A incomer rating panels:</b> (a) The panel manufacturer should have minimum average manufacturing turnover of 5 (Five) Crores for similar panels manufacturing in last Two (2) financial years (Trading or contracting turnover shall not be considered), duly certified by Chartered Accountant (b) Panel manufacturer must have supplied at least one no. LV Panel having incomer rating of 800A in any Municipal Corporation Body/Urban Local Body/Urban Development Authority/State Government Body or Undertaking/Any Department or Undertaking of Government of India in last two years.</li> <li><b>For above 1000A incomer rating panels:</b> The panel manufacturer should have minimum average turnover of 10 (Ten) Crores for similar panels manufacturing in last Two (2) financial years (Trading or contracting turnover shall not be considered), duly certified by Chartered Accountant.</li> </ol> <p><b>Additionally following requirements shall also be fulfilled by Panel Vendor to qualify to supply of LV Panels:</b></p> <ol style="list-style-type: none"> <li>Should have obtained from CPRI/ERDA type test certificate for LV Panel with rated voltage of 415V (3 Phase + N), 50Hz rated frequency and Minimum 3200A rated current and having short circuit withstanding strength of Minimum 65kA for one second.</li> <li>Should have obtained from CPRI/ERDA type test certificate for Degree of Protection Class IP-55 or above for LT Panel with rated voltage of 415V (3 Phase + N), 50Hz rated frequency</li> <li>The company should be in existence for Minimum 5 years and shall have GST Registration Certificate or required such supporting documents.</li> <li>Shall have ISO 9001:2015 or latest amended up to date certified.</li> </ol> <p>Necessary self-attested supporting documents / copy of certificates in support for documents as specified above shall be submitted by bidder of panel vendor whose name is being proposed for make approval / supply panel during execution stage while proposing the vendor make approval for client's review and approval. Client reserves the right to inspect the works facility of such panel vendor to assess the facility and verifying the requirements as specified above (The cost of such visit by Client officials of up to two persons including travel, lodging, boarding, local conveyance etc. shall be borne by the Bidder). Further Bidder and vendor (LV panel manufacturer) to note that if it is observed that the LV panel vendor's details submitted are incorrect or fake or forged, Client reserves right to initiate action against such Bidder/Vendor including keeping their registration with Client in abeyance for up to 3 years or as decided by the concerned authority of Client.</p>	
ACTIVE HARMONIC FILTER SOLUTION / PANEL	ABB / AMTECH / AB LIFASA / CONSULE NEOWATT / DANFOSS / EPCOS / FUJI ELECTRIC / LK-E&A

	(FORMLY L&T E&A) / NEPTUNE / SCHNEIDER / SCHNEFFER / SUBODHAN / SHREEM / TRINITY
APFC PANEL	ABB / ASIAN / ALSTOM / CG POWER / CSPC (C&S) / DATAR / EPCOS / EASUN / LK-E&A (FORMLY L&T E&A) / NEPTUNE / SCHNEIDER / SIEMENS / ALL APPROVED VENDORS FOR LT PANEL
DETUNED SERIES REACTORS WITH TEMPERATURE MICRO SWITCH (HARMONIC FILTER REACTOR)	ABB / EPCOS / NEPTUNE / SUBODHAN / VISHAY / YESHA / WHEPL / SIEMENS
DYNAMIC POWER FACTOR CORRECTION THYRISTOR MODULE	ABB / EPCOS / NEPTUNE / SUBODHAN / SCHNEIDER / SIEMENS
CAPACITOR DUTY CONTACTOR	ABB / EPCOS / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS / C & S
AC/DC POWER & AUXILLARY CONTACTOR	ABB / BCH / C&S / GE / INDO ASIAN / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS / MITSUBISHI
MV CAPACITORS	ABB / EPCOS / SHREEM / UNIVERSAL / VISHAY
LV CAPACITORS / POWER CAPACITOR	ABB / ASIAN / BHEL / CG POWER / EPCOS / GE / HAVELLS / KHATAU JUNKER / MADHAV / MALDE / NEPTUNE / PRABODHAN / POWER MATRIX / SCHNEIDER / SUBODHAN / SHREEM / SIEMENS / UNIVERSAL / VISHAY
SOFT STARTER (MICRO PROCESSOR BASED)	ABB / CG POWER (EMOTRON) / DANFOSS / ROCKWELL / SCHNEIDER / SIEMENS / LK-E&A (FORMLY L&T E&A)
VVVF DRIVES (VFD)	ABB / CG POWER (EMOTRON) / DANFOSS / ROCKWELL / SCHNEIDER / SIEMENS / YASKAWA / NORD / LK-E&A (FORMLY L&T E&A)
SEMICONDUCTOR FUSE	BUSSMANN / FERRAZ / GE / SIEMENS
HRC FUSE (POWER & CONTROL)	ABB / C&S / GE / INDO ASIAN / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS / TECHNOELECTRIC
AIR CIRCUIT BREAKERS	ABB / C&S / LEGRAND / LK-E&A (FORMLY L&T E&A) / MITSUBISHI / SCHNEIDER / SIEMENS
MCCB'S	ABB / C&S / GE / LEGRAND / LK-E&A (FORMLY L&T E&A) / MITSUBISHI / SCHNEIDER / SIEMENS
MPCB	ABB / C&S / INDO ASIAN / LK-E&A (FORMLY L&T E&A) / MITSUBISHI / SCHNEIDER / SIEMENS
MCB / RCCB / RCBO / ISOLATORS	ABB / C&S / GE / HAVELLS / INDO ASIAN / LEGRAND / LK-E&A (FORMLY L&T E&A) / MITSUBISHI / MOELLER / SCHNEIDER / SIEMENS
SWITCH DISCONNECTOR FUSE UNIT (SDF) AND SWITCH DISCONNECTOR ISOLATOR	ABB / C&S / GE / INDOASIAN / LK-E&A (FORMLY L&T E&A) / MITSUBISHI / SCHNEIDER / SIEMENS
CHANGE OVER SWITCH	ABB / BCH / C&S / GE / HAVELLS / HPL / KRAUS & NAIMER / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS
TEMPERATURE SCANNER WITH RS 485 MODBUS COMMUNICATION	ELECTRONET / MULTISPAN / MASIBUS / NIVAM / NISHKO / REDIX / SELEC
KWH / LOAD MANAGER / MULTI FUNCTION METER	ABB / CONZERV / ENERCON / IMP / KRYKARD / LK-E&A (FORMLY L&T E&A) / MECO / RISHABH / SCHNEIDER / SECURE / SIEMENS
DIGITAL AMMETER / VOLTMETER / POWER FACTOR METER	ABB / ALSTOM / AE / ASIAN / CONZERV / IMP KRYKARD / LK-E&A (FORMLY L&T E&A) / MECO /

	MASIBUS / MULTISPAN / NEWTEK ELECTRICALS / RISHABH / SCHNEIDER / SECURE / SIEMENS
ANALOG (ELECTROMECHANICAL) METERS – AMMETER & VOLTMETER	AE / IMP / MECO / RISHABH / SELEC
HANDHELD DIGITAL MULTIMETER / CLIP-ON METER / MEGGER	FLUKE / IMP / MECO / MOTWANE / RISHABH
CONTROL / SELECTOR SWITCH	ABB / ALSTOM / BCH / EE / GE / HAVELLS / JYOTI KAYCEE / LK-E&A (FORMLY L&T E&A) / RECOM / SCHNEIDER / SIEMENS / SULZER
INDICATING LAMPS	ABB / BCH / EE / IEC / LK-E&A (FORMLY L&T E&A) / SCHNEIDER / SIEMENS / TEKNIC CONTROLS / VAISHNO
PUSHBUTTONS	ABB / BCH / LK-E&A (FORMLY L&T E&A) / RASS / SCHNEIDER / SIEMENS / TEKNIC / VAISHNO
CONSTANT VOLTAGE TRANSFORMER/CONTROL TRANSFORMER	AE / ASHMORE / G & M / INDCOIL / NEC / PRAGATI / PRECISE / SILKAANS
MICROPROCESSOR BASED MOTOR PROTECTION RELAY WITH RS 485	ABB / CSPC (C & S) / EXCEL-TECH INDIA / LK-E&A (FORMLY L&T E&A) / PROK DEVICES / SCHNEIDER / SIEMENS / MITSUBISHI
BI-METAL / ELECTRONIC / MICROPROCESSOR BASED OVERLOAD RELAY	ABB / ALSTOM / CSPC (C&S) / CG POWER / GE / INDO ASIAN / LAURITZ KNUDSEN ELECTRICAL & AUTOMATION / SCHNEIDER / SIEMENS / MITSUBISHI
THERMISTOR RELAY	ALSTOM / INSTA CONTROLS / MINILEC / SELEC
SINGLE PHASING PREVENTER WITH UV/OV PROTECTION	ABB / C&S / GE / LK-E&A (FORMLY L&T E&A) / MINILEC / SCHNEIDER / SIEMENS
TIME SWITCH	GIC / LEGRAND / SCHNEIDER / SIEMENS / THEBEN
TIMERS / TIME DELAY RELAY	ABB / BCH / EAPL / ELICO / INDO ASIAN / LEGRAND / LAURITZ KNUDSEN ELECTRICAL & AUTOMATION / MINILEC / OMRON / PLA / SCHNEIDER / SIEMENS / TEKNIC / THEBEN
PANEL VENTILATION FAN	COOLTRON / HICOOL / NADI / REXNORD
TERMINAL BLOCK/CONNECTORS	CONNECTWELL / ELMEX / PHEONIX / TELEMCHANIQUE / WAGO
LIGHTING / SMALL POWER DISTRIBUTION BOARDS / ENCLOSURES	ABB / BCH / C&S / ELDON / ENCLOTEK / HENSEL / HAVELLS / INDO ASIAN / LEGRAND / LK-E&A (FORMLY L&T E&A) / RITTAL / SCHNEIDER / SIEMENS / STANDARD ELECTRIC / ALL APPROVED VENDORS FOR LT PANEL
PUSH BUTTON STATIONS / JUNCTION BOX (FOR CAST ALUMINIUM ONLY)	BALIGA / BCH / CEAG / EXPROTECTA / EXCEL / FCG FLEXPOR / HANSU / HENSEL / PUSTRON / SCHNEIDER / SIEMENS / SUDHIR
NON METALLIC ENCLOSURES (INCLUDING INDUSTRIAL RECEPTACLES / PB STATION)	BCH / HENSEL / LEGRAND / PUSTRON / RITTAL / SCHNEIDER / SIEMENS / SINTEX
MOTORS (LV)	ABB / BBL / BHEL / CG POWER / JYOTI / KEC / LHP / MARATHON / SIEMENS
CABLES HV - XLPE INSULATED	ASIAN CABLE / CCI / FINOLEX / GLOSTER / HAVELLS / KEI / NICCO / POLYCAB / PRIMECAB (RAVIN CABLES) / RPG CABLES (KEC INTERNATIONAL)/ TORRENT CABLES / UNIVERSAL



CABLES LV - POWER & CONTROL CABLES / EARTHING CABLES	ASIAN CABLE / AVOCAB / CCI / FINOLEX / GLOSTER / HAVELLS / KEI / LAPP / NICCO / POLYCAB / PRIME CAB (RAVIN CABLES)/ RPG CABLES (KEC INTERNATIONAL) / RR KABEL / TORRENT / UNIVERSAL CABLES
WIRES - FLEXIBLES (ALL TYPES)	AVOCAB / ANCHOR / ATLAS / FINOLEX / GLOSTER / HAVELLS / KEI / LK-E&A (FORMLY L&T E&A) / LAPP / POLYCAB / RR KABEL / UNIVERSAL
GI / FRP CABLE TRAYS, ANY OTHER FRP ITEMS	DUDHAT INFRA / FIBER TECH COMPOSITE / GLOBE / INDIANA / JACINTH / LEGRAND / KISMAT ENGITECH LLP / M.M. ENGINEERING / SHARDA / SILVERLINE POWER / SHREE KRISHNA ENGG. / SUPER ELECTRO / SUMIP / SATYAM COMPOSITES / VATCO
CABLE GLANDS (SINGLE / DOUBLE COMPRESSION, NI-PLATTED BRASS)	BALIGA / BRACO / COMET / EX-PROTECTA / ELECTROMECH / FCG / HMI / JAINSON / SIEMENS / SUDHIR
CABLE GLANDS – POLYAMIDE	FIBOX / GEWISS / HENSEL / LAPP
CABLE LUGS	3D / 3M / COMET / CONNECTWELL / DOWELLS / JAINSON
CABLE TERMINATION/JOINTING KITS	3M / ABB / CCI / KABELDON / M SEAL / RAYCHEM / XICOM
UPVC CONDUIT & ACCESSORIES	AKG / BHAGYALAXMI PIPE INDUSTRY / CLIPSAL / LK-E&A (FORMLY L&T E&A) / POLYCAB / PRECISION / SALZER / ANY OTHER FOR UPVC PIPES AS PER MECHANICAL VENDOR LIST
MS / GI CONDUIT & PIPES	BEC INDUSTRIES / JINDAL / JK TUBE / SAIL / TATA STEEL / ZENITH / ANY OTHER FOR MS/GI PIPES AS PER MECHANICAL VENDOR LIST
HIGH MAST LIGHTING SYSTEM	BAJAJ / CGL / PHILIPS / SURYA / VALMONT
MS / GI LIGHTING POLES & BRACKETS (TUBULAR SWAGED / OCTAGONAL)	AMBICA POLES PVT LTD / BAJAJ / BOMBAY TUBES AND POLES / FABIRON / KISMAT ENGITECH LLP / GAYATRI ELECTRICALS / INDIA ELECTRIC POLES / RIDDHI POLES / SHAKTI POLES / SURYA / SHREE KRISHNA ENGG. / UTKARSH INDIA
LIGHT FIXTURES	BAJAJ / C&S / CGL / GE / HAVELLS / LK-E&A (FORMLY L&T E&A) / PHILIPS / SURYA / SCHREDER / TISVA (USHA INTERNATIONAL LIMITED) / WIPRO
DECORATIVE / MODULAR SWITCH & SOCKET	ABB / ANCHOR / CLIPSAL / CRABTREE / HAVELLS / INDO ASIAN / LK-E&A (FORMLY L&T E&A) / LEGRAND / MK-HONEYWELL / MDS / SIEMENS / SCHNEIDER / TOYAMA
CEILING / WALL MOUNTING / EXHAUST FANS	ATOMBERG / ALMONARD / BAJAJ / CGL / HAVELLS / KHAITAN / ORIENT / USHA
CHEMICAL TYPE EARTHING INCLUDING COPPER BONDED ELECTRODE & BACK FILL COMPOUND	ASHLOK / CURSP / ECO TECHNOLOGY & PROJECTS/ ENNOV INFRA / ERICO / ISG GLOBAL / JEF / PRAGATI ELECTROCOM / SAARA EARTHING/ EQUIVALENT REPUTED MAKE SUBJECT TO CLIENT APPROVAL

The contractor shall distinctly understand that it will not be their prerogative to insist on a particular brand from the list, and final selection will be done with the approval of Engineer-in-charge.

## **D-20 : SPECIFICATIONS FOR INSTRUMENTATION WORK**

### **SECTION : D-20**

#### **INTENT OF SPECIFICATIONS**

This specification along with specific job requirements (if any) is intended to cover the design, engineering, supply, installation, testing and commissioning of entire instrumentation equipment and items and accessories including consumable against price quoted for instrumentation works as indicated here in and else where covered in the scope of this tender.

Compliance with this specification and / or review of any of the vendor documents shall not relieve the vendor of his responsibility towards his contractual obligation with regard to the completeness and satisfactory operation of the plant.

#### **APPLICABLE NATIONAL/INTERNATIONAL STANDARDS**

AGA	American Gas Association, Gas Measurement Committee	
ANSI/ASME	American National Standards Institute/American Society of Mech. Engineers	
	B 1.20.1	Pipe Threads
	B 16.5	Steel Pipe Flanges and Flanged Fittings
	B 16.20	Ring Joint Gaskets and Grooves for Steel Pipe Flanges
ANSI/FCI	American National Standards Institute/Fluid Controls Institute	
	70.2 Control Valve Seat Leakage Classification	
API	American Petroleum Institute	
	RP 520	Sizing, selection and installation of pressure relieving systems in refineries. Part-I - Sizing and selection Part-II - Installation
	RP 521	Guide for pressure relieving and depressurising systems
	RP 526	Flanged steel safety relief valves
	RP 527	Seat tightness of pressure relief valves
	MPMS	Manual of Petroleum measurement standards
	RP 551	Process measurement instrumentation Part - I Process Control and Instrumentation
	RP 552	Transmission Systems
	S 2000	Venting atmospheric and low pressure storage tanks
	S 670	Vibration, Axial-Position and Bearing Temperature Monitoring Systems
ASTM	American Society for Tests and Materials	
BS	British Standards	
	BS-1042	Measurement of Fluid Flow in Closed Conduits
	BS-5308 Part-II	Specification for PVC insulated cables
	BS-7244	Breather Valves
DIN-43760	Temperature Vs. Resistance curves for RTDs	
DIN-19234	Electrical Distance Sensors; DC interface for distance sensors and signal	

DIN-50049	converter Document on Material Testing
IEC	International Electrotechnical Commission
IEC 79	Electrical apparatus for Explosive Gas atmosphere
IEC 85	Thermal evaluation and classification for electrical insulation
IEC 332	Test on bunched wires or cables Part III Cat. A
IEC 529	Classification of degree of protection provided by enclosures
IEC 534-2	Industrial Process Control Valves - Flow capacity
IEC 584-2	Thermocouples - Tolerances
IEC 751	Industrial Platinum Resistance Thermometer Sensors
IEC 801	Electromagnetic compatibility for industrial process measurement and control equipment
IS	Indian Standard
IS-5	Colours for ready mixed paints
IS-319	Specification for free cutting brass bars, rods and sections
IS-1239	Mild Steel tubes, tubulars and other wrought steel fittings
IS-1271	Specification of Thermal Evaluation and Classification of Electrical Insulation
IS-1554 Part-I	PVC insulated (heavy duty) electrical cables – working Voltage upto and including 1100V
IS-2074	Ready mixed paints, air drying, red oxide - zinc chrome
IS-2147	Degree of protection provided by enclosures for low Voltage switch gear and control gear
IS-2148	Flame proof enclosures for electrical apparatus
IS-3624	Specification for Pressure and Vacuum gauges
IS-5831	PVC insulation and sheath of electric cables
IS-7358	Specification for Thermocouples
IS-8784	Thermocouple compensating cables
ISA	Instrument Society of America
S-5.2	Binary logic diagrams for process operations
S-7.3	Quality standard for instrument air
S-75.01	Flow equations for sizing control valves
ISO 5167	Measurement of fluid flow by means of orifice plates, nozzles and venture tubes inserted in circular cross-section conduits
NACE	National Association of Corrosion Engineers - MR-01-75
NEC	National Electric Code
NEMA	National Electrical Manufacturer's Association
ICS-6	Enclosures for industrial control and systems
NFPA	National Fire Protection Association

**1. GENERAL:**

The Contractor shall obtain all instruments from manufacturers of international standing.

The design and quality of all instruments shall be fully suited to the conditions which will be met in service. The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC-801.

The instrumentation and control system shall be designed, manufactured and installed to ensure highest standard of operational reliability. Major instrumentation shall be electronic type. Panel mounted receiving instruments shall be electrically operated miniature flush mounting type unless otherwise specified. All instruments shall be installed in accordance with the recommendations or instructions of the instrument manufacturer for particular application.

All instruments shall be capable of carrying their full load currents without undue heating. They shall not be damaged by the passage of fault currents within the rating of the associated MCB or through the primaries of their corresponding instrument transformers. All instruments shall be back connected and the cases shall be earthed. Approved means shall be provided for zero adjustment of instruments without dismantling.

All voltage circuits to instruments shall be protected by MCB's in each unearthed phase of the circuit placed as close as practicable to the main connection.

Analogue signals shall be 4-20 mA according to BS 5862:Part I 1986 or its latest edition. They shall operate over two wires and be isolated from earth. 1-5V DC signals shall only be permitted within the main instrument enclosure.

The contractor shall furnish technical details / catalogues / drawings for the instruments and panels offered for monitoring and control of the entire plant to client/consultant for their approval prior to procurement of the same. Contractor shall offer inspection for the instruments/panel offered by him and in case of waiver of inspection by the client / consultant, necessary test certificates shall be submitted for approval of client / consultant before clearing the material for dispatch. Contractor shall submit their inspection plan to client/consultant for their approval for this purpose.

All instruments procured by the contractor as per the Engineer's approval, and those which perform similar duties shall be of uniform type and manufacture throughout the scheme (zone) in order to facilitate maintenance and the stocking of spare parts. Moving parts and contacts shall be adequately protected from the ingress of dust, and all instruments shall be protected by moisture and dust-proof cases including those mounted in panels. All equipment shall be suitable for its environment.

Panel mounted receiving instruments shall be of the electrically operated miniature flush mounting type unless other wise stated.

Scales shall be clearly marked with black lettering and graduations on a white background. Instruments of the same type and range shall have identical scales.

Instrumentation System shall be designed as per good engineering practice.

**POWER SUPPLY TO PACKAGE:**

Power Supply shall be made available by the bidder at the following voltage levels, **unless otherwise specified**.

- For Instruments, Control Systems, Analysers : 230V AC  $\pm$  10%, 50 Hz  $\pm$  3 Hz
- Solenoid Valves, Relays, Lamps : 24V DC
- Input Interrogation Voltage : 24V DC
- Panel/Cabinets Lighting : 230V AC  $\pm$  10%

Client shall provide for a separate feeder in the Plant MCC of suitable current rating and at suitable locations to provide 230V AC  $\pm$  10%, 50 Hz  $\pm$  3Hz supply to Instrument Panel(s). Necessary cabling work shall be carried out by successful bidder for required power distribution.

24V DC required for Input Interrogation, relays and lamps etc., same shall be generated by the bidder using SMPS. Power shall be suitably conditioned by providing UPS / Isolation Transformer-Voltage Stabilizer-CVT to prevent damage to instruments against power fluctuation / disturbances.

Instrument power circuits shall be individually protected from fault with the help of MCBs of adequate rating with overload protection. MCBs shall be two pole type.

#### **EARTHING :**

Vendor shall provide separate earth bus bar connections for shield and panel electrical earthing.

Any special earthing requirements, if required, shall be provided by vendor during detailed engineering.

Necessary earth pits shall be provided for the same by the vendor.

#### **ENCLOSURE :**

All instruments enclosure mounted in the field shall be weatherproof to IP-65 / NEMA4 as a minimum.

#### **For Hazardous Areas :**

All electrical instruments except solenoid valves shall be intrinsically safe while solenoid valves shall be explosion proof. All such instruments shall be suitable for the applicable hazardous area classification. All intrinsically safe/explosion proof instruments shall be certified by any statutory body for use in specified hazardous area.

All electronic instruments like field transmitters shall be certified intrinsically safe.

All solenoid valves, field switches etc. shall be certified explosion proof to NEMA7. Contacts shall be gold plated rated for 30V, 1 Amp.

#### **INTERLOCKS / LOOPS :**

All plant interlocks shall be carried out using PLC / electromagnetic relays to be supplied by vendor for fail safe and reliable operation. Vendor to indicate all process interlock requirements on the P&IDs.

Loop integrity must be maintained for each loop. No component of any loop shall be shared by other loop.

The system shall be designed fail safe and shall meet the following requirements, as a minimum :-

- a) All initiating contacts shall be close under normal conditions and shall open under abnormal conditions.
- b) All relays and solenoid valves shall be energised under normal conditions and shall de-energise under abnormal conditions.

The system shall be designed using PLC / electromagnetic relays unless specified otherwise and shall be located locally or remotely as per the operational requirements. The system shall meet the following requirements as a minimum :

- a) The electromagnetic relays shall be low power continuously rated type and shall have LED for status indication.
- b) The relays shall be plug-in type and their plug-in bases shall have screwed terminals for interconnection. Lug type soldered connection shall not be acceptable.
- c) Each relay shall have minimum two numbers of 'NO' and two numbers of 'NC' contacts as a minimum. Out of these, one 'NO' and one 'NC' contacts shall not be used.
- d) Each shutdown/interlock logic shall be individually protected using separate switch-fuse unit and shall have a lamp for indicating power healthy status.

Each shutdown circuit and solenoid valve shall be provided with a MCB / switch-fuse unit separately.

## **2. CONTROL PANEL :**

Control panels shall be prefabricated type, Sourced from Approved Vendors.

Control Panel shall be CNC machine prefabricated out of CRCA sheet steel of thickness not less than 1.5 mm, modular in construction, properly reinforced, powder coated and having rigid frame structure. Internal mounting plate including the gland plate shall be 3 mm thick. The instrument panel shall have dimensions as per system requirement. However, the Control panel height shall not exceed 2100 mm.

The exterior corners and edges shall be rounded to give a smooth overall appearance with projections kept to a minimum.

Lifting lugs shall be provided for installation purposes and shall be replaced with corrosion resistant bolts after installation.

Control Panel shall be completely metal enclosed and shall be dust, moisture and vermin proof. Panel enclosures shall provide a degree of protection not less than IP 52 in accordance with IS: 13947 Part-I.

Control Panel shall be freestanding type. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation.

Metal sills in the form of metal channels properly drilled shall be furnished along with anchor bolts and necessary hardware for mounting the Instrument panels. These shall be dispatched in advance so that they may be installed and leveled when concrete foundations are poured.

Cable entries to the panels shall be from the bottom with fire retardant spray compound sealing. Instrument panels shall be provided with louvers along with washable micron filters AIRIN – AIROUT fans will be provided.

No process fluid of any kind, except instrument air, shall enter the instrument cubicle. All cable entry shall be from the bottom of the panel. Also power supplies greater than 230 V shall not enter the LCP.

The internal layout of the panel/cabinets shall be designed considering proper approach for each item for maintenance. Following point must be taken into consideration while deciding the internal layout :

- a.) All wiring inside the panels shall be housed in covered non-flammable plastic raceways arranged to permit easy accessibility to various instruments for maintenance adjustment, repair and removal. No raceway shall be more than 70% full.
- b.) Separate wiring raceways shall be used for power supply wiring, DC and low level signal wiring.
- c.) Distance between terminal strips and side of the panel parallel to the strips up to 50 terminals : Min. 50 mm.
- d.) Distance between terminal strip and top and bottom of cabinet : Min. 75 mm.
- e.) Distance between two adjacent terminal strips : Min. 100 mm.
- f.) Distance between cable gland plate and the bottom of strips : Min. 300 mm.
- g.) 20% spare terminals shall be provided as a minimum.

Overall height of Control Panel shall not exceed 2100 mm. Panel mounted instruments and controls shall be such mounted that they are accommodated between 800 mm and 1300 mm from floor level.

Control Panel shall be provided with fluorescent type lighting fixtures controlled from totally enclosed door operated switches for internal illumination of the panel cabinets.

Contractor shall provide with necessary cooling fans and cut-outs covered with appropriate filters for necessary air changes to limit temperature rise within panel to 5 deg C over ambient temperature.

Contractor shall consider necessary power conditioning unit (UPS) to prevent power fluctuation and surge to damage the instruments as well as other electronic components.

For cases where PLC is to be mounted, panel shall be designed suitably as per PLC manufacturer's recommendation. Necessary marshalling boxes may be considered if required as per design.

### **Mounting**

All equipments on front of panel shall be mounted flush or semi-flush. In case of semi-flush mounting, only flange or bezel shall be visible from the front.

Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent equipment.

Equipment mounted inside the panel shall be so located that terminals and adjacent devices are readily accessible without the use of special tools. Terminal markings shall be clearly visible.

### **Earthing for Instruments**

The panel shall be equipped with an earth bus securely fixed along the inside base of panel.

Minimum two numbers of Dedicated Earth Stations to be provided each for Instruments / Panel Earthing and for Signal (Electronic) earthing. The earth station shall be of cu plate type electrode or maintenance free pipe in pipe technology having earth electrode of 50 mm dia. and length of 3000 mm.

All metallic cases of instruments and other panel mounted equipment shall be connected to the instrument earth bus.

Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken shall not be permitted. However, looping of earth connections between equipment to create alternative paths to earth bus shall be provided.

A separate instrument earth bus will be created which will be floating and all the cable shields will be terminated onto this bus. This bus will be connected to an electronic earth pit as specified above.

### **Frame Earthing**

All metal parts other than those forming part of an electrical circuit shall be connected to a copper earth bar run along the inside bottom of the panel. The minimum section of the earth bar shall be 25 mm x 3 mm. A 15 mm diameter hole is to be provided at each end of the bar. Connection of the earth bar to the station earth shall be carried out by Contractor.

### **Space Heater**

Strip type space heaters of adequate capacity shall be provided inside control panels to prevent moisture condensation on the wiring and panel mounted equipment when the panel is not in operation. The heaters shall operate on 230 V AC. Heaters inside the panels shall not be mounted close to the wiring or any panel mounted equipment. The operation of heaters shall be controlled by thermostats.

### **Interior Lighting and Receptacles**

Each panel shall be provided with either a CFL lighting fixture rated for 11 watt, 230V, 1 phase, 50 Hz supply for the interior illumination of the panel during maintenance. The illumination lamp shall be operated by door switch or manual switch. Each panel section shall be provided with separate lighting.

Each panel shall be provided with 230V, 1 phase, 50 Hz, combined 5 amps and 15 amps, 3 pin receptacle with a switch and neon indication. The receptacle with switch shall be mounted inside the panel at a convenient location. If the panel has front and rear doors then maintenance socket shall be provided at both locations.

### **Labels**

All the equipment mounted on the front facia of Instrument panel as well as equipment mounted inside the panels shall be provided with individual labels with equipment designation engraved. The labels shall be mounted directly below the respective equipment. Also the panel shall be provided at the top with a label engraved with panel designation.

### **Switches and Miniature Circuit Breakers (MCBs)**

Each instrument panel shall be provided with necessary arrangement for receiving, distributing, isolating and protecting of DC and AC supplies for various controls, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with DP Miniature Circuit Breakers (MCBs). Potential circuits for relaying and metering also shall be protected by MCBs.

### **Intra-panel (i.e. Panel Internal) Wiring**

Connections within a panel, between panel mounted devices and terminal blocks or between two panel mounted devices will be made by 600 volt grade, multi stranded copper flexible conductor insulated with FRLS Grade PVC and designed for a minimum conductor temperature of 70 degrees centigrade. The wires shall be shielded, where necessary.

Panels shall be supplied completely wired internally, with a colour coding scheme decided mutually between the Purchaser and the Contractor, to equipment and terminal blocks and ready for external cable connections at the terminal blocks.



Wires within the panel shall be continuous i.e. without splicing and shall comprise stranded copper conductors. Internal wiring or wiring between the two assemblies shall be commensurate with mechanical safety.

Wire termination shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules, marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires and shall not fall off when the wire is disconnected from terminal blocks. The ferrule system shall adopt single tube printed arrangement so that all the characters remain on one line always & hence easily readable

### **Terminal Blocks**

Terminal blocks for power connection shall be 600V grade, 20 amps rated, one-piece moulded, complete with stud type terminals, washers, nuts and lock nuts and identification markings. Terminal block design shall include a white fibre marking strip with clear plastic, hinged terminal covers. Markings on the terminal strips shall correspond to wire numbers on the wiring diagrams. All control output terminals will be fused type and all other input signal terminals will be clip on shrouded type.

All spare contacts and terminals of the panel mounted equipment and devices shall be wired to terminal blocks.

Panel internal wiring shall not be looped directly from instrument to instrument. The same shall be looped through the panel terminal block only.

If accidental short circuiting of certain wires is likely to result in malfunction of equipment, such as closing or tripping of a breaker, these wires shall not be terminated on adjacent terminal blocks.

### **Cable Supports**

All external cables shall present a neat appearance and shall be suitably braced, placed in troughing clipped or laced to prevent effects of vibration.

### **Terminal / Identification**

Every terminal plug shall be uniquely identified within the terminal cabinet by means of a terminal number. Appropriate labels shall be used to permit quick and unambiguous identification of each terminal and test plug.

### **Painting of System Cabinet/ Control Desk**

All sheet steelwork shall be painted using seven tank processes in accordance with the following procedure:

- i. The pre treatment shall be hot process with running water for rinsing.
- ii. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.
- iii. Rust and scale shall be removed by trickling with clean water followed by final rinsing with dilute dichromate solution.
- iv. The control panel shall be powder coated. Thickness of coating shall be around 60 microns. QA test certificate shall be furnished for thickness adhesion and hardening of powder coating.

### **ALARM ANNUNCIATOR :**

- (i) Microprocessor based alarm annunciators shall be provided, **if specified**, for generating audio-visual alarms for each abnormal condition. Alarms shall be initiated by the opening and closing

- (ii) The operation or acceptance of one alarm shall not inhibit the operation of the audible device or the flashing of the appropriate alarm indicator if a future alarm condition occurs.
- (iii) Alarm circuitry shall be arranged so that spurious or transient alarm states persisting for less than 0.5 seconds do not initiate any action.
- (iv) Isolation facilities shall be provided for the hooter using an MCB
- (v) Alarm annunciator/indicator legends or labels shall be arranged with three lines of text as follows :

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- x Power supply : 24 V DC/240 V AC
- xi. Power supply status : Required indication
- xii Weather protection : IP-52 of IS 13947
- xiii No. of Windows : as per requirement + 20% spare windows

**In case if hard wired annunciator is not specified in detailed specifications for instruments, then visual alarm shall be provided at HMI and audio alarm through panel mounted hooter along with reset push button shall be provided for all the required alarms as per specifications / approved P&ID / process requirement.**

Annunciator, in general, shall be solid state type with plug-in modules, in a cabinet with backlighted engraved windows and integral power supply.

Alarm logic module shall be single channel type. In case multi-input alarm module are selected, only one channel shall be used.

Intrinsically safe annunciator circuit, when used, shall have power supply unit in a safe area.

Annunciator alarm sequence shall be Automatic Reset Type / Automatic Reset First Out with First Out flashing and Reset Push Button as a minimum.

The design of alarm annunciator system shall be such that transient alarms of less than 330 milliseconds duration shall be automatically rejected.

#### **ANALOGUE SIGNAL MULTIPLIERS:**

The flow and level signals shall be provided with back of panel mounted signal multipliers. They'll provide loop power with option to select measurement with power and without. The multiplier will provide 2 outputs of 4-20mA one for the panel mounted indicator and other for PLC i/p. There will be total galvanic isolation between field I/O's and also between the 2 outputs.

#### **RECEIVING INDICATORS/CONTROLLERS :**

All indicators/controllers shall be electronic (microprocessor based) programmable indicator and shall be mounted on the control panel located in the control room.

#### **Notes :**

Indicating instruments shall indicate various process parameters as per following measuring units, in general :

Flow	M <sup>3</sup> /Hr or MLD or LPS	as per process requirement
Level	m	Meters
Pressure	Mt. head of water or Kg/Cm <sup>2</sup>	as pr process req.
Temperature	C	Degree Celsius
Concentration	ppm or mg/l	Parts per million or Milligram per litre.
Current	A	Amperes
Voltage	V	Volts
Power	W	Watts
Electrical Energy	Whr	Watt-hours
Frequency	Hz	Hertz

Speed                                      r.p.m.                                      Revolutions per minute.

Multiplying factors for flow scales shall be specified on manufacturer's name plate.

## **FIELD MOUNTED INSTRUMENTS**

Field mounted instruments shall, where possible, be hermetically sealed. If this is not possible, they shall be of weatherproof construction with heavy cases. Transmitters and similar equipment shall be further enclosed in purpose made weatherproof, glass reinforced fire-retardant polyester resin cabinets.

Particular regard shall be paid to the ease of access to all instruments. Serial number/calibration plates shall be visible when the instrument is in its cabinet.

Locally mounted indicating instruments shall be mounted in viewable positions.

Field mounted instruments shall be complete with all mounting brackets, pillars, fittings and fixings to complete the installation.

## **FIELD TRANSMITTERS :**

Smart transmitters when used shall be used in analog mode only. Smart transmitters when specified shall have accuracy of 0.1% of span, as a minimum.

DP Type Flow Transmitter if used for congealing, corrosive and highly viscous services shall have Diaphragm Seal element with Capillary.

Transmitter shall be capable of delivering rated current into external load of at least 600 ohms when powered with 24V DC nominal voltage.

## **PUSHBUTTONS AND SWITCHES**

Pushbuttons for operational circuits shall be provided with a shroud, guard or other suitable means to prevent inadvertent operation. They shall be in accordance with the high standard generally required by the specification as a whole and by the equipment with which they are associated.

Illuminated pushbuttons where used shall be of a design that allows easy replacement of the lamps from the front of the panel.

If legends are engraved on the pushbuttons they shall be clear and concise and shall be approved by the Engineer – In charge before manufacture.

Control switches shall be in accordance with the high standard generally required by the specification as a whole and by the equipment with which they are associated.

## **INSTRUMENT CONNECTIONS:**

Electrical cable entry shall be ½" NPT(F). Suitable cable gland shall be used.

End connections shall meet the following unless, otherwise specified:

Threaded end connection shall be NPT as per ANSI / ASME B.1.20.1

Flanged end connection shall be as per ANSI / ASME B16.5

### 3. INSTRUMENTS:

Instruments as per following details and specifications shall be provided by vendor as a minimum. Quantities mentioned, if any, are indicative only and contractor shall provide all necessary instruments described in this section or as required for proper operation of the plant as described elsewhere in this tender or found necessary during detailed engineering in addition to below mentioned instruments and their locations. Bidder choosing to supply instrument with communication port suitable for process / diagnostic data transfer with PLC/HMI need not consider analog signal and alarm contacts inputs to PLC.

All instruments, gauges and control equipment shall be strictly procured as per the list of approved vendors enclosed herewith as part of the tender documents.

#### a) HYDROSTATIC TYPE LEVEL TRANSMITTER:

Hydrostatic level transmitter shall be provided to measure liquid level for Sump. The purpose is to monitor Sump levels and for start/stop of pumps in auto mode (to start at High level and stop at Low level or through suitable logic to be decided during detailed engineering). The specification shall be as under:

<b>A.</b>	<b>General</b>		
1	Location		Sump and other as specified in tender specs elsewhere
2	Function		To measure & transmit Level
3	Type		Hydrostatic Type
4	Service		Stroam Water
5	Max. Operating Temperature		Ambient, 70 °C Max.
6	Max. Operating Pressure		Atm./ Upto 1 Bar
7	Installation		Outdoor/Field
<b>B.</b>	<b>Transmitter /Sensor</b>		
1	Type		2 Wire type
2	Power Supply		24 V DC (2 wire)
3	Measurement Range, mtr		10 m H2O
4	No. of Measurement Channels		One
5	Accuracy		±0.5% of full scale
6	Out put signal	Analog	4-20 mA
7	Measuring Principle		Hydro-static Pressure Measurement
8	MOC - Body		SS-316L
9	Measuring Cell		Ceramic / as per mfr. Std.
10	Seal MOC		Viton / as per mfr. Std.
11	Protection Class		IP 68
12	Process Connection/Mounting		Mounting clamp, MOC SS 316L
13	Cable Length		10 mtr
14	Guide Pipe/Mounting Assembly		Required
<b>C.</b>	<b>Options / Accessories</b>		
a.	Mounting Hardware		Required
b.	Tag Plate		Required, SS 304
c.	Cable Glands		Required
d.	Canopy		Required
<b>D.</b>	<b>Quantity of Instruments:</b>		<b>As per SOQ</b>

Level readings shall be continuously displayed at PLC / HMI and Panel mounted Indicaator. Low-Low & High-High level alarms shall be annunciated at HMI.

#### b) FLOAT TYPE LEVEL SWITCHES:

<b>A.</b>	<b>GENERAL</b>	
1	Type	Float Type
2	Max. Temperature	Ambient / 45°C
3	Max. Pressure	Atm. + Liq Depth, Max. 1 Bar
4	Specific Gravity	1.0 to 1.1
<b>B.</b>	<b>Float</b>	
1	MOC of Float	Polypropylene
2	Construction	Circular / Tubular / Bio-conical
3	No. of Float	1
4	Protection	Min IP-68
5	Switch Type	Micro Switch, SPDT
6	Contact Rating	8A @ 230V AC (1 NO + 1 NC)
7	Cable	Inbuilt cable from Float up to Terminal Box
8	Cable Material	Suitable for Fluid application as specified in below table
9	Cable Length	10 meter
10	Process Connection	Flanged 4" NB
11	Counter Weight (Ballast)/	Required to ensure stable vertical position of the Float
	Support pipe for Clamping cable	
12	Adj. Stopper	As Applicable
13	Stopper / Ballast MOC	Rubber
<b>C.</b>	<b>Junction Box</b>	
1	Mounting	On Top of tank & sump, Flanged
2	Junction Box - MOC	Cast Alu.
	Prot. Class	IP-55
3	Connection Size	1/2" NPT / 3/4" ET or to suit cable dia.
4	Electrical Area Classification	Safe
5	Process Connection	Through Flange
<b>D</b>	<b>Accessories</b>	
1	Cable gland	Required
2	Mounting accessories	Required
<b>E</b>	<b>Locations / Service</b>	As per SOQ for Dry Run Protection of Pump (through relay multiplication any one starter and internal wiring to other starter, relay based logic to stop pump in any mode, auto or manual,

**c) PRESSURE GAUGES:**

All pumps, compressors and air blowers shall have PG at their discharge lines. Pressure Gauges for process fluids containing sludge/solids and corrosive chemicals shall be of diaphragm type.

PG dial face shall be marked with pressure element material. Ranges shall be so specified that the gauge normally operates in the middle third of the scale and shall confirm to IS-3624 standard dials, wherever possible.

Diaphragm seals, filled type or mechanical type shall be furnished where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be of clean out type with flushing connection.

Pressure Gauge Dial Size shall be of minimum 150mm and of white with black engraving, shall be provided with blow out disc, toughened/safety glass window, bayonet type bezel ring, case material

of SS304, Boudron Element / Socket of SS316, movement parts of SS, weather proof to IP-65, offering accuracy of  $\pm 1\%$  of FSD. Micro-zero adjustment at the pointer, bottom process connection shall be 1/2" NPT, over-range protection of 130% of FSD.

In case of Diaphragm type Pressure Gauge, Diaphragm / Lower Chamber Wetted Parts shall be os SS316, Upper Chamber of SS304 / SS316, with silicon oil sealing fluid, 2" ANSI B16.5 flanged process connection

Following accessories shall shall be supplied as a standard with all pressure gauges:

Isolation Valve : Required, Gate / Ball Valve, SS 316  
Manifold Valve : Required, SS 316, 3 Way 2 Valve type

**d) RECEIVING INDICATORS MOUNTED AT ICP/LCP:**

All indicators/controllers shall be electronic (microprocessor based) type programmable indicator and shall be mounted on the control panel located in the control room. Multiplying factors, shall be specified on manufacturer's nameplate, if applicable. Specifications, as applicable are as follows:

**Process Indicator:**

Type	:	Microprocessor based, programmable
Input	:	4-20 mA
Display	:	4 ½ Digit, 7 Segment LED display
Display Units	:	% or Engg. Units, user programmable at site
Alarm Setpoint	:	Two nos., pot. free relay contact rated at 5A @230V AC resistive load, adj. over entire range
Transmitter Supply	:	Required, 24V DC @30mA
Retransmission Output	:	Required, 4-20 mA in 600 ohm load
Accuracy	:	$\pm 0.25\%$ of FSD
Terminals	:	suitable for up to 2.5 sq.mm. wires
Mounting	:	panel flush mounting
Power	:	110/230 V AC, 50 Hz

**Flow Indicator cum totaliser** shall also have following in addition to above:

Totalising Counts/Hr	:	User Programmable at site
Totaliser Display	:	6/8 Digit Digital Display with Battery Backup to retain totalized data in the event of power failure for a minimum period of 24 hours.

**e) ELECTRO MAGNETIC FLOW MEASURING SYSTEM**

Generally, the flowmeter shall be as follows:

**Flowmetering System**

Each flow metering system shall consist of the primary transducer (Sealed to IP-68), earthing electrode / rings, the necessary signal converter and power supply unit and all cabling between the primary transducer and signal converter and power supply unit. Flowmeter in general shall be sized considering maximum design line velocity as specified in this tender specifications (2.5m/sec for pumped flow)

Each of the signal converts / power supply units shall be supplied for remote mounting, unless otherwise specified.

The signal converts / power supply units shall be provided with a 4-20 mA output signal, linear with flow and suitable for retransmission to remote instrumentation. The above units shall operate from a 230 VAC / 24V DC supply.

The contractor shall provide sufficient suitable cable to allow for the primary transducers to be situated up to **20** meters from their signal converters, unless a longer length is specified.

The Contractor shall provide full details of the cable; he proposes to use.

The general specifications for electromagnetic flow meter shall be as under:

Service		Stroam Application
Function		To measure & indicate Instantaneous Flow and Totalised Flow / Transmit (Flow)
Fluid Conductivity		> 20 $\mu$ S/cm
Installation		Indoor or Outdoor, Below or Above Ground as per piping / site conditions
Overall Accuracy of Measuring Loop		$\pm 0.5$ % of Flow Rate / Meas. Value or better
Operating Temperature		0 to 50°C
<b>Flow Sensor / Tube / Element</b>		
Type of Sensor		Full Bore type
Flange Materials		CS/MS with anti-corrosive epoxy paint or SS-304 or better as per mfr. Std.
Tube Material		SS304 or SS 316
Liner Material		Hard Rubber
Body Material / Coil Housing		MS / CS or better with anti-corrosive epoxy paint
Electrode Material		SS316L or Ha-C
Power Supply		From Transmitter
Grounding	Type / Material	Built-in Earthing Electrodes or Set of Earth Ring / SS-316
Protection Class		IP-68
Cable Entry (for separated / remote version) & Glands		Shall be as per mfr. Std. and suitable to maintain the specified protection class at site
Cable Length	Sensor to Transmitter	Min. 20 m, dual shielded cable
Painting, where applicable	CS / other	Chemical Resistant, Epoxy Painted
<b>TRANSMITTER</b>		
Function		Transmit and Indicate
Type		Remote (Non-Integral) type, Microprocessor based, User Programmable, 2-Wire or 4-Wire type as per mfr. Std.
Flow / Velocity Measurement Range	Max. Flow Velocity	Flowmeter shall be capable to measure flow with velocity up to max. 10 m/sec.
	Minimum Flow Velocity	up to 0.3 m/sec. (shall measure flow without loss of accuracy up to 0.5 m/sec and below that, accuracy shall be as per mfr. Std.)
Accuracy	Flow Vel. $\geq 0.5$ m/s	$\pm 0.5\%$ of Flow Rate / Measured Value or better



	Flow Vel. < 0.5 m/s	as per mfr. Std. for flow velocity up to 0.3 m/s
Output Signal	For Flow	Modbus RS-485 with diagnostic facility
Pulsed O/P	For Flow	Required for totalized flow
Instrument Power Supply		100 to 240 VAC $\pm$ 10%, 50 Hz $\pm$ 5% or 24V DC as per mfr. Std.
Cable / Conduit Entry		1/2" NPT
Local Indicator / Display	Inst. & Total Flow	LCD Display (Inst. Flow and 8/9 digit internal totalized flow)
Enclosure	Type & Protection Class	Weather Proof to IP-65 as a minimum or better
	MOC	Cast Alu. or equi. as per mfr. Std. suitable for withstanding harsh environment with chemical resistant / epoxy coating
	Type	Wall mounting / Pipe mounting
Vibration Conditions		Conformity with IEC 60068-2-6 or equi., shall be able to endure vibration, when in service, without any degradation in performance
Pipe not Full Detection / Empty Pipe Detection		Required
Canopy for Transmitter	To prevent from direct sun and rain	Required. MOC: FRP - min. 4mm thick / G.I. - min. 2mm thick

Flow (Instantaneous and Totalised) readings shall be continuously displayed locally as well as PLC/HMI.

Flowmeter shall be mounted as per manufacturer's recommendation and good engineering practices and each flow meter shall be provided with a bellows at suitable location to enable ease of removal / insertion of flowmeter for maintenance. For flowmeter mounted below ground level, chamber shall be sized suitably to accommodate flowmeter and bellows in the same chamber.

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#### 4. PROGRAMMABLE LOGIC CONTROLLERS

##### Codes and Standards

PLC shall comply with International standards such as NEMA, IEC, ANSI, ISA, IEEE, DIN and VDE

##### DESIGN AND CONSTRUCTION REQUIREMENTS

PLC H/W & S/W shall be from the same family and should be sourced from approved Vendors only.

Programmable logic controller (PLC) shall be microprocessor based with 32 bit or suitable processor and be fully programmable and capable of performing control relay logic, including timing, counting, sequencing, and interlocking.

The PLC shall be high performance processors suitable for real time process application. High inherent reliability, self checking, error-recovery and trouble-shooting features shall be some of the features of PLC.

The PLC shall have a modular / modular chassis design which allows for ease of future expansion. The processor module shall be easily removed from the I/O chassis for service or repair. The I/O chassis shall have slots for installing I/O cards, communications, or other special function modules. All I/O cards and modules shall be capable of being installed in any open slot in the chassis or DIN rail mounted. Module and channel level diagnostics should be standard feature.

The PLC shall have a suitable power supply and can be easily serviced or replaceable. The system shall be capable of being powered on 120VAC / 230VAC / 24V DC as per mfr. Std..

The PLC shall be rated to operate from 0 to 60 Degrees C, with a humidity rating of 5 to 95% (non-condensing). All module circuit boards shall be encased and protected such that, when properly installed, they are not exposed to accidental contact by personnel or other objects.

The PLC shall be of high quality and reliability with replacement processors, power supplies, chassis, I/O and specialty modules that are readily available on an urgent or emergency basis. **All PLC products shall be fully supported and available for purchase for up to ten (10) years from the date of the original system purchase.**

#### Basic Processor Functions

Real-time control of output points for turning on and off digital devices such as motor starters and solenoids.

Read the status of real world digital inputs from limit switches, float switches, and other field devices.

Real-time control of analog process control variables.

Read the status of real world analog set points and feedback values.

Perform timing, counting, sequencing, and interlocking functions for pump/equipment control.

Process local alarm handling functions

#### Math and Advanced Functions

Four function math in floating point or signed integer format

Convert to/from BCD

Data comparison and manipulation

Scaling from integer data into engineering units such as flow, level and pressure

Full PID Instructions for control of process control variables such as flow, level and pressure.

ASCII instruction set for interfacing to ASCII devices

Compute Instruction which executes a mathematical expression and can be used for totalizing functions

Trigonometric and Exponential math functions

Real-Time Calendar Clock for time stamping alarms and events.

Automatic restart of the system on resumption of power shall be provided.

The processor shall have solid state RAM memory to store the application program, process data, and alarm status. This memory shall have both capacitor and battery backup in the event that input power to the processor is lost. It shall also have the capability of EEPROM backup which automatically reloads the memory on a power cycle. The processor shall have the ability to automatically control the process on a power cycle, provided there are no major or unrecoverable processor faults.

Processor RAM memory shall be adequate and selected with at least 25-30% spare capacity for application program storage over the actual requirement, and also should be expandable for future expansions. Bidder shall demonstrate the spare capacity at the time of commissioning and after completion of entire logic development for the plant controls and monitoring as per the logic write-up to be furnished by client / consultant to the successful bidder after award of work.

Sufficient program memory and data memory space shall be provided. System initialization and application software shall be stored in EEPROM or EPROM with necessary hardware. Running data shall be stored in a RAM with internal battery back-up

All process parameters and electrical parameters as specified in the tender shall be monitored at HMI and necessary controls actions shall be initiated.

**The PLC & SCADA System shall be provided either by PLC OEM or Authorized System integrator of PLC OEM only.** In case of system integrator, required valid certificate from OEM shall be provided in this regards along with drawing / document submission.

**Note :** AMC has already implemented central SCADA system for various sewage pumping stations and treatment plants which is based on Rockwell Platform. Hence bidder to note that PLC / SCADA as per tender scope is preferred of Rockwell make for telemetry / remote data transfer (wire or wireless method as specified), acquisition and storage and ease of integration with existing SCADA.

#### **Specific Requirements for PLC :**

- |     |   |   |  |
|-----|---|---|--|
| (a) | Expandability in future                           | : | 30% of installed capacity  |
| (b) | Weather Protection                                | : | IP-20 for PLC hardware and shall be IP-52 of IS 13947 when mounted in ICP  |
| (c) | Power Supply                                      | : | 230V AC / 24V DC   |
| (d) | Interrogation Voltage                             | : | 24V DC   |
| (e) | CPU, communication module and power supply module | : | Required , high performance 32 bit or suitable CPU Module having modular configuration suitable for real time process application. CPU shall be of same family if provided at different locations. |
| (f) | Scan time   | : | 0.7 Milliseconds or better for 1K instructions   |
| (g) | Key Switch for Processor                          | : | Shall be as per mfr. Std.  |
| (h) | Two way to configure channel                      | : | (1) Via BOOT P or DHCP<br>(2) Manually by software   |
| (i) | Mounting  | : | Inside the main instrument/local instrument control panel  |
| (j) | Inputs and Outputs                                | : | As required for process operation with an intention to maximise the automatic operation of equipment/plant and ease of operation and maintenance of the plant.                                     |
| (k) | System Loading                                    | : | Max. 60% under worst loading conditions  |
| (l) | Power supply to sensor / transmitters             | : | Required   |
| (m) | Type of input                                     | : | NO/NC – Contacts field selectable from programmer  |
| (n) | Outputs   | : | Relay outputs for driving MCC starter coils, driving motorized valves etc.   |
| (o) | Spare I/O (Wired)                                 | : | Min. 2 nos. or 20% of each type of I/O, whichever is higher, at each panel/location,   |

- wired to terminal block
- (p) Interposing Relays : Shall be provided for all (Actual + Spare) the Digital Output (DO) including spare DO & for Digital Input where ever required
  - (q) Interface (Hardware and Software) to SCADA : Required (plug and play) ready to use type Remote data transmission facility (GPRS Modem-4G)
  - (r) Printers for alarm, status, report generation : NA
  - (s) HMI : 10" color touch screen
  - (t) Type of Protocol on communication port : As required / specified.
  - (u) Tests : Functional test (simulated) for complete system  
Test for monitoring function  
Factory acceptance test (to be witnessed by Purchaser / purchaser's representative)  
Simulation test for all logic / loops (to be witnessed by Purchasers / purchaser's representative)  
Vendor to submit all Test Certificates for purchaser / consultant's review.

### **Input / Output Modules**

- (a) Standard DIN Rail / rack mounted I/O modules with plug-in cards shall be provided. Field wiring shall be terminated in screwed terminal blocks and interconnected to the processor I/O system with preferably pre-fabricated cables and plug in card type connectors.
- (b) Min. 2 nos. or 20% of each type of I/O, whichever is higher, extra I/O's of installed capacity for each type shall be provided as spares and shall be wired to the terminal block of the control panel. Provision shall be made for future expansion of extra I/O modules of the installed capacity.
- (c) Discrete Input Cards: Solid-state input circuits rated for 10-30VDC operation. Cards must be available in 8 or 16 or 32 point configurations and shall source current to the field device. Each input point shall have a status LED which indicates the ON or CLOSED condition for that field sensor or switch. Cards must have removable terminal strips so that module can be easily replaced without disturbing the field wiring online while system is running.
- (d) Discrete Output Cards: Solid-state output circuits rated for 24VDC operation. Cards must be available in 8 or 16 or 32 point configurations and shall be able to operate a control relay. Each output point shall have a status LED which indicates the ON condition of the output. Cards must have removable terminal strips so that module can be easily replaced without disturbing the field wiring. The control Relay-contact shall be rated for 5A @240VAC or 5A @125VDC. The control relay shall have a LED indication to show the status of the control relay.
- (e) Analog Input Cards: Analog inputs shall capable of reading in 0 to 20mA or 4 to 20mA signal. The A/D converter shall provide a minimum 12 bit resolution over the full range from module minimum to module maximum.
- (f). Analog Output Cards: Analog Outputs shall be capable of outputting 0 to 20mA or 4 to 20mA signals. The A/D converter shall provide a minimum 12 bit resolution over the full range from module minimum to module maximum.

## Communications

- (a) RS 232/ RS 485/ Ethernet or other such required port/s for the program upload / download, on-line editing, peer-to-peer messaging, data acquisition and man machine interface.
- (b) One Modbus Converter port for connecting devices over network for data acquisition from Energy analyzers/soft starters /temp. scanners etc. Bidder to include connectivity of all energy analyzers of along with required cabling in the scope of work.

### General specifications for HMI shall be as under:

1	HMI shall be with 10" Wide Size TFT Color LCD Touch Screen Display with 800 x 400 dots resolution as a minimum
2	HMI shall have LED Backlight
3	HMI shall have FRAM/ROM of 10MB and SRAM of 128KB as a minimum
4	HMI shall have 1 nos. 485 Port and 1 no. RS-232 port as a minimum. Ethernet port shall be available as an option
5	HMI shall be with 1 no USB Port to permit insertion of pen drive for Data Backup and 1 no. Mini USB port (for programming/printing, as required) as a min.
6	HMI shall have Built in RTC with Lithium Primary Battery
7	HMI shall be suitable to operate for ambient temperature of 50 deg C and 95% RH
8	HMI shall be provided with Built in Software for Viewing HMI Screen on LAN (with Ethernet Port)
9	HMI shall be provided with 32 GB Removable Pen Drive for Recording Historical Data & Streaming

### Specifications for GPRS Modem shall be as under:

1	Modem shall support SIM900 Quad Band GSM/GPRS engine suitable to transfer data over GPRS for any 4G or latest network
2	Modem shall have Built In RS232 Serial Interface Port/ Ethernet /Suitable port/SIM
3	Modem shall have Built In Network Status LED
4	Modem shall have Built In Sim Card Holder
5	Modem shall have configurable Baud Rate
6	Modem shall operate with Input Voltage of 24VDC
7	Modem must have auto reset facility when network resume

Bidder to note that the operation philosophy / logic specified anywhere in tender specifications is indicative only and same shall be submitted by successful bidder as per requirement and to ensure smooth and trouble free operation with minimum manual intervention during detailed engineering for review and approval and shall carry out all software development as per approved philosophy only.

Contractor shall provide minimum of 3 sets of as-built control panel wiring drawings, PLC logic write-up, I/O Schedule/assignment, ladder diagram and other relevant documents in hard copy format and 3 sets in soft copy form on CDs. Soft copy format shall be in editable form to enable incorporating any changes in future. 3 sets of application program as back-up shall also be provided

in soft form on CDs. All application programs shall be without password protection and as per final approved scheme ready to install and use by client and same shall be demonstrated by bidder prior to acceptance of system at site.

**5. Uninterruptible power Supply**

UPS of suitable capacity as per following specifications for minimum 60 minutes back-up shall be supplied for entire load of instrument control panel including PLC and essential / critical instrument supply for necessary shut-down in case of power failure.

- (a) The UPS shall be floor mounted, self contained and metal clad and shall be suitable for supplying a non linear load.
- (b) It shall be possible to open the enclosure front door when the unit is in use without exposing any live contact touch.
- (c) The UPS shall be on-line type incorporating a six-pulse rectifier and pulse width modulation inverter technology with microprocessor control. It shall incorporate a static bypass switch that shall operate in event of UPS failure, overload or manual initiation in order to transfer the output supply to mains without disturbance to the output supply.
- (d) The UPS shall incorporate a DC under voltage trip circuit to Electro-mechanically trip the UPS output in order to protect the batteries.
- (e) The noise level of the unit shall not exceed 50 dB(A) at 1 m from the UPS cabinet.
- (f) The output of the inverter shall be a sine wave having less than 3% THD for linear loads and less than 5% for 50% non linear loads. It shall be suitable for load power factors 0.8 lag to 0.9 lead.
- (g) The unit shall have a dynamic response such that 100 % step load causes an output voltage transient of less than  $\pm 4\%$  with a recovery of less than 4ms. The load crest factor shall not be less than 3:1.
- (h) Indicators shall be provided for the following
  - i. UPS status
  - ii. PS alarm conditions
- (i) The UPS shall provide volt free contact outputs for the following purpose:
  - i. Warning, (viz., low battery voltage)
- (j) The UPS shall have an overloaded capacity of 110-125 % for 30 seconds and shall be protected in the event of a short circuit of the output.
- (k) The batteries shall be housed, within a separate matching battery cubicle suitable for location adjacent to the UPS. The batteries shall be of the rechargeable, sealed maintenance free lead acid type. The battery supply to the UPS shall be via a fused load break switch disconnecter circuit breaker. The battery recharge time to 90% of full charge shall be approximately ten times the discharge time at full load.
- (l) Terminals shall be shrouded to prevent accidental contact  
The Uninterruptible Power Supply (UPS) System with SMF Lead Acid battery shall conform to the minimum following specifications:

i. Input

Input Voltage	:	230 V, $\pm 5\%$

Frequency	:	50 Hz $\pm$ 5%
Nominal DC input (Battery)	:	Bidder to design and submit calculations

ii. Output

Output	:	230 V AC,applicable KVA with 25 % margin as per Load Calculation
Regulation mode	:	$\pm$ 1%
Load power factor	:	0.8 to unity
Duty	:	Continuous
Ripple on DC	:	< 2%

iii. General

Principal of operation	:	Shall be solid state, pulse with Modulation (PWM)
Cable entry	:	Bottom
Cooling method	:	Forced air
Type of Battery	:	Sealed Maintenance free
Alarms		Potential free contact for Power Healthy, Fault and Batt. Low shall be provided

## 6. INSTALLATION MATERIALS:

Vendor shall supply all erection hardware required for the installation of complete instrumentation forming part of this tender.

This includes items like cables, cable glands, junction boxes, instrument valves and manifolds, mounting accessories, impulse piping / tubing, pipe/tube fittings, pneumatic signal tubes, air line pipes and fittings, filter regulator, insulation material, cable duct and trays, conduits, identification tags, structural material required for instrument supports and trays etc.

### A) CABLES:

Specifications for cables for analog signals, digital signals and instrument power cables shall be as follows:

#### Cables For Analog Signals:

Cables shall be of 660V/1100V grade, single or multi-pair cables, annealed, tinned, high conductivity 1.5 sq.mm stranded copper conductor, PVC insulated two cores twisted into pair, laid up collectively, individual pair shielded and overall shielded with aluminium mylar tape, ATC drain wire running continuously in contact with aluminium side of the tape, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC, conforming to IS:1554 & IEC:189 Part II shall be used for analog signals. Sequential marking of the length of the cable in meters shall be

provided on the outer sheath at every one meter. For multipair cable, Pair identification as per BS 5308 Part-II marking pair no. for each pair shall be provided at maximum 50mm between two consecutive numbers.

**Cables For Digital Signals:**

Cables of 660V/1100V grade, multi-core cables, multi-stranded high conductivity annealed 1.5 sq.mm stranded, tinned copper conductor, PVC insulated, overall shielded with aluminium mylar tape, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC, conforming to IS:1554 & IEC:189 Part II shall be used for digital signals. Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing/engraving shall be legible and indelible. Control cables having 6 cores and above shall be identified with prominent and indelible Arabic numerals on the outer surface of the insulation. Colour of the numbers shall contrast with the colour of insulation with a spacing of maximum 50mm between two consecutive numbers. Colour coding for cables upto 5 cores shall be as per IS.

**Cables For Instrument Power Supply:**

Cables of 660V/1100V grade, multi-core cables, multi-stranded high conductivity annealed 1.5 sq.mm, stranded, tinned copper conductor, PVC insulated, PVC inner sheath, armoured with galvanised steel wire overall sheathed with PVC, conforming to IS:1554 & IEC:189 Part I & II shall be used for instrument power supply. Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter

**Laying of Cables:**

Cables shall be laid on trays, in trenches, conduits, ducts as necessary. Instrument cables shall not be buried in ground as far as possible. Cable joints in instruments signal and power supply cables shall not be permitted. In case if some of the instrument cables are to be buried in the ground, it shall be as per standard/good engineering practice and shall be subject to client's/consultant's approval.

The contractor shall also supply necessary materials such as junction boxes, glands, lugs etc. required for termination of cables. Each cable shall be terminated to individual panel/terminals box. Cable glands shall be of Nickel plated Brass and of Double Compression Weather proof type.

A distance of minimum 300 mm shall be maintained between the cables carrying low voltage AC & DC signals and a distance of minimum 600 mm shall be maintained between cables carrying HT & LT cables.

Identification of each cable shall be by proper ferrules at each junction as per cable schedule to be prepared by contractor. All cables shall be identified close to their termination point by cable numbers as per cable interconnection schedule. Identification tags shall be securely fastened to the cables at both ends.

**B) CABLE GLANDS:**

Cable glands shall be nickel-plated brass and shall be of double compression type suitable for armoured cables.

**C) INSTRUMENT VALVES (MINIATURE TYPE) AND MANIFOLDS:**

Body rating shall be as per piping class or better. Valve body and Trim material shall be SS316 as a minimum. Packing material in general shall be PTFE. Valves and Manifolds shall be of forged type only.

**D) PIPE AND TUBE FITTINGS:**



Tube fitting shall be flareless compression type and of three piece construction of Swagelok / Parker Hannifan make.

Ferrule shall be as SS in general.

Socket Weld type forged pipe fitting of suitable material and rating shall be supplied for pipe fittings. The minimum rating shall be 3000 lbs. Weld neck fittings shall be used where socket weld is not allowed by piping class.

For air service instrument brass fittings suitable for use on copper tubes conforming to ASTM B 68 / B 68M shall be used. It shall be manufactured from Bar Stock or equivalent and shall be nickel plated.

**E) CABLE TRAYS:**

All branch cables/tubes, cables on various civil units/structures shall run on cable trays only.

Cable trays shall be made out of galvanized mild steel sheets of 2 mm thickness with required accessories. All material shall be hot dip galvanized (610 g/m<sup>2</sup>) as per IS 2629. The width shall be so selected that 40-50% space is available for future use.

Suitable cable clamps shall be supplied for binding cables / tubes at every 500mm.

**F) JUNCTION BOX:**

Junction Box material shall be Cast Aluminium (LM-6) only and shall be weather proof to IP-65. Flame proof junction boxes shall be supplied with Ex(d) certification in addition.

The boxes shall have terminals suitable for a minimum of 4 mm<sup>2</sup> cable termination mounted on rails. 20% spare terminals shall be supplied in junction boxes.

Each junction box shall have 10% or minimum 2nos., whichever is higher, spare entries of each size. Spare entries shall be provided with plugs.

**7. INSPECTION :**

➤ **PLC-SCADA Panel**

**100% quantity of PLC-SCADA based Control panels**, tests (FAT) shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

SCADA Screens, operation logic, report format and report generation, etc. shall be witnessed at site by the Client/PMC/TPI. Report format shall be finalized as per client requirement at site.

➤ **Electro-Magnetic Flow Meters**

**Flow Meters ≤ 500 mm dia. NB:** Wet calibration tests carried out internally and test certificates shall be submitted for review and acceptance by the Client/PMC/TPI.

**Flow Meters > 500 mm dia. NB to ≤ 900 mm Dia. NB:** Wet calibration tests of **5% quantity or one number (whichever is higher)** of each class type and size shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

**Flow Meters > 900 mm dia. NB:** Wet calibration tests of **10% quantity or one number (whichever is higher)** of each class, type and size shall be witnessed @ Manufacturers' works by the Client/PMC/TPI.

Wet calibration (3 point calibration, 3 separate point) test shall be conducted as per governing standards approved Quality Assurance Plan (QAP) by Client/PMC/TPI as applicable shall be as specified below.

All electro-magnetic flow meters shall be provided with manufacturers' calibration certificates.

Manufacturer shall test all the meters internally and shall provide their internal test records for hydrostatic test along with material test certificates, Dimensional check certificates etc. and as per approved QAP for review, record and dispatch clearance prior to dispatch of materials.

The flow calibration and testing should be as per ISO 8316 (Calibration by Volumetric Method) or ISO 4185 (Measurement of fluid flow in closed conduits - Weighing Method) and shall be calibrated for minimum 3 Point Calibration (3 Separate point). Performance Type Testing Certification (ISO 9104) is strictly not acceptable. The manufacturer shall also have a flow calibration and testing facility in India or abroad so that methodology and procedures can be verified and each meter shall be tested and wet calibrated before shipment by the manufacturer. The flow calibration and testing facility shall be duly accredited in accordance with ISO 17025 standards.

The manufacturer's flow calibration and testing facility if in India shall be preferably accredited by National Accreditation Board for Testing & Calibration Laboratories (NABL). If the manufacturer is outside India then their flow calibration and testing facility should be accredited by a reputed International authority.

Further, if manufacturer test bed in India is not accredited to NABL or for flow meters imported from outside India then,

- The flow meter shall be calibrated/witnessed for wet calibration at the facility of FCRI, Palakkad, Kerala or other FCRI facility in India.  
**OR ALTERNATIVELY,**
- The flow meter shall be calibrated/witnessed for wet calibration at any NABL accredited laboratory / facility in India (laboratory to meet above mentioned requirements for conducting wet calibration test)  
**OR ALTERNATIVELY,**
- For flow meters imported from outside India, contractor shall arrange to inspect/ witness for wet calibration by a reputed third party inspection agency (SGS/ Bureau Veritas/TUV) as per approved inspection plan at manufacturer works at no extra cost. The test/performance certificates and relevant supporting documents shall be submitted to Client/PMC/TPI for review and approval. The meter(s) shall be dispatched only after obtaining dispatch clearance from Client. Additionally if desired by Client a simultaneous inspection

- For rest all instruments Test / Calibration Certificates shall be reviewed and approved prior to dispatch clearance.

All material shall be dispatched only after obtaining dispatch clearance from client.

## 8. LIST OF APPROVED VENDORS FOR INSTRUMENTATION SYSTEM

Item Description	Approved Vendors
Ultrasonic Type Level/ Diff. Level/Open Channel Flow Transmitter	ABB, E+H, Krohne, Siemens, Vega, Yokogawa
Hydrostatic Type Level Transmitter	ABB, E+H, Siemens, Yokogawa
Differential Pressure / Pressure/ Temperature Transmitter	ABB, Emerson, E+H, Honeywell, Siemens, Yokogawa
Electro Magnetic Flow Meter	ABB, E+H, Krohne (Krohne Marshall), Siemens, Yokogawa
Pressure/Compound Pressure Gauges	Wika, General Instruments Consortium, Manometer (India) P. Ltd., Baumer
Float/Buoyancy/Displacer Level Switch	ATMI, E+H, Nivelco, P+F, Pune Techtrol, SBEM, Baumer
Float & Board type Level Gauge	Nivo, Pune Techtrol, Revathi, S.B.Electro, Levcon
Programmable Logic Controller(PLC) System / HMI / SCADA Software	ABB, Honeywell, Rockwell (Allen Bradeley), Schneider, Siemens
Computer System/Laptop	HP/ Dell/ Lenovo/ Apple
UPS	APC, Emerson (Liebert), Hi-rel, Merlin Gerin, Powerware, Socomec, Schneider, Invensys, ABB, Fuji
SMF Batteries	Panasonic, Exide, Base, Prestolite
Instrument Cables(Power, Signal,Control)	Associated Cables, Brooks Cables, Havells, Uday Pyro
Communication Cables	D-Link, Delton, Finolex, Molex
Cast Aluminium Junction Boxes	Ex-protecta, CEAG, Sudhir, Baliga
Panel Enclosures	Eldon, BCH, Enklotek, Rittal, Bartakke
Panel Mounted Indicator	Masibus, Radix, Selec, Multispan
Instrument Valves and Manifolds,Tube Fittings, Pneum. Brass Fittings	Excel Hydropneumatic,Industrial Enterprise, Festo, Multimetal Industries, Placka, SMC, Technomatic
Miniature Relay	ABB, OEN, Omron, Phoenix
Indication Pilot Lamps(LEDType)	Teknic, Schneider, Siemens
Push Button/Selector Switch(with NO/NC Element)	Teknic, Schneider, Siemens
DC Power Supplies (DIN Rail mounted)	Phoenix, Omron, Aplab, IFM
Terminals	Elmex, Phoenix,Wago,Connectwell
Panel Wires	Finolex, Havell's, RR Kabel, L&T
Panel illumination	Philips, Crompton, GE
Cable Glands	Ex-protecta,Braco,Sudhir,Comet,Connectwell, HMI
Cable Tray	Silverline Power, Globe, Jacinth, M.M. Engineering, Tushar Tech
Ethernet Switches	D-link, Phoenix, Alen Bradely,Siemens
CCTV	Dvtel, Axis, Indigovision, Pelco, Smart Guard, Panasonic, Sony, Siemens, GE, Samsung, Honeywell
Printer	HP, Brothers
GSM/GPRS Modem	Masetro, Moxa, Netgear, D-link,Axitech, Phoenix,
TV	Sony, Samsung, LG

## **D-21 : SPECIFICATIONS FOR OPERATION & MAINTENANCE WORK**

### **SECTION: D-21**

#### **1.0 ADMINISTRATIVE PROVISIONS**

The following additional clauses shall apply only during the Two (2) year of Operation and Maintenance period for entire system of storm water pumping station (SWPS).

#### **1.1 DEFINITIONS**

1.1.1 In this Agreement, the following words and expressions shall have the meanings hereby assigned to them, except where the context otherwise requires:

1. **“Contract”** shall mean the agreement between the Client and the Contractor along with all documents incorporated therein by reference and all documents incorporated by these Conditions of Contract.
2. **“Contractor’s Equipment”** shall mean all equipment, instruments, tools, machinery and other appliances and things of whatsoever nature required for the fulfillment of the Contract or of the Contractor’s Obligations, but not including those items which are intended to form, or which form part of the Facility.
3. **“Contractor's Obligations”** shall mean the obligation to execute the Project in its entirety and shall, without limitation, include the Contractor’s Operation and Maintenance.
4. **“Taking Over Certificate”** shall mean the certificate to be issued when the whole of the Works or any sections or parts of the Permanent works have been substantially completed and satisfactorily passed the tests on completion in accordance with the provisions of the Contract.
5. **“Date of Taking Over”** shall mean the date of issue of the “Taking-Over Certificate” under the construction phase.
6. **“Defects Liability Period”** shall mean the Defects Liability Period of One (1) year for all works commencing on and from Date of Taking Over during which the Contractor shall undertake the responsibilities, and have the liability for the facility (including Civil Works, mechanical and electrical installations including all allied works at SWPS).
7. **“Facility”** shall mean the entire system to be designed and constructed in accordance with the provisions hereof, including the buildings, structures ,ramps, pits, pipes, fencing, lighting, testing and analysis equipment, tools, mechanical, electrical as well as safety equipment, Sewage/ Storm Water pumping machinery, supplies, instruments and inventory incorporated therein, as well as all open areas within the site, and including any additions, modifications, alterations, replacement and repairs as may be made thereto from time to time.
8. **“Authority”** shall mean any Municipal Corporation, Authority or Body exercising executive, legislative, judicial, regulatory or administrative functions, including, without limitation, any Government/Semi-Government Authority, Agency, Department, Board, Commission or Instrumentality of Indian or any political sub division thereof, court, tribunal, arbitrator or self-regulatory organization.

9. **“Law”** shall mean and include all the provisions of all Indian statutes, regulations, ordinances, codes, official or other standards, administrative or other rules, zoning and other plans and restrictions, building and other permits, judgements awards and decrees of, or agreements with any Governmental, semi-Governmental or quasi-Governmental Authority, municipal corporation etc. as currently in effect or as may be in effect from time to time and /or as may be amended or supplemented from time to time.
10. **“Maintenance Standard”** shall mean the requirements for maintaining, repairing, and renewing the Facility:
  - a) As set forth in the O & M Manual;
  - b) Required pursuant to applicable Law;
  - c) As may be necessary for keeping the facility in a satisfactory condition such that the Facility will continuously, comply with the Operation Standard; and
  - d) As may be necessary to ensure that the Facility shall continuously be in an optimum condition and state in relation with the lifetime of the Facility.
11. **“O & M Manual”** shall mean the final Manual for the Operation and Maintenance of the Facility to be prepared by the Contractor in accordance with the Bid Documents.
12. **“Operation and Maintenance Obligations”** shall mean the obligation of the Contractor pursuant to the Agreement to operate and maintain the Facility on and from the Date of Taking Over until the date of completion of this Agreement.
13. **“Operation and Maintenance Period”** shall mean the period starting on the Date of Taking Over and continuing for the term of the Agreement.
14. **“Operation and Maintenance Price”** shall mean the amount payable by the Client to the Contractor, for the fulfillment of the Contractor’s Operation and Maintenance Obligations.
15. **“Operation Standard”** shall mean:
  - a) The Performance Guarantees;
  - b) All applicable Laws;
  - c) All of the requirements, policies and procedures set forth in the O & M Manual
  - d) All other operational requirements set forth in this Agreement.
16. **“Performance Guarantees”** shall mean the List of Guarantees offered/provided by the Contractor in its Bidder Submission pursuant of the Bid Documents.
17. **“Site”** shall mean that specific area specified in the Bid Documents and shall include any other places as may be specifically designated by the Client from time to time as forming part of the Site.

## **1.2 OBJECT OF CONTRACT**

### **1.2.1 RISKS AND OBLIGATION OF THE CONTRACTOR**

- 1.2.1.1 For the duration of COMPREHENSIVE O & M period, Contractor shall render and make available to the Client the following services: -
- a) During testing & commissioning work, required raw sewage/ storm water and power will be the scope of Contractor.
  - b) ~~Drawl of sewage from the inlet chamber of sewage pumping station and passing through screens and collected into wet well and from the wet well to sewage pumping and then transfer of sewage up to proposed point of location to join the sewage into large size sewer through rising main, as applicable.~~
  - c) Control and Operation of Sewage / Storm Water Pumping Station with supply of all necessary spares, tools, consumables, lubricants, etc.
  - d) Routine Maintenance of all Buildings, mechanical & electrical installations and equipment and areas; at the site of sewage / Storm Water pumping station
  - e) Management of the Sewage / Storm Water pumping station in administrative and financial operations connected to Sewage / Storm Water pumping management;
  - f) Training of O & M staff of the Client.
- 1.2.1.2 The Contractor shall take full responsibility for the care of the Facility and materials and Sewage/ Storm Water pumping from the date of issue of the Taking-Over Certificate for the whole of the Works, until the date of completion of the Operation and Maintenance period, when the responsibility for the care shall pass to the Client.
- 1.2.1.3 If any loss or damage happens to the Facility, or any part thereof, or materials or Sewage/ Storm Water pumping for incorporation therein, during the period for which the Contractor is responsible for the care thereof, from any cause whatsoever, other than the risks defined in Sub-Clause 1.2, the Contractor shall, at his own cost, rectify such loss or damage so that the Facility conform in every respect with the provisions of the Contract to the satisfaction of the Client. The Contractor shall also be liable for any loss or damage to the Works occasioned by him in the course of any operations carried out by him for the purpose of complying with his obligation.
- 1.2.1.4 In the case of a combination of risks causing loss or damage any such determination shall take into account the proportional responsibility of the Contractor and the Client.

## **1.2.2 RISKS AND OBLIGATION OF THE CLIENT**

- 1.2.2.1 For the duration of COMPREHENSIVE O & M Contract, Client will supply power only.
- 1.2.2.2 Provide free access to the site and the Sewage/ Storm Water pumping and all its components free of charge.
- 1.2.2.3 Make payments to the Contractor according to the terms of this Contract as specified here in after.
- 1.2.2.4 If the Client shall carry out work on the Site with his own workmen he shall, in respect of such work:
- a) Have full regard to the safety of all entitled to be upon the Site, and
  - b) Keep the Site in an orderly state appropriate to the avoidance of danger to such persons.
- 1.2.2.5 If the Client shall employ other contractors in the Site, he shall require them to have the same regard for and avoidance of danger.

## **1.3 COMMENCEMENT AND DURATION OF COMPREHENSIVE O & M**

## **CONTRACT**

- 1.3.1 The O&M Period shall commence upon issuing of Taking-Over Certificate under the construction phase of the project and shall continue for a period of Two **(2) years, including defect liability period** as mentioned in the Conditions of Contract.

In event of any electrical and mechanical fault, the contractor has to attend the same immediately.

## **1.4 LIABILITY**

- 1.4.1 The Contractor will not under any circumstances be liable for costs or loss of profit that the Client may incur as a result of the unavailability of the Sewage/ Storm Water pumping on account of force major.

## **1.5 INSURANCE**

- 1.5.1 The Contractor shall, without limiting his or the Client's obligations and responsibilities insure:

- a) The Works, together with materials and Sewage / Storm Water pumping for incorporation therein, to the full replacement cost (term "cost" in this context shall include profit).
- b) The Contractor's Equipment and other things brought onto the Site by the Contractor, for a sum sufficient to provide for their replacement at the Site.

- 1.5.2 Any amounts not insured or not recovered from the insurers shall be borne by the Contractor in accordance with their responsibilities.

- 1.5.3 The Contractor shall, except if and so far as the Contract provides otherwise, indemnify the Client against all losses and claims in respect of :

- a) Death of or injury to any person, or,
- b) Loss of or damage to any property (other than the Works),

Which may arise out of in consequent of the Operation and Maintenance of the Facility and the remedying of any defects therein, and against all claims proceedings, damages, costs, charges and expenses whatsoever in respect thereof or in relation thereto.

- 1.5.4 During O&M period if Penalty raised from DISCOM for Power factor, than Penalty will be imposed at actual & Penalty will be deducted from Running Bill of O&M of Contractor.

- 1.5.5 The Painting to all equipment & Civil Work should be carried out as per specifications at the start of O&M period within first 3 months and it should be repeated 3 months before completion of 5 years O&M.

The contractor shall be responsible, at his own expenses for confirming to and complying with all existing laws and regulations to protect his personnel against job connected accidents and third party claim against property damages as well as for the death injury arising out of any action on the part of the contractor personnel/third party while engaged in the performance of duties in connection with the contract. The contractor shall furnish the Ahmedabad Municipal Corporation with documentation certifying that he has procured and maintained coverage to this extent as follows:

- A. Workman's Compensation Insurance (including) occupational disease covering the contractor's personnel engaged on the project/job.
- B. General liability insurance (including contractual) of third party injuries, including accidental death to any person and property damage.

The documentation to be furnished to the Ahmedabad Municipal Corporation within 15 days of signing of the contract. Contractor will be responsible for insurance cover of his personnel and Ahmedabad Municipal Corporation will have no liability whatsoever on this account.

- 1. Notwithstanding that all proper precautions may have been taken by contractor at all the times during the progress of the work, the contractor shall be held responsible for all damages whether to the work under execution or to any other property or to lives of persons during the progress of the work and the period of maintenance/ period of contract.
- 2. Before taking up any maintenance/repairing work, proper lockout/work permits are to be obtained by contractor from concerned authorities.
- 3. The personnel deputed by the contractor for the job should also meet following requirements
  - (a) Should be medically fit to work at site.
  - (b) Should possess good conduct and discipline.
  - (c) Should be above 18 years age.

All personnel shall carry identity cards which shall be issued by the contractor. Contractor should also consider all the staff must have dress code and wear safety jacket/shoes/hand gloves/helmets etc., in field.

## 1.6 STAFF

- 1.6.1 All Contractor's staff employed at the Sewage/ Storm Water pumping at any time during the period covered by the present Contract will be provided by him. The Client is not liable for staff in any way and cannot be held responsible in the event of litigation of any sort between the Contractor and members of Sewage/ Storm Water pumping staff or their representatives.
- 1.6.2 All decisions related to staff numbers and qualifications should be approved by the Client.
- 1.6.3 The Contractor undertakes to comply with applicable legislation and the code of labour law on matters of health, hygiene and safety, and shall assume responsibility for works required in the event of any change in applicable regulations.
- 1.6.4 The Contractor shall provide the following staff for the O&M with comprehensive repairing work as per BOQ:
  - (1) **Pump Operator:** One Operator per Shift (Operator should remain present @ site on round the clock basis) as per BOQ (Skilled Operator/Experienced) to be deployed during months from **June to October** each year.
  - (2) **Gate Operator cum Helper:** Two Gate Operators per Shift (Two Gate Operators should remain present @ site on round the clock basis) as per BOQ (Physically Fit Person) to be deployed during months from **June to October** each year.



- (3) **Security Guard cum Helper cum Sweeper cum Mali:** One No. per Shift (Security Guard should remain present @ site on round the clock basis) as per BOQ (Physically Fit with basic knowledge to operate the pump in the emergency condition) to be deployed during months from **November to May** each year.

During Comprehensive O&M period for operation work of electro-mechanical equipment, pump operator must be skilled operator with previous experience of water supply/sewage/ Storm Water Pumping Station operation as per BOQ.

Gate operator cum helper may be unskilled but must be physically fit person.

Minimum one pump operator must be present on storm water pumping station 24 hours a day & 7 days a week during period from June to October each year.

Simultaneously two gate operators must be present on storm water pumping station 24 hours a day & 7 days a week during period from June to October each year.

Security guard cum sweeper cum Mali must be present on storm water pumping station 24 hours a day & 7 days a week during period from November to May each year.

## **1.7 PENALTY**

Failing the execution of the operation, maintenance, servicing & comprehensive repairing work as per the tender document, the penalty will be applicable as per the mention in the tender. If the penalty occurs three times in the month, then the contract shall be liable to terminate, security deposit shall be forfeited and party shall be black listed in the AMC.

- 1.7.1 Due to negligence, forget ness, irresponsibility of contractor's staff, Pump sets and Machinery remains in non-usable condition/idle for more than Two day then in such a case penalty as mention below shall be recoverable from contractor's O & M bill. If such incidents occur three or more times in one month, then AMC can terminate the O & M Service and Comprehensive repairing work contract.

Idleness up to 7 days	: Rs.500/- per day per pump
Idleness for 8 days & above	: Rs.1000/- per day per pump

- 1.7.2 Spare pumps shall also be kept ready for operation. If spare pump is not ready for operation for work more than five days AMC will deduct Rs.500/-per day per pump as penalty from their bill.

- 1.7.4 If fault occurs in transformer, H.T. breaker or any electrical machinery (as applicable), that should be rectified or faulty parts should be replaced within 16 hours. Otherwise penalty of Rs.5000/- Per day will be deducted from the contractor's bill.

- 1.7.5 (a) If the Contractor does not recruit/deploy the 'Personnel' identified as per the schedule or found remain absent during the visit of AMC official then penalty/Liquidated Damages will be deducted as follows:

For Pump attendant	: Rs.1200/- per person per shift.
For Helper	: Rs.1150/- per person per shift

(b) Force majeure means an event beyond the control of the contractor and not involving the contractor's fault or negligence and not force able. Such events may include but are not restricted to, acts of the contractor either in its sovereign or contractual capacity, wars or revolutions, fires, floods, epidemics, quarantine restrictions and freight embargoes.

## **1.8 TERMINATION**

### **1.8.1 Termination by the Client**

The relevant clause of the General Conditions of Contract shall be applicable in this case.

### **1.8.2 Termination by the Contractor**

The relevant clause of the General Conditions of Contract shall be applicable in this case.

## **1.9 FORCE MAJEURE**

The relevant clause of the General Conditions of Contract shall be applicable in this case.

## **1.10 CONTRACT INTERPRETATION AND DIPUTES SETTLEMENT**

### **1.10.1 The relevant clause for Amicable Settlement of Disputes of the General Conditions of Contract (Part I) shall apply.**

## **1.11 ASSIGNMENT**

### **1.11.1 The Contractor will not be entitled to sub-contract any part of his obligation to any third party without prior approval of the Client.**

## **1.12 COMPLETION OF THE CONTRACT**

### **1.12.1 On the date of Contract Completion or if the Contract is terminated, all the installations, works and equipment placed under the Contractor's responsibility shall be handed over to the Client, at no cost, in good working order, except for normal wear and tear. The Client may perform any inspections, tests or expert appraisals he shall consider necessary with a view to checking that the property is in good working order.**

### **1.12.2 At the end of O&M period, the Contractor shall be entitled to receive an Operation and Maintenance Completion Certificate within twenty-one (21) days, of the completion of the Contract.**

### **1.12.3 The delivery of such Completion Certificate will relieve the Contractor from his responsibility as regard to the Operation and Maintenance and confirm that the Contractor has fulfilled all of his obligations under the contract.**

## **1.13 ADDITIONAL CONDITIONS**

### **1.13.1 The contractor has to provide communication facility viz. smart mobile handset to the staff deployed @ SWPS without fail. Contractor is bound to furnish the list of staff deployed @ SWPS including their individual mobile number to AMC within 24 hours of deployment. If any operating staff is changed or their mobile nos. are changed, the same shall also be intimated within 24 hours, failing which penalty @ Rs.1000/- shall be imposed & recovered from the bills of contractor for every such instance.**

Simultaneously contractor has also to provide 02 nos. chain of adequate length, 03 nos. locks, torch, 02 nos. rain coat and 02 nos. umbrella without fail @ SWPS for pumping & gate keeping operation & maintenance.

### **1.13.2 During the currency of the O&M contract, the contractor has to dismantle pump motor assembly in the event of failure and ensure that such faulty pump-motor set is sent for repairs immediately.**

- 1.13.3 During the currency of the O&M contract, the contractor has to ensure deployment of gate operators on both sides of the underpass on round the clock basis meaning one operator for each side of the underpass thus two gate operators' simultaneous deployment during monsoon.
- 1.13.4 Contractor has to arrange for reliever staff as required during shift change or for any other reason to ensure operation of facility without any interruption on round the clock basis.
- 1.13.5 In case if staff deployed by the contractor is not as specified in O&M schedule during any visit of Engineer/Officer of AMC, the recovery for non-deployment of such staff shall be made from contractor's bills. The recovery shall be made as per Clause no. 1.7.5. In order to avoid such recovery, contractor must ensure deployment of staff as specified in the tender.
- 1.13.6 Contractor has to attend to and repair any electrical or mechanical fault in pumping machinery etc. equipment during the time of heavy rains within 01 hour. If the fault remains unattended and is not cleared within 01 hour by the contractor then penalty @ Rs.5000/- per such incident/instance shall be recovered from his bills. Further in case if the occurred fault(s) is not repaired on emergency basis by the contractor, leading to the situation of flooding of the underpass and chances of accidents happening are increased, the AMC may undertake such urgent repairs/supply spares at its discretion and all such expense/cost incurred will be recovered on actual basis along with additional amount @ 20% as a penalty from the bills of O&M contractor.
- 1.13.7 It will be sole responsibility of the contractor if any temporary/permanent damage is done to the pumping machinery etc. equipment installed in SWPS either due to absence of the operating staff deployed by the contractor or their negligence thereof. Any expense on this account shall be recovered from the bills of O&M contractor.

If pumping is adversely affected due to absence or negligence by the pump operator and similarly or if gate operation is adversely affected due to absence or negligence by the gate operator leading to possibility of happening of accident, the same shall merit imposition of fine/penalty of Rs.2000/- per incident recoverable from bills of O&M contractor.

- 1.13.8 Contractor has to provide standard log book @ SWPS and ensure proper entries are registered timely in the log book for starting & stoppage of pumping etc. Also measurement of water level on hourly basis shall be recorded in the log book during raining time..

If any problem arises in starting/stoppage of drain pump, the same shall be reported to the concerned Engineer-in-charge by the operator and entry shall be recorded in the logbook. If this instruction is not followed strictly by the operator, fine/penalty shall be recovered @ Rs.1000/- for every such incident from the O&M bills of the contractor.

- 1.13.9 Contractor has to properly supervise the pumping of storm water especially during heavy rains and ensure that rain water is not allowed to accumulate in the underpass. Further contractor should coordinate with engineer(s) of AMC and other furnish required & detailed information to AMC officials & Control Room via Walky-Talky/Wireless Instruments installed by AMC. Operators & Supervisory staff have to remain in constant contact with AMC officials.
- 1.13.10 Contractor has to ensure proper cleaning of pump house of SWPS every fortnight. Pumping machinery shall also be checked every fortnight and any debris/garbage etc. shall also be removed from there.

1.13.11 Contractor has to ensure proper cleaning of pump house of SWPS every fortnight. Pumping machinery shall also be checked every fortnight and any debris/garbage etc. shall also be removed from there.

1.13.12 It will be sole responsibility of the contractor to ensure safe keeping of pumping machinery etc. equipment in the pump house, sump pit or any surrounding area. It will be contractor's sole & absolute responsibility if any minor or major accident/mishap occurs leading to fatality. All electrical equipment must be properly earthed (grounded) at all times. Utmost care is to be taken by the contractor so that there are no leakage currents from any electrical equipment leading to incidents of accidental shock to anyone.

Further in case of occurrence of any theft of any material or any such fatal accident, contractor shall book/register complaint to relevant Police Authority/Station and if any penalty/fine is imposed then it will be direct & sole responsibility of the contractor. AMC shall not be responsible for such incident/accident under any circumstances.

1.13.13 In case of failure of power supply from M/s. Torrent Power Limited, contractor has to immediately register complaint with them and coordinate to ensure restoration of power on urgency basis. At the same time such instance of power failure shall be intimated to Engineer-in-charge immediately and entry in the log book shall also be made accordingly.

## **2.0: TECHNICAL PROVISIONS**

### **2.1 NOT USED**

### **2.2 MAINTENANCE**

- 2.2.1 The Contractor shall be responsible for routine as well as corrective (preventive) maintenance of hydraulic, mechanical, electrical equipment as well as miscellaneous equipment and instruments as described in Conditions of Contract for O&M.
- 2.2.2 The Contractor shall be responsible for carrying out regular servicing and lubrication of machines, complying with maintenance instructions as defined in the Operation and Maintenance manual, and ensuring that electromechanical equipment and motors operate correctly at all times.
- 2.2.3 The Contractor shall ensure that measurement systems operate correctly at all times.
- 2.2.4 The Contractor is responsible for the maintenance of the landscaped areas inside the client's Sewage/ Storm Water pumping fences.
- 2.2.5 The Contractor shall be responsible for maintenance of civil structures including inlet and screen chambers as well as wet and dry well, sewage/ Storm Water pumping machineries as well as mechanical & electrical installations/equipment.

#### **Performance Standards**

The Contractor will operate and maintain in a state of continuous operational readiness all Sewage/ Storm Water pumping and systems to meet the incoming flow. It shall remain the Contractor's responsibility to ensure that sewage/ Storm Water pumping systems are at all times able to operate to the maximum capacity of the installed duty Sewage pumping.

All Sewage/ Storm Water pumping installation shall be operated within their designed limits. The Contractor shall operate the Sewage/ Storm Water pumping strictly within these operating ranges and shall manage the operation of the sewage/ Storm Water pumping to achieve optimum performance as far as possible.

### **2.3 CONSUMABLES AND UTILITIES SERVICES - SPARE PARTS - STORES**

#### **2.3.1 CONSUMABLES AND UTILITIES SERVICES**

- 2.3.1.1 Unless stipulated otherwise elsewhere in the document, for the duration of the COMPREHENSIVE O & M period, the Contractor will be responsible for the supply and control of lubricants, spare parts, tools and consumable materials excluding electrical power, necessary for the continuous operation of the works.
- 2.3.1.2 The Contractor will manage the consumables and utilities services to ensure their most economic consumption and to minimize wastage.
- 2.3.1.3 Power required for COMPREHENSIVE O & M period will be supplied free of cost by the client from Power Supply Company. If any other energy required for COMPREHENSIVE O & M will have to be borne by contractor.

### **2.4 SPARE PARTS AND STORES**

- 2.4.1 The store inventory, the issuing and recording of spare parts will be the responsibility of the Contractor.
- 2.4.2 The Contractor is also responsible for providing required spare parts, tools and any other material required during year of operation and maintenance period by **free of cost**, and also bare the cost of storing and safeguarding also.
- 2.4.3 The Contractor will make all necessary arrangements to ensure the continuous supply of spare parts and material for the works as would ensure uninterrupted operation and shall be supplied free of cost.
- 2.4.4 Spare parts shall be supplied by the Contractor and the same will be used during Two (2) year operation and maintenance period free of cost. Any spare parts not used during the O&M period shall be handed over to the Client at no cost.
- 2.4.5 The quality of spare parts, lubricants etc. required for COMPREHENSIVE O & M activities will be checked frequently by the Engineer-in-charge or his representative and the quality/brand of each will be approved. The material without approval shall not be allowed to be used and such material shall be immediately removed from the site in presence of the Client with a letter, addressed to the Engineer-in-charge as a confirmation.

## **2.5 MISCELLANEOUS EQUIPMENT**

### **2.5.1 OFFICE**

All the furniture and administrative office equipment etc. required shall be furnished by the Contractor. Costs of operating Administrative office and supplies shall be borne by the Contractor.

The Contractor shall take out subscriptions for standard telephone lines. Running cost for the telephone will be borne by the Contractor.

### **2.5.2 SEWAGE/STROM WATER PUMPING STATION COMPLEX**

Cost of operation and maintenance and housekeeping of Sewage/Strom water pumping station complex including domestic water supply and drainage, roads, gardens, electrical installations, etc. will be borne by the contractor.

## **2.6 INSPECTION**

### **2.6.1 GENERAL PROVISIONS**

- 2.6.1.1 The Client shall check the operation of the Sewage/ Storm Water pumping or designate an organization of his choice to carry out inspections regularly. The Client or the organization appointed by him shall check that the Contractor is performing the tasks for which he is responsible with due diligence. The Contractor shall at his cost provide all the assistance the Client requires to complete these inspections.

### **2.6.2 MEASUREMENT AND ANALYSIS**

The Client has the right to perform any analysis or inspection he deems necessary. Before any inspection, the Client shall give a prior written notice of one day to the Contractor and shall cover the costs of such action.

## **2.7 SEWAGE/STORM WATER PUMPING STATION COMPLEX VISITS**

- 2.7.2 Contractor have to work as per instruction of AMC representative during the site visit. The Client reserves the right to call in equipment manufacturers or specialized technicians for visits.
- 2.7.3 These visits shall provide an opportunity for examining maintenance programs and operating procedures and improvements requiring additional investments.

## **2.8 DOCUMENTS TO BE PROVIDED BY THE CONTRACTOR**

### **2.8.1 OPERATION LOG BOOK**

- 2.8.1.1 The Contractor shall keep a permanent record of Sewage/ Storm Water pumping station operation (logbook). This log book shall be kept at the site and shall be presented on request to agents approved by the Client.
- 2.8.1.2 During Rainy time, the following information shall be recorded in the log book:
  - a) The information like Pump On/Off time, Level, etc. as required to be maintained in the log book.
  - b) Report of visits by persons other than those of the Client and the Contractor to the Facility.
- 2.8.1.3 The Contractor shall also indicate any significant modifications to the set-up characteristics of the installation, shut-downs, anomalies or incidents that have occurred with respect to operation.

### **2.8.2 Maintenance Register**

- 2.8.2.1 The maintenance register shall include but not be limited to:
  - a) List of the parts replaced and quality of other different consumable items consumed during the month.
  - b) List of major defects/break down during the month
  - c) Details of rectification works during the month.

### **2.8.3 ANNUAL REPORT OF OPERATION**

- 2.8.3.1 The Contractor shall provide the Client by March 31 of the current year (n) with an annual report for the preceding year (n-1). This report shall include:
  - a) All technical statistics related to Sewage pumping operation as supplied by the operation;
  - b) A statement of works carried out during the preceding year n-1 in connection with the Contractor's maintenance obligation;

### **3.0: FINANCIAL PROVISIONS**

#### **3.1 FINANCIAL PROVISIONS**

##### **3.1.1 METHOD OF PAYMENT**

- 3.1.1.1 The Client will pay the Contractor for the O&M Price on a monthly basis subjected to satisfactory performance of the entire system. The payment for comprehensive operation and maintenance shall be in **as per Price Schedule of tender document.**

##### **3.1.2 INVOICING**

- 3.1.2.1 The Contractor shall prepare and submit to the Client an invoice each month with all documents supporting its claim. The invoice shall be submitted between the first and fifth day of the month.
- 3.1.2.2 The Client shall have fifteen (15) calendar days from receipt of such invoice to notify in writing to the Contractor its acceptance thereof or the grounds for disputing such invoice. The Client shall pay to the Contractor all accepted amounts, within forty-five (45) calendar days from the date of acceptance.

##### **3.1.3 FLUCTUATION FACTORS**

- 3.1.3.1 Deleted.

#### **3.2 LIQUIDATED DAMAGES**

- 3.2.1 The system shall be capable to deliver the designed capacity of sewage pumping. However in the initial stage the sewage flow may not get developed fully, due to less population coverage. However, the bidder shall keep all the installations and system in working condition throughout the COMPREHENSIVE O & M period.
- 3.2.2 **For the non-compliance of employment of key staff**
- 3.2.2.1 If the successful bidder does not recruit/depute or in absence of the key staff identified as per schedule, then liquidated damages will be deducted as per Clause no. 1.7.5.

#### **3.3 TAXES, LICENSES, PERMITS AND FEES**

- 3.3.1 No extra payment against any taxes, licenses, permits and fees shall be made to the contractor.

#### **3.4 TRAINING**

- 3.4.1 Before end of the contract, suitable training shall be given to the Client's staff.

#### **3.5 O & M MANUAL**

- 3.5.1 Three sets of O&M manual to be submitted by the contractor for each equipment.