IS : 4656	-	Indian Standard Specification for Form Vibrators for Concrete.
IS : 4925	-	Indian Standard Specification for Concrete Batching and Mixing Plant.
IS : 4926	-	Indian Standard Specification for Ready Mixed Concrete.
IS : 4990	-	Indian Standard Specification for Plywood for Concrete Shuttering work.
IS : 4991	-	Indian Standard Specification for Blast Resistant Design of Structure for Explosion above ground.
IS : 4995 (Part-I&II)	-	Indian Standard Specification for Design of Reinforced Concrete Bins for the Storage of Granular and Powdery Materials.
IS : 4998 (Part-I)	-	Indian Standard Specification for Design of Reinforced Concrete Chimneys.
IS : 5512	-	Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials.
IS : 5513	-	Indian Standard Specification for Vicat Apparatus.
IS : 5515	-	Indian Standard Specification for Compaction Factor Apparatus.
IS : 5751	-	Indian Standard Specification for Precast Concrete Coping Blocks.
IS : 5816	-	Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders.
IS : 5891	-	Indian Standard Specification for Hand Operated Concrete Mixers.
IS : 6452	-	Indian Standard Specification for High Alumina Cement for Structural Use.
IS : 6909	-	Indian Standard Specification for Supersulphated Cement.
IS : 6923	-	Indian Standard Specification for Method of Test for performance of Screed Board Concrete Vibrators.
IS : 6925	-	Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.
IS : 7242	-	Indian Standard Specification for Concrete Spreaders.

IS : 7246	-	Indian Standard Specification for Table Vibrators for Consolidating Concrete.
IS : 7251	-	Indian Standard Specification for Concrete Finishers.
IS : 7320	-	Indian Standard Specification for Concrete Slump Test Apparatus.
IS : 7861 (Part-I&II)	-	Indian Standard Specification for Recommended Practice for hot and cold Weather Concreting.
IS : 7969	-	Safety Code for Storage and Handling of Building Materials.
IS : 8041	-	Indian Standard Specification for Rapid Hardening Portland cement.
IS : 8043	-	Indian standard specification for hydrophobic cement.
IS : 8112	-	Indian Standard Specification for 43 grade ordinary Portland Cement.
IS : 8142	-	Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance.
IS : 8989	-	Safety Code for Erection of Concrete Framed Structures.
IS:9013	-	Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated - cured Concrete Test Specimens.
IS : 9077	-	Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction.
IS : 9103	-	Indian Standard Specification for Admixtures for Concrete.
IS: 9417	-	Recommendation for welding cold worked bars for reinforced concrete construction.
IS : 10262	-	Recommended Guideline for concrete Mix Design.
IS : 12269	-	Indian standard specification for 53 grade ordinary portland cement.
IS : 12330	-	Indian standard specification for sulphate resting portland cement.
IS : 12600	-	Indian standard specification for low heat portland cement.

TECHNICAL SPECIFICATION
FOR
VI) DRIVEN PRECAST CONCRETE PILES

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VI) DRIVEN PRECAST CONCRETE PILE

1.00.00 SCOPE

This Specification deals with the requirements regarding materials, workmanship, casting, curing, handling, transportation and driving of precast concrete piles (both vertical and raker) and all related items of work like surveying, layout of piles, sand filling in holes (considering driving of precast piles into the ground using follower) after driving of the piles, lengthening of the piles, redriving of the piles, jetting, and load testing of the piles, etc.

IS:2911 (Part I/Sec.3) shall form a part of this Specification and shall be complied with unless they are at variance with the Specification where the latter will prevail.

2.00.00 GENERAL

2.01.00 Work to be Provided by the Contractor

Work to be provided for by the Contractor, unless otherwise specified, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, forms, templates, supports, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Prepare and submit for approval detailed drawings and bar bending schedules for reinforcement bars showing the positions and details of spacers, supports, etc.

c) Submit for approval detailed scheme of all operations required for executing the work e.g. Material handling, casting, curing, handling, transporting, driving, testing, services, approaches, sand filling of holes etc.

d) Design and submit for approval concrete mix designs required to be adopted for the job.

e) Furnish samples and submit for approval results of tests for various properties e.g. various ingredients of concrete, concrete cubes etc.

f) Supply and install the pile shoes made of chilled cast iron of approved design.

g) Supply and paint Bitumen coating, if required, on the outer surfaces of the piles prior to their driving, as per schedule of items.

h) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings, specifications and schedule of items.

2.02.00 **Work to be Provided by Others**

No work under this specification shall be provided by any agency other than the Contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 **Codes and Standards**

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practices.

IS-269	:	I.S. Specification for ordinary, and Low Heat Portland Cement.
IS-383	:	I.S. Specification for Coarse and Fine Aggregates from Natural Source for concrete.
IS-432	:	I.S. Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for Concrete Reinforcement.
IS-456	:	I.S. Code of Practice for Plain and Reinforced Concrete.
IS-516	:	I.S. Specification for Methods of Test for Strength of Concrete.
IS-1199	:	I.S. Specification for Methods of Sampling and Analysis of Concrete
IS-1786	:	I.S. Specification for Cold-twisted Steel Bars for Concrete reinforcement.
IS-2386	:	I.S. Specification for Methods of Test for Aggregates for Concrete - Part - I to VIII.
IS-2502	:	Codes of Practice for Bending and Fixing of Bars for concrete Reinforcement.
IS-2751	:	Code of practice for welding of mild steel bars used for Reinforced concrete construction.
IS-2911 (Part-I/ Sec.3)	:	Code of practice for Design and Construction of Pile Foundations. Driven Precast Concrete Piles.
IS:2911 (Part-IV)	:	Code of Practice for Design and Construction of Pile Foundations - Load Test of Piles.
IS:3558	:	Code of Practice for use of immersion Vibrators for Consolidating Concrete.

IS-6999	:	I.S. Specifications for super-sulphated cement.
IS-8112	:	I.S. Specification for high strength Ordinary Portland Cement.
IS : 12269	:	Indian standard specification for 53 grade ordinary portland cement

2.04.00 **Conformity with Design**

The Contractor will prepare check lists in approved proforma which will be called "Pile Installation Cards". At each important stage of the work as decided by the Engineer, the work will be checked and approved by the Engineer for Correctness and conformity with the design, Specifications and drawings, before allowing the next phase of the work to commence. The intermediate checks and approval by the Engineer will not, however, absolve the Contractor from his total responsibility to execute the work as per the specification and drawings and remove and/or rectify all work which is defective or inaccurate.

2.05.00 **Materials**

2.05.01 **Cement**

Cement used shall conform to IS:8112 or IS 12269.

2.05.02 **Aggregates**

Aggregates both fine and coarse shall comply with requirements of IS:383. Size of coarse aggregates shall be selected considering the size of section. Generally 20 mm down coarse aggregate shall be used.

2.05.33 **Steel**

Reinforcement Steel shall conform to IS:432 (Part-I) and IS:1786.

2.05.04 **Concrete**

Controlled concrete grade M25 (minimum) shall be used for the piles, unless specified otherwise in the schedule of items. Water/cement ratio including water contained in aggregates shall not be more than 0.45. However, minimum cement content and corresponding W/c ratio shall be determined by trial mix design and as approved by the Engineer. Materials and methods of manufacture of concrete shall be in accordance with IS:456. In addition, the materials shall have special resistance against sulphate attack where subsoil conditions warrant it.

2.05.05 **Water**

Clear water, free from acids and other impurities, shall be used for the manufacture of concrete. Normally potable water is found to be suitable.

2.06.00 **Storage of Materials**

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer shall not be used, failing which, the Engineer shall be at liberty to get the materials removed and the cost increased thereof shall be realised from the Contractor's dues.

2.07.00 **Quality Control**

The Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The requirements will include but not be limited to the following :

a) Casting of piles

b) Inspections of piles

c) Location and Plumb : Control survey for accuracy in plan and check for verticality.

d) Driving : Correlation of weight of hammer, length of stroke, number of strokes per minute and rate of penetrations.

e) Load tests.

3.00.00 **INSTALLATION**

All installation requirements shall be in accordance with IS:2911 (Part-I/ Sec. 3) latest edition and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification might not have covered all this aspects to the full satisfaction of the Engineer.

3.01.00 **General**

The tenderer shall furnish complete information about the type of piles offered, method of driving of piles, details and availabilities of driving equipment, formula or data curve on which the tenderer bases the load carrying capacity of piles as well as the criteria for determining suitable and sufficient `founding' of individual piles and any other relevant details.

The Contractor shall acquaint himself fully about the nature of the soil encountered from bore hole logs or any other data as available with the owner. All piles will have to be driven to the required set and/or based on load tests, as decided by the Engineer. In case the Contractor is required to drive piles to greater or shallower depths than that is envisaged the rates will be adjusted as per relevant items in Schedule of Items and no other extra claims

will be entertained. The tenderer should, in his own interest, investigate the site thoroughly and take additional bore holes if he feels it necessary to assess the type of equipment to be used and the depths to which the piles may have to be driven finally.

3.02.00 **Casting and Curing**

Precast concrete piles shall be square with chamfered edges. (25mm x 25mm) and conical bottom. The top edges of all piles shall also be chamfered (25mm x 25mm).

Before placing in moulds, the steel skeletons shall be accurately fabricated and assembled away from the moulds, complete with metal shoe if specified, accurately fitted so that the point is truly on the axis of the pile.

Care shall be taken to ensure that the binders are perfectly tight and main reinforcements straight and true. Spacer fork of approved design are to be inserted throughout and spacing shall not be more than 1.5 m apart.

Longitudinal bars shall be in one length. In cases where laps in reinforcement bars cannot be avoided, the bars shall be staggered. Welded joints in reinforcement may be used with prior approval of the Engineer. Welding of reinforcements shall be done in accordance with the recommendations of relevant IS Code of practice. The cages shall be rigidly fixed straight and parallel to the moulds and held correctly as to maintain cover by spacer blocks. Care shall be taken to ensure correct and uniform cover throughout.

Formwork to be used for casting of the piles must be strong and level so that the outer faces of the piles are smooth and free from undulations. The prefabricated steel formwork with proper fasteners shall be used. Deformed and out of alignment formwork will be rejected.

The Casting Yard shall be so located that the piles can be lifted directly from their beds and transported to the piling frame with a minimum of handling. The casting yard should have a well drained surface to prevent excessive uneven settlement due to softening of soil during manufacturing and curing. The contractor shall submit layout drawing of the casting yard to the Engineer for approval prior to its construction.

Each pile shall be cast in continuous operation from end to end. The concrete shall be thoroughly compacted against the forms and around the reinforcement by means of immersion and/or shutter vibrators. Care shall be taken to ensure that the heads of the piles are formed plane and square to the axis. Particular attention must be paid to compaction at head and toe having regard to the more closely spaced reinforcement and the need for the densest possible concrete.

Immediately on completion of the casting the top surface shall be finished level without excess trowelling. Care shall be taken to ensure that vibration from adjacent work does not affect the previously placed concrete for piles during the setting period.

Side shutters shall be stripped off only after 24 hours of concreting. The piles shall be kept continuously wet for at least 7 days and protected from rapid drying by sheltering them from the wind and direct sunlight by covering the stacks.

3.03.00 **Storing and Handling**

Storage area shall be of firm ground free from liability to unequal subsidence or settlement under weight of the stack of piles. The piles shall be placed on timber supports which are truly level and spaced so as to avoid undue bending in the piles. The supports shall be vertically one above the other. Space shall be left round the piles to enable them to be lifted without difficulty. The order of stacking shall be such that the older piles can be withdrawn for driving without disturbing the new piles.

Great care shall be taken at all stages of transporting, lifting and handling of the piles that they are not damaged and cracked. Piles shall be lifted only by means of bolts or shackles inserted through the lifting holes provided and in no other way. Any pile damaged in handling shall be replaced free of charge by the Contractor.

All lifting and toggle holes shall be formed by casting in pieces of steel pipe for the full length of the concrete section. In places where lifting holes have not been provided in the piles, the points of lifting shall be clearly marked on the surface of the pile over at least half the perimeter. If the piles are put down temporarily after being lifted, they shall be placed on trestles or blocks located at lifting points. Lifting shall be by two points i.e. at 1/5th length of pile from either end so as to keep the handling stress minimum. Single point lifting is not permitted.

Piles must not be taken for driving before 28 days have passed after casting.

3.04.00 **Driving**

The proposed arrangement for driving, the equipment and accessories shall be to the approval of the Engineer.

The equipment and accessories are to be selected considering the hardness of driving, the capacity suitable for the size and weight of the pile to be handled. Piles may be driven with any type of hammer provided they penetrate to the prescribed depth or attain the specific resistance without being damaged. A hammer may be 'single acting' or 'double acting'. The hammer, dolly, helmet and the pile should be co-axial and sit squarely one upon the other. For a single acting or drop hammer, the fall should be limited to 1.2m, preferably 1m.

The head of precast concrete piles shall be protected with packing of resilient material, evenly spread and held securely in place. A helmet should be placed over the packing and provided with dolly of hardwood or equivalent not thicker than the width of pile.

Any sudden change in rate of penetration which cannot be explained due to normal change of nature of the ground should be noted and the cause ascertained before driving is continued.

Jetting may be used in case of sand, gravel and fine grained soils provided percentage of clay is small, after approval of the Engineer, as a means of minimizing the to resistance and skin resistance along the pile shaft. Jetting shall not be used in case of clay soils. The pressure of jetting should be from 6 Kg./Sq.cm. to 10 Kg./Sq.cm. Proper arrangement shall be made for taking away water that emerge at the ground so that the stability of the piling equipment is not endangered by softening of the ground. Special care should be taken to ensure that pile penetrates vertically.

Jetting shall be stopped prior to completing the driving which should always be made by ordinary methods. Jetting shall also be stopped if there is any tendency of the pile tip to be drawn towards the piles already driven owing to disturbance of the ground.

Piles should be installed as accurately as possible as per the drawings. As a guide, for vertical piles a deviation 1.5% and for raker piles a deviation of 4% shall not be exceeded. Piles shall not deviate more than 75 mm from their designed position. Spacing of the piles shall be as per the drawings.

In case of piles deviating beyond these limits, the piles shall be replaced or, supplemented by one or more piles as instructed by the Engineer at no extra cost to the owner.

In a group the sequence of installation shall be from the centre to the periphery of the group or from one side to the other, such that the carrying capacity of previously installed pile is not reduced. The driving shall not cause appreciable upheaval of the ground or cause unusual soil resistance to rest of the pile driving. It shall be ensured that soil is not flowing out literally during driving operation.

Set criteria shall be same as those used when the sets of test piles were obtained under identical driving conditions.

3.05.00 **Stripping of Pile Heads**

If specified in the schedule of items the concrete shall be stripped to the cut-off levels shown on the drawings. Reinforcements shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile cap. All concrete and cement shall be removed from the bars which shall also be wire brushed to remove any loose rust, dirt and scale. Any cracked or defective concrete shall be cut away and made good with new concrete properly bonded to the old concrete.

3.06.00 **Lengthening of Piles**

Length of individual piece of precast pile is generally restricted from handling point of view. Considering the required total length of pile and the length of individual piece as mentioned above, the contractor shall develop standard

splicing detail using studs, dowels, keys etc. at the spliced end of the piles and get it approved by the Engineer. The splice shall be as strong as the pile segments.

If due to unforeseen site conditions over and above the preplanned splicing mentioned above, further lengthening of pile is required during driving the longitudinal reinforcement shall be exposed by stripping of head and jointed properly either by welding or lapping as directed by the Engineer. The exposed surface of the concrete shall be hacked to form a key, brushed to remove loose material and covered with 25 mm thick cement mortar (1:2 mix) immediately before the new concrete is placed.

3.07.00 **Risen Piles**

In places where the piles may rise due to ground heaving, levels of the tops of the piles should be measured at interval while nearby piles are being installed. Piles which have risen as a result of driving adjacent piles should be redriven to the original depth as per the direction of the Engineer.

3.08.00 **Defective Piles**

Defective piles shall be removed or left in place without affecting performance of the adjacent piles as per direction of the Engineer. Additional piles shall be provided by the Contractor free of charge.

3.09.00 **Idle Period**

The phasing of construction and movement of plant shall be done as desired by the Engineer. The phasing may involve some extra movement of the plant or some idle period, but the Contractor will not be entitled for any claim due to this reason.

During the actual testing of the piles, the Contractor's plant and personnel may remain temporarily idle. Again, during the period of redesign, if any, (based on the pile test results), the plant personnel of the contractor may remain idle for any reason whatsoever.

For such idle periods mentioned above, the Contractor will not be entitled to any claim and rates quoted by him shall include the same. However, during the testing of piles and other hold ups, pile driving operation may be allowed on other piles wherever possible, if decided by the engineer with a view to minimise idle times.

If due to change in loading, elevations or any other alteration, some amendments become necessary in the design of foundations, the Contractor shall not be entitled to any claim whatsoever for such amendments in the pile layout during the progress of work including claims for any idle labour or tools and plant on this account.

3.10.00 **Test Pile**

The Contractor may have to construct test piles, if desired by the Engineer, before he starts systematic piling operation at locations indicated. For this

purpose, the pile construction process shall be the same as in usual piling process to be followed on this job. Load test on such piles shall be as per the provisions under "Procedure for Initial Load Test" in IS:2911.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

The Contractor shall carry out all sampling and testing for the components of reinforced concrete in accordance with the relevant Indian Standards at his own cost unless otherwise specified in the Contract. Whenever directed, the Contractor shall get the specimens tested in a laboratory approved by the engineer and submit to the Engineer the test results in triplicate within three (3) days of completion of the test.

Initial tests and/or routine tests as indicated in the Schedule of Items or as directed by the Engineer shall be carried out on single pile or pile groups to ascertain the capacities of the piles and their behaviour.

Any or all of the following tests shall be carried out as indicated in the Schedule of Items and as directed by the Engineer.

a) Vertical load test on pile (Compression)

b) Lateral load test on pile

c) Pull out test on pile

All the above tests are to be performed as per requirements of IS:2911 (Part-IV) - latest revision and as supplemented herein.

4.02.00 Static Load Test on Working Piles

In order to determine the carrying capacity of piles, static load tests shall be undertaken by the Contractor on single pile or pile groups, as indicated on drawings. Before any load test is made, the proposed arrangement of the structure, dead load to be used in making the load test, and method of application of load to the pile shall have to be approved by the Engineer. All load tests shall be made under the supervision of the Engineer. All responsibilities for conducting the test safely and properly lie with the Contractor.

The test load to be applied on pile or piles shall be one and a half times the proposed load value of the pile or piles as claimed by the Contractor. The test load shall be applied in 6 increments equal to one fourth, half, three fourth, one, one and one fourth and one and one half times the proposed working load. Readings of settlements and rebounds shall be referred to a constant elevation bench mark and shall be recorded with the help of three dial gauges of 0.02 mm sensitivity each positioned at equal distance around the pile. Each stage of loading, except the final test load of one and one half times the working load, shall be maintained till the rate of movement of the pile top is not more than 0.02 mm per hour. The final test load shall be maintained for

24 hours and hourly readings of settlements are to be recorded. The total test load shall be removed in decrements not exceeding 1/5 of the total test load with intervals of not less than one hour. The rebounds shall be recorded after each decrement is effected and the final rebound shall be recorded 24 hours after the entire test load has been removed. A complete record in triplicate shall be filed with the Engineer on the loads and readings obtained duly verified and countersigned by the Engineer.

The tested piles shall be used as usual foundation piles if they satisfy the acceptance criteria and no extra payment shall be made except for load tests on the piles.

If so desired by the Engineer, special test caps may have to be cast and subsequently dismantled at no extra cost.

4.03.00 **Acceptance Criteria**

The piles shall be accepted as satisfactory only when the work has been executed in order with this Specification to the satisfaction of the engineer and satisfy the following requirements :

a) Deviations shall be within the prescribed limit of tolerance specified in this specification.

b) Results of the load tests satisfy the specification and IS Code requirements.

4.04.00 **Recording Data**

The Contractor shall maintain a separate register, signed jointly by him and the Engineer, giving the following information during installation of the piles:

a) The sequence of installation of piles in each group with dates of starting and completion

b) The dimensions of the pile including the reinforcement details of the piles

c) The depth driven

d) The final set for the last ten blows or as may be specified by the Engineer

e) Cut-off levels

f) The type and size of hammer and its stroke, or with double acting hammers, the number of blows per minute

g) The type and condition of the packing on the pile head and the dolly in the helmet; and

h) Any other important observation

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The tenderer shall submit the following information along with his tender.

5.01.01 Programme of Construction

The tenderer will submit the details of the method of construction and the construction equipment that he will employ. A proposed construction programme, matching with the capacity of the equipment and taking into consideration the various idle and non production periods on account of shifting of equipment, testing and possible delays due to modifications of design should be drawn up and submitted along with the tender, keeping in view the completion dates stipulated in the tender.

5.02.00 After Award

After award of the contract, the successful tenderer is to submit the following details.

5.02.01 Execution Plan

Within 15 days of the receiving the Letter of Intent the Contractor will submit 6 (six) copies of drawings showing the sequence of driving. The drawings will be prepared on the basis of a master plan giving identification number of the piles, which will be furnished by the Engineer.

5.02.02 Detailed Construction Programme

Within 30 (thirty) days of the award of contract, a detailed construction programme for completion of the work is to be submitted. This master programme will be reviewed and updated every month or at more frequent intervals as directed by the Engineer, incorporating the various factors which have caused or are likely to cause changes in the programme.

5.02.03 Requirement of Materials, Tools and Plants and Equipment

In accordance with the master programme, a detailed material, tools and plants and equipment requirement schedule, particularly for those items which the Owner is to supply or is to help in procurement as per the terms and conditions of the Contract, is to be submitted within 30 (thirty) days of the contract.

5.02.04 Test Results

The test data and result for the various ingredients of R.C.C., concrete cubes and cylinders, driving of the pile, static load test on single piles and group will be submitted regularly and as and when directed by the Engineer.

TECHNICAL SPECIFICATION
FOR
VII) DRIVEN CAST IN SITU CONCRETE PILES

CONTENTS

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VII) DRIVEN CAST-IN-SITU CONCRETE PILES

1.00.00 SCOPE

This specification covers driven reinforced cement concrete cast in situ piles including movement of pile driving equipment as per drawings as made available from time to time, and all related items of work like sand filling in the holes left after casting the piles, testing the load bearing capacity of individual piles and group of piles, etc. The relevant clauses of the "Technical Specification for Cement Concrete (Plain or Reinforced)" appearing in this document elsewhere, fall within the Scope of this Specification.

IS : 2911 (Part-I/Sec-2) shall form a part of this specification and shall be complied with unless they are at variance with the specification where the latter will prevail.

Other items of work like, excavation, casting pile caps, beams etc. which in most cases, will be required to be executed in connection with piling, will fall under the Scope of other relevant sections of the Technical Specifications which appear separately in this document.

2.00.00 GENERAL

2.01.00 Work to be provided by the Contractor

The work to be provided for by the Contractor, unless otherwise specified, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, equipment, tools, plants, transportation etc. required for the supply and installation of piles of desired capacity.

b) Mark the proposed sequence of driving on six (6) copies of identification plan. The identification plan will be prepared by the Contractor as per the basic plan furnished by the Engineer, if so desired by him.

c) Furnish detailed drawings in six (6) copies of the pile driving equipment giving all salient dimensions and loads.

d) Submit detailed daily report of pile driving incorporating information as required by the Engineer.

e) Carry out load tests to the satisfaction of the Engineer including casting and dismantling of test caps if necessary and submit the test results in approved proforma.

f) Make necessary earthwork and approaches for movement of the pile driving rig.

g) Provide all necessary work mentioned under the "Technical Specification for Cement Concrete (Plain or Reinforced)", as may be applicable.

2.02.00 **Work to be provided by others**

No work under this Specification will be provided by any agency other than the Contractor unless specifically mentioned otherwise elsewhere in the Contract.

2.03.00 **Codes and Standard**

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standards Specifications and codes of Practice. In case any particular aspect of work is not specifically covered by Indian Standard Specifications, any other Standard Practice as may be specified by the Engineer shall be followed :

IS : 269 Indian standard Specifications for 33 Grade ordinary Portland Cement.

IS : 383 Indian Standard Specifications for Coarse and fine Aggregates from Natural sources for concrete.

IS : 432 I.S. specification for Mild Steel and Medium (Part-I) Tensile Steel Bars and Hard Drawn Steel Wire for Concrete Reinforcement : Part I Mild Steel and Medium Tensile Steel Bars.

IS : 455 Indian Standard Specification for Portland Slag Cement.

IS : 456 Code of Practice for Plain and Reinforced concrete.

IS : 516 Indian Standard Specification for Methods of test for Strength of concrete.

IS:1199 Indian Standard Specification for Method of sampling and Analysis of Concrete.

IS:1786 Indian standard Specification for Cold worked steel High strength Deformed Steel Bars and Wires for Concrete Reinforcement.

IS : 2502 Code of practice for bending & Fixing of Bars for Concrete Reinforcement.

IS: 2722 Indian Standard Specification for Portable Swing Weight Batches for Concrete (Single and Double Bucket Type).

IS : 2751 Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction.

IS :2911	Code of Practice for Design and (Part-I/Construction of Pile Foundations - Driven Sec-2)Cast-in-situ Concrete Piles.
IS : 2911	Code of Practice for Design and Construction (Part-IV) of Pile Foundations - Load Test on Piles.
IS : 4926	Indian Standards Specification for Ready Mixed Concrete.
IS : 5121	Safety Code for Piling and other Deep Foundations.
IS : 8112	I.S. Specification for 43 grade Ordinary Portland Cement.
IS : 12269	I. S. Specification for 53 grade ordinary portland cement

2.04.00 **Conformity with Design**

The Contractor will prepare check lists in approved proforma which will be called "Pile Installation Cards". At each important stage of the work as decided by the Engineer, the work will be checked and approved by the Engineer for correctness and conformity with the design, specifications and drawings, before allowing the next phase of the work to commence. The intermediate checks and approvals by the Engineer will not, however, absolve the Contractor from his total responsibility to execute the work as per the specification and drawings and to remove and/or rectify all work which is defective or inaccurate.

2.05.00 **Materials**

2.05.01 **General**

All materials whether incorporated in the works or used temporarily as aids or for executing enabling works will be of best approved quality conforming to the latest Indian Standard Specification.

2.05.02 **Pile Shoes and Shells**

Piles shoes, where used, should be manufactured out of best quality cast Iron or Steel with proper treatment, the composition and thickness of the materials being of special importance where they are likely to be in contact with harmful chemicals and organic materials causing deterioration in service. The shell tubes which are to be left in place should also receive similar consideration in selection.

2.05.03 **Cement**

Cement used shall conform to IS : 8112 or IS : 12269 (Portland Cement.

2.05.04 **Aggregates**

Aggregates both fine and coarse shall comply with the requirements of IS : 383. Size of coarse aggregates shall be selected considering the size of the section. Generally, 20 mm down coarse aggregates shall be used.

2.05.05 **Steel**

Reinforcement steel shall conform to IS : 432 (Part - I) (Mild Steel plain bars) or IS : 1786 (High yield strength deformed bars).

2.06.00 **Storage of Materials**

2.06.01 **General**

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer shall not be used, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The relevant clauses pertaining to storage of material under "Technical Specification for Cement Concrete (Plain & Reinforced)" will apply.

2.06.02 **Cast Iron or Steel Shoes and Shells**

All cast iron or steel shoes and shells will be painted with two coats of anticorrosive paint or smeared with protective layer of grease and kept stored in weatherproof sheds, off the ground, on sturdy racks in such a manner as to enable quick and easy inspection.

2.07.00 **Quality Control**

The Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The Quality Control requirements stipulated under the "Technical Specifications for Cement Concrete (Plain and Reinforced)" will apply wherever relevant. In addition, the requirements will include but not be limited to the following :

a) Location and Plumb : Control survey for accuracy in planned check for verticality.

b) Driving : Correlation of wt. of hammer, length of stroke, number of strokes per minute and rate of penetration.

c) Casting of Piles : Check inside casing, reinforcement cage, concrete mix, placing, consolidation and curing.

d) Inspection of Pile

e) Load Tests

2.07.01 **Non-conformance**

Any work which fails to conform to the specification will be subject to the issue of a non-conformance report in line with the quality control procedures to be implemented at site. Corrective or remedial action, design modification or product rejection will be reviewed in accordance with site quality plan.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS:2911 (Part I) and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification might not have covered all the aspects to the full satisfaction of the Engineer.

3.01.00 General

The Tenderer shall furnish complete information about the type of piles offered with sketches of pile sections showing reinforcement, method of driving the piles, details and availability of driving equipment, formula or data curve on which the Tenderer bases the load carrying capacity of piles as well as the criteria for determining suitable and sufficient 'founding' of individual piles and any other relevant details.

The Tenderer will be supplied with bore hole logs or any other data indicating the nature of the soil expected to be encountered. The information furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the Contract. All piles will have to be driven to the required set and/or based on load tests, as decided by the Engineer. In case the Contractor is required to drive piles to greater or shallower depths than that is envisaged the rates will be adjusted as per relevant items in the Schedule of Items and no other extra claims will be entertained. The tenderer should, in his own interest, investigate the site thoroughly and take additional bore holes if he feels it necessary to assess the type of equipment to be used and the depths to which the piles may have to be driven finally.

3.02.00 Type of Pile

All piles shall be adequately reinforced cast in situ concrete piles driven as specified on the drawing/s. The reinforcement and diameters of piles should be exactly as indicated in the drawing and specification. Only cast in situ piles with complete reinforcement for the total length and casing driven to total depth required for pouring controlled concrete mixture shall be accepted.

3.03.00 Identification of Piles

A plan, in triplicate, showing clearly the designation of all piles by an identifying system shall be filed with the Engineer before installation of piles is started if so desired by the Engineer.

3.04.00 Sequence of Construction

The piles shall be installed in such a sequence that the carrying capacity of previously installed pile is not reduced. The driving shall not cause appreciable upheaval of the ground or cause unusual soil resistance to rest of the pile driving. It shall be ensured that the soil is not flowing out laterally during driving operation. The Engineer shall decide on the sequence of the groups of piles and the Contractor shall have to follow this sequence.

3.05.00 **Driving of Piles**

Piles shall be installed with due consideration to the adjacent structures and by a method which leaves their strength unimpaired and which develops and retains the required bearing resistance. Equipment and the method of driving the pile shall be such that the pile is installed in its proper position and alignment. The pile shall not be out of plumb by more than 2% of the pile length. If any pile goes out of plumb by more than 2% of the pile length, the design of the foundation shall have to be modified in a manner approved by the Engineer to support the resulting vertical and lateral forces properly. The cost of modification, however, has to be borne by the Contractor at no extra cost to the Owner. A maximum positional deviation of 7.5 cm at the cut off level from the designed location of pile may be permitted, beyond which modification in the design shall become necessary.

Jetting shall not be done except when permitted in writing by the Engineer. The driving shall start from the existing ground level. After completion of driving, concrete shall be placed and compacted to fill up the hole left by the driving up to 300 mm above the cut of level. The balance depth between the G.L. and the top of concrete shall be filled up with sand so that the next pile does not move out of place during construction. To construct the pile cap, the ground will be excavated to expose the top portion of the piles, which will be dismantled neatly upto the cut off level removing all cracked, loose and unsound concrete. the top surface of the piles will be kept rough to ensure bond with the pile cap in which they will be ultimately embedded. The reinforcement rods of the pile should project out of the top by at least the value of bond length for the bar depending on its diameter and grade of concrete in pile cap. This length of bar will be later on bent and embedded in the pile cap concrete.

During the process of driving, should an obstruction be encountered, through which piling tube can not penetrate, the Contractor shall be compensated for the cost of removal of such obstruction at actual cost plus 20%.

Liquefaction of soil or localised compaction of soil due to driving of piles, if occurring, may create conditions when determination of load bearing capacity by the usual method of 'set' sometimes gives erroneous results. The pile, in such cases, shall be driven to the set desired or the desired strata based on the experience gained on the various load tests as desired by the Engineer.

The Contractor shall ensure that any green concrete in the nearby piles or any pile loaded in testing operation is not disturbed by driving the tube adjacent to it.

3.06.00 **Concrete in Pile**

This shall conform to the requirements of "Technical Specification for Cement Concrete (plain and reinforced)" enclosed herewith, to the extent it has been referred to or as applicable to this Specification. The concrete shall be of controlled grade and approved quality M 25 (minimum). The stipulation laid down in IS:2911 (Part I), regarding selection of mix shall be generally followed unless otherwise specified by the Engineer.

Concreting shall start as soon as possible after the hole is completed. Concrete shall be so placed as to fill the entire volume of the hole without segregate 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 for the subsequent piles.

Where the concrete is cast in place in a 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 minimise shrinkage and to minimise the possibility of cement being washed down by flow of subsoil water while casing is withdrawn. Care shall be taken against segregation of concrete while passing the reinforcement cage, and against inflow of soil and water during withdrawal of the tube 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 piles.

The method of concreting shall strictly conform to the above specification and no deviation shall be allowed.

As mentioned in Section 3.5, concreting of the pile shall have to be done at least 300 mm above the cut off level of the pile. The remaining part of the hollow formed by the withdrawal of driving tube from ground down to the top of the concreted pile shall be filled up with sand.

3.06.01 Trimming of Pile Heads

Completed piles shall be trimmed to the cut-off levels shown on the drawings or until sound concrete is found. In the event of trimming being carried below the cut-off level, the pile shall be made up to the correct cut-off level, with concrete of the same quality as used in the piles at the contractor's expense. A 'non-conformance' will be raised in such circumstances. Reinforcement shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile cap as per drawing. All concrete and cement shall be removed from the bars, which shall also be wire-brushed to remove any loose rust, dirt and scale.

3.06.02 Lengthening of Piles

Where it is necessary to increase the length of any pile after it has been installed, the head of the pile shall be cut-off to expose the reinforcement for a full bond length of the bars to lap with the new bars. The exposed surface of the concrete shall be chiselled to form a key brushed to remove loose material and covered with 25 mm thick cement mortar (1 : 2 mix) immediately before the new concrete is placed.

3.07.00 Reinforcement in Piles

Steel Reinforcement conforming to IS:432, IS:1139 or IS:1786 grade suitable for reinforced cement concrete for general building work shall be applicable for the specification to the extent it has been referred to or applicable.

Pile has to be reinforced throughout its length. In spite of different methods of driving, concreting, etc. of different types of cast-in-situ driven piles, the minimum area of longitudinal reinforcement within the pile shaft shall be 0.4 percent of the sectional area calculated on the basis of outside diameter of the casing of the shaft when mild steel plain bars conforming to IS : 432 Grade I are used. For other grades of steel noted above, the area of reinforcement may be adjusted suitably, but in no case shall the number of vertical reinforcing bars be less than six and the bar diameter less than 16 mm. The minimum diameter of the links or spirals shall be 6 mm and their spacing shall not be less than 150mm. In addition to the binders/links, spacer bars of 8 mm diameter shall be welded at the inside face of the cage of suitable intervals.

Reinforcement used in cast in situ piles shall be made up into cages sufficiently well wired or spot welded to withstand handling without damage. The bars shall be so spaced as not to impede the placing of the concrete. Care shall be taken to preserve correct cover and alignment of reinforcement throughout the whole operation of placing the concrete by means of concrete rollers or by any other means approved by the Engineer. Any distortion or displacement of reinforcement, during the compaction of concrete or while extracting the tube, shall be avoided. The reinforcement in the pile shall be exposed for a minimum length of the anchor length in tension above cut off level to permit it to be adequately bonded into the pile cap. All reinforcement in piles including the dowels projecting above the piles, shall be measured and paid separately.

3.08.00 **Dowels**

The Contractor shall provide necessary dowels as directed by the Engineer. In case of inadequate length of dowels, the same shall be extended by welding or by mechanical devices, if necessary as per direction of the Engineer. The expenditure on this account shall be borne by the Contractor. The extra reinforcement thus required shall be taken into consideration during reconciliation if the same is supplied by the Owner.

3.09.00 **Inspection**

Before placing the reinforcement and concrete in the driven pile, the same shall be inspected by lowering a battery or flash lamp or by any other method approved by the Engineer to ensure water tightness of the tube. In case of water in any bore or damage to any cast iron shoe, the tube shall be extracted and redriven after earthfilling of the hole, with a fresh shoe at the cost of the Contractor.

3.10.00 **Record for driving of Piles**

A joint record of the entire penetration shall be maintained by the Contractor in a proforma approved by the Engineer for every pile for the behaviour of such pile during its entire process of construction. Such records shall be submitted to the Engineer 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 shall be promptly reported to the Engineer and adequate corrective measures shall be taken free of any charge as decided by the Engineer.

Upon completion of the pile driving, all records together with the records of such additional borings or other subsurface information that were obtained during the process of driving shall also be filled with the Engineer in triplicate.

3.11.00 **Defective Piles**

Piles that are defective or piles with deviation in alignment of the tube or position of the base more than that permissible under this specification shall be pulled out or left in place as per the direction of the engineer. Additional piles shall be driven to replace them and/or the pile cap shall be redesigned in consultation with the engineer. All the additional costs associated with the corrective action shall be borne by the Contractor. However, the extra reinforcement and cement that will be required for such work shall be taken into consideration during reconciliation of Owner's material, if the same are supplied by the Owner.

3.12.00 **Idle Period**

The phasing of construction and movement of plant shall be done as desired by the Engineer. The phasing may involve some extra movement of the plant or some idle period, but the Contractor will not be entitled for any claim due to this reason.

During the actual testing of the piles, the contractor's plant and personnel may remain temporarily idle. Again, during the period of redesign, if any, (based on the pile test results), the plant personnel of the contractor may remain idle for any reason whatsoever.

For such idle periods mentioned above, the Contractor will not be entitled to any claim and rates quoted by him shall include the same. However, during the testing of piles and other hold ups, pile driving operation may be allowed on other piles wherever possible, if decided by the engineer with a view to minimise idle times.

If due to change in loading, elevations or any other alteration, some amendments become necessary in the design of foundations, the Contractor shall not be entitled to any claim whatsoever for such amendments in the pile layout during the progress of work including claims for any idle labour or tools and plant on this account.

In case of extra rolling of rig arising out of a decision taken by the Engineer due to non-availability of drawings or site, or priority consideration, the same shall be paid under the relevant item in the schedule of items.

3.13.00 **Test Pile**

The Contractor may have to construct test piles, if desired by the Engineer, before he starts systematic piling operation at locations indicated. For this

purpose, the pile construction process shall be the same as in usual piling process to be followed on this job. Initial test shall be carried out on such piles as per the relevant provision in IS : 2911 (Part-IV).

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in the Contract. Whenever directed, the Contractor shall get the specimens tested in a laboratory approved by the engineer and submit to the Engineer the test results in triplicate within three (3) days of completion of the test.

4.02.00 Components of R.C.C

The testing and acceptance criteria for the components of Reinforced Cement concrete shall be as stipulated in the relevant clauses of the Technical Specification for Cement concrete (Plain and Reinforced) appearing in the document elsewhere.

4.03.00 Static Load Test on Working Piles

In order to determine the carrying capacity of piles, static load tests shall be undertaken by the Contractor on single pile or pile groups, as indicated on drawings. Piles to be tested shall be cast at least 30 days before loading unless otherwise directed by the Engineer. Before any load test is made, the proposed arrangement of the structure, dead load to be used in making the load test, and method of application of load to the pile shall have to be approved by the Engineer. All load tests shall be made under the supervision of the Engineer. All responsibilities for conducting the test safely and properly lie with the Contractor.

The test load to be applied on pile or piles shall be one and a half times the proposed load value of the pile or piles as claimed by the Contractor. The test load shall be applied in 6 increments equal to one fourth, half, three fourth, one, one and one fourth and one and one half times the proposed working load. Readings of settlements and rebounds shall be referred to a constant elevation bench mark and shall be recorded with the help of minimum two dial gauges of 0.02 mm sensitivity and resting on diametrically opposite sides. Each stage of loading, except the final test load of one and one half times the working load, shall be maintained till the rate of movement of the pile top is not more than 0.02 mm per hour. The final test load shall be maintained for 24 hours and hourly readings of settlements are to be recorded. The total test load shall be removed in decrements not exceeding 1/5 of the total test load with intervals of not less than one hour. The rebounds shall be recorded after each decrement is effected and the final rebound shall be recorded 24 hours after the entire test load has been removed. A complete record in triplicate shall be filed with the Engineer on the loads and readings obtained duly verified and countersigned by the Engineer.

The tested piles shall be used as usual foundation piles if they satisfy the acceptance criteria, and no extra payment shall be made except for load tests on the piles.

If so desired by the Engineer, special test caps may have to be cast and subsequently dismantled at no extra cost.

4.03.01 **Acceptance Criteria**

The pile or piles tested shall be accepted to carry the proposed working load provided that the total settlement of the pile top under the load does not exceed 12 mm.

4.04.00 **Lateral Load Tests/Pull out Tests**

If desired by the Engineer lateral load tests on piles will be carried out by the Contractor as per IS:2911. Pull out tests will be carried out in special cases if required by either cantilever or fulcrum loading as may be approved by the Engineer. The quantum and nature of test loading will be as approved by the Engineer.

4.05.00 **Non-destructive Dynamic Testing on Working Piles**

In addition to the above load tests, the Contractor may also have to carry out testing of piles by non-destructive dynamic testing methods before or during piling work as desired by the engineer.

4.05.01 **"Low Strain" Method for Integrity Investigation of Concrete Piles**

The method of testing shall conform to ASTM D4945. All equipment including small impact device, 16 lbs nylon tipped hand held hammer accelerometer pile integrity tester and pile driving analyser shall be arranged by the Contractor. Analysis shall be carried out by exponential amplification of the signal with line and the average velocity curve obtained by numerically integrating the acceleration record to be submitted. From analysis of the results any defect like necking, honey-combing, segregation or weakness in concrete, when detected shall be reported in detail.

4.05.02 **"High Strain" Method for Determination of Pile Capacity**

The method of testing shall conform to ASTM D 4945. All equipment including piezoelectric transducers, strain gauges, pile driving analyser, two track oscilloscope for displaying data and contractor for every hammer below the analyser shall determined the following data :

a) Pile bearing capacity

b) Transferred energy

c) Maximum compression force

d) Maximum tension force

e) Maximum impact velocity

f) Maximum acceleration

g) Maximum displacement

which are to be properly recorded and analysed and submitted in detailed report form.

4.06.00 **Lateral Dynamic Load Test on Piles**

Two types of tests, namely, free and forced vibration lateral tests shall be carried out to observe response of soil-pile system under horizontal dynamic loads and for the evaluation of soil pile stiffness, soil modulus, natural frequency, time period and damping characteristics of soil- pile system.

A minimum of three representative piles of same type in almost similar soil conditions shall be tested. Two adjacent piles shall be subjected first to free vibrations and then to forced vibrations, the third pile shall only be tested under forced vibrations.

The equipment and accessories for the test, setting up and test procedure and recording of observations shall be as described in relevant sections IS : 9716 (Guide for Lateral Dynamic Load Test on Piles).

The tests shall normally be carried out without sustained vertical load other than that of the oscillator assembly. However, sustained weight can be used to increase dynamic force to obtain resonance or nearly resonance condition.

From analysis of test data, the following parameters shall be determined:

i) Frequency of vibrations

ii) Amplitude of vibrations

iii) Imparted dynamic force

iv) Natural frequency

v) Damping coefficient

vi) Soil-pile stiffness

vii) Coefficient of horizontal soil modulus variation

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **With Tender**

The Tenderer should submit the following information alongwith his tender :

5.01.01 **Design Data**

The Contractor will submit full details of method of construction, design data and drawings for the type of piles he wishes to adopt.

5.01.02 **Programme of Construction**

The Contractor will also submit the details of the construction equipment that he will employ. A proposed construction programme, matching with the capacity of the equipment and taking into consideration the various idle and non production periods on account of shifting of equipment, testing and possible delays due to modifications of design should be drawn up and submitted along with the tender, keeping in view the completion dates stipulated in the tender.

5.02.00 **After Award**

After award of the contract, the successful tenderer is to submit the following details.

5.02.01 **Execution Plan**

Within 15 days of receiving the letter of Intent the Contractor will submit 6 (six) copies of drawings showing the sequence of driving. The drawings will be prepared on the basis of a master plan giving identification number of the piles, which will be furnished by the Engineer.

5.02.02 **Detailed Construction Programme**

Within 30 (thirty) days of the award of contract, a detailed construction programme for completion of the work is to be submitted. This master programme will be reviewed and updated every month or at more frequent intervals as directed by the Engineer, incorporating the various factors which have caused or are likely to cause changes in the programme.

5.02.03 **Requirement of Materials, Tools and Plants and Equipment**

In accordance with the master programme, a detailed material, tools and plants and equipment requirement schedule, particularly for those items which the Owner is to supply or is to help in procurement as per the terms and conditions of the Contract, is to be submitted within 30 (thirty) days of the contract.

5.02.04 **Test Results**

The test data and result for the various ingredients of R.C.C., concrete cubes and cylinders, driving of the shell, static load test on single piles and group and non-destructive dynamic test on working piles will be submitted regularly and as and when directed by the Engineer. For testing the ingredients of R.C.C. the relevant clauses of the "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply.

TECHNICAL SPECIFICATION
FOR
VIII) BORED CAST IN SITU CONCRETE PILES

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VIII) BORED CAST IN SITU CONCRETE PILE

1.00.00 SCOPE

This specification deals with the requirements regarding materials, workmanship and installation of bored cast-in-situ reinforced concrete piles and all related items of work like sand filling in the holes after casting the piles, testing the load bearing capacity of individual piles and group of piles, etc. The relevant clauses of the "Technical Specification for Concrete Work", appearing elsewhere in this document, fall within the scope of this specification.

IS:2911 (Part-I/Sec-2) shall form a part of this specification and shall be complied with unless they are at variance with the specification where the latter shall prevail.

2.00.00 GENERAL

2.01.00 Work to be provided by the Contractor

The work to be provided for by the contractor, unless otherwise specified, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, equipment and accessories, tools, plants transportation including consumables and temporary works required for the supply and installation of piles of desired capacity.

b) Mark the proposed sequence of installation on six (6) copies of identification plan. The identification plan will be prepared by the contractor as per the basic plan furnished by the Engineer, if so desired by him.

c) Furnish full details of the proposed piling equipment, accessories, temporary works and method of pile construction for approval of the engineer.

d) Submit detailed daily report of boring and pile casting incorporating information as required by the Engineer.

e) Carryout load tests to the satisfaction of the engineer including casting and dismantling of test caps if necessary and submit the test results in approved proforma.

f) Make necessary earthwork and approaches for movement of pile installation equipment.

g) Provide all necessary work mentioned under "Technical Specification for Cement Concrete (Plain and Reinforced)", as may be applicable.

2.02.00 **Work to be provided by others**

No work under this specification will be provided by any agency other than the contractor unless specified elsewhere in the Contract.

2.03.00 **Codes and Standards**

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements/amendments of the following or any other Indian Standard Specifications and Code of Practice.

IS : 269 Indian Standard Specifications for 33 Grade Ordinary Portland Cement.

IS : 383 Indian Standard Specifications for Natural Sources for Concrete.

IS : 432 Indian Standard Specification for (Part - I)Mild Steel & Medium Tensile Steel Bars and Hard drawn Steel Wire for Concrete Reinforcement : Part I Mild Steel and Medium Tensile Steel Bars.

IS : 455 Indian Standard Specifications for Portland Slag Cement.

IS : 456 Indian Standard Code of Practice for Plain and Reinforced Concrete.

IS : 516 Indian Standard Specifications for Methods of Test for Strength of Concrete.

IS : 1199 Indian Standard Specifications for Methods of Sampling and Analysis of Concrete.

IS : 1786 Indian Standard Specifications for high strength deformed steel bars and wires for concrete reinforcement.

IS : 2062 Steel for General Structural Purposes

IS : 2386 Indian Standard Specification for Methods of Test for Aggregates for Concrete Part - I to VIII.

IS : 2502 Code of Practice for Bending & Fixing of Bars for Concrete Reinforcement.

IS : 2722 Indian Standard Specifications for Portable Swing Weight Batches for Concrete (Single and Double Bucket Type).

IS : 2751 Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction.

IS : 2911 Code of Practice for Design and Construction of Pile Foundations - Bored Cast-in-situ piles.

IS : 2911	Code of Practice for Design and (Part - IV)Construction of Pile Foundations - Load Test on Piles.
IS : 4926	Indian Standard Specifications for Ready Mixed Concrete.
IS : 8112	I.S. Specification for 43 grade Ordinary Portland Cement.
IS : 9716	Guide for Lateral Dynamic Load Test on Piles.
IS : 12269	I. S. Specification for 53 grade ordinary portland cement

2.04.00 **Conformity with Design**

The contractor will prepare check lists in approved proforma which will be called "Pile Installation Cards". At each important stage of the work as decided by the engineer, the work will be checked and approved by the engineer for correctness and conformity with the design, specification and drawings, before allowing the next phase of work to commence. The intermediate checks and approvals by the engineer will not, however, absolve the contractor from his total responsibility to execute the work as per the specification and drawings and to remove and/or rectify all work which is defective or inaccurate.

2.05.00 **Materials**

2.05.01 **General**

All materials whether incorporated in the works or used temporarily as aids or for executing enabling works will be of best approved quality conforming to the latest Indian Standard specification.

2.05.02 **Casing**

Casing in boreholes where used, should be manufactured out of best quality mild steel with proper treatment, the composition and thickness of the materials being of special importance where they are likely to be in contact with harmful chemicals and organic materials causing deterioration in service. Casing to be left in place like in offshore piling should also receive similar consideration in selection. They shall have sufficient strength and rigidity to permit their being driven and not to be distorted by soil pressure or driving of adjacent tubes. They shall be sufficiently water-tight to exclude water during placing of concrete.

2.05.03 **Concrete**

Concrete type M-25 (minimum) grade shall be used for piles as indicated in drawings. Materials and method of manufacture for cement concrete shall in general be in accordance with IS : 456. The concrete cube strength on 15 cm. cubes at 28 days shall satisfy the acceptance criteria as per IS : 456. Concrete cubes will be cast as per instruction of the Engineer. These will be cast and cured by the Contractor at site for testing. The concrete shall be of such consistency as to give a slump of 100 to 150 mm. Cement used for the concrete shall be 43 / 53 Grade ordinary Portland cement conforming to IS:8112 & IS:12269 respectively.

2.05.04 **Reinforcement**

Reinforcement shall be mild steel bars conforming to IS: 432. If instead of mild steel, Tor steel bars are used, they shall conform to IS : 1786.

2.06.00 **Storage of Materials**

2.06.01 **General**

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the engineer shall not be used, failing which, the engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the contractor's dues. The relevant clauses pertaining to storage of material under "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply.

2.06.02 **Casing**

Mild steel casing will be painted outside with two coats of anticorrosive paint or smeared with protective layer of grease and kept stored in weather proof sheds, off the ground, on sturdy racks in such a manner as to enable quick and easy in spectrum. Epoxy painting on outside surface shall be provided if so specified in the drawing.

2.07.00 **Quality Control**

The contractor shall establish and maintain quality control for different items of work and materials as may be directed by the engineer to assure compliance with contract requirements and maintain and submit to the engineer records of the same. The quality control requirements stipulated under the "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply wherever relevant. In addition, the requirement will include but not be limited to the following.

a) Location and plumb : Control survey for accuracy in plan and check for verticality.

b) Driving of casing : Correction of weight of hammer, length of fall, number of strokes per minute and rate of penetration.

c) Boring : Boring method to suit soil profile.

d) Casting of piles : Check inside casing, reinforcement cage, concrete mix, placing, consolidation and curing.

e) Inspection of pile

f) Load tests

2.07.01 Any work which fails to conform to the specification will be subject to the issue of a `non-conformance report' in line with the quality control procedures to be implemented at site. Corrective or remedial action, design modification or product rejection will be reviewed in accordance with site quality plan.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS:2911 (Part-I/ Sec.2) and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification might not have covered all the aspects to the full satisfaction of the engineer.

3.01.00 General

The tenderer shall furnish complete information about the type of piles offered with sketches of pile sections showing reinforcement, method of boring, details and availability of equipment and accessories formula or data curve on which the tenderer bases the load carrying capacity of piles as well as the criteria for determining suitable and sufficient founding of individual piles and any other relevant details.

The tenderer will be supplied with bore hole logs or any other data indicating the nature of the soil expected to be encountered. The information furnished to the contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. Piles should be founded on suitable continuous hard strata. In case the contractor is required to drive piles to greater or shallower depths than that is envisaged, the rates will be adjusted as per relevant items in the schedule of items and no other extra claims will be entertained. The tenderer should, in his own interest, investigate the site thoroughly and take additional bores if he feels it necessary to assess the type of boring equipment to be used and the depth to suitable founding strata.

3.02.00 Design of Pile

The contractor shall satisfy the engineer as to the boring procedure and equipment which he proposes to use for the particular conditions of the site. If the engineer desires, sufficient test piles shall be installed to prove the adequacy of the pile, at the places indicated by the engineer and a load test shall be performed on each pile.

The Contractor shall satisfy the Engineer as to the boring procedure and equipment which he proposes to use for the particular conditions of the site. If the Engineer desires, sufficient test piles shall be driven to prove the adequacy of the pile, at the places indicated by the Engineer, and a load test shall be performed on each pile.

Piles have to be reinforced throughout their length. Main longitudinal reinforcement in the length of the piles as well as links or spirals shall be provided as shown in the drawings. Longitudinal bars shall preferably be in one length. Reinforced cage shall be handled and installed carefully without damaging its shape. All other requirements of reinforcement bars i.e., quality,

workmanship, etc. shall be as specified for reinforced concrete work in Technical Specification for Concrete work.

The average basic length of the piles shown in the drawing/schedule of items is tentative and is to be assumed from cut-off level to the tip of the pile, but the final length will be decided by the Contractor with approval of the Engineer on the basis of boring resistance actually observed at site at the particular location. It will be the responsibility of the Contractor to prove by subsequent load tests/pull-out tests that the adopted length of the pile shall carry the safe loads, in compression and tension with the resulting deflections being within permissible limits. To ensure this, the length of the pile actually installed will be subject to change if considered necessary from the above mentioned basic length and payment shall be made to the Contractor on the basis of the actual lengths of pile installed at the rates quoted by the Contractor for deviation in length above or below the stipulated basic length.

If the load test is satisfactory and the Engineer accepts the type of the pile as suitable, payment shall be made for the pile. If the piles by reasons of defective workmanship or failure of one or more load tests, are found to be unsatisfactory, the cost of the test piles shall be borne by the Contractor.

3.03.00 **Identification of Piles**

A plan in triplicate, showing clearly the designation of all piles by an identifying system shall be filed with the engineer before installation of piles is started if so desired by the engineer.

3.04.00 **Sequence of Piling**

Individual piles and pile groups shall be constructed in such a sequence that the adjacent piles already installed are not disturbed, nor their carrying capacity reduced by subsequent boring/driving operation. The Contractor shall submit the sequence order and programme chart to the Engineer and get his confirmation before starting the work.

3.05.00 **Boring**

3.05.01 **With Casing**

Boring equipment and accessories shall generally conform to IS:2911 - relevant section. Boring may be done by either rotary or percussion equipment or grabbing equipment using reversed or direct mud circulation method. In case of unstable soils the boring tools used should be such that suction effects are minimised. Stabilisation of the sides of bore hole shall be done by use of casing. The size of cutting tools shall not be less than the diameter of the pile by more than 75 mm.

The casing should be used from the ground level and shall be kept ahead of boring in case where there is danger of caving-in due to subsoil water entering into the bore hole or where the soil is loose. While boring below subsoil water level, precaution shall be taken so that no boiling of the bottom of the hole occurs due to difference in hydrostatic head.

Boring shall proceed by alternatively driving the casing and extracting the bored material with the boring tools. While boring in soft material liable to cavitation boring tools shall not be operated at a level below the toe of the casing. Care shall be taken to ensure that the volume of water added to the bore shall be not more than the minimum necessary for the operation of the boring tools. The casing shall be driven down through the soft material to penetrate a hard stratum not subjected to cavitation and shall be sealed in this material as far as possible. Thereafter the boring shall be continued by means of the boring tools until the approved bearing layer is reached.

Criteria for approval of the bearing layer will be agreed between the Engineer and the Contractor based on visual inspection of recognisable samples, recovered from the pile bore in the upper levels of the compact layer. The approved samples shall consist of sound material shall be consistent in quality for a depth of 300 mm in the pile bore. A sample of this material shall be supplied by the Contractor to the Engineer duly labelled for maintaining records of the founding strata.

The piles shall be installed with due consideration for safety of adjacent structures by a method which leaves their strength unimpaired and which develops and retains the required bearing resistance.

Where the soil is such that driving of a pile causes previously installed piles to heave, load test shall be conducted at the expense of the Contractor on such proportion of the heaved piles which shall be ordered by the Engineer.

3.05.02 **With Drilling Fluid**

Alternate to the boring with casing, stabilisation of the sides of bore hole can be effected by the use of drilling fluids.

In such cases the drilling fluid must be used at least from the level of subsoil water, as the hole, should then be always kept almost full with the fluid. The density and composition of the fluid shall be such as to suit the requirements of ground conditions and to maintain the fine materials from the boring in suspension. At the last stage of boring or in intermediate hard layers chisel or a chopper may be used. The rate for piling work should be inclusive of any chiselling, chopping of hard strata, clearing of bottom of pile borehole etc. complete as per specifications and necessary penetration test as may be required to prove the soundness of the founding strata. A five per cent bentonite suspension would be generally suitable and its quality shall conform to specification given in Appendix 'A' of IS : 2911 (Part-I/Sec.2).

3.06.00 **Spacing of Piles**

In general, all piles shall have a minimum spacing on centres of 3 d (where 'd' is the diameter of the pile) unless shown otherwise in the drawings.

3.07.00 **Placing of Reinforcement**

Reinforcement as required shall be made into stiff cages sufficiently wired or welded to withstand handling without any damage or distortion. Reinforcement shall be placed immediately after cleaning and inspection of

the bottom of bore holes. The reinforcement should be supported away from the sides of the shaft by means of suitable space block to ensure concentric alignment in the shaft. Steps shall be taken to ensure correct positioning during concreting of reinforcement in the piles without any distortion.

Nominal lap between reinforcement cages shall be 60 cm and the main reinforcing steel shall project for a length sufficient to develop bond (45 times the diameter of reinforcing bar) above the level of the underside of the pile cap.

The concrete cover to main reinforcement shall not be less than 5 cm and suitable spacer blocks shall be provided at intervals not exceeding 2 metres and wired to the main reinforcement.

3.08.00 **Concreting**

Immediately before concreting the bottom of the hole shall be cleaned very carefully. The cleaning of the hole shall be ensured by careful operation by air lifting process unless otherwise allowed by the Engineer. To lift the spoil at founding level before concreting, borehole shall be agitated by jetting with fresh drilling mud with relatively higher pressure than that used during boring or air through tremie pipe. While boring by use of drilling mud, the specific gravity of the mud suspension in the vicinity of the bottom of the borehole shall be determined by suitable slurry sampler in a first few piles and at suitable interval of the piles and recorded. Consistency of the drilled mud suspension shall be controlled throughout the boring as well as concreting operation in order to keep the hole stabilised and to avoid concrete mixed up with the thicker suspension of the mud.

Concreting of boreholes shall start as soon as possible after the completion of boring. If a borehole, be left unconcreted for more than two hours, it shall be cleaned thoroughly as directed by the Engineer before concreting. Concrete shall be so placed as to fill the entire volume of the tube or bore without the formation of voids caused by faulty consolidation or entrapped air. Great care shall be taken to ensure that the fluid alluvial soil does not penetrate between batches of the concrete. Concreting under water shall be done in one operation. Concrete shall be placed by means of a tremie pipe. It shall, however, be ensured that concrete entering the tremie pipe does not get mixed up with the slurry and 1/4 kg of granulated vermiculite shall be poured in the tremie pipe before pouring concrete as directed by the Engineer.

3.08.01 **Tremie Method of Concreting**

The tremie pipes and funnel shall be filled and lifted just 15 cm above bottom before releasing the concrete column to facilitate flushing out the bottom. The concrete levels in the tremie shall be checked every few centimeters in order to note the difference, if any, between the theoretical quantity that should have been placed and actual quantity that has gone in. This is to locate the position of over cut during boring.

In addition to the normal precautions to be taken in tremie concreting as per relevant section of IS:2911 the following specifications shall be particularly applicable for the use of tremie concrete in pipes :

a) The concrete shall be coherent, rich in cement (not less than 400 kg/m3) and of slump not less than 100 mm.

b) The hopper and tremie shall be closed system embedded in the placed concrete, through which water cannot pass.

c) The tremie shall be large enough with due regard to the size of the aggregate. For 20 mm aggregate the tremie pipe shall be of diameter not less than 200 mm, aggregates more than 20 mm shall not be used.

d) The first charge of concrete shall be placed with a sliding plug pushed down the tube ahead of it or with a steel plate of adequate charge to prevent mixing to concrete and water. However, the plug shall not be left in the concrete as a lump.

e) The tremie pipe shall always penetrate well into the concrete with an adequate margin if safety against withdrawal of the pipe is required while discharging the concrete.

f) The pile shall be concreted wholly by tremie and the method of deposition shall not be changed part way up the pile, to prevent the laittance from being entrapped within the pile.

g) All tremie tubes shall be scrupulously cleaned after use.

Normally concreting of the piles shall be uninterrupted. In exceptional cases interruption of concreting may be allowed but it will be resumed within 1 or 2 hours. The tremie shall not be taken out of the concrete, instead it shall be raised and lowered slowly, from time to time to prevent the concrete around the tremie from setting. Concreting should be resumed by introducing a little richer concrete with a higher slump for taking care of the partly set concrete in the bore.

If the concreting cannot be resumed before final setting of concrete already placed, the pile so cast may be rejected.

In case of withdrawal of tremie out of the concrete, either accidentally or to remove a choke in the tremie, the tremie may be reintroduced in the following manner to prevent impregnation of laittance or scum lying on the top of the concrete already deposited in the bore.

The tremie shall be gently lowered on to the old concrete with very little penetration initially. A vermiculite plug shall be introduced in the tremie. Fresh concrete of slump between 150 mm and 175 mm shall be filled in the tremie which will push the plug forward and will emerge out of the tremie displacing laitance/scum. The tremie will be pushed further in steps making fresh concrete sweep away laitance/scum in its way. When tremie is buried by about 60 to 100 cm, concreting may be resumed.

3.08.02 **Concreting in Cased Holes**

In case of cased holes, after the required founding level is encountered, the bottom shall be sealed with concrete and the reinforcement cage shall be lowered. If the borehole is dry, concrete shall be deposited by direct pour from the top followed by gradual withdrawal of casings. If water is present in the borehole, it shall be bailed out by bailer.

If it is difficult to dewater by the bailer, concrete shall be placed under water by means of a placer. After the head of water has been neutralised by the head of the concrete, excess water shall be bailed out and concrete shall then be deposited by direct pouring from the top, as is done, if the borehole is dry.

Extraction of casing shall be done in such a way that no necking or shearing of the concrete in the shaft takes place.

During the extraction of casing, slumping of concrete shall be observed and when required, additional quantity of concrete shall be poured so that the pile is formed above the cut-off level as per the requirements indicated below.

3.08.03 **Cut-off Level**

The top of concrete in a pile shall be brought above the cut-off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment into the pile cap.

Where cut-off level is less than 1.5 m below the working level concrete shall be cast to a minimum of 500 mm above cut-off level. For each additional 0.3 m increase in cut-off level below the working level additional coverage of 50 mm minimum shall be allowed. Higher allowance may be necessary depending on the length of the pile as directed by the Engineer. When concrete is placed by tremie method, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection or to a minimum of one metre above cut-off level. In the circumstances where cut-off level is below ground water level, the need to maintain a pressure on the unset concrete equal to or greater than water pressure shall be observed and accordingly length of extra concrete above cut-off level shall be determined and allowed in Works.

3.09.00 **Steel Pipe or Casing Tube**

This item shall be fabricated with mild steel plates conforming to IS : 2062 and/or steel tubes for structural purpose conforming to IS : 1161 & IS : 1239 as shown on drawings and/or described in the schedule of items.

Fabrication work and welding of steel shall be done in accordance with IS : 800 and IS : 9595. Welding of pipes shall be done by experienced and good welder who have been qualified by tests in accordance with IS : 817.

3.10.00 **Trimming of Pile Heads**

Completed piles shall be trimmed to the cut-off levels shown on the drawings or until sound concrete is found to the satisfaction of the Engineer. In the event of trimming being carried below the cut-off level, the pile shall be made upto the correct cut-off level, with concrete of the same quality as used in the piles at the Contractor's expense. Reinforcement shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile cap. The minimum distance of keying of pile into pile cap shall be 75 mm unless noted otherwise. All concrete and cement shall be removed from the bars, which shall also be wire-brushed to remove any loose, rust, dirt and scale.

Manual chipping shall be permitted after three (3) days of pile casting. Pneumatic chipping, if permitted by the Engineer, shall not be started before seven (7) days. In case Portland Pozzolana cement is used, chipping shall only be started as directed by the Engineer.

3.11.00 **Lengthening of Piles**

Where it is necessary to increase the length of any pile after it has been driven, the head of the pile shall be cut-off to expose the reinforcement for a full bond length of the bars to lap with the new bars. The exposed surface of the concrete shall be hacked to form a key, brushed to remove loose material and covered with 25 mm thick cement mortar (1:2 mix) immediately before the new concrete is placed.

3.12.00 **Removal of Spoil**

The Contractor shall be responsible for the prompt removal from the site of all spoil due to the boring to places indicated by the Engineer. The cost of such disposal shall be deemed to have been included in the cost of piling.

3.13.00 **Back-Filling of Abandoned Borings**

The Contractor shall backfill all the abandoned borings between the concrete pile and the surface level after setting of concrete of the piles, by sand or by other materials as directed by the Engineer.

All permanently abandoned boreholes generally shall be backfilled with selected materials and for a depth of 5 M below cut-off level with plain concrete of mix 1:4:8 so that resistance to lateral forces on neighboring piles are developed.

3.14.00 **Record for Installation of Piles**

The Engineer and the Contractor shall maintain separate registers, signed jointly by both the parties, giving the following information for each pile or any other proforma as agreed between Engineer and Contractor. These data shall be submitted to the Engineer, in triplicate, on completion of installation of each pile.

a) Date of completion, pile number & sequence of installation of piles in a group.

b) Bored depth, concreted depth, empty boring and nature of stratum at founding level.

c) Pile diameter, details of reinforcement and details of mild steel liner where provided along with stiffener.

d) Volume of concrete poured, time taken, cement bag consumption, slump of concrete and RL of top of concrete.

e) Time taken for penetration of every 15 cm during last 2 M depth before founding level.

f) Method of cleaning bottom of hole at founding level before concreting.

g) Records of additional borings or other subsurface information obtained during the process of boring.

h) Any other relevant important information.

Any sudden change in the rate of boring which cannot 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 shall be promptly reported to the engineer and adequate corrective measures shall be taken free of any charge as decided by the engineer.

The data for pile load test (load, displacement, time, etc.) are to be recorded sequentially for the test under consideration in a suitable proforma as agreed between Engineer and Contractor. These data along with the load displacement curve shall be submitted to the Engineer, in triplicate, on completion of each load test.

3.15.00 **Defective Piles**

Any pile which is shown to be defective under load test shall not be accepted and the Engineer will relate such failure to the acceptance of other piles in the area.

If an individual pile should fail to meet the requirements specified in Clause 16.00.00 above such piles may be deemed to be defective and the Engineer may order such investigation to be made as he considers appropriate.

When any pile is found defective, the Contractor shall perform at his own expense one or more of the following remedial measures as directed by the Engineer.

i) Replacement of defective piles.

ii) Providing additional piles.

iii) Alteration in design of pile caps.

3.16.00 **Idle Period**

The phasing of construction and movement of plant shall be done as desired by the engineer. The phasing may involve some extra movement of the plant or some idle period, but the contractor will not be entitled to any claim due to this reason.

3.17.00 **Test Pile**

The contractor may have to construct test piles, if desired by the engineer, before he starts systematic piling operation at locations indicated. For this purpose, the pile construction process shall be the same as in usual piling process to be followed on this job. Load test on such piles shall be as per the provisions under "Procedure for Initial Load Test" in IS : 2911 (Part-IV) or as directed by the engineer.

3.18.00 **Offshore Piles**

Offshore piles, subjected to high horizontal forces and having large unsupported height above the bed level are to be installed under structures to be constructed on river/sea bed. Installation shall be done with the help of floating rig/crane from the river or by cantilever method from land using moving gantry or similar other equipment. Temporary filling of the area for movement of the piling rig will, however, be allowed to the extent that such filling does not encroach on the flow of the river and also no hindrance is caused to adjoining work. The cost of building such temporary gangway/ filling, embedment and removal of the same shall be included in the cost for relevant items related to installation of offshore Piles in the schedule of items.

The piles adopted are in general large diameter bored piles with mild steel liner retained for a height as indicated in the related drawings. The liner shall be of 6 mm mild steel plates fabricated to true shape and be provided with protective surface treatment. The concreting shall be done by tremie method as described earlier and according to the other stipulation as described in the Technical Specification.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

The contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in the contract. Whenever directed, the contractor shall get the specimens tested in a laboratory approved by the engineer and submit to the engineer test results in triplicate within three (3) days of completion of the test.

4.02.00 Components of RCC

The testing and acceptance criteria for components of reinforced cement concrete shall be as stipulated in the relevant clauses of the Technical Specification for Cement Concrete (Plain and Reinforced).

4.03.00 **Components of Steel**

Testing and acceptance criteria for the component of steel pipe material and fabrication work shall be as stipulated in relevant clauses of IS : 800 and IS : 9595.

4.04.00 **Load Tests**

4.04.01 **General**

Initial tests and/or routine tests as indicated in the schedule of items or as directed by the engineer shall be carried out on single pile or pile groups to ascertain the capacities of the piles and their behaviour.

Minimum three (3) nos of test piles are to be provided for each test – Vertical, lateral and pull out test. Minimum load for initial test shall be 2.5 (Two and half) times of design load. Safe load shall be derived from IS code and Technical specification guideline.

Any or all of the tests described below shall be carried out as indicated in the schedule of items and as directed by the engineer. The tests shall be performed as per requirements of the relevant Indian Standards and as supplemented herein.

4.04.02 **Vertical Load Test [as per IS : 2911 (Part-IV)]**

Load tests shall be carried out on single piles to check the bearing capacity or the quality of piles in the manner specified below :

From among the completed piles the Engineer at his discretion shall select piles for the purpose of testing.

At least 1% of the piles driven shall be tested to an overload of 50% above the working load of the pile and 0.1% of the piles driven shall be tested to an over load of 100% above the working load of the pile.

Load shall be applied in increments of about one-fifth of the design load till the design load is reached and thereafter in increment of 10 tonnes till the test load is reached.

Each increment of load shall be maintained for minimum of half an hour upto design load and thereafter for one hour till the test load is reached. Test load shall be maintained for 24 hours.

For each increment of load, readings of settlement at every ten minutes shall be taken. The next increment of load shall be applied only when the difference in settlement of readings between the last two readings does not exceed 0.02 mm. On application of test load, readings shall be taken at every hour.

Unloading will be done in following decrements of load :

i) Test load to design load

ii) Design load to 50% of design load

iii) 50% of design load to 25% of design load

iv) 25% of design load to complete unloading

Each decreased load shall be kept for a minimum of half an hour and readings of rebound taken every ten minutes. The next decrement shall be applied only when the difference in readings between the last two readings is less than 0.02 mm.

The observation and recording of settlement and rebound shall be done simultaneously by the Contractor and the Engineer's representative. Three copies of all the readings for the test shall be supplied by the Contractor to the Engineer-in-charge. Actual proforma for recording the results shall be proposed by the Contractor and approved by the Engineer-in-charge before the start of the load test.

The pile shall be deemed to be acceptable if the gross settlement at the test load of one and a half times the designed load does not exceed 0.01" per tonne of test load or 1/2" (12 mm) whichever is less.

In case a pile fails under or during the load test, the Engineer shall select two additional piles in lieu of each of such piles failed and the Contractor shall carry out load tests on these piles in the same way as the load tests on the original piles at his own cost. This procedure will be repeated in the case of each failure of pile under/during load test.

The Contractor shall arrange at his own expense sufficient amount of knowledge for loading well in advance of the commencement of the load test.

Detailed proposal together with a sketch for the load test arrangement shall be furnished by the Contractor to the Engineer-in-charge for checking and approval.

The pile head shall be chipped off to natural horizontal plane till sound concrete is met. The projecting reinforcement shall be cut-off or bent suitably and the top finished smooth and level. A bearing plate with a hole at the centre shall be placed on the head of the pile for the jacks to rest.

Jacks used in any particular load test should be of the same capacity and their number shall be limited to two only. They should preferably be connected and operated by one pump. The Contractor shall submit certificates certifying the correctness of the calibrations of the pressure gauges and jacks before use. All jacks should be fitted with locking devices. Settlement and rebound shall be recorded by minimum two (2) deflectometers of 0.01 mm sensitivity and also by other independent means of direct measurement. Deflectometers shall be supported independently and in such a way as to be not affected by the settlement of the piles.

4.04.03 **Lateral Load Test**

The test shall be carried out by introducing hydraulic jack with gauge between two piles under test or the reaction shall be suitably obtained otherwise. When the test is conducted by jack located between two piles, the full load imposed by the jack shall be taken as the lateral resistance of each pile.

Load shall be applied in increments of about one-fifth of the design load. The next increment shall be applied after the rate of displacement is nearer to 0.1 mm per 30 minutes. Displacement shall be read by using at least two (2) deflectometer of 0.01 mm sensitivity spaced by 30 cm and kept horizontally one above the other or by any means as per IS-2911 (Part-4) or as approved by the Engineer. The safe lateral load on pile shall be taken as the least of the followings :

a) Fifty percent (50%) of the final load at which displacement increases to 12 mm.

b) Final load at which the total displacement corresponds to 5 mm.

4.04.04 **Pull-out Test**

The test shall be carried out to an overload of fifty percent (50%) of the estimated safe load or a displacement of 12mm total whichever is earlier.

Uplift force may preferably be applied by means of hydraulic jack(s) with gauge using a suitable pull-out set up as per IS-2911 (Part-4) or as approved by the Engineer.

The pull-out load increments and consequent displacement readings shall be same as in the case of Vertical Load Test.

The safe load shall be taken as the least of the followings :

a) Two-thirds of the total load at which the displacement is 12mm.

b) Half the load at which the load-displacement curve shows a clear break (downward trend).

4.05.00 **Non-destructive Dynamic Test on Working Piles**

4.05.01 **"Low Strain" Method for Integrity Investigation of Concrete Piles**

The method of testing shall conform to ASTM D 4945.

All equipments e.g., small impact device 16 lbs. nylon tipped hand held hammer, accelerometer, pile integrity tester & pile driving analyser shall be arranged by the Contractor. Analysis shall be carried out by exponential amplification of the signal with time and the average velocity curve obtained by numerically integrating the acceleration record to be submitted. From analysis of the results any defect like necking, honey-combing, segregation or weakness in concrete, when detected shall be reported in detail.

4.05.02 **"High Strain" Method for Determining of Pile Capacity**

The method of testing shall conform to ASTM D 4945. All equipment including piezoelectric transducers, strain gauges, pile driving analyser, two track oscilloscope for displaying data and analog tape recorders for recording data shall be arranged by the contractor. For every hammer below, the analyser shall determine the following data :

i) Pile bearing capacity

ii) Transferred energy

iii) Maximum compression force

iv) Maximum tension force

v) Maximum impact velocity

vi) Maximum acceleration

vii) Maximum displacement

which are to be properly recorded and analysed and submitted in a detailed report form.

4.06.00 **Acceptance Criteria**

The piles shall be accepted as satisfactory only when the work has been executed in accordance with this specification to the satisfaction of the Engineer and the standards stated hereinafter.

a) The head of the pile shall be within 75 mm of the specified position on the drawings.

b) The pile shall not be out of plumb by more than two percent.

c) The toe of the pile shall be at the approved bearing level in each case.

d) The total volume of concrete shall not be less than 20% and not more than 50% greater than the calculated volume. The calculated volume for this purpose shall be the cross-sectional area inside the casing multiplied by the length of the shaft. The concrete shall show the specified strength as indicated by the cube test results.

e) The results of the load tests including non destructive dynamic test carried out in accordance with the contract and with the specifications shall be satisfactory.

f) In case of single pile the positional tolerance shall not be more than 50mm.

4.07.00 **Lateral Dynamic Load Test on Piles**

Two types of tests, namely, free and forced vibration lateral tests shall be carried out to observe response of soil-pile system under horizontal dynamic loads and for the evaluation of soil-pile stiffness, soil modulus, natural frequency, time period and damping characteristics of soil-pile system.

A minimum of three representative piles of same type in almost similar soil conditions shall be tested. Two adjacent piles shall be subjected first to free vibrations and then to forced vibrations, the third pile shall only be tested under forced vibrations.

The equipment and accessories for the test, setting up and test procedure and recording of observations shall be as described in relevant sections of IS : 9716 (Guide for Lateral Dynamic Load Test on Piles). The tests shall normally be carried out without sustained vertical load other than that of the oscillator assembly. However, sustained weight can be used to increase dynamic force to obtain resonance or nearly resonance condition.
From analysis of test data, the following parameters shall be determined:

i) Frequency of vibrations

ii) Amplitude of vibrations

iii) Imparted dynamic force

iv) Natural frequency

v) Damping coefficient

vi) Soil-pile stiffness

vii) Coefficient of horizontal soil modulus variation

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **With Tender**

The tenderer should submit the following information along with his tender.

5.01.01 **Design Data**

The contractor will submit full details of the method of construction, design data and drawings for the type of piles he wishes to adopt.

5.01.02 **Programme of Construction**

The contractor will also submit the details of the construction equipment that he will employ. A proposed construction programme, matching with the capacity of the equipment and taking into consideration the various idle and non production periods on account of shifting of equipment, testing and

possible delays due to modifications of design should be drawn up and submitted along with the tender, keeping in view the completion dates stipulated in the tender.

5.02.00 **After Award**

After award of the contract, the successful tenderer is to submit the following details :

5.02.01 **Execution Plan**

Within 15 days of receiving the letter of intent the contractor will submit six (6) copies of drawings showing the sequence of piling. The drawings will be prepared on the basis of a master plan giving identification number of the piles, which will be furnished by the engineer.

5.02.02 **Detailed Construction Programme**

Within thirty (30) days of award of the contract, a detailed construction programme for completion of the work is to be submitted. This master programme will be reviewed and updated every month or at more frequent intervals as directed by the engineer, incorporating the various factors that have caused or are likely to cause changes in the programme.

5.02.03 **Requirement of Materials, Tools and Plants and Equipment**

In accordance with the master programme, a detailed material, tools and plants and equipment requirement schedule, particularly for those items which the owner is to supply or is to help in procurement as per the terms and conditions of contract is to be submitted within thirty (30) days of award of the contract.

5.02.04 **Test Results**

The test data and results for the various items like welding of pipes, ingredients of RCC, concrete cubes and cylinders, driving of the shell, static load tests on single piles and pile groups and dynamic tests on working pile will be submitted regularly and as and when directed by the engineer.

TECHNICAL SPECIFICATION
FOR
IX) FABRICATION OF STRUCTURAL STEEL WORK

CONTENTS

CLAUSE NO.	DESCRIPTION
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5.00.00	INFORMATION TO BE SUBMITTED

IX) FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable required for fabrication and supply of all bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork in general covered under the scope of the contract. However, for any special structures such as rail & road bridges, steel chimney, tanks, transmission towers, furnace structures, etc., the relevant Indian Standard or IRC specification and Codes of Practices shall be given due consideration over & above this specification.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following :

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on design drawings to be furnished by the Owner.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and connections developed by the contractor along with detailed fabrication drawings.

d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections. The field connection materials supplied by the contractor shall be to the extent of actual requirement plus 10% (ten percent).

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Despatch lists, Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

h) Insure, load and transport all fabricated steelwork field connection materials to site.

i) Furnish necessary test certificates of all raw steel material supplied by the Contractor.

2.02.00 **Work by others**

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 **Codes and standards**

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard Specification, any other standard practice, as may be specified by the Engineer shall be followed:-

List of IS Codes - Relevant to Fabrication of Structural Steel Work

IS Codes	Description
IS:800	Code of practice for general construction in steel.
IS:801	Code of practice for use of cold formed light gauge steel structural members in general building construction.
IS:806	Code of practice for use of steel tubes in general building construction.
IS:808	Dimensions for rolled steel beams, channels and angle sections.
IS:812	Glossary of terms relating to welding & cutting of metals.
IS:813	Scheme of symbols for welding.
IS:814	Covered electrodes for metal arc welding of carbon and carbon manganese steel.
IS:815	Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
IS:816	Code of practice for use of metal arc welding for general construction in mild steel.
IS:817	Code of practice for training & testing metal arc welders.
IS:818	Code of practice for safety and health requirements in electric and gas welding and cutting operations.

IS:819	Code of practice for resistance spot welding for light assemblies in mild steel.
IS:822	Code of practice for inspection of welds.
IS:919	Recommendations for limits and fits for (Part-1&2) engineering.
IS:1161	Steel Tubes for structural purposes.
IS:1182	Recommended practice for Radiographic Examination of fushion welded butt joints in steel plates.
IS:1200	Method of measurement of steel work and iron (Part-8) work
IS:1239	Mild steel tubes, tubulars and other wrought (Part-1&2) steel fittings
IS:1363	Hexagon head bolts, screws and nuts of product (Part-1 to 3) grade C.
IS:1364	Hexagon head bolts, screws and nuts of product (Part-1 to 5) grade A & B.
IS:1365	Slotted counter sunk head screws (dia. 1.6 to 20 mm)
IS:1367	Technical supply conditions for threaded steel (Part-1 to 18) fasteners.
IS:1608	Method for tensile testing of steel products.
IS:1730	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.
IS:1852	Rolling and cutting tolerances for hot-rolled steel product.
IS:1977	Structural steel (Ordinary quality)
IS:2016	Plain washer
IS:2062	Steel for general structural purposes.
IS:2629	Recommended practice for hot-dip galvanizing of iron and steel.
IS:2633	Method for testing uniformity of coating on zinc coated articles.
IS:3644	Code of practice for ultrasonic pulse echo testing by contact and immersion method.
IS:3757	High Strength Structural Bolt

IS:4000	High strength bolts in steel structure
IS:4759	Specifications for hot-dip zinc coatings on structural steel and other allied products.
IS:4923	Hollow steel sections for structural use.
IS:5334	Code of practice for magnetic particle flaw detection of weld.
IS:5369	General requirements for plain washers and lock washer.
IS:6005	Code of practice for phosphating of iron and steel.
IS:6649	Specification for hardened and tempered washers for high strength structural bolts and nuts.
IS:6623	Specification for high strength structural nuts.
IS:7215	Tolerances for fabrication of steel structures.
IS:7280	Bare wire electrode for submerged arc welding
IS:8500	Structural steel micro alloyed (medium & high strength quality).
IS:8629	Code of practice for protection of iron and (Part-I to III) steel structures from atmospheric corrosion.
IS:9595	Recommendation for metal arc welding of carbon manganese steels.

Painting

IS:117	Specification for ready mixed paint, brushing, finishing, exterior, semi-gloss, for general purposes.
IS:128	Specification for ready mixed paint, brushing, finishing, semi-gloss for general purposes, black.
IS:1477	Code of practice for painting of ferrous metal (Part-I & II) in building.
IS:2074	Ready mixed paint, air-drying red-oxide zinc chrome priming.
IS:2339	Specification for aluminium paints for general purposes in dual container.
IS:2932	Specification for enamel, synthetic exterior type-I.
IS:2933	Specification for enamel, synthetic exterior type-II.

2.04.00 **Conformity with Designs**

Except where the standard connection details are furnished, the contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer Keeping in view the maximum utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 **Materials to be used**

2.05.01 **General**

All steel materials shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant.

If desired by the Engineer, Test Certificates of materials supplied by the contractor in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tonnes or less of any particular section.

The arc welding electrodes shall conform to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and ampereage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 **Steel**

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable :

1)	IS:801	Cold formed light gauge steel structural member.
2)	IS:806	Steel tubes in general building construction.
3)	IS:1161	Steel tubes for structural purpose.
4)	IS:1977	Structural steel (Ordinary quality) St-42-0.
5)	IS:2062	Steel for general structural purpose
6)	IS:8500	Structural steel-micro alloyed (Ordinary & high strength quality)

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 **Electrodes**

All electrodes to be used under the Contract shall comply with any of the following Indian Standard Specifications as may be applicable :

1) IS:814 Covered electrodes for metal arc welding structural steel

2) IS:815 Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.

3) IS:7280 Base wire electrode for submerged arc welding.

2.05.04 **Bolts and Nuts**

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS:1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel : All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm2 and a minimum elongation of 23 per cent on a gauge length of $5.6\sqrt{A}$, where 'A' is the cross sectional area of the test specimen :

   1) IS:1367 Technical supply conditions for threaded fastners.

   2) IS:1608 Method for tensile testing of steel other than sheet, strip, wire and tube.

b) High Tensile Steel : The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS:1367 or as approved by the Engineer.

2.05.05 **Washers**

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract :

1) IS:1977 Structural steel (Ordinary Quality) St-42-0

2) IS:2062 Steel for general structural purpose

3)	IS:8500	Structural steel - microalloyed (medium & high strength quality)
4)	IS:6623	High Strength Structural Nuts
5)	IS:6649	Hardened and tampered washers for high strength structural bolts & nuts.

2.05.06 **Paints**

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS:2074 - Ready mixed Paint, Air Drying, Red Oxide - Zinc Chromate Priming.

In highly corrosive environment other type of primer such as epoxy resin based zinc rich primer may be necessary.

2.06.00 **Storage of Material**

2.06.01 **General**

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.06.02 **Steel**

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground sectionwise and lengthwise so that they can be easily inspected, measured and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.06.03 **Electrodes**

The electrodes for electric are welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.06.04 **Bolts, Nuts and Washers**

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.

2.06.05 **Paints**

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.07.00 **Quality Control**

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work :

1)	Steel	Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
2)	Bolts, Nuts Washers	Manufacturer's certificate, dimension checks, material testing.
3)	Electrodes	Manufacturer's certificate, thick-ness and quality of flux coating.
4)	Welders	Qualifying Tests
5)	Welding sets	Performance Tests
6)	Welds	Inspection, X-ray, Ultrasonic tests
7)	Paints	Manufacturer's certificate, physical inspection reports
8)	Galvanizing	Tests in accordance with IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-Dip Zinc

coatings on Structural Steel and other allied products.

2.08.00 **Standard dimensions, forms and weights**

The dimensions, forms, weights and tolerances of all rolled shapes bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.09.00 **Shop Drawings**

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and delivery of structural steelwork for approval. He shall within forty five (45) days after issue of design drawings start to submit progressively for approval, the shop drawings based on the Design Drawings furnished to him and, before proceeding with the fabrication work, shall get the said shop drawings approved in accordance with the contract.

The sequence of submission of shop drawings for approval shall match with the approved fabrication and delivery schedule. The approval for the shop drawings will be accorded only towards the general conformity with the design requirements as well as specification and will ensure the correctness of general arrangement for centreline dimensions and levels, Section sizes, and adequacy of connections including splice joints as to the no. of bolts, weld length, size of gusset/end plates. The correctness of all other details like cutting lenghts, matching of holes, notch dimensions, match markings, bill of materials, bolt list etc. will be entirely the contractor's responsibility. The approval of the drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The shop drawings shall include but not be limited to the following :

a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolt location etc.

c) Details of all connections with supporting calculations.

d) Comparison sheets to show that the proposed alternative section, if any, are as strong as the original sections shown on the Design Drawings.

e) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

f) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

The shop drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this Specification. Shop drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Shop drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between shop and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the shop drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked -up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification IS:813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall pay for any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS:800 - Code of Practice for use of Structural Steel in General Building Construction and other relevant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification IS:1852 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600 Deg. C.

3.01.03 Cutting

Cutting shall be effected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges. Occasional notches or gauges not more than 4 mm deep will be permitted. Gouges greater than 4 mm, that remain from cutting, shall be removed by grinding. All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 **Planning of edges**

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 **Clearances**

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practical reasons, greater clearance is necessary, suitably designed cleatings shall be provided.

3.02.00 **Bolted construction**

3.02.01 **Holes**

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of H8 as specified in IS:919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for bolts shall not be formed by gas cutting process.

3.02.02 **Assembly**

Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer, one spring washer or lock-nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.03.00 **Welded Construction**

3.03.01 **General**

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS:817.

3.03.02 **Preparation of Material**

Surface to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas-cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 **Assembling**

Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2 Deg.).

The work shall be positioned for flat welding whenever practicable.

3.03.04 **Welding Sequence**

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 **Welding technique**

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the Contract.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03.06 **Temperature**

No welding shall normally be done on parent material at a temperature below (-) 5 Deg.C. However, if welding is to be undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5 Deg. C and 0 Deg. C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is

greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20 Deg. C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03.07 **Peening**

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03.08 **Equipment**

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 **Finish**

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., after welding together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2.0 mm.

3.05.00 **Slab bases and caps**

Bases and caps fabricated out of steel slabs, except when cut from material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3.06.00 **Lacing bars**

The ends of lacing bars shall be neat and free from burrs.

3.07.00 **Separators**

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.08.00 **Bearing Plates**

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.09.00 **Architectural Clearances**

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.10.00 **Shop connections**

a) All shop connections shall be welded as specified on the Drawings.

b) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the Contractor will have to make the desired changes at no extra cost to the Owner.

3.11.00 **Castings**

Steel castings shall be annealed.

3.12.00 **Shop erection**

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before despatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchangeability.

3.13.00 **Shop painting**

3.13.01 **General**

Unless otherwise specified, steelwork which will be concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other mechanical cleaning methods to remove loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by through sweeping with a fibre brush.

After completion of the precleaning, the metal surface shall be immediately painted with red oxide zinc chromate primer conforming to IS : 2074.

In highly corrosive environment, all steelwork shall be given a coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned by sand blasting to SA 2/1/2 grade minimum. The shop paint shall be epoxy rasin based zinc rich primer.

Painting on Structural Steel

All structural steel shall receive 2 coats of red oxide zinc chromate primer (conforming to IS:2074), over 2 coats of synthetic enamel paint (of approve quality) Minimum thickness of each coat shall not be less than 25 micron).

3.13.02 **Inaccessible parts**

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.13.03 **Contact surfaces**

Contact surface shall be cleaned in accordance with Sub-clause 3.13.1 before assembly.

3.13.04 **Finished surfaces**

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.13.05 **Surfaces adjacent to field welds**

Unless otherwise provided for, surfaces within 50 mm of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.14.00 **Galvanizing**

3.14.01 **General**

Structural steelwork for switchyard or other structures as may be specified in the Contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS : 2629 - Recommended practice for Hot-Dip Galvanising of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.14.02 **Surface Preparation**

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, dirt, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.14.03 **Procedure**

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after having been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport and handling. Damages, if occur, shall be made good in accordance with the provisions of this Specification or as directed by the Engineer.

4.00.00 **INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY**

4.01.00 **Inspection**

Unless specified otherwise, inspection to all work shall be made by the Engineer or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract.

The Contractor shall guarantee compliance with the provisions of this Specification.

4.02.00 **Testing and Acceptance Criteria**

4.02.01 **General**

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost, unless otherwise specified in the Contract. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 **Steel**

All steel supplied by the Contractor shall conform to the relevant Indian Standards. Except otherwise mentioned in the Contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T. or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be borne by the Contractor.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance.

4.02.03 **Testing Criteria for checking Lamination in raw steel plates**

All raw steel plate of thickness more than 20 mm supplied by the contractor shall be checked against lamination before procurement & prior to commencement of fabrication work in the following ways as directed by the Engineer.

a) Ultrasonic testing along the edge of specified points of the plates shall be carried out to delete lamination in the plates, if any.

b) If the results of the tests in (a) are not satisfactory, the whole area of the plates shall be checked by ultrasonic testing at specified nodal points formed at equidistant grid locations. The spacing of the grids shall be determined from tests in (a) or as directed by the Engineer.

c) All raw steel plate of thickness more than 40 mm shall be procured with UT tested condition.

If the results of the above tests are not satisfactory, the plates shall not be taken up for fabrication work. Even after fabrication at shop, if the Engineer requires any ultrasonic testing to detect lamination of plates, the same shall be carried out by the Contractor. If the plates in the fabricated item are found to be laminated, the component will be rejected.

4.02.04 **Welding**

All electrodes shall be procured from reliable manufacturers with test certificates. The correct grade and size of electrode which has not deteriorated in storage shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tonnes of welded fabrication, the Engineer may ask for at least 1 (one) test- destructive or non-destructive including X-ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor. In the event of further tests as may be desired by the Engineer, the cost of such test shall be borne by the Contractor if the results are found to be unsatisfactory; and if the test shows no defect, the cost shall be borne by the Owner. In cases of the test results showing deficiency, the Engineer shall have option to reject or instruct any remedial measures to be taken free of charge to the Owner.

4.02.05 **Bolts, nuts and washers**

All bolts, nuts and washers shall be procured from reputed manufacturer approved by the Engineer and shall conform to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor.

4.02.06 **Shop painting**

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02.07 **Galvanizing**

All galvanizing shall be uniform and of standard quality when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 **Tolerance**

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS:1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures other than steel railway & road bridges, structures subjected to dynamic loading (like wind, seismic etc.) and

thin walled construction (like box girders) shall be as specified in IS:7215 - Tolerances for Fabrication of Steel Structures.

4.04.00 **Acceptance**

Should any structure or part of a structure be found not to comply with any of the provisions of this Specification, the same shall be liable to rejection. No structure or part of the structure, once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check the test results obtained at the Contractor's works by independent tests at an approved laboratory and should the items, so tested, be found to be unsatisfactory, the costs shall be borne by the contractor, and if satisfactory, the costs shall be borne by the Owner.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue an acceptance certificate, upon receipt of which, the items will be shop painted, packed and despatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 **Delivery of materials**

4.05.01 **General**

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. the Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.05.02 **Marking**

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03 **Packing and Shipping**

All projecting plates or edges and all ends of members of joints shall be stiffened, all straight members and plates, shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers, and small loose parts shall be packed separately in order to prevent damage or distortion during shipping.

Shipping shall be strictly in accordance with the sequence stipulated in the agreed programme. Payment may be held up for items sent in advance of the sequence till they could be erected. The Contractor shall include and provide for in his rates, the freight and other charges for despatching the materials to

the worksite and also for securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All packings shall allow for easy removal and checking at site. Special precautions shall be taken against rusting, corrosion, breakage or damage otherwise of the materials. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following :

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water- proof envelope, quoting especially

a) Name of the Contractor

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each package shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner without any extra payment.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel

belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above mentioned charges, the amount paid will be deducted from the progressive bills of the Contractor.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following information are required to be submitted with the Tender:

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

1) Preparation and approval of shop drawings

2) Procurement of materials

3) Fabrication and shipping of all anchor bolts

4) Fabrication and shipping of main steelwork

5) Fabrication and shipping of steelwork for bunkers. Tanks and / or silos as applicable.

6) Fabrication and shipping of all other remaining steel work including miscellaneous steelwork

7) Final date of completion of all shipments

Time required for completion being one of the main criteria for selecting the successful bidder, it is desired that the bidder quotes the minimum time required by him for completing the work.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity and the capacity that will be available exclusively for this contract shall be submitted.

5.02.00 After Award

After award of the Contract the successful Tenderer is to submit the following :

a) Complete fabrication drawings, material lists, cutting lists, bolt lists, field welding schedules based on the design drawings furnished to him in accordance with the approved schedule.

b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day of each month, giving the up to date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

c) Results of any test as and when conducted and as required by the Engineer.

d) Manufacturer's mill test report in respect of steel materials, bolts, nuts and electrodes as may be applicable.

TECHNICAL SPECIFICATION
FOR
X) ERECTION OF STRUCTURAL STEEL WORK

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X) ERECTION OF STRUCTURAL STEEL WORK

1.00.00 **SCOPE**

This specification covers the erection of structural steelwork and installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 **GENERAL**

2.01.00 **Work to be provided for by the Contractor**

The work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour and supervision required for the erection of the structural steelwork.

b) Receiving, unloading, checking and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. any defect observed in the foundation shall be brought to the notice of the Engineer. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, leveling, bolting, welding and securely fixing the fabricated steel structures in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures if required by the Contract.

g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:

   i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size bolt if required.

iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication. Welding in place of bolting will be permitted only at the discretion of the Engineer.

v) Re-fabrication of parts damaged beyond repair during transport and handling or Re-fabrication of parts which are incorrectly fabricated.

vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vii) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

viii) Carry out tests in accordance with this Specification if directed.

2.02.00 **Work by others**

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 **Codes and Standards**

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

IS-800	:	Code of Practice for general construction in steel
IS-456	:	Code of Practice for plain or reinforced concrete
IS-7205	:	Safety Code for erection of Structural Steel work
IS-12843	:	Tolerance for erection of Steel Structures

2.04.00 **Conformity with designs**

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the design criteria detailed in the approved erection drawings and/or other stated document. All work shall conform to the provisions of the relevant Indian Standard Specifications and/or the instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specification and /or the instructions of the Engineer.

2.05.00 **Material**

2.05.01 **General**

All fabricated steel structures and connection materials shall be supplied by the Contractor for fabrication work. The Contractor may also have to take delivery directly from railway wagons or trucks at Site as per terms & condition of the contract, in which case he shall have to unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.1.0 and as specified herein before.

While taking delivery, the Contractor will check the quantity, quality and the sizes of the materials and verify the adequacy of the same in accordance with the Drawings and Specifications. In case the Contractor finds any material inadequate, he shall inform the Engineer immediately prior to taking delivery of the same. No claim whatsoever, in respect of bad quality, shortages or difference in size will be entertained once the delivery is taken and the Contractor shall make good any such deficiency, if detected later, either by repair or with fresh material as may be directed by the Engineer at the Contractor's Own cost.

Excepting all field connection materials like bolts, nuts, washers and electrodes, which will be supplied by the fabrication Contractor to the extent of 10% in excess of the estimated requirements as per Drawings, all other consumables like oxygen and acetylene gas, paints, fuels, lubricants, oil, grease, cement, sand, aggregates and any other material that may be required for the execution of the works in accordance with the contract will be supplied by the contractor for erection work and will be deemed to have been included in this rates.

2.05.02 **Materials to conform to Indian Standards**

All materials required to be supplied by the Contractor under this Contract shall conform to the relevant Indian Standard Specifications.

2.06.00 **Storage of materials**

2.06.01 **General**

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the Engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.

2.06.02 **Yard**

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other materials according to the Contract. The yard shall have proper facilities like, drainage, lighting, suitable access for large cranes, trailers and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of

sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work.

The Tenderer should visit the site prior to submission of his Tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.06.03 **Covered Store**

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

2.07.00 **Quality control**

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the following items of work :

a) Erection : Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

b) Grouting : Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency and strength of grout.

c) Painting : Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00 **Taking Delivery**

The erection Contractor shall take delivery of fabricated structural steel and necessary connection materials supplied by the fabrication Contractor from railhead, trucks at site as may be necessary and as per terms & conditions of the contract or as directed by the Engineer. He shall check, unload, transport the materials to his stores for proper storing at his own cost. The erection Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The erection contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Erection shall arrange for most economical method and sequence available to him consistent with the Drawings and Specifications and such information as may be furnished to him prior to the execution of the Contract.

3.01.03 Temporary bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, free of cost to the Owner, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The responsibility of the Contractor in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, leveled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work and cribbing shall be removed immediately upon completion of the steel erection and shall return to the Owner's store in good condition if the materials are supplied by the Owner otherwise permission shall be given to Contractor to take out the materials from the project site. The Owner may remove and return the materials in good condition to the Contractor without any charge if they have been left in place under other agreed arrangement.

3.01.04 Temporary floors for buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or by-laws of state, Municipal or other local authorities.

3.01.05 **Setting out**

Positioning and leveling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. Concrete foundations, where required, shall be made by other agencies. Anchor bolts and other anchor steel shall be embedded by other agencies. The Contractor shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, etc. the Contractor shall set proper screed bars if desired by the Engineer, to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable under this Specification.

No permanent field connections by bolting or welding shall be carried out until proper alignment and plumbing has been attained.

3.01.06 **Field bolting**

All relevant portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following :

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into good contact with each other. "snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-1 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 x dia. or 200 mm	Bolt length exceeding 8xdia. or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation-30 over or under.

Bolts may be installed without hardened washers when tightening is done by the turn-of-nut method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the nut match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II. Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm)	Torque to be applied (Kg.M) for bolt class 8.8 of IS:1367
20	59.94
22	81.63
24	103.73

Note :

The above torque values are approximate for providing tensions of 14.7 MT for 20 mm dia., 18.2 MT for 22 mm dia.; and 21.2 MT for 24 mm dia., bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular torque wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.07 **Field Welding**

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.08 **Holes, cutting and fitting**

No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done unless specifically approved and / or instructed by the Engineer.

The erector shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.02.00 **Drifting**

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 **Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)**

Grouting shall be carried out with Ordinary Cement grout as described below :

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air-locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm downgraded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

Admixtures like aluminium powder, "ironite" or equivalent may be required to be added to the grout to enhance certain desirable properties of the grout.

Alternatively, the grouting may be done with non-shrink high strength free flow cementious grout (ready mixed) like "Sika grout - 214", or "Anchor NSG" or approved equivalent.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally leveled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

3.04.00 **Painting after erection**

Field painting, if required to be done by the erection Contractor, shall only be done after the structure is erected, leveled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. However, touch up paintings, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the erection Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in rainy or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field bolts, welds and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces which will be in contact after site assembling shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface which will be inaccessible after field assembly shall receive the full specified protective treatment before assembly. Bolts and fabricated steel members which are galvanized or otherwise treated and steel members to be encased in concrete shall not be painted.

The specification for paint and workmanship shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable to the project. The number of coats and the shades to be used shall be as specified or as directed by the Engineer.

3.05.00 Stainless Steel Plate Lining in Bunker Hopper

The hopper portion of the coal bunkers shall be lined with stainless steel plates of 3 mm thickness. The stainless steel shall be of AISI-316 quality. The work includes supply, fabrication, welding and fixing of stainless steel lining plate to bunker M.S. plate as per drawing & specification.

The stainless steel liner shall be fixed to the bunker hopper MS by plug welding using special electrodes (such as, Inox-CW coding AWS-310-16, ISMBOS-311 or Inox-D2 coding AWSE-309-16, ISMB 04-311 manufactured by Advani Oerlikon Ltd. or equivalent). Such plug welding shall be done by drilling 21.5 mm dia. holes at 300 mm centre to centre both ways as per drawings. The plug welding shall be ground flush with the lining plate.

3.06.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the Contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

3.07.00 Safety Measures during Erection

The safety measures to workmen and supervisors during all types of erection work (e.g., use of lifting appliances, slinging, welding, gas cutting, etc.) should be taken as per IS:7205. When any statutory provisions exist, the same shall be complied with in addition to the provisions contained in the above code.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract of either fabrication or erection of steelwork whoever is responsible for it and no payment towards the cost of the dismantled portion and any connected work shall be made to the Contractor, unless it is proved that the deficiency is due to reasons beyond the Contractor's scope. On the basis of the tests, the Engineer will decide whether the fabricator or the erector is responsible for the unacceptable member or structure and his decision will be final. In case it is established that the unacceptability of the member or

structure is due to design deficiency, the cost of replacement and/or modifications will be borne by the Owner. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor responsible, to the satisfaction of the Engineer. The cost of the tests specified hereinafter shall be borne by the Owner. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following Sub-clauses 4.1.1, 4.1.2 and 4.1.3. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 **Stiffness Test**

In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 **Strength Test**

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 **Structure of same design**

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of

comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 **Repair for subsequent test and use after strength tests**

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 herein before and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.1.1. herein before.

4.02.00 **Tolerances**

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steelwork applicable to this Project and as specified below:

I. For Buildings Containing Cranes

Component	Description		Variation Allowed
Main columns	a)	Shifting of column axis at foundation level with respect to building line	
		i) In longitudinal direction	i) $\pm$ 3.0 mm
		ii) In lateral direction	ii) $\pm$ 3.0 mm
	b)	Deviation of both major column axis from vertical between foundation and other member connection levels :	
		i) For a column upto and including 10M height	i) $\pm$ 3.5 mm from true vertical

Component	Description		Variation Allowed
	ii)	For a column greater than 10M but less than 40M height any 10M	ii) ± 3.5 mm from true vertical for length measured between connection levels, but not more than ± 7.0 mm per 30 m length
	c)	For adjacent pairs of columns across the width of the building prior to placing of truss.	± 9 mm on true span.
	d)	For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e)	For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	3 mm
Trusses	a)	Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord	1/1500 of the span or not greater than 10 mm whichever is the least
	b)	Lateral displacement of top chord at centre of span from vertical plane running through centre of supports.	1/250 of depth of truss or 20 mm whichever is the least
Crane Girders & Tracks	a)	Difference in levels of crane rail measured between adjacent columns.	2.0 mm
	b)	Deviation to crane rail gauge	± 3.0 mm

Component	Description		Variation Allowed
	c)	Relative shifting of ends of adjacent crane rail in plan and elevation after thermit welding.	1.0 mm
	d)	Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion gaps		At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per Deg.C per unit length.	

II. For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ± 3.0 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10M section of height and not more than 7.0 mm per 30 M section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 **Acceptance**

Structures and members which have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.1.0, 4.1.1, 4.1.2, 4.1.3 and 4.1.4 and other applicable provisions of this Specification and are within the limits of tolerances specified in Sub-clause 4.2.0 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this Contract.

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **Before Tender**

Along with the Tenders the Tenderers will be required to submit the following information :

5.01.01 **Tentative Programme**

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to Site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.01.02 **Constructional Plant & Equipment, Tools, Temporary Works & Manpower**

A detailed list of all Constructional Plant & Equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 **Erection yard**

A site plan showing the layout and location of the erection yard proposed to be established by the Tenderer shall be attached with the Tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.02.00 **After award of the Contract**

After award of the contract, the Contractor shall submit the following :

5.02.01 Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 **Fortnightly Progress Report**

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub- clause 5.2.1 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

TECHNICAL SPECIFICATION
FOR
XI) ROADS AND DRAINAGE

PART-I : CONSTRUCTION OF ROADS & DRAINS

CONTENTS

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5.00.00	INTERLOCKING PAVING BLOCKS

XI) ROADS AND DRAINAGE

PART-I : CONSTRUCTION OF ROADS & DRAINS

1.00.00 SCOPE

This specification covers all work required for the construction of road including box-cutting, edging, sub-base, water bound macadam, bituminous macadam, wearing course etc. and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

This specification also includes all work required for drainage including road side drain, R.C.C. culverts, pipe-culverts, drainage pipes, manholes etc. and all other incidental items.

2.00.00 GENERAL

2.01.00 Work to be Provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, equipment, tools and plants, transportation etc. required for the work.

b) Submit for approval detailed schemes of all operations required for executing the work e.g., material handling, placement, services, approaches etc.

c) To carry out and submit to the Engineer results of tests whenever required by the Engineer to assess the quality of work.

2.02.00 Work to be Provided for by Others

No work under this specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant I.S. Specifications and Codes of Practice.

1. Specification for road and bridge works of Ministry of shipping & Transport (Roads wing) Published by the IRC.

2. IRC-19 Standard specifications and Code of Practice for Water Bound Macadam.

3. IRC:SP-11 Hand Book of Quality Control for Construction of Roads and Runways.

4. IS:456 Indian Standard Code of Practice for Plain and Reinforced Concrete.

5. IS:2212 Code of Practice for Brickwork.

6. IS:783 Code of Practice for Laying of Concrete Pipes.

7. Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by Indian Standard Specification, any other standard practice as may be specified by the Engineer shall be followed.

2.04.00 **Conformity with Designs**

The contractor shall carryout the work as per the drawings issued to him and/or contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be Used**

2.05.01 **General**

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

2.06.00 **Quality Control**

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used.

All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer. Permitted tolerances for roadworks are described hereinafter.

i) Horizontal Alignments

Horizontal alignments shall be reckoned with respect to the center line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of $\pm$ 25 mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be $\pm$ 40 mm.

ii) Longitudinal Profile

The levels of the sub-grade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer, beyond tolerances mentioned below:

Sub-grade	$\pm$ 25 mm
Sub-base	$\pm$ 20 mm
Base course	$\pm$ 15 mm
Wearing course	$\pm$ 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance for base course if the thickness of the former is thereby reduced by more than 6 mm.

iii) Surface Regularity of Sub-grade and Pavement Courses

The surface regularity of completed sub-bases, base courses and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table-I.

TABLE-I

PERMITTED TOLERANCES OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal Profile with 3 m straight edge					Cross Profile
		Max. Permissible undulation.	Max. number of undulations permitted in any 300 metres length exceeding :				Max. permissible variation from specified profile under camber template
			mm	mm	mm	mm	
			18	12	10	6	
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50mm & 40-63mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.	Surface dressing ** (two coat) over WBM (20-50mm or 40-63mm size metal), Bituminous penetration macadam or built-up spray grout	12	-	-	20	-	8
6.	Open graded premix carpet, mixseal surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20 ***	6
8.	Semi-dense carpet	10	-	-	-	20 ***	6
9.	Asphaltic Concrete	8	-	-	-	10 ***	4

The longitudinal profile shall be checked with a 3 meter long straight edge, at the middle of each traffic lane along a line parallel to the center of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10 metres.

Notes :

1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

2. *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However, this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.00.00 EXECUTION

3.01.00 Shoulder Construction

3.01.01 Description

This work shall consist of constructing shoulders on either side of the pavement, in accordance with the requirements of this specification and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

3.01.02 Materials

Shoulder may be of selected earth or granular material conforming to the requirements of embankment construction or granular sub-base construction respectively.

3.01.03 Construction Operations

Except in the case of bituminous constructions, shoulders shall be constructed in advance of the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and included area cleaned of all spilled material before proceeding with the construction of the pavement layer.

In the case of bituminous courses, shouldering operations shall start only after the pavement course has been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed, without damage to the pavement and the area so affected thoroughly cleaned.

During all stages of shoulder construction, the required cross-fall shall be maintained to drain off surface water.

3.02.00 **Kerb**

3.02.01 **Material**

Kerb, if required for construction of footpath, shall consist of precast concrete blocks with a concrete grade of M-20 (minimum).

3.02.02 **Laying**

The Kerb shall be laid by cutting trenches 150 mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the Kerbs shall be in plumb and the gap between the block shall not be more than 10 mm.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.03.00 **Sub-base (Granular Sub-base)**

3.03.01 **Description**

This work shall consist of laying and compacting well-graded material on prepared sub-grade in accordance with the requirements of these specifications. The material shall be laid in one or more layers as shown on the drawings and according to lines, grades and cross sections shown on the drawings or as directed by the Engineer.

3.03.02 **Materials**

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kanker etc. or combinations thereof depending upon the grading required. The mixed materials shall be free from organic or other deleterious constituents and conform to one of the three gradings given in Table-II below.

TABLE-II
GRADING FOR GRANULAR SUB-BASE MATERIALS

Sieve designation	**Percent by weight passing the sieve**		
	Grading 1	**Grading 2**	**Grading 3**
80 mm	100	100	100
63 mm	90-100	90-100	90-100
4.75 mm	35-70	40-90	50-100
75 micron	0-20	0-25	0-30
CBR Value (Minimum) : for fraction of material passing 20 mm sieve	30%	25%	20%

Note : The material passing 425 micron sieve for all the three gradings when tested according to IS:2720 (Part V) shall have liquid limit and plasticity index of not more than 25 percent and 6 percent respectively.

3.03.03 **Physical Requirements**

The fraction of material passing 20 mm sieve shall give a CBR value as specified in Table-II when tested in accordance with IS:2720 (Part XVI) after preparing the samples at maximum dry density and optimum moisture content corresponding to IS:2720 (Part VII) and soaking the same in water for 4 days.

3.03.04 **Spreading and Compacting**

Immediately prior to the laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water, if necessary, and rolled with one pass of 8-10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of the layer after consolidation does not exceed 150 mm.

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part II) and suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS:2720 (Part VIII). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be started with 8 to 10 tonne smooth wheeled rollers or other approved plant. Rolling shall commence at the edges and progress towards the center longitudinally except that on super elevated portions it shall progress from the lower to the upper edge parallel to the center line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density for the material determined as per IS:2720 (Part VII). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

3.04.00 **Water Bound Macadam Sub-base/Base Course**

3.04.01 **Description**

Water bound macadam shall consist of clean, crushed aggregates mechanically interlocked by rolling, and bonded together with screenings, binding material, where necessary and water, laid on a prepared sub-grade or sub-base, as the case may be, and finished in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or otherwise directed by the

Engineer.

3.04.02 **Materials**

3.04.02.1 Coarse Aggregates - General Requirements

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table-III.

TABLE-III

PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WATER BOUND MACADAM

Sl. No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value*	IS:2386 (Part IV)	50 percent maximum.
		or		
		Aggregate Impact Value	IS:2386 (Part IV)	40 percent maximum.
		or IS:5640**		
2.	Base	a) Loss Angeles Abrasion Value*	IS:2386 (Part IV)	50 percent maximum.
		or		
		Aggregate Impact Value	IS:2386 (Part IV)	40 percent maxi mum.
		or IS:5640**		
		b) Flakiness Index***	IS:2386 (Part I)	15 percent maximum.

* Aggregate may satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water, shall be tested for impact value under conditions in accordance with IS:5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

3.04.02.2 Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt and other objectionable matter.

3.04.02.3 Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table-IV, provided, however, the use of Grading No. 1 shall be restricted to sub-base courses only.

TABLE-IV

GRADING REQUIREMENTS OF COARSE AGGREGATES

Grading No.	Size range	Sieve designation	Percent by weight passing the sieve
1.	90 mm to 40 mm	100 mm	100
		80 mm	65-85
		63 mm	25-60
		40 mm	0-15
		20 mm	0-5
2.	63 mm to 40 mm	80 mm	100
		63 mm	90-100
		50 mm	35-70
		40 mm	0-15
		20 mm	0-5
3.	50 mm to 20 mm	63 mm	100
		50 mm	95-100
		40 mm	35-70
		20 mm	0-10
		10 mm	0-5

3.04.02.4 Screenings

Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the gradings set forth in Table-V Screenings of Type A in Table shall be used with coarse aggregates of grading 1 in Table IV. Screenings of Type A or B, shall be used with coarse aggregates of grading 2. Type B screenings shall be used with coarse aggregates of grading 3.

TABLE-V

GRADINGS FOR SCREENINGS

Grading Classifi-cation	Size of screenings	Sieve designation	Percent by weight passing the sieve
A.	12.5 mm	12.5 mm	100
		10.0 mm	90-100
		4.75 mm	10-30
		150 micron	0-8
B.	10 mm	10 mm	100
		4.75 mm	85-100
		150 micron	10-30

3.04.02.5 Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value of less than 6 as determined in accordance with IS:2720 (Part V).

Application of binding material may not be necessary, when the screenings used are of crushable type such as moorum or gravel.

3.04.03 **Construction Operations**

3.04.03.1 Preparation of Base

The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50 mm x 50 mm furrows shall be cut at an angle of 45 degrees to the center line of the road at 1 meter intervals in the latter before laying the coarse aggregate.

3.04.03.2 Inverted Choke

If the water bound macadam is to be laid directly over the sub-grade, without any other intervening pavement course, a 25 mm course of screenings (Grading B) shall be spread on the prepared sub-grade before application of the coarse aggregates is taken up.

3.04.03.3 Spreading Coarse Aggregate

The coarse aggregates shall be spread uniformly upon the prepared surface in such quantities that the thickness of the compacted layer is 100 mm for grading 1 and 75-100 mm for gradings 2 and 3 for each layer.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over uncompacted or partially compacted base be permitted.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall not normally be spread more than 3 days in advance of the subsequent construction operations.

3.04.03.4 Rolling

Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the center. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the center line of the road, in successive passes uniformly lapping preceding tracks by at least one half width.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done, if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wave-like motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding or removing necessary amounts of aggregate and re-rolling until the entire surface conforms to desired camber and grade. In no case shall the use of screenings be permitted to make up depressions.

3.04.03.5 Applications of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreaders, or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand-brooms or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

3.04.03.6 Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued, with additional screenings applied as necessary, until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excessive quantities of water during construction.

3.04.03.7 Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

3.04.03.8 Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer shall have the discretion to stop hauling traffic from using the completed water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.05.00 Tack Coat

3.05.01 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

3.05.02 Materials

Binder : The binder used for tack coat shall be bitumen of a suitable grade as directed by the Engineer and conforming to IS:73, 217 or 454, as applicable, or any other approved cutback.

3.05.03 Construction Operations

3.05.03.1 Preparation of Base

The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous material before the application of the binder.

3.05.03.2 Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight-run bitumen shall be 5 kg. per 10 square meter area for an existing bitumen treated surface and 10 kg per 10 square meter area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers.

The tack coat shall be applied just ahead of the on-coming bituminous construction.

3.06.00 **Bituminous Macadam Binder Course**

3.06.01 **Description**

This work shall consist of construction, in a single course, of 50 mm / 75 mm thickness of compacted crushed aggregates premixed with a bituminous binder, laid immediately after mixing, on a base prepared previously in accordance with the requirements of these Specifications, and in conformity with the lines, grades and cross sections shown on the drawings or directed by the Engineer.

3.06.02 **Materials**

3.06.02.1 Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS:73.

3.06.02.2 Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, of fairly cubical shape and free of disintegrated pieces, organic and other deleterious matter, and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table-VI.

TABLE-VI

PHYSICAL REQUIREMENTS OF AGGREGATES FOR BITUMINOUS MACADAM

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion * Value	IS:2386 (Part IV)	35% Maximum
2.	Aggregate Impact Value *	-do-	30% "
3.	Flakiness Index	IS:2386 (Part I)	35% "
4.	Stripping Value	IS:6241	25% "
5.	Water Absorption	IS:2386 (Part III)	2% "

* Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thicknesses shall conform to the grading A or B given in Tables-VII & VIII.

TABLE-VII

AGGREGATES GRADING FOR 75 MM COMPACTED THICKNESS OF BITUMINOUS MACADAM

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90-100	
40 mm	35-65	100
25 mm	20-40	70-100
20 mm	-	50-80
12.5 mm	5-20	-
4.75 mm	-	10-30
2.36 mm	-	5-20
75 micron	0-5	0-4

TABLE-VIII

AGGREGATE GRADING FOR 50 MM COMPACTED THICKNESS OF BITUMINOUS MACADAM

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90-100	
25 mm	50-80	100
20 mm	-	70-100
12.5 mm	10-30	-
10 mm	-	35-60
4.75 mm	-	15-35
2.36 mm	-	5-20
75 micron	0-5	0-4

3.06.02.3 Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate grading A and B respectively, except when otherwise directed by the Engineer.

The quantities of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

3.06.02.4 Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A variation in binder content of $\pm$ 0.3 percent by weight of total mix shall, however, be permissible for individual specimens taken for quality control tests.

3.06.03 **Construction Operations**

3.06.03.1 Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

3.06.03.2 Preparation of Base

The base on which bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free from dust and foreign matter.

3.06.03.3 Tack Coat

A tack coat shall be applied over the base.

3.06.03.4 Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix.

The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg.C and that of aggregates in the range 125 Deg. - 150 Deg.C, provided that the difference in temperature between the binder and aggregate at no time exceeds 25 Deg.C.

Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly.

The mixture shall be transported from the mixing plant to the point of use in suitable vehicles. The vehicles employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

3.06.03.5 Spreading

The mix shall be spread immediately after mixing by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However, in restricted locations and in narrow widths, where the available plants cannot operate in the opinion of the Engineer, he may permit manual laying of the mix.

The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg.C.

In multilayer construction, the longitudinal joint in one layer shall offset that in the layer below by about 150 mm. However, the joint in the topmost layer shall be at the center line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the center line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

3.06.03.6 Rolling

After the spreading of mix, rolling shall be done by 8 to 10 tonne power rollers or other approved plant. Rolling should start as soon as possible after the material has been spread. Rolling shall be done with care to keep from unduly roughening the pavement surface.

Rolling of the longitudinal joint shall be done immediately behind the paving operation. After this, the rolling shall commence at the edges and progress towards the center longitudinally except that on super-elevated portions it shall progress from the lower to the upper edge parallel to the center line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface or having the mix pick up on the roller wheels. The second or inter-mediate rolling shall follow the break down rolling as closely as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh material. The rolling shall then be continued till the entire surface has been rolled to compaction, there is no crushing of aggregate and all roller marks have been eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking to the wheels and being picked up. In no case shall fuel lubricating oil be used for this purpose.

Rolling operations shall be completed in every respect before the temperature of the mix falls below 80 Deg.C.

Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

The bituminous macadam shall be provided with final surfacing without any delay. If there is to be any delay, the course shall be covered by a seal coat before allowing any traffic over it.

3.07.00 Open-Graded Premix Carpet

3.07.01 Description

This work shall consist of laying and compacting an open-graded carpet of 2 cm thickness in a single course composed of suitable small sized aggregates premixed with a bituminous binder on a previously prepared base, to form a wearing course, in accordance with the requirements of these specifications.

3.07.02 **Materials**

3.07.02.1 Binder

The binder shall be bitumen of a suitable grade, as directed by the Engineer, and satisfying the requirements of IS:73, 217, 454 or other approved cutback as applicable.

3.07.02.2 Aggregates

The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, and vegetable or other deleterious matter. They shall preferably be hydrophobic type.

The aggregates shall satisfy the quality requirements set forth in Table-VI except that the Flakiness Index shall be limited to a maximum of 30.

3.07.02.3 Proportioning of Materials

The materials shall be proportioned as per quantities given in Table IX.

TABLE-IX

QUANTITIES OF MATERIALS REQUIRED FOR 10 SQ.M OF ROAD SURFACE FOR 2 CM THICK OPEN-GRADED PREMIX CARPET

Aggregates of Carpet

a)	Stone chippings - 12 mm size; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
b)	Stone chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
	Total :	0.27 Cu.m

Binder for premixing (quantities in terms of straight run bitumen)

a)	For 0.18 Cu.m of 12 mm size stone chippings at 52 kg per Cu.m	9.5 kg
b)	For 0.09 Cu.m of 10 mm size stone chippings at 56 kg per Cu.m	5.1 kg
	Total :	14.6 kg

3.07.03 **Construction Operation**

3.07.03.1 Weather and Seasonal Limitations

Open-graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg.C or below.

3.07.03.2 Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade & cross section in accordance with Table I as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matter with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

3.07.03.3 Tack Coat

A tack coat complying with clause 3.5 shall be applied over the base preparatory to laying of the carpet. Application of tack coat shall, however, not be necessary when the laying of carpet follows soon after the provision of a bituminous course.

3.07.03.4 Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer, in boilers of suitable design avoiding local overheating and ensuring a continuous supply.

The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified.

The mixing of binder with chippings shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

3.07.03.5 Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader, without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material has been laid rolling shall commence with 6 to 8 tonne power rollers, preferably of smooth wheel tandem type, or other approved plant. Rolling shall begin at the edges and progress toward the center longitudinally, except that on the super elevated portions it shall progress from the lower to upper edge parallel to the center line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

3.07.03.6 Seal Coat

A seal coat conforming to clause 3.8 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.08.00 **Seal Coat**

3.08.01 **Description**

This work shall consist of application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels, grade and camber.

Seal coat shall be of either of the two types below, as specified:

Type A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

3.08.02 **Materials**

3.08.02.1 Binder

The binder shall be bitumen of a suitable grade as directed by the Engineer and conforming to the requirements of IS:73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be utilised, in terms of straight run bitumen shall be 9.8 kg and 6.8 kg per 10 square meter area for Type A and Type B seal coat respectively.

3.08.02.2 Stone Chippings for Type A Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matter. Stone chippings shall be of 6 mm size defined as 100 percent passing through 10 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.09 cubic meter per 10 square meter area. The chippings shall satisfy the quality requirements spelled out in Table-VI except that the upper limit for flakiness Index shall be 30.

3.08.02.3 Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky

material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic meter per 10 square meter area.

3.08.03 **Construction Operations**

3.08.03.1 Preparation of Base

The seal cost shall be applied immediately after the laying of bituminous course which is required to be sealed. Before application of seal coat materials the surface shall be cleaned free of any dust or other extraneous matter.

3.08.03.2 Construction of Type A Seal Coat

The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state, shall be spread uniformly on the surface, preferably by means of a mechanical gritter, otherwise manually so as to cover the surface completely. If necessary, the surface shall be broomed to ensure uniform spread of chippings.

Immediately after the application of the cover material, the entire surface shall be rolled with a 8-10 tonne smooth wheeled roller. Rolling shall commence at the edges and progress towards the center except in super elevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present a uniform closed surface.

3.08.03.3 Construction of Type B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature directed by the Engineer before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the latter are thoroughly coated with the former.

The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed.

As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6-8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.08.04 **Opening to Traffic**

In the case of Type B Seal coat, traffic may be allowed soon after final rolling when the premixed material has cooled down to the surrounding temperature. However, as regards Type A seal coat, traffic shall not be permitted until the following day.

3.09.00 **Repair of Existing Water Bound Macadam Surface**

Pot holes or patches and ruts in water bound macadam base or surface course, which is to be surface treated, shall be repaired by removal of all loose material by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under :

Pot holes, patches and ruts shall be drained of water and cut to regular shape with vertical sides, and then be filled either with i) coarse aggregate and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer or ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer. Payment for i) shall be done as per items for water bound macadam and for ii) as per item for open graded premix carpet.

The above is only applicable in case of damage to the existing water bound macadam surfaces. In case, however, it is found that there has been damage to the granular sub-base as well, the area of the damaged surface shall be repaired by removal of all loose materials, cut to regular shape with vertical sides & relaid with graded material as per specification of granular sub-base & then surfaced with water bound macadam as per specification for the same.

For the record purposes, measurements for stone metal shall be taken before they are actually used on the work. Pre-measurements of materials taken for record purposes shall simply serve as a guide and shall not form the basis for payment. Thickness of treatment shall be the ruling criterion for payment for repair of water bound macadam surfaces and sub-base.

Payment for repairs shall be made on the basis of unit rates quoted by the Contractor for the items and shall include supply and laying of sub-base, water bound macadam, rolling etc. including labour, materials, tools, plants, tackle etc. required for the work.

3.10.00 **Road Side Drains**

3.10.01 **Formation of Drains**

The road side drains shall be made in sizes and slopes as shown on drawings and/or as instructed by the Engineer. The minimum side slope shall be as instructed by the Engineer. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts, outside plant area, as per instructions of the Engineer.

The excavated spoils shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for the drains shall be as per approved drawing. Lining of drains will be of RCC construction with necessary slopes.

3.11.00 **Culverts**

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the instructions of Engineer after clearing the site, etc. as per specifications of earthwork. Backfilling with ramming and watering shall be done after construction of the foundations.

The construction of culverts shall be done true to lines and levels and as shown on the drawing. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed, as applicable.

3.12.00 **Pipe Culverts and Drainage Pipes**

3.12.01 **Materials**

The drainage pipes unless otherwise shown on drawings or instructed by the Engineer shall be made of R.C.C. and shall be either Class NP2 or NP3.

Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP3 or of RDSO class for railway as decided by the Engineer or shown in the drawing. All pipes shall meet the requirements of IS:458 - Latest edition and shall be procured from approved manufacturers with collars as per manufacturer's standard specifications. The tenderer shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland Cement as per IS:269 - Latest edition.

Aggregates shall be as per IS:383 - Latest edition - Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller.

Fine aggregates for concrete shall be as per IS:383 - Latest edition.

3.12.02 **Laying of Pipes**

Laying of concrete pipes shall correspond to IS:783 - Latest edition - and to specification given below :

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings or as directed by the Engineer. When trenching is involved its width on either side of the pipe shall not be less than 150 mm nor more than one-third the diameter of pipe unless otherwise instructed/ permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water, etc. as required shall be done by the Contractor without any extra cost to the Owner. Side slips, if there be any, shall be removed by the Contractor without any extra cost to the Owner. After laying of the pipes are completed, backfilling of the trenches shall be done in 250 mm layers, measured loose, clods & lumps broken, watered and compacted with iron rammers to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area, as instructed by the Engineer.

When bed-rock or boulder strata are encountered, excavation shall be taken down to at least 200 mm below the bottom level of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented material, shaped to the requirements and thoroughly

compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

Laying of pipes shall start from the outlet and proceed towards inlet.

All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care not to damage them. Under no circumstances the pipes shall be dropped into the trench or on supports from a height.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS:783 - Latest edition - having a projection ratio of not greater than 0.70, in which the pipe is carefully bedded on fine granular materials in an earth foundation carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height, and in which earthfilling material is thoroughly rammed and tamped in layers not exceeding 15 cm in depth around the pipe for the remainder of the lower 30 percent of its height.

If the pipe is laid in trench, pipe bedding shall be first class bedding as per IS:783.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a craddle constructed of concrete having a mix not leaner than M15. The shape and dimension of the cradle shall be as indicated on the drawing or directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete has set.

c) The drop walls shall be made with Fly ash brick or first class clay bricks having compressive strength minimum of 50 kg/cm^2, in 1:4 cement:sand mortar.

d) The pipe culverts shall be made with proper care regarding the invert of the pipe, gradient, if any, etc. as specified on drawings and/or as instructed by the Engineer.

e) Where R.C.C. pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and remaining height of block to be concreted subsequently.

f) The R.C.C pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part cement and 2 parts of clean sand with only enough water for workability. Procedure of jointing shall be as per IS:783 - latest edition.

3.12.03 **Relation with Water Supply Pipeline**

Unless specifically cleared by the Engineer, under no circumstances shall drainage pipes be allowed to come close to water supply pipelines.

3.13.00 **Manholes and Inspection Chambers**

The maximum distance between manholes shall be 30 meter unless specifically permitted otherwise. In addition at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be watertight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels & drains shall be shaped and laid to provide smooth flow.

Connection to existing pipelines shall be through a manhole.

Manholes shall be provided with standard covers, usually C.I. or as directed by the Engineer. The covers shall be close fitting so as to prevent gases from coming out.

3.14.00 **Masonry**

3.14.01 **Brick Masonry**

All bricks shall be Fly ash brick or clay bricks of first class (Class A) quality, well burnt, of uniform size, shape and colour free from cracks, flaws or nodules of free lime. Bricks shall be soaked in water for at least two hours prior to use and shall be laid truly horizontal and vertical in headers and stretchers with cement mortar consisting of one part of cement and four parts of sand, unless otherwise mentioned in the schedule of Items or directed by the Engineer, in layers not exceeding 1.5 M in height. Each layer shall be allowed at least 24 hours to settle itself before another layer is placed on it and every layer cured with water until the starting of next layer above it.

Materials for mortar such as sand and cement shall be of approved quality. Mortar shall be well mixed, first dry mixed and then by adding water slowly to have a thick workable consistency. Mortar shall be mixed in small batches consistent with the rate of consumption so that no mortar is used after one hour of mixing.

Mortar joints shall be kept uniformly 10 mm thick and all joints should be full of mortar. Brickwork shall be carried up regularly in plumb every course being horizontal. No vertical joints shall come directly over one another.

Joints of the brickwork shall be raked minimum 10 mm deep using raking tool while mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. The brickwork shall be kept moist for 14 days.

All bricks which absorb water more than 20% of their own dry weight after being immersed in water for 24 hours shall be rejected. Brick should be as per IS:1077. Bricks shall have minimum crushing strength of 50 kg/Sq.cm.

3.14.02 **Stone Masonry**

All stones shall be from approved quarries, hard, tough, durable, compact grained, uniform in texture & colour and free from decay, flaws, veins, cracks & sand holes. A stone shall not absorb more than 5% of its weight of water after 24 hrs. immersion. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

Stone shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall not be less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

3.14.03 **Pointing to Masonry**

After raking out of the joints, the brickwork shall be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water, mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finished with suitable tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

3.15.00 **Plaster to Masonry and Concrete**

Before application of plaster the surface shall be cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess water shall be mopped up.

Unless otherwise mentioned in the schedule of items plastering shall be done with cement sand mortar - 1 part by volume of cement to 4 parts by volume of clean, sharp, well graded sand. For sand cement plaster, sand & cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency. For lime gauge plaster, lime putty or hydrated lime and sand in the required proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall than be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No mortar which has stood for more than half an hour shall be used.

Plaster, when more than 12 mm thick, shall be applied in two coats. All plaster work shall correspond to IS:1661 - latest edition.

3.15.01 **Finish**

Generally, all plastered surfaces shall have a standard finish unless otherwise shown on the drawing or directed by the Engineer. The interior plaster shall be finished to a smooth surface by steel trowelling. The exterior surfaces shall be finished with a wooden float.

However, if shown on the drawing or directed by the Engineer the plastered surface shall have a neat cement finish. Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg per Sq.M. and rubbed smooth with a trowel.

3.16.00 **Cement Concrete (Plain and Reinforced)**

3.16.01 **General**

All concrete work shall be according to ISI relevant Codes unless mentioned otherwise herein and the ISI Codes particularly IS:226, IS:455, IS:385, IS:1786 & IS:456 - latest editions - shall form a part of the present specification.

3.16.02 **Materials**

a) Cement : The cement used shall be ordinary portland cement of grade 43 / 53 of approved manufacture and shall be fresh when delivered. Consignments shall be used in the order of delivery. Damaged or partly set cement shall not be permitted to be used and shall be removed from site at once.

Admixture shall be used only if approved by the Engineer. The Contractor shall furnish to the Engineer, the manufacturer's certificate for cement for each consignment, procured by the Contractor direct. If at any time, the Engineer feels that the quality of cement is not upto the specification, he can stop the work and send samples of cement for testing to an approved laboratory. The Contractor shall have no claim for any loss arising out of such suspension of work.

If the cement is procured by the Owner and issued to the Contractor, the Contractor shall satisfy himself at the time of taking delivery that quality and freshness of cement are upto the specified standard. No complaint will be entertained later on from the Contractor for poor concrete work due to the poor quality of cement supplied by the Owner. All rectification work on this account shall be done entirely by the Contractor at his own expenses.

b) Aggregate :

i) General

Aggregate shall consist of natural sand, crushed stone procured from a source known to produce satisfactory aggregate for concrete and shall be chemically inert strong, hard, durable against weathering, of limited porosity and free from adhering coatings, clay lumps, coal and coal residues, clinkers, slag, organic and other impurities that may cause corrosion of the reinforcements or may impair the strength and/or durability of the concrete. They shall conform to IS:383 - latest edition.

ii) Sand and Fine Aggregate :

It shall be clean, sharp and coarse and free from all impurities

and shall be washed and/or screened at the site if so demanded by the Engineer. Sand and fine aggregate shall correspond to IS:383 - latest edition. The fine aggregate shall not contain more than 3 percent of clay or foreign matter. Fineness modulus of sand shall not be less than 2.5.

iii) Coarse Aggregate:

This shall consist of broken trap, basalt or granite or some other suitable stone from a source to be approved by the Engineer and shall meet the requirements of IS:383 - latest edition. The coarse aggregate shall be machine crushed, hard, strong, durable, free from clayey films or loamy admixtures, vegetable or organic matters and shall be washed with water and/or screened if so demanded by the Engineer. The aggregate shall be well graded. The pieces shall be angular in shape and shall have granular or crystalline surface. Friable, flaky and laminated pieces, mica and shell may be present only in such quantities that will not affect adversely the strength and/or durability of concrete and to the approval of the Engineer. The maximum size of coarse aggregate shall be 38 mm for lean concrete and M10 Grade concrete and 20 mm for M15 Grade concrete.

Where permitted by the Engineer, the maximum size of the coarse aggregate may be large. All aggregate shall be uniformly graded. The amount of fine particles occurring in the free state or as loose adherent shall not exceed 1% when determined by laboratory sedimentation tests. After 24 hours immersion in water, a previously dried sample shall not have gained more than 10% of the weight.

c) Water :

Water shall be clean, fresh and free from organic or deleterious matter in solution or in suspension in such amounts that may impair the strength or durability of the concrete. The Contractor shall, however, satisfy himself that the quality is upto the desired standard and shall also submit an analysis from an approved analyst if so desired by the Engineer, free of charge.

d) Reinforcements :

The reinforcement shall be mild or torsteel bars conforming to the latest edition of IS:432 or IS:1786.

All reinforcing bars must be completely free from grease, oil, dirt, scales, scrapable rust, bituminous material, paint, pitted surface and manufacturing defects.

e) Formwork :

The formwork shall be composed of best quality well seasoned hardwood, steel, suitable plywood or equivalent, well seasoned best quality soft wood (for ornamental works) as directed by the Engineer. Bamboos, small diameter ballies, etc. shall not be used unless specially approved by the Engineer in specific cases.

3.16.03 **Storage of Materials**

a) Cement :

Cement shall be stored at the works in such a manner as to prevent deterioration either through moisture or intrusion of foreign matter. Sufficient storage shall be arranged by the Contractor to ensure continuity of consumption. Cement shall be stored in easily countable stacks.

b) Aggregates :

Aggregates shall be stored on planking, steel plates or concrete. Different sizes shall be separated with wooden, steel, or concrete bulkheads. Care shall be taken to prevent any segregation of various sizes of particles. The aggregates must not be allowed to come in contact with dirt, clay and other injurious substances at any stage. The aggregate shall be stored in easily measurable stacks. Procurements must be at least two months in advance of consumption in dry season and four months in advance in rainy season.

c) Reinforcement :

Reinforcing steel shall be stored as far as possible under cover. It shall be protected from oil, grease, dirt, etc. The stacks shall be easily measurable.

3.16.04 **Workmanship**

a) Reinforcement

i) Bending :

Reinforcement bars shall be bent by machine or other approved means producing a gradual & even motion. All the bars shall be cold bent unless otherwise approved. Bars correctly bent only will be used. Bends and shapes shall comply strictly with the dimensions in the approved bar bending schedule. Bending schedule shall be prepared by the Contractor and got approved by the Engineer before bending and he shall be entirely responsible for its correctness. No reinforcement shall be bent when in position in the work without approval of the Engineer, whether or not it is partially embedded in concrete. Unless described otherwise, lapping dimensions shall conform to IS:456 - latest edition and all bending shall correspond to IS:2502 - latest edition.

ii) Placing in Position :

Fixing of reinforcement shall correspond to IS:2502 - latest edition. Reinforcements shall be accurately fixed & maintained in position by such means as mild steel chairs and concrete spacer pieces, Bars intended to be in contact at passing points shall be securely bound together at all such points by No. 20G annealed soft iron wire conforming to IS:280 - latest edition. Binders and the like shall tightly embrace the bars with which

they are intended to be in contact and shall be securely bound.

The vertical distances between successive layers of bars shall be maintained by provision of mild steel spacer bars at such intervals that the main bars do not sag perceptibly between adjacent spacer bars.

The placing of reinforcements shall be completed well in advance of concreting. Immediately before concreting, the reinforcement shall be examined for accuracy of placing and cleanliness by the Engineer and corrected if it is so desired by him. The cover for concrete over the reinforcements shall be as shown or as specified on the approved drawings. Unless otherwise directed, all laps shall be minimum 52 times the diameter of the bar in case of H.T. deformed bar and 40 times diameter of the bar in case of mild steel. If the bars in a lap are not of same diameter, the smaller will guide the lap length. The laps shall be staggered.

Where concrete blocks are used for ensuring the cover and position, they shall be made of mortar not leaner than one (1) part cement to two (2) parts sand and cured for at least seven days.

b) Formwork :

The formwork shall conform to the shape, line and dimensions as shown on the plans and shall be made of timber close and tight to prevent leakage of mortar with necessary props, bracings and wedges sufficiently strong and stable so that it should not yield on laying of concrete. Formwork shall conform to IS:456 - latest edition - in respect of above and stripping time, cleaning and oiling, etc.

c) Concrete :

Mix : The following concrete mixes shall be used as specified in drawings or as directed by the Engineer :

Grade	**Mix**	**Minimum Cement Content**
M-15	To be designed	325 kg/Cu.M.
M-20	-do-	360 kg/Cu.M.
M-25	-do-	410 kg/Cu.M.
Plain Concrete	1:3:6 (nominal) 1.4.8 (nominal)	

i) Water cement ratio and slump shall be determined to suit strength requirements of the concrete mix.

ii) Mixing : The aggregate and sand shall be washed free from all dust and earthy matter if required by the Engineer. The above materials will then be accurately measured in boxes. The quantity of cement shall be determined by weight. The quantity of water shall be predetermined after allowing for

moisture content in the aggregate. All the ingredients as proportioned shall then be mixed in a mechanical mixer till the mass is uniform in texture and consistency, but in no case the mixing time shall be less than two minutes. Hand mixing if permitted by the Engineer as a special case shall be carried out on a water tight platform using 10% extra cement at Contractor's cost and care shall be taken to ensure that the mixing is continued till the mass is uniform in colour and consistency.

iii) Placing and Compacting : Concrete shall be transported from the place of mixture to the place of final deposit within 45 minutes after water has been added and shall be compacted before initial setting commences and should not be subsequently disturbed. Method of transporting & placing shall be such as to preclude segregation. Concrete shall be thoroughly worked around the reinforcements, etc. and into all corners of formwork. For compaction of concrete, mechanical vibrators shall be used. Concrete shall not be placed in water. Mixing, transporting, placing and compacting of concrete shall conform to IS:456 - latest edition.

iv) Curing : Concrete shall be cured for at least 28 days from the date of placing of concrete.

v) Testing of Concrete : Concrete shall be tested in accordance with IS:516 - latest edition and accepted in accordance with IS:456 - latest edition.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Roads

All testing, as mentioned in the body of the specification and as mentioned in Clause No. 900 of Specification for Roads and Bridge Works, 1983 published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per direction of the Engineer. No extra payment shall be made for such tests.

4.02.00 Masonry and Plastering

Masonry and finish to masonry and concrete shall fully comply with the drawings, specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness and any other special criteria as mentioned in the body of the specification or as shown on drawing.

4.03.00 Cement Concrete

The strength requirements and acceptance criteria shall conform to the relevant clauses of IS:456.

5.00.00 INTERLOCKING PAVING BLOCKS

5.01.00 Area of roads and pavements for vehicular traffic to be paved with precast interlocking concrete blocks shall be placed over 250 mm thick crushed aggregate sub-base and 100 mm thick water bound macadam base. For other pavement areas these are to placed over 150 mm thick crushed aggregate sub-base and 100 mm thick water bound macadam base.

5.02.00 A stable edge shall be provided to retain the paving units and sand bedding by means of precast concrete edging unit or kerb set in-situ concrete.

5.03.00 The paving blocks shall be laid true to levels and grades for the finished work over a sand bedding of 50 mm uncompacted thickness.

5.04.00 The sand for bedding shall be a fine, well graded in a dry to moist condition.

5.05.00 The interlocking paving blocks shall be a minimum of 80 mm thick and the concrete quality shall be approved by the Engineer. The mix of paving block shall contain a water repelling additive. The sample of paving block shall be submitted to the Engineer for approval. No orders shall be placed with the manufacturer until the Engineer's approval has been given.

5.06.00 The paving blocks shall be laid in accordance with the manufacturer's instruction and shall be compacted at completion of each days work.

PART-II
TECHNICAL SPECIFICATION FOR CONSTRUCTION OF WET MIX MACADUM ROAD

1.0.0 WET MIX MACADAM

1.1.0 Description

Wet mix macadam shall consist of clean, crushed, graded aggregates premixed with water and laid and shall be rolled to a dense mass on a prepared sub-grade, sub-base, base or existing pavement as the case may be. In each case the construction shall be carried out to conform to specified lines, grades and cross-sections.

1.2.0 Materials

1.2.1 Aggregates - General Requirements

The aggregates shall consist of hard, durable particles of crushed stone, crushed gravel or crushed slag of requisite quality as stated hereinafter. These shall satisfy the physical requirements set forth in Table-1.

Table-1

Physical Requirements of Aggregates for Wet-Mix Macadam

Sl. No.	Type of Construction	Test Method	Test	Requirement
1.	Sub-base	Los Angeles Abrasion Value	IS:2386 (Part IV)	Max. 60%
		or		
		Aggregate Impact Value*	-do-	Max. 50%
2.	Base	a) Los Angeles Abrasion Value*	-do-	Max. 50%
		or		
		Aggregate Impact Value*	-do-	Max. 40%
		b) Flakiness Index	IS:2386 (Part I)	Max. 30%

Note :

1. *Aggregates may pass the requirements of either the Los Angeles Test or Aggregate Impact Value Test.

2. Fraction of the aggregates passing 425 micron sieve when tested in accordance with IS:2720 (Part V) should not have a PI value of more than 6.

1.2.2 **Crushed Stone/Gravel**

Crushed stone/gravel shall be free of flat, elongated, soft and disintegrated particles. They shall also not contain an excess of dirt or other objectionable matter.

1.2.3 **Crushed Slag**

Crushed slag shall be manufactured out of air-cooled blast furnace slag. It shall be of angular shape, reasonably uniform in quality and density and generally free of any thin, elongated and soft pieces, as well dirt or other objectionable matter. Crushed slag shall not weigh less than 1120 kg. per m' or absorb more than 10 percent water by its weight when tested in accordance with IS:2386 (Part III).

1.2.4 **Aggregates - Grading Requirements**

As far as possible, aggregates for wet-mix macadam shall conform to one of the gradings given in Table-2.

Table-2

Grading Requirements of Aggregates for Wet-Mix Macadam

	Percent by Weight Passing the Sieve	
Sieve Designation (IS:460)	**Grading 1 Max. Nominal Size 40 mm**	**Grading 2 Max. Nominal Size 20 mm**
50 mm	100	
40 mm	95-100	
25 mm	-	100
20 mm	60-80	90-100
10 mm	40-60	-
4.75 mm	25-40	35-55
2.36 mm	15-30	-
600 micron	8-22	10-30
75 micron	0-8	2-9

The nominal size of aggregate to be used in a given case shall depend on availability. While both the grading can be used for base/sub-base course construction, preferably layers of grading No. 1 shall not be used above layers of grading No. 2.

Generally it should be possible to obtain aggregates conforming to the above gradings directly from the crusher. However, where this is not so for any reason, necessary quantities of missing fractions shall be blended as to bring the grading of the mixed material upto the specified limits.

1.2.5 **Quantity of Aggregates**

Approximate quantity of aggregates required for 75 mm & 100 mm compacted thickness of wet-mix macadam will range from 1.1 to 1.2 cu.m and 1.45 to 1.6 cu.m respectively per 10 sq.m area.

1.3.0 **Construction Operations**

1.3.1 **Preparation of Foundation for Receiving the Wet-Mix Macadam Courses**

The sub-grade, sub-base or base to receive the wet-mix macadam course shall be prepared to the required grade and camber and cleaned of all dust, dirt and other extraneous matter. Any ruts or soft yielding places that have appeared due to improper drainage, service under traffic, or other reasons, shall be corrected and rolled until firm. If necessary, the existing surface may be scarified and reshaped to achieve this objective.

Where the existing road surface is black-topped, 50 mm x 50 mm furrows shall be cut in the existing surface at 45 deg. to centre line of the carriageway, spaced every one metre, before proceeding with the laying of the coarse aggregates.

In all cases, the foundation shall be kept well drained throughout the construction operations.

1.3.2 **Provision of Lateral Confinement of Aggregates**

Before starting with wet-mix macadam construction, necessary arrangements shall be made for the lateral confinement of aggregates. This could be done by constructing side shoulders in advance to a thickness corresponding to the compacted layer of the wet-mix macadam course. After the shoulders are ready, their inside edges shall be trimmed vertical and the included area cleaned of all spilled material, thereby setting the stage for spread of aggregates. The practice of constructing the macadam in a trench excavated after finishing formation shall be completely avoided.

1.3.3 **Mixing of Aggregates with Water**

Aggregates for wet-mix macadam shall be mixed with the requisite quantity of water in a power mixer of suitable capacity and optimum moisture for mixing shall be determined in accordance with IS:2720 (Part VII) after replacing the aggregate fraction retained on 20 mm sieve with material of 4.75 mm to 20 mm size. While adding water due allowance shall be made for evaporation losses. However, at the time of compaction, water in the wet mix shall not vary from the optimum value by more than $\pm$ 0.5 percent. The mixed material shall be uniformly wet and no segregation shall be permitted.

1.3.4 **Spreading of Aggregates**

Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared base in required quantities. In no case shall these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed base to be permitted. The aggregates shall be spread to proper profile by using templates placed across the road about 6 metre apart.

Where possible approved mechanical devices may be used for this purpose so as to minimise the need for their manipulation by hand.

Wet mix macadam course shall normally be constructed in layers each not exceeding 75-100 mm in compacted thickness. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles shall be allowed. The aggregates as spread shall be of uniform gradation with no pockets of fine materials.

1.3.5 **Rolling**

After aggregates have been laid to the required thickness, grade and camber, these shall be compacted to the full width by rolling with either three-wheeled power roller of 8 to 10 tonnes capacity or an equivalent vibratory roller.

The rolling shall begin at edges with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road, uniformly lapping each preceding rear wheel track by one half width.

On super elevated portions of the road, rolling shall commence from the lower edge and progress gradually towards the upper edge of the pavement.

Rolling shall not be done when the sub-grade is soft or yielding or when it causes a waver-like motion in the base course or sub-grade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 metre straight edge, the surface shall be loosened and aggregates added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and cross-section. The surface shall also be checked transversely by template for camber, and any irregularities corrected in the manner described above. In no case shall the use of un-graded material or fines permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 100 percent of the maximum dry density for the material determined in accordance with the procedure explained in para 1.3.3. After completion the surface of any finished layer shall be well-closed, free from movement under compaction plant or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and re-compacted.

1.4.0 **Opening of Traffic**

Preferably no vehicular traffic of any kind shall be allowed on the finished wet-mix macadam surface till it has dried and the wearing surface laid. In exceptional cases, construction traffic may be permitted for short durations once the course is completely dry provided vehicles move over the full width avoiding any rutting or uneven compaction.

1.5.0 **Surface Evenness of Wet-Mix Macadam Course**

The surface evenness of the completed wet-mix macadam course in the longitudinal and transverse directions shall be within the following tolerances :

i)	Longitudinal profile when tested with a 3 metre straight edge	Maximum permissible variation	12 mm
ii)	Cross profile when checked with a camber template	Maximum permissible variation	8 mm

The longitudinal profile shall be checked with a 3 metre long straight edge at the middle of each traffic lane along a line parallel to the centre line of the road. The transverse profile shall be checked with a series of three camber boards at intervals of 10 metres.

1.6.0 **Rectification of Defective Construction**

Where the surface irregularity of the wet-mix macadam course exceeds the tolerances specified in Para 1.5.0, or where the course is otherwise defective due to sub-grade soil getting mixed with the aggregates, the full thickness of the layer shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material as applicable and recompacted in accordance with Para 1.3.1 thru' 1.4.0. The area treated in the aforesaid manner shall not be less than 10 sq.m. In no case shall depressions be filled up with un-graded material or fines.

TECHNICAL SPECIFICATION
FOR
XI) ROADS AND DRAINAGE

PART-III : CONSTRUCTION OF RCC ROAD WITHIN PLANT

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	EXECUTION
4.00.00	TESTING AND ACCEPTANCE CRITERIA

XI) ROADS AND DRAINAGE

PART-III : CONSTRUCTION OF REINFORCED CEMENT CONCRETE ROAD WITHIN PLANT

1.00.00 SCOPE

This specification covers all work required for the construction of road including box-cutting, edging, reinforced cement concrete pavement slab on lean concrete base, water bound macadam sub-base including preparation of subgrade etc. and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

This specification also includes all work required for drainage including road side drain, R.C.C. culverts, pipe-culverts, drainage pipes, manholes etc. and all other incidental items.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, equipment, tools and plants, transportation etc. required for the work.

b) Submit for approval detailed schemes of all operations required for executing the work e.g., material handling, placement, services, approaches etc.

c) To carry out and submit to the Engineer results of tests whenever required by the Engineer to assess the quality of work.

2.02.00 Work to be provided for by Others

No work under this specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant I.S. Specifications and Codes of Practice.

1. Specification for road and bridge works of Ministry of shipping & Transport (Roads wing) Published by the IRC.

2. IRC-19 Standard specifications and Code of Practice for Water Bound Macadam.

3. IRC:SP-11 Hand Book of Quality Control for Construction of Roads and Runways.

4. IS:456 Indian Standard Codes of Practice for Plain and Reinforced Concrete.

5. IS:2212 Code of Practice for Brickwork.

6. IS:783 Code of Practice for Laying of Concrete Pipes.

7. IRC:15 – 2002 Standard Specifications and Code of Practice for Construction of concrete roads

8. IRC:58 - 2002 Guidelines for the design of plain jointed rigid pavements for Highways.

9. Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by Indian Standard Specification, AASHTO and any other standard practice as may be specified by the Engineer shall be followed.

2.04.00 **Conformity with Designs**

The contractor shall carryout the work as per the drawings issued to him and/or contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be Used**

2.05.01 **General**

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

2.06.00 **Quality Control**

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used.

All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer. Permitted tolerances for road works are described hereinafter.

i) Horizontal Alignments

Horizontal alignments shall be reckoned with respect to the center line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of $\pm$ 25 mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be $\pm$ 40 mm.

ii) Longitudinal Profile

The levels of the sub-grade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer, beyond tolerances mentioned below:

Sub-grade	± 25 mm
WBM Sub-base	± 20 mm
Lean concrete Base	± 15 mm
RCC Pavement Slab	± 10 mm

Tolerance in RCC Pavement Slab shall not be permitted in conjunction with the positive tolerance for base course if the thickness of the former is thereby reduced by more than 6 mm.

iii) Surface Regularity of Sub-grade and Sub base WBM

The surface regularity of completed sub-bases and base courses in the longitudinal and transverse directions shall be within the tolerances indicated in Table-I of Technical Specification for Roads and Drains – Part-I (flexible pavement.

iv) Surface regularity and surface texture of Reinforced Cement concrete pavement

The surface levels and regularity of concrete pavement shall be within the tolerance indicated in Section 600 of MORT&H (Ministry of Road Transport & Highways) – specifications for Road and Bridge Works.

Texture depths shall not be less than the minimum required when measurements are taken as given in Table 600-2 of MORT&H nor greater than a maximum average of 1.25mm.

TABLE- : 600-2. Texture Depth

Time of Test	Number of Measurements	Required Texture Depth (mm)	
		Specified Value	Tolerance
1. Between 24 hours and 7 days after the constn., of the slab or until the slab is first used by vehicles	An average of 5 measurements	1.00	±0.25
2. Not later than 6 weeks before the road is opened to public traffic	An average of 5 measurements	1.00	+0.25 -0.35

After the application of the brushed texture, the surface of the slab shall have a uniform appearance.

Where the texture depth requirements are found to be deficient, the Contractor shall make good the texture across the full lane width over length directed by the Engineer, by retexturing the hardened concrete surface in an approved manner.

v) Minimum thickness of RCC pavement slab will be 300mm of M25 grade concrete. Reinforcement bars will not be less than 0.18% of Gross cross-sectional area. Reinforcement bars shall be placed in both layers – top & bottom. Minimum cement content will be 360 Kg/cum.

vi) Design and detailing of RCC pavement shall be done in accordance with IRC:58 – 2002 and IRC:15 – 2002. The spacing of control joints shall be as follows:

a)	Transverse expansion joint	=	30m (maximum)
b)	Transverse crack control/ contraction joint	=	4.5m (maximum)
c)	Longitudinal separation joint	=	One at centre for 7.5m wide road

Tender drawing no. K9213R-DWG-S-0007 may be referred for details of joints.

3.00.00 EXECUTION

3.01.00 Shall be as per Technical Specification for Road & Drainage Part-I and MORT&H specification for Road and Bridge.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Shall be as per Technical Specification for Road & Drainage Part-I and MORT&H specification for Road and Bridge.

TECHNICAL SPECIFICATION
FOR
XII) REINFORCED CONCRETE CHIMNEY

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	EXECUTION
4.00.00	TESTING AND ACCEPTANCE CRITERIA
5.00.00	INFORMATION TO BE SUBMITTED

I) REINFORCED CONCRETE CHIMNEY

1.00.00 SCOPE

This specification covers plain and reinforced cement concrete work, lining and insulation work, miscellaneous steel and metal work, painting and protective treatment work, lightning protection system and aviation obstruction lighting system, connected with construction of RCC Chimney.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

Work to be provided by the Contractor, unless specified otherwise, shall include but shall not be limited to the following :

a) Furnish all labour, supervision, services, insurance, material, power, fuel, forms, templates, supports, scaffolding, tools, plants, construction equipment, approaches, transportation etc. required for the entire work.

b) Design and prepare working drawings for formworks, scaffoldings, supports, staging etc. and submit them for approval.

c) Prepare and submit for approval, as per approved schedule, detailed drawings for R.C. work in foundation, shell, hopper, platforms & ground floor & bending schedules for reinforcement bars, showing the positions and details of spacers, chairs, supports, hangers, openings etc.

d) Prepare detailed fabrication and erection marking drawings for steel and metal works and submit them for approval.

e) Prepare detailed shop drawings for various inserts, anchors, sleeves, frames, templates, anchor bolts etc. showing relative locations of their installations and submit them for approval.

f) Prepare and submit for approval the detailed schemes for operations like material handling, placement of concrete etc. and for items like approaches, services etc.

g) Design and submit for approval the mix proportions for concrete to be adopted on job.

h) Furnish samples and submit for approval the results of tests for various properties of the following materials :

   i) Ingredients of concrete
   ii) Concrete
   iii) Metal work components
   iv) Acid proof bricks

v) Fire bricks
vi) Castable refractories
vii) Insulation material
viii) Paints
ix) Electrical Items.

i) Provide all incidental items not specified or shown on drawings in particular but reasonably implied or necessary for successful completion of the work in accordance with drawings and specifications.

j) Produce, if directed by the Engineer, a guarantee, in approved proforma, for satisfactory performance, for a specified period, of material manufactured by specialist firms.

2.02.00 **Work by others**

No work under this specification will be provided for by agency other than the Contractor for this Contract unless specifically mentioned otherwise in the Contract.

2.03.00 **Codes and Standards**

All works under this Specification, unless specified otherwise, shall conform to the latest revisions/replacements of the following Indian Standard Codes, Criteria, Specifications, alongwith those mentioned therein. In case any particular aspect of work is not covered by Indian Standards, other standard specification, as may be specified by the Engineer, shall be followed. 'IS Specification' shall mean Codes, Criteria etc. of ISI :

IS:6 Moderate heat duty fire clay refractories, Group-A.

IS:104 Ready mixed paint, brushing, zinc chrome, priming.

IS:158 Ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and heat resisting for general purposes.

IS:269 Ordinary, and low heat Portland cement.

IS:383 Coarse and fine aggregates from natural sources for concrete.

IS:432 Mild steel and medium tensile steel bars.

IS:456 Code of practice for plain and reinforced concrete.

IS:516 Methods of test for strength of concrete.

IS:732 Code of practice for electrical wiring installations (System voltage not exceeding 650 Volts).

IS:800 Code of practice for general construction in steel.

IS:808 Rolled steel beam, channel & angle sections.

IS:813	Scheme of symbols for welding.
IS:814	Covered electrodes for metal arc welding of structural steel.
IS:816	Code of practice for use of metal arc welding for general construction in mild steel.
IS:817	Code of practice for training and testing of metal arc welders.
IS:818	Code of practice for safety and health requirements in electric and gas welding and cutting operations.
IS:822	Code of procedure for inspection of welds.
IS:9595	Recommendation for Metal Arc Welding of Carbon and Carbon Manganese steels.
IS:1139	Hot rolled mild steel, medium tensile steel and high yield strength steel deformed bars for concrete reinforcements.
IS:1161	Steel tubes for structural purposes.
IS:1199	Methods of sampling and analysis of concrete.
IS:1200	Methods of measurement of building works.
IS:1239 (Part-I)	Mild steel tubes.
IS:1367	Technical supply conditions for threaded fasteners.
IS:1526	Sizes and shapes for firebricks (230 mm. series).
IS:1566	Hard-drawn steel wire fabric for concrete reinforcement.
IS:1608	Methods for tensile testing of steel products.
IS:1730	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.
IS:1731	Dimensions for steel flats for structural and general engineering purposes.
IS:1786	Cold-twisted steel bars for concrete reinforcement.
IS:1791	Batch type concrete mixers.
IS:1977	Structural steel (ordinary quality).
IS:2062	Steel for general structural purposes
IS:2074	Ready mixed paint, red oxide - zinc chrome priming.

IS:2309	Code of practice for the protection of buildings and allied structures against lightning.
IS:2386	Methods of test for aggregates for concrete. (Part-I) Particle size and shape.
IS:2386	Estimation of deleterious materials & organic (Part-II) impurities.
IS:2386	Specific gravity, density, voids, absorption and (Part-III) bulking.
IS:2386	Mechanical properties. (Part-IV)
IS:2386	Soundness. (Part-V)
IS:2386	Measuring mortar making properties of fine aggregate. (Part-VI)
IS:2386	Alkali aggregate reactivity. (Part-VII)
IS:2386	Petrographic examination. (Part-VIII)
IS:2502	Code of practice for bending & fixing of bars for concrete reinforcement.
IS:2505	Concrete vibrators, immersion type.
IS:2506	Screed board concrete vibrators.
IS:2633	Methods of testing uniformity of coating on zinc coated articles.
IS:2722	Portable swing weigh batchers for concrete (single and double bucket type).
IS:2750	Steel scaffoldings.
IS:2751	Code of practice for welding of mild steel bars used for reinforced concrete construction.
IS:3025	Methods of sampling and test (Physical and Chemical) for water used in industry.
IS:3346	Method for the determination of thermal conductivity of thermal insulation materials (two slab, guarded hot-plate method).
IS:3495	Method of test for clay building bricks. (Part-I to IV).
IS:3550	Methods of test for routine control for water used in industry.
IS:3558	Code of practice for use of immersion vibrators for consolidating concrete.

IS:3677	Unbonded rock and slag wool for thermal insulation.
IS:4014	Code of practice for steel tubular scaffolding. (Part-I&II).
IS:4031	Method of physical tests for hydraulic cement.
IS:4634	Method for testing performance of batch-type concrete mixers.
IS:4687	Gland packing asbestos.
IS:4860	Acid-resistant bricks.
IS:4990	Plywood for concrete shuttering work.
IS:4998	Criteria for design of reinforced concrete chimneys. (Part-I).
IS:5410	Cement paint, colour as required.
IS:5445	Long fluted machine reamers with Morse taper shanks.
IS:5495	Sizes and shapes for firebrick (300 mm. and higher series).
IS:8112	High strength ordinary portland cement.
CP326	British Standard - Protection of structures against lightning.
NEPA 78	Code of protection against lightning.

Draft Code of Practice for the protection of buildings against lightning - 1954 of Institution of Engineers (India).

The Indian Electricity Rules.

The requirements of Department of Civil Aviation, Govt. of India.

2.04.00 **Conformity with drawings and specifications**

The Contractor shall carry out all the work in strict accordance with the drawings stamped 'Released for Construction' and specification issued to him and as per Contractor's detailed drawings approved by the Consulting Engineer. Prior to concreting, the Contractor shall prepare a check list on a set format of all items of work involved, and inform the Engineer well in advance so that the Engineer shall have the opportunity of satisfying himself if the works mentioned in the format are done according to drawings and specification, and he can allow the Contractor in writing to start pouring of concrete. The entire operation of concreting shall be carried on as per specification, to the complete satisfaction of the Engineer. No deviation from the drawings will be allowed unless otherwise directed by the Engineer in writing.

For steelwork and metal work, the Contractor shall design all connections, inserts for scaffolding, supply and fabricate all steelwork and metal work and furnish all connection materials in accordance with approved shop drawings prepared by him and/or as instructed by the Engineer, keeping in view the

maximum utilisation of the available sizes and shapes for metal components.

2.05.00 **Materials to be used**

2.05.01 **General Requirement**

All materials, whether to be incorporated in the work or to be used temporarily for the construction, shall conform to the relevant IS specifications unless stated otherwise and shall be of the quality approved by the Engineer.

2.05.02 **Cement**

Generally, cement shall be 43 grade / 53 grade ordinary Portland Cement conforming to IS-8112 / IS 12269. In special cases any of the following type of cement may be permitted or directed to be used with prior approval by the Engineer :

a) 33 Grade ordinary Portland Cement conforming to IS-269.

b) Rapid hardening Portland Cement conforming to IS-8041.

c) Portland slag cement conforming to IS-455.

d) Portland Pozzolona Cement (fly ash based) Conforming to IS-1489 (Part-1).

e) Portland pozzolona Cement (calcined clay based) conforming to IS-1489 (Part-2).

f) Hydrophobic Cement conforming to IS-8043.

g) Low heat Portland Cement conforming to IS-12600.

h) Sulphate Resisting Portland Cement conforming to IS-12330.

2.05.03 **Coarse Aggregate**

Coarse aggregate shall be graded crushed or broken stone from approved sources, free from impurities and shall be screened free of dust and other deleterious matter. It shall conform to IS:383 or IS:515 and shall be washed clean, if necessary. The max. size of coarse aggregate for chimneys shall be 20 mm. down graded, unless otherwise stated (vide serial 5(b) of clause 3.3.6). Grading for a particular size shall conform to relevant IS Codes and shall be such as to produce a dense concrete of specified proportion and strength and shall be of consistency that will work readily into position without segregation.

2.05.04 **Fine Aggregate**

Fine aggregate shall be river or pit sand, free from any clay, earth, vegetable matters, salt or other impurities and shall be clean and fit for use, to the satisfaction of the Engineer. Sand acceptable for the work shall normally have a grading falling within the limits of one of the three grades, mentioned

in the relevant IS Specifications.

2.05.05 **Water**

The water for both mixing and curing of concrete shall be clean, free from oil, acid, alkali, organic or other deleterious substances. Contractor shall test the water as and when required by the Engineer, at no extra cost to the Owner.

2.05.06 **Reinforcement**

Mild steel or Medium or High Tensile steel deformed bars specified for reinforcement shall conform to the latest relevant IS Specifications and shall be of tested quality under ISI Certification Scheme. The reinforcement shall be free from any oil, foreign material or mill or rust scales.

Reinforcement bars shall be procured from approved manufacturers for example SAIL/ TISCO/ VIZAG Steel or equivalent.

2.05.07 **Structural Steel**

All steel materials to be used in construction of Chimney ladder, hand rails, flue opening frame, access door frame, door shutters etc. shall comply with IS:2062, IS:1239, IS:1367, IS:1608 & with other relevant IS Specifications.

2.05.08 **Paints**

Paints to be used for shop coat of fabricated steel shall conform to the IS:2074. Paint for treatment of outside face of Chimney shall be with Poly .urethane paint.

2.05.09 **Fire Bricks, Acid Resistant Bricks and Castable Refractories**

Fire Bricks for the internal lining of the shell shall conform to IS:6-1967 Group-A and IS:5445. Acid resistant bricks for internal lining of shell and hopper shall conform to IS:4860. Castable refractories shall be of hydraulic setting, rapid hardening type. It shall have refractory properties similar to Fire bricks conforming to IS:6, Group-A and working temperature shall be upto 1350^{o}C.

2.06.00 **Storage of Materials**

2.06.01 **General**

All materials shall be so stored as to prevent deterioration & intrusion of foreign matter and to ensure the preservation of their quality and characteristics for the work. Any material, which is deteriorated or is damaged or is otherwise considered defective by the Engineer, shall not be used for construction and shall be removed from site immediately, failing which the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain an upto date accounts of receipt, issue & balance of all materials issued by the Owner.

2.06.02 **Cement**

Contractor shall store cement in water-tight and properly designed stores so that the Cement can be kept dry and the stock can be handled in rotation. The doors of stores shall be at least 30 cm above G.L. Deteriorated cement shall be removed immediately from the site. Not more than ten bags of cement shall be stacked one above the other.

2.06.03 **Aggregate**

Different materials shall be transported, handled and stored separately in such a manner as to prevent damage, deterioration or contamination. Stock piles of fine and coarse aggregates shall be allowed to drain, so that aggregates do not contain too much water.

2.06.04 **Reinforcement**

Reinforcement shall be stored preferably under cover and stacked off ground in size and grade-wise separate stacks for easy identification.

2.06.05 **Steel, Metal and Fittings**

All steel, metal & fittings to be used for fabrication and erection shall be stored sectionwise and lengthwise in separate stacks, off ground, so that they can be handled, inspected, measured and accounted for easily at any time. If required by the Engineer, the materials may have to be stored in a covered shed.

2.06.06 **Paints**

Paints shall be stored under cover, in air-tight containers. Paints supplied in sealed containers shall be used as soon as possible once the container is opened. Left over paints shall be kept in air-tight containers.

2.06.07 **Bricks**

Bricks shall be stored in systematic stacks for ease of handling and counting. While unloading the bricks from trucks, they shall be stacked right away and shall not be dumped in a heap.

2.06.08 **Insulation Material**

All insulation materials like glass or mineral wool, asbestos ropes etc. shall be stored in packing boxes, under covered shed, avoiding their coming in contact with objectionable matter.

2.06.09 **Electrical Items**

All electrical items shall be stored properly under covered water-tight shed so that they do not come in contact with moisture or cement dust.

2.07.00 **Quality Control**

Contractor shall establish and maintain quality control for different items or work and materials as may be directed by the Engineer to assure compliance with contract requirement and submit to the Engineer records of the same. The Contractor shall submit all records and test results in original to the Engineer for his approval, if so desired by him.

The quality control operation shall include but shall not be limited to the following items of work :

a)	Cement	:	Test to satisfy relevant IS Specifications if supplied by the Contractor.
b)	Aggregate	:	Physical, Chemical and Mineralogical qualities, grading, moisture contents and impurities.
c)	Water	:	Impurities Test.
d)	Reinforcement	:	Material tests or certificates to satisfy relevant IS Specification if supplied by the Contractor
e)	Structural Steel	:	Material tests or certificate to satisfy relevant IS Specification if supplied by the Contractor.
f)	Bricks	:	Compressive strength, water absorption, efflorescence, warpage.

3.00.00 **EXECUTION**

3.01.00 **Concrete**

3.01.01 **Trial Mix, Grades of Concrete**

At least three weeks before commencing any concreting in the work the Contractor shall make trial mixes using samples of coarse aggregates, sand, water and cement, typical of those to be used in the work. A clean dry mixer shall be used for mixing and the first batch shall be discarded.

For guidance in designing the mix, standard tables for maximum allowable water-cement ratio, minimum cement content, maximum proportion of aggregates and limits of consistency may be used by the Contractor. The Contractor's design mix shall fall within limits of the following tables :

i)	Strength requirements of concrete	:	Table-2 of IS:456-2000.
ii)	Concrete Mix Proportion	:	Design mix concrete as per Clause no.9 of IS:456-2000.

iii) Minimum cement content/Cu.m. of finished concrete shall be as per Table 5 of IS:456-2000 unless otherwise stated (vide serial 5(c) of clause 3.3.6).

iv) Limit of consistency : Refer Table in Item 3.1.4 of this specification.

v) Cement/Total Aggregate Ratio : As per the following table.

TABLE-II

MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO (FOR GUIDANCE)

CEMENT/TOTAL AGGREGATE RATIOS

WORKABILITY	WATER/ CEMENT RATIO	RATIO BY WEIGHT OF CEMENT TO GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT TO CRUSHED STONE AGGREGATE	
		20 mm size	38 mm size	20 mm size	38 mm size
Very low Slump 0-25 mm	0.4	1:4.8	1:5.3	1:4.5	1:5.0
	0.5	1:7.2	1:7.7	1:6.5	1:7.4
	0.6	1:9.4	1:10	1:7.8	1:9.6
	0.7	1:10	1:12	1:8.7	1:10.6
Low Slump 25-50 mm	0.4	1:3.9	1:4.5	1:3.5	1:4.0
	0.5	1:5.5	1:6.7	1:5.0	1:5.5
	0.6	1:6.8	1:7.4	1:6.3	1:7.0
	0.7	1:8.0	1:8.5	1:7.4	1:8.0
Medium Slump 50-100 mm	0.4	1:3.5	1:3.8	1:3.1	1:3.6
	0.5	1:4.8	1:5.7	1:4.2	1:5.0
	0.6	1:6.0	1:7.3	1:5.2	1:6.2
High Slump 100-175 mm	0.4	1:3.2	1:3.5	1:2.9	1:3.3
	0.5	1:4.4	1:5.2	1:3.9	1:4.6
	0.6	1:5.4	1:6.7	1:4.7	1:5.7
	0.7	1:6.2	1:7.4	1:5.5	1:6.5

Note: 1 Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Engineer.

Note: 2 It should be noted that such high aggregate cement ratios will be required or concretes of very low slump and high water- cement ratios which may be required to be used in mass concrete work only.

The above figures are for guidance only, the actual cement/ aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

For each grade of concrete, a set of eighteen cubes shall be made. Of these not more than six may be made on any day and further, of the six cubes made in one day not more than two cubes may be made from any single batch. Nine of these cubes each representing a different batch of concrete shall be tested at the age of seven days and remaining at twenty-eight days. The making of the cubes, their curing, storing, transporting and testing shall be in accordance with the relevant IS Specifications. The test shall be carried out in laboratory approved by the Engineer. If the average strength of the concrete cubes falls below the requirement, the method described above shall be repeated till acceptable results are obtained. The method may have to be repeated whenever there is a significant change in the quality of any of the ingredients for concrete, at the discretion of the Engineer. All cost for trial mixes and tests shall be borne by the Contractor and shall be included in the contract rates.

3.01.02 **Batching of concrete**

For controlled concrete, only weigh batching shall be allowed. All concrete ingredients, except water, shall be batched by weight, using an approved make of weigh batcher. Batching shall be accurate to 1/2 Kg. The batcher shall be tested for accuracy of calibration, first before commencement of work and at least once a fortnight or as directed by the Engineer thereafter. Water shall be batched by weight or by volume measures, as approved by the Engineer.

3.01.03 **Mixing of Concrete**

Materials for concrete shall be emptied in rotation into the mixer. When all the ingredients are in the drum, the drum will rotate for one minute for dry mixing. After that water shall be added in measured quantities in the manner specified. The mixer shall then rotate for at least two minutes, or at least forty revolutions or until there is apparent uniform distribution of the materials and till the mass is uniform in colour. The entire content of the drum shall be discharged before the ingredients for the succeeding batch are fed into the drum. The mixer shall be thoroughly cleaned to the satisfaction of the Engineer, before a different quality of concrete is put through the mixer and also at the end of day's work.

3.01.04 **Workability of Concrete**

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments, and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. 15 mm. to 40 mm. slump in chimney works shall be adopted

subject to Engineer's approval unless stated otherwise (vide serial 1(d) of clause no. 3.3.6). The usual limits of consistency for various types of structure are given below:

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm. with standard concrete		Use for which concrete is suitable
	Min.	Max.	
Very Low	0	15	Large mass concrete work with heavy compaction equipment.
Low	15	35	Uncongested wide and shallow RCC structures.
Medium	35	65	Deep and wide RCC structures with congestion of reinforcement and inserts.
High	65	100	Very narrow and deep RCC structures with congestion due to reinforcement and inserts.

Note :

The above table is for guidance only. Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately, to keep the ratio of water to cement same, as adopted in trial mix design, for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively, where facilities exist or if required by the Engineer, the compacting factor test, in accordance with IS:1199, shall be carried out.

3.01.05 **Placing and Compaction of Concrete**

Concreting shall proceed in a manner directed by the Engineer, concrete shall be placed in forms as soon as possible but in no case later than twenty minutes, after mixing.

The height of any single lift of concrete, for different structural members, shall be decided by the Engineer. The concrete shall be placed in the forms gently and not dropped from a height which may cause segregation of aggregates. Each layer of concrete shall be compacted fully before the succeeding layer is placed and separate batches shall follow each other so closely that the succeeding layer shall be placed and fully compacted before the layer immediately below has taken an initial set.

The concrete, after placing, shall be consolidated only by power driven vibrators. The vibrators shall be of a make and size, approved by the Engineer. In using the vibrator, the standard practice and the Engineer's directions, shall be followed.

Vibration shall begin as soon as one batch of concrete has been placed and shall continue till the entire section being poured has been thoroughly consolidated.

To secure even and dense surfaces, free from aggregate pockets, vibration shall be supplemented by tamping or rodding by hand in the corners of forms and along the form surfaces while the concrete is plastic, without damaging or endangering the stability of the formwork.

A sufficient number of spare vibrators including petrol vibrators shall be kept readily accessible to the place of deposition of the concrete to assure adequate vibration in case of breakdown of those in use.

3.01.06 **Curing of Concrete**

Curing of exposed surface of concrete shall commence immediately after the concrete has set. Exposed sides shall be covered with canvas etc. immediately after stripping of forms, and curing shall be continued for a period of not less than 14 days, reckoned from the date and hour of completion of concreting. All surfaces of the pour shall be kept wet with water at all times after concreting and till the curing period is over. The Contractor shall plan and employ proper equipment and sufficient labour considered adequate by the Engineer under able supervisor for curing and all cost for this purpose shall be borne by him.

3.01.07 **Construction Joints**

In concreting the chimney shell one full ring lift shall be completed in a day's pour. Before the formwork for the following pour starts the horizontal surface of the Chimney shell shall be chipped, cleaned and washed with water, and when the formwork is complete, the surface shall be cleaned and washed again and covered with 1:2 sand cement slurry before fresh concrete is placed. The horizontal construction joints shall be so arranged and made that they are regular and neat. No vertical joint shall be allowed. No separate payment shall be allowed to the Contractor for forming joints or chipping and cleaning them or cover with slurry prior to concreting. The number of construction joint shall be kept minimum and the spacing should not exceed three (3) meters. The Contractor shall submit to the Engineer, any proposal of providing construction joints to facilitate his work, for the study and approval of the Engineer well in advance.

3.01.08 **Ordinary Concrete**

Ordinary concrete like lean concrete shall be of nominal mix as per relevant clauses of IS:456.

3.02.00 **Reinforcement**

3.02.01 **Bending of Reinforcement**

All bars shall be carefully and accurately bent by the Contractor in accordance with approved Drawings and bar bending schedules. Special care shall be taken to ensure correct lengths of laps. The bars shall not be bent or straightened in any manner that will injure the bars or impair the bond between reinforcement & concrete. Bends and hooks are to be provided as laid down in the IS:2502.

3.02.02 **Placing**

All reinforcement shall be placed and maintained in the position shown in the drawings. Contractor shall provide approved type of cover blocks to suit the requirement of the Drawings. Where reinforcement is to be provided on two faces of the shell, the Contractor shall provide adequate number of separators, with the approval of the Engineer. Any additional support to the reinforcing cage, if required at the time of concreting, shall also be provided, to the satisfaction of the Engineer. Lapping of reinforcement as specified in the drawings or as directed by the

Engineer, shall be provided. Laps shall be staggered and too many laps shall be avoided. Welded laps shall be provided only when directed or approved by the Engineer.

3.02.03 **Fixing of Reinforcement**

18 SWG annealed steel wire shall be used as binding wire. Bar crossing one another and contact laps shall be bound with this wire twisted tight to make the skeleton or network rigid so that the reinforcement is not displaced during placing of concrete.

3.03.00 **Forms**

3.03.01 **Design and Material of formwork**

The shuttering for the chimney shell shall be either steel formwork or steel framed plywood formwork of adequate thickness, proper surface texture and with requisite supports and battens to produce a shell surface which will be even, smooth and of uniform curvature and batter as per Drawing and free from all blemishes.

The Contractor shall be responsible for designing the formwork, alongwith its supports etc. Contractor shall obtain the approval of the Engineer for the design of forms, before assembling them. Approval of the Engineer does not relieve the Contractor of his responsibility to ensure the soundness of formwork.

3.03.02 **Installation of Formwork**

All formwork shall be set to plumb and to line and level, or curvature or batter as per drawing. All shutters shall be adequately supported, to the satisfaction of the Engineer, to prevent deflection under dead weight of concrete, imposed load of workmen, materials and plant and to withstand vibration.

No joint in any props shall be allowed. The joints in formwork shall be watertight. Surface of formwork shall be oiled with approved quality mould oil which shall not stain the surface of the shell.

3.03.03 **Tolerance**

The formwork shall be so made as to produce a finished concrete true to shape, lines, levels, plumb and dimensions, as shown on the drawings, subject to the following tolerances, unless otherwise specified.

a)	Out of plumb between two consecutive lifts	:	3 mm.
b)	Errors in level	:	3 mm.
c)	Errors in sectional dimensions	:	5 mm.
d)	Out of plumb in general	:	1 in 1000 of height subject to a maximum of 200 mm.

However, the Contractor shall aim at improving upon this figure. Should the limitations exceed, the Contractor shall, if directed by the Engineer, demolish that portion of work and recast at his own cost, to the complete satisfaction of the Engineer. No tolerance shall be allowed between the two consecutive plates of the formwork either radially or vertically placed.

3.03.04 **Stripping of formwork**

Unless otherwise permitted in writing by the Engineer, the minimum period of keeping formwork in position after the completion of pouring of concrete shall conform to relevant clause of IS:456. For the chimney shell the stripping time shall be 48 hours minimum.

Formwork shall be so arranged as to permit removal without jarring or damaging the concrete. Immediately after stripping of formwork, the Engineer shall be informed by the Contractor. The Contractor shall ensure that the site is cleared of stripped shuttering nails or any other material which might hinder the inspection, so that the Engineer can inspect the concrete surface.

3.03.05 **Re-use of formwork**

Before re-use, all forms shall be thoroughly scraped, cleaned, examined, repaired, and treated with mould oil as specified herein before. Formwork, declared unfit or unserviceable, by the Engineer, shall not be used or reused.

3.03.06 **Construction by slip-form Method**

Slip-form construction will be encouraged if proposed by the Tenderer. Type of Slip-form proposed should be indicated in the offer with sketches, drawings and construction statement as explained hereinafter. Number, type and capacities of jacks, the control system and achievable rate of progress in mm/hour should also be indicated. The chosen scheme shall be of a past proven design. A certified performance record of the scheme should be submitted with the offer to guarantee workability of the scheme both from execution time and safety point of view.

The Tenderer should furnish a brief but comprehensive statement indicating the planning & programme and method of work to be followed, for the approval of Owner at the time of submitting Tender. This statement shall include the following items :

i) Type and description of Slip-form equipment and its accessories.

ii) Design of scaffolding and staging.

iii) Description of materials including admixtures to be used for construction.

iv) Manpower planning, construction spaces required, standby arrangement.

v) Rate of Slip-forming.

vi) Proposed workability requirement of concrete and type of cement & admixture to be used.

vii) Quality assurance programme.

viii) Method of Transportation of material

ix) Method of curing and rectification of defects.

x) Planned interruption, if proposed, and activities during planned interruption. Treatment of construction joint.

xi) Contingency solution for unplanned interruptions.

xii) Time of completion.

While selecting the Contractor, due consideration will be given to the merit of the above mentioned statement proposed by the Tenderer and minimum time of completion, apart from his past experience in such types of work as also technical and financial resources of the Tenderer.

Not withstanding what have been specified in earlier clauses, following guide lines are being presented which should be kept in view by intending Tenderers, while quoting for Slip-form method of construction :

1. Care to be taken to prevent dragging of concrete alongwith upward movement of the shuttering. For this purpose following steps are advisable :

   a) Shutter plates have to be smooth and should be thoroughly clean. Before fixing them in position all the surfaces which will be coming in contact with concrete to have a coat of epoxy paint.

   b) In areas where concrete thickness is 750 mm or more rate of pouring should be such that minimum slipping of shuttering is 100 mm per hour.

   c) Mix design should be so done that it will be self-lubricant at the contact face of shutter and concrete and thus reduce friction. Suitable cement of approved manufacturer (conforming to relevant I.S. Specification) may be used for the purpose. An optimum ratio of coarse/fine aggregate should be established to suit the purpose depending on availability of aggregates.

   d) Mix design also should be so done that it has a slump of 50 mm at the point where concrete is placed under an ambient temperature of around 40^{o}C. This will also keep vibration by needle vibrators to required minimum. Slump should not drop down to zero in less than 45 minutes. Suitable retarding agent or plasticizer of approved manufacture may be added in mix to achieve this purpose. These admixtures to be properly identified by preliminary tests both for performance and for compatibility with particular type of cement proposed to be used.

      Additional steps like spraying of water over the shutters and keeping down the temperature of coarse aggregates by continuous spraying of water over those may be resorted to if ambient temperature is more than 40^{o}C.

2. Care must be taken to prevent twist, which predominantly occur in the initial stages because of low slipping rate, in the horizontal plane of Slip-form assembly. A thorough check on this aspect must be kept at every 15 minutes interval. One person should exclusively be assigned this work together with rectifying any defect.

3. Every endeavor has to be made so as not to occur any tilt in the shutter assembly. To achieve this following steps need be taken

   a) Performance of jacks has to be closely observed and any defective one needs immediate replacement. Difference in levels of opposite jacks at any instant of time should not exceed 5 mm.

   b) Loading on Slip-form truss/yokes has to be fairly equal.

c) Sleeve through which jacking rod passes has to be of sufficient length so that later gets an uniform clearance and does not get any chance to tilt. Sleeve should have a minimum wall thickness of 3.25 mm and should be such that jacking rod gets a maximum clearance of 1 mm to 1.5 mm around.

4. For taper walled chimneys overlapping of shutters which are kept to effect the tapering, needs careful attention otherwise these may be filled with concrete slurry.

5. In designing the mix following aspects should be borne in mind:

a) Cement used should have an initial setting time of not less than 50 minutes and preferably should have a specific surface around 3600 Sq.Cm. per gram.

b) Coarse and fine aggregates should be well graded and rounded aggregates offer better performance in Slip-form technique. These help to keep down water/cement ratio and also offers better lubrication between concrete and shutter surface. 40 mm down size of coarse aggregates should preferably be used unless reinforcement detailing calls for lesser size aggregates.

c) From the point of view of creep, shrinkage as well as initial setting property of concrete, cement content should not preferably be more than 400 Kg. per Cu.M of concrete.

d) Minimum compressive strength (after 4 to 6 hours of mixing) of concrete immediately below the shutter as slipform proceeds should be between 0.1 to 0.2 Newton/ Sq.mm.

e) It is advisable to use cement from a single source during the entire operation of slipform technique since once the system starts, there might not be any time left for conducting trial mixes if the source of procurement of cement changes.

6. Large dia. vibrator needles should not be used for vibrating concrete. Sizes of these needles should preferably be restricted to 25 mm diameter and to 40 mm diameter - only in exceptional cases. At least two nos. standby vibrator units should always be maintained on top of working deck at all time during the entire period of slipform operation.

7. It is preferable to have membrane curing compounds sprayed on fresh surfaces emerging out of shutter panels for ensuring proper curing at great heights.

In case such spraying is not envisaged then elaborate arrangement has to be made for adequate supply of water both on inside and outside vertical surfaces with spraying arrangement, necessary length of pipelines and pump of adequate head to serve the purpose. It is always advisable to have a stand-by pump for effective utilisation of the system.

8. If Slipforming is carried out in summer, rate of slipping should be around 400 mm per hour. If lesser value is contemplated appropriate retarders should be specified.

9. Exact number and capacity of jacks as well as spacing of yoke frames are to be determined taking into account various loadings including self weight of the system, dead and live loads on working and other platforms, horizontal load on formwork, wind load etc.

   It is desirable that jacking system, based on which the entire slipform system works, should consist of jacks 3 Tonne/6 Tonne capacity and a hydraulic pump with necessary pipe connections.

   Spacing of yoke legs should preferably be kept within 2 metres to prevent overloading on jacks and consequent failure resulting in twist of the formwork.

   Jacking rods should be of 25 mm diameter for 3 Tonne Jacks and 32 mm diameter for 6 Tonne Jacks.

10. At least 30% spare jacks and jacking rods should be kept ready during the entire operation. It is obligatory to maintain spare hydraulic pump alongwith a set of loose pipes in perfect working condition on top of working deck.

11. In sections where thickness is 500 mm or more it is prudent to go in for two nos. of jacks for each slipform yoke.

12. For effective utility of this technique following areas need careful attentions at the very conceptual stage:

    a) Detailed quality assurance programme.

    b) Advance Planning and preparations.

    c) Arrangement for on site supervision and adequate access facilities.

13. Construction methods including description and types of different equipment proposed to be used, structural arrangement and analysis of the system, description and type of different materials, planned interruptions, description and frequency of various checks and tests for Slipform technique as well as for material, method of preparing, transporting and pouring of concrete, solution for probable defects during slipping, sequence of operations during planned interruptions etc. should be prepared beforehand by executing agency and to be approved by Engineer before starting the actual work.

14. Placing and binding of reinforcement is also a very critical item and needs special attention. From practical considerations not more than two or three layers of horizontal steel can be tied at a time and this causes a definite limitation in placement of reinforcement.

Vertical reinforcements should be kept vertical by providing suitable holders within the slipform system.

15. It is desirable to have a break of at least one day for every two weeks of continuous operation. Such break should be utilised for various maintenance activities, removal of jack rods etc.

16. Numbers and locations of hoists for lifting concrete, reinforcement and other materials have to be planned well in advance. Capacity of hoists should be such as to match with hourly requirement of concrete and reinforcement. If felt necessary one hoist may be exclusively earmarked for transporting concrete.

    For movement of personnel supervising the work a separate hoist must be arranged for.

17. The system being operative round the clock it is obligatory to have adequate lighting arrangement both on various platform levels as well as on ground below. Arrangement has to be made for facilitating continuous upward movement of the entire system alongwith slipform.

18. Winches for lifting men and material and mixers, if located within unsafe area around chimney, should be protected by adequate shelter from possible damage.

19. Proper tele-communication system has to be established between the personnel working on top of Chimney and control room below.

20. A small laboratory should be maintained at site for testing different materials like cement, coarse and fine aggregates. A cube testing machine may also be installed at site for getting quick feed back results.

    Apart from using plumb bobs, level and theodolite instruments for survey purpose arrangement should also be kept for lasers.

21. In case of interruption in the course of slipping of formwork following measures should be taken:

    a) Provision of a key and additional reinforcement at the junction of new and old concrete.

    b) Slipform system should be brought up freely to have a minimum overlap of 100 mm or so over previously cast concrete.

    c) Washing of old concrete surface with compressed air and water jet and thereafter pouring a layer of neat cement grout.

    d) Clearing of shuttering panels of loose materials, concrete etc. by compressed air and applying a coat of epoxy paint, if felt necessary by Engineer.

e) Neatly finishing the interface of old or new concrete as soon as it comes out of shutter panel.

22. It is preferable to suspend the construction work under high wind condition.

23. It is of utmost importance that for effective implementation of this system an Engineer fully conversant with Slipform technique with enough experience in planning and control of formwork should be in overall command of the site and he should be ably supported by well trained mid level supervisory staff, skilled workers and operators.

24. Operation of slipform method of construction is a continuous one and it demands continuous/intermediate inspection of accuracies in line, level, dimensions and position and immediate rectification of any noticed deviation. All these ask for personnel of high quality having constant vigilance over the construction activity.

25. While all the activities in effective implementation of the work needs utmost care keeping safety of men and material in mind it is obligatory that all activities should be carried out under the guidance of a qualified and trained safety Engineer.

Safety measures as listed below must be adhered to but should not be limited to only these:

a) Safety helmets and belts to be provided to all supervising staff and workers.

b) Safety nets to be provided below both inside and outside platforms as instructed by Engineer.

c) Handrailing and toe guard to be provided around all openings and platforms.

d) Regular maintenance of equipment, checking of hoists, scaffoldings etc.

e) Passenger hoist must have multiple ropes.

f) Emergency lights, coloured lamps to be provided in accordance with relevant Indian Standards and as supplemented in the Specification and to be operative in case of sudden power failure Emergency standby generator must be kept ready during the entire period of slipform method of construction.

g) Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

26. Permissible construction tolerances should be limited to the following:

Variation in wall thickness : (-) 5 mm, (+) 25 mm

Variation from Design Diameter	:	(±) 25 mm or (±) 12.5 mm per 3 m dia. whichever is larger, but in no case more than (±) 75 mm.
Out of Plumb in General	:	1 in 1000 of height subject to a maximum of 200 mm.

Although deviations in general will not be encouraged, the Contractor, however may mention in his offer the additions to or deviations from drawings/Technical Conditions/Schedule of items issued with the tender papers and any other special requirement implied with the adoption of the Slipform method, which may include but need not be limited to the following items as applicable:

a) Particular requirement of type and brand of cement, if any.

b) Special admixture to be added to concrete.

c) Any change required in the geometry of the Chimney including the shell thickness or side slope from that shown in the N.I.T. drawing.

d) Any change/special requirement in the arrangement of reinforcement.

e) Implications if any of necessary insitu bending of rebars for corbels/ brackets etc. and straightening/cleaning of the same prior to casting of brackets.

f) Any additional constructional opening in the shell required at ground level for concreting.

All deviations from tenders must be justified and tender price shall include all such variation/deviation. Such deviation without assigning any reason will be rejected.

3.04.00 **Chimney Steel and Metal Work**

3.04.01 **General**

All workmanship shall be of best practice in modern structural shops, and shall conform to the provisions of the IS:800 and other relevant IS Specifications, unless otherwise specified.

3.04.02 **Fabrication**

Rolled materials, before being used for fabrication, shall be straight and shall be within the tolerance laid down in the IS:852. Straightening, if necessary, may be done by mechanical means and if required, by applying localised heat the temperature of the material not exceeding 600 Deg.C locally. Cutting of mild steel members shall be effected by power saw or gas cutting. If gas cutting is used, allowance shall be made in working out the effective length,

based on the shop drawing and templates. Care shall be taken in gas cutting so that the member does not bend or warp. Edge preparation for welding may be done by gas cutting with necessary precautions and cleaning. Holes shall be drilled with power drill. Arrangement shall be made for clamping the member to be drilled so that the member is not displaced while drilling is in progress. When two or more members are to be drilled together, all the parts shall be clamped together. After drilling they shall be separated and burs shall be removed with power driven hand grinder. Bolt holes shall not be formed by a gas cutting torch.

3.04.03 **Assembly**

Riveting, bolting and welding shall be carried out as per requirements laid down in IS:800. Shop assembly of elements of platforms or the entire platforms, brackets and similar items if required and/or asked for by the Engineer, shall be arranged so as to check the accuracy of fit. Necessary temporary supports like props, cross bracings etc. shall be provided to keep the parts in place both for mock up and at the time of erection. Each steel piece shall bear erection marking, written in paint.

3.04.04 **Painting**

If steel and iron members are to be painted as per contract, it shall be done as per requirement laid down in IS:800. A coat of shop painting shall be applied to all steel and metal work, unless stated otherwise. All steel ladder, platforms, balconies, hand railing, frames, doors etc. which are specified for painting shall be painted first with two coats of red oxide zinc chromate paint conforming to IS:2074 and then with two coats of Synthetic enamel paint (as per IS:2932 & 2933) or aluminium paint (as per IS:2339) of approved quality or acid resisting paints as specified in drawing or elsewhere.

Total dry-film thickness of paints provided on structures located outside windshield shall be 190 microns and that on inside be 125 microns minimum.

All paints shall be of make and shade as instructed and approved by the Engineer. Necessary test certificates, manufacturer's literature & samples shall be submitted to the Engineer, for his approval, before bulk purchase is made.

The metal surfaces which are to be painted shall be prepared properly by rubbing, washing, treating prior to application of paint as per paint manufacturer's specifications and as per relevant IS Specifications.

3.04.05 **Galvanizing**

All steel including threaded bolts, nuts and washers, unless specified otherwise in contract, shall be hot dip galvanized in accordance with American Society for Testing and Material Specification ASTM 123 or IS:2629 - Recommended practice for Hot- Dip Galvanising of Iron and Steel.

All members to be galvanized shall be cleaned thoroughly, to the satisfaction of the Engineer, by the process of pickling. Pickling shall be carried out in an acid bath containing sulphuric or hydrochloric acid of suitable and adjusted

concentration and temperature. Pickling process shall be completed by rinsing the members thoroughly in warm water.

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath and it shall meet all the requirements when tested in accordance with IS:2633 and IS:4759. The zinc coating shall be of uniform thickness. If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage and if so directed, the galvanizing may have to be redone in the similar manner stated above.

3.04.06 **Erection**

Erection of structural members and C.I. Chimney caps shall be done as per requirement of IS:800. The Contractor shall submit to the Engineer a programme of erection for his approval. All plant, equipment, tools, tackle and any other accessories required for the erection shall be provided by the Contractor. Storing and handling of fabricated materials for erection, setting out of members, providing temporary supports, bracing, fasteners, bolts, nuts etc. shall be the responsibility of the Contractor and shall be taken into account in quoting the rate.

3.04.07 **Cast Iron Chimney Cap**

The cast iron cap, fitted at the top of the chimney, shall be of thickness not less than 10 mm. This shall preferably be a single cap covering both the concrete shell and the lining, with the segments bolted together securely and properly anchored inside the concrete in such a manner as to form a complete annular unit, allowing for unequal circumferential and vertical expansion and contraction of concrete shell and lining and for deflection of shaft due to wind.

All bolts, nuts, washers, rag bolts and other fasteners as required for fixing cast iron cap shall be of bronze material. Gaps between segments are to be filled with asbestos mill-board or fiber-glass packing. Casting is to be assembled to match with the dimensions specified in drawings, before despatch to site. C.I. caps to be painted with two coats of acid resisting paints over primer coats as recommended by paint manufacturer.

3.05.00 **Insulation and Protective Treatment**

3.05.01 **Acid and Heat Resistant Paint**

The inside surface of concrete shell and corbels and outside surface for height as specified in the drawing shall receive a protective treatment of three coats of acid and heat resistant black paint. The quality and type of the paint shall have the prior approval of the Engineer. For this, a small area shall be painted and a sample of paint shall be shown to the Engineer.

The surface to be painted shall be prepared and primary coat, if required as per the paint manufacturer's specification and direction of the Engineer, shall be applied. The paint shall conform, unless otherwise stated, to the requirement of IS:158. Necessary samples, test certificates and manufacturer's literature shall be submitted to the Engineer for his approval.

The surface to be painted shall be completely dry before the paint is applied and the drying time between consecutive coats shall not be less than 5 hours.

3.05.02 **Cement Paint**

The outside face of the Chimney shell, unless specified otherwise, shall be painted with Cement waterproof paint. The quality shall be approved by the Engineer. Necessary samples shall be submitted to the Engineer for his approval. The surface of the shell shall be prepared as per paint manufacturer's specification. In addition, care shall be taken that the surface is free from stain, honey comb and any rough and uneven surface. The joints between two shuttering and two lifts of shuttering shall be so prepared that any unevenness, if by chance exists, shall be removed. If one coat of paint is not sufficient to give the required finish, the Contractor, at his own cost, shall repaint the surface, until the Engineer is satisfied with the workmanship. The paint shall conform, unless otherwise stated, to IS:5410. Necessary samples, test certificates and manufacturer's literature shall be submitted to the Engineer for approval.

3.05.03 **Acid Resistant Brick Lining**

The Contractor shall use acid resistant bricks for the job as indicated in the Drawing. They shall be fine grained in texture, dense and homogeneous. The brick shall be sound, true to shape, flat and free form flaws and other manufacturing defects affecting their utility. The bricks shall conform to IS:4860-1968 Class-I for acid resistant bricks. The bricks shall be of necessary curvature and of taper so that the lining conforms to the inner radius of the flue lining and hopper surface. No attempt shall be made to use straight bricks and than to try to match with the inner radius of the lining of chimney by providing extra mortar. No broken bricks shall generally be used. The compressive strength of the bricks shall not be less than 700 Kg/Sq.cm as per IS:4860 Class-I. The Contractor shall provide sample for visual inspection and approval. For testing purposes, the Contractor shall select, at random, bricks from the stack, in presence of the Engineer. The sample bricks thus collected, shall be sent to laboratory for testing of compressive strength, acid resistance and water absorption. The cost of sending to the laboratory, testing and any other incidental expenditure shall be borne by the Contractor and the rate should include such test.

The Contractor shall submit to the Engineer the original test results for his scrutiny and approval.

Bricks shall be thoroughly wetted before using. The mortar to be used shall have similar characteristics, i.e., it shall also be acid resistant. The mortar shall be acid-proof mortar-potassium silicate type (resistant to sulphuric acid) as per IS-4832 Part-I & IS-4441. The mortar shall also be tested at Contractor's cost, in a laboratory approved by the Engineer. The mortar shall be used immediately after mixing. The water cement ratio and the workability shall be strictly maintained. The brickwork shall be flush pointed, after necessary raking of joints and cleaning of surfaces. The lining shall be kept wet for a period of at least 3 days, after which exposed face shall be thoroughly cleaned. The air space and all ventilation holes in the shell and corbels shall be kept clean of any mortar for thorough ventilation. The mortar

between bricks shall not be more than 3 mm thick and the mortar used shall be freshly prepared, used within the setting time. No retampering shall be permitted.

3.05.04 **Fire Brick Lining**

The Contractor shall use fire bricks for lining of the Chimney and hopper as shown in the drawing. The bricks shall be of necessary curvature and of taper so that the lining conforms to the inner radius of the flue lining. No attempt shall be made to use straight bricks and then to try to match with the inner radius of flue lining of chimney by providing extra mortar. Fire bricks shall be well burnt, compact and of homogeneous texture generally white to yellowish white in colour and free from cracks and other flaws; no broken bricks shall be allowed to be used except for closing the course. The crushing strength of the bricks shall be not less than 200 Kg./Sq.cm and shall be of Group-A conforming to IS:6-1983, Specification for Moderate Heat Duty Fire clay Refractories, Group-A. The water absorption of the bricks shall not exceed 13% and the density of bricks shall be approximately 1800 to 2000 kg/Cu.m. Thermal conductivity of fire brick shall not exceed 1 kcal/hr.m.deg.C. Sample of bricks shall be submitted by the contractor for approval of the Engineer. For testing of bricks sample shall be taken according to the scheme given in IS:1528-1962, IS for Sampling and Physical Testing of Refractory Material; and cost for testing and incidental expenditure shall be borne by the Contractor and rates quoted shall include the cost.

The brick shall be laid with air setting fire clay mortar free from potassium/ Sodium silicate. The mortar may be "Tataset-FK-40" manufactured by Tata Refractories Ltd. or equivalent. The material shall be kept in a cool place under covered shed before use. The mortar shall be applied strictly as per manufacturer's instructions.

Thickness of mortar joint shall not be more than 3 mm. The bricks are to be laid one course of header followed by two courses of stretchers and so on or as directed by the Engineer. The exposed face shall be true to the line, parallel to the Chimney shell unless shown otherwise. Steel starps made of flats shall be provided on the exterior surface of brick lining both circumferentially and vertically for both acid resistant brick lining and firebrick lining. The steel straps shall be double hot dip galvanised.

3.05.05 **Insulation and Packing**

All packing and insulation material shall be of thickness, diameter and type, shown in the drawing. The packing and insulating material shall be made of asbestos rope, vermiculite concrete, slag or mineral wool and asbestos mill boards.

a) **Asbestos Rope**

The diameter of the rope shall be as per drawing. The material shall be of best quality available in the market and shall be purchased after a sample is approved by the Engineer. The rope shall be plain, Grade-I, conforming to IS:4687-1968. The strand shall be long, well twisted and no torn thread shall stick out. The rope shall be firmly packed so as to prevent gas leakage.

b) **Slag or mineral wool**

The thickness of packed slag wool shall be as shown in the dwg. The packed density of the wool shall be within the range of 175 to 200 Kg./cu.m and the co-efficient of thermal conductivity shall conform to the requirement of IS:3677 at a mean temperature of 150 Deg.C. The material shall be well packed in position where possible. IS:3677 for Rock and Slag wool mats for thermal insulation may be referred for guidance. The co-efficient of thermal conductivity and packed density shall be tested according to IS:3677 and IS:3346.

c) **Vermiculite Concrete**

Vermiculite concrete shall be made by mixing exfoliated vermiculite, portland cement and water. It shall be of Grade-B, having a density of 210 Kg./Cu.M. The vermiculite aggregate size shall be maximum 6 mm. The mix shall be 1 cement and 8 vermiculite by volume.

d) **Asbestos Mill Board**

Asbestos mill board shall be of thickness as indicated in drawing. It shall be of best quality of standard make available in the market and samples shall be submitted to the Engineer for approval. It shall be plain, dense and homogeneous texture, without cracks, flaw and any other manufacturing defect. It shall be laid directly onto the concrete bed after removing any loose material or any aggregate. The concrete shall be prepared without mortar so that the board can have a good seating.

3.06.00 **Lightning Protection System**

3.06.01 Refer electrical specification volume II F / 2, Section – XV – “Technical Specification fpr Chimney and Natural Draft Cooling Tower – Electrical Works.”.

3.06.02 Not used.

3.06.03 Not used.

3.06.04 Not used.

3.06.05 Not used.

3.07.00 **Aviation Obstruction Lighting System**

3.07.01 Refer electrical specification volume II F / 2, Section – XV – “Technical Specification for Chimney and Natural Draft Cooling Tower – Electrical Works.”.

3.07.02 Not used.

3.07.03 Not used.

3.07.04 Not used.

3.07.05 Not used.

3.07.06 Not used.

3.08.00 **Sampling Port**

Sampling ports of minimum 0.1 m dia. shall be provided in the Chimney as shown in the drawing to maintain records of emission. Minimum length of port shall be 0.5 m measured from inside face of the lining to the outside end of the port. The port shall be provided with industrial flange capped when not in use. Location of port shall be at least two times the top diameter below the stack exit and at least eight times the stack diameter above the last obstruction. One meter below sampling port a working platform has to be provided at least 1 m wide with safe guardrail and access ladder. Ladder well shall be located at least 1 m away from ports. There shall be no obstructions within 1 m horizontal radius on platform beneath ports. A power source of 220 V, 15A single phase 50 Hz AC shall be located on the platform. There shall be two ports 90 Deg. apart when stack dia. is less than 3 m plus port length and 4 ports when stack dia. is more than 3 m plus port length.

3.09.00 **MS insert plates for mounting of instruments for the measurement of amplitude of vibration and wind speed**

For mounting of accelerometer and wind speed censors 600 x 600 x 20 thick, MS inserts with 25 nos. threaded (1/2" whitworth) holes shall be fixed on the outer circumference of the chimney shell with MS lugs as shown on the drawing. During casting, the holes shall be temporarily plugged to prevent concrete from filling in the holes. Two nos. of such inserts shall be fixed at the top of the chimney for mounting accelerometers and a set of four nos. of such inserts shall be fixed at one-third and two-third heights of the chimney for mounting wind speed censors. A working platform of 1 meter width with safe guardrail shall be provided 1 metre below each level of these inserts as shown on the drawing.

For laying of cables, the same cable tray used for illumination/ aviation light shall be utilized.

4.00.00 **TESTING AND ACCEPTANCE CRITERIA**

4.01.00 **General**

The Contractor shall carry out all sampling and testing in accordance with the relevant IS Specifications and as supplemented herein, for the following items or any other item as may be required by the Engineer, at his own cost, unless otherwise specified in this specification. The Contractor shall get the specimens tested in laboratory, approved by the Engineer and shall submit to him, the original test results in triplicate, within seven days after the completion of the test.

4.02.00 **Cement**

Representative samples shall be taken as per the relevant IS Specification from each consignment of Cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time, compressive strength and soundness tests, and the Contractor shall carry out the above tests as per relevant Indian Standard. If the cement is supplied by the Contractor the test shall be carried out by him at his own cost.

4.03.00 **Aggregate**

The Contractor shall carry out any or all the tests on aggregates as may be required by the Engineer, in accordance with IS:2386 Parts-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant IS specifications.

4.04.00 **Water**

Sampling and testing of water being used for concrete works shall be carried out as per IS:3550, by the Contractor, at regular intervals and whenever directed by the Engineer. The final acceptance criterion in case of doubt shall be as per IS:3025.

4.05.00 **Concrete**

The Contractor shall take cubes for works test as per requirement laid down in IS:516 regularly from the day's pour. The number of test cubes to be taken shall be as per IS:456. The Engineer may also use his discretion in deciding the rate of cubes to be taken. The acceptance criteria is to meet the requirement of IS:456. If the cube test results indicate that some portions of the work is below the required strength, the Engineer may order demolition of that portion of work which is below strength and ask the Contractor to rebuild, provided a satisfactory method of load testing is not possible. Such testing or demolishing and rebuilding shall be carried out by the Contractor at his own cost.

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **With Tender**

The following technical information are required with the tender:

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used. All details as per clause 3.3.6 to be submitted, if slip form method is proposed to be used.

e) Proposal for lifting of men and material in constructing the chimney.

5.02.00 **After Award**

The following information and data including samples where necessary, shall be submitted by the Contractor, progressively during the execution of the Contract.

5.02.01 **Programme of execution and requirement of materials**

Within 30 days of the award of the Contract, the Contractor will submit a Master Programme for completion of the work giving monthwise requirement of materials, particularly mentioning in details the materials which are to be supplied by the Owner and for the procurement of which the help of the Owner is required as per the terms & conditions of the Contract. In case the Contractor proposes to take on hire any machinery or tools and plants from the Owner, the detailed phased out programme of such hire is also to be submitted.

The master programme may have to be reviewed and updated by the Contractor quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day to day programme of every month is to be submitted by the Contractor before the commencement of the month.

5.02.02 **Samples**

Samples of all materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities, free of cost, for approval. All samples shall be submitted well in advance of starting work at site. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying material of specified quality.

5.02.03 **Design Mix**

Design mix as per details of this specification giving proportions of ingredients, sources of aggregates and cement along with accompanying test results of trial mixes as per relevant IS Specifications shall be submitted to the Engineer, for his approval, before it can be used on the work.

5.02.04 **Detail Drawings**

Following items shall be provided by the Contractor which are to be approved by the Owner.

a) Detail drawings and designs of form work including scaffolding to be used. If slipform method of construction is adopted, then detail drawings showing all the arrangements for slipform technique including methods for reducing internal diameter and providing required slopes on outer diameter.

b) Detail drawings and bar bending schedules for concrete components.

c) Shop drawings for steel and metal work, including inserts etc.

d) Detail drawings for templates and temporary supports for embedments.

e) Detail lining drawing.

5.02.05 **Reports**

Following Test Reports shall be furnished by the Contractor:

a) Mill Test Report for cement and reinforcing steel if the materials are supplied by the Contractor.

b) Inspection Report of formwork and reinforcement.

c) Reports of tests of various material and concrete.

d) Any other data or report or test result required by the relevant IS Specifications and if required by the Engineer for satisfactory quality control of the workmanship.

TECHNICAL SPECIFICATION
FOR
XIII) PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIAL

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
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XIII) PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIAL

1.00.00 **SCOPE**

The scope of this Section is to specify the properties, storage and handling of common building materials unless otherwise mentioned in drawings or schedule of items.

2.00.00 **MATERIALS**

a) **Bricks**

Bricks for general masonry work shall conform to IS:1077-1970 and for face brick work shall conform to the specifications in IS:2691-1972.

Bricks for general masonry work shall be of class 10, well burnt, of uniform size, shape and colour free from cracks. This brick will have average compressive strength of 50 kg/cm^2. Fractured surface shall show uniform texture free from grits, lumps boles etc. Compressive strength shall be 50 Kg/cm^2 minimum for face bricks. Water absorption after 24 hours immersions shall not exceed 15% by weight for common bricks & 12% for face bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for common bricks and 3% for face bricks. All bricks shall have rectangular faces & sharp straight edges. Maximum permissible chippage for face bricks shall be 6 mm at the edges and 10 mm for corners. The bricks shall show no efflorence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved sample shall be retained by the Engineer for future comparison and reference. The colour and texture of face bricks shall be upto the specification and defective bricks shall be removed immediately from site at the Contractor's own cost.

ai) Fly ash bricks conforming to IS 12894-2002 shall be used where good quality burnt clay bricks are not available or specifically desired by the owner. The Minimum compressive strength shall be 100 Kg/Sq.Cm Only full size bricks shall be used for masonry work. Brick bat shall be used only with permission of engineer to make-up required wall length or boundary. Conventional brick bats with the approval of site Engineer may be used.

b) **Stone**

All stones shall be from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky or earthy appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of

water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) **Lime**

Lime shall be stone lime and conform to the specification Building Limes - IS:712. Lime putty may be prepared from hydrant lime or quick lime. Hydrated lime shall be mixed with water to form a putty and stored with reasonable care to prevent evaporation for at least 24 hours before use. Quick lime shall be shaken with enough water to make a cream, passed through a No. 0 Sieve and then stored with reasonable care to prevent evaporation for at least 7 days before use.

d) **Cement**

Cement used shall be ordinary Portland Cement conforming to Code for ordinary cement in IS:8112 / IS:12269, Portland Pozzolona Cement (PPC) conforming to IS 1489 (Part-1) or IS 1489 (Part-2) and shall be fresh when delivered. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If the cement is procured by the Owner and issued to the Contractor, the Contractor shall satisfy himself at the time of taking delivery that the quality, quantity and freshness of cement are upto the specified standards. No complain later on regarding the cement supplied by the Owner shall be entertained and all rectification work on this account shall be done by the Contractor at his own expense. If at any time, the Engineer feels that the cement being used by the Contractor is not upto specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

e) **Coarse Aggregates**

Coarse aggregates shall be as per IS:383 latest edition, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS:383 and shall be such as to produce a dense concrete of the specified proportions and strength and of consistency that will work readily into position without segregation.

f) **Sand**

Sand shall be hard, durables, clean and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosions to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded. Unless otherwise directed by the Engineer all sand shall pass through IS Sieve No. 240 and 15 to 35% of and for masonry mortar and 5 to 50% of sand for plaster shall pass through IS Sieve No. 30. Sand for concrete shall conform to IS:383.

g) **Water**

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

h) **Reinforcement**

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings which may impair proper bond. Structural steel shall conform to IS:226. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS:432 Cold twisted steel bars shall conform to IS:1786. Hexagonal wire netting shall conform to IS:3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

3.00.00 STORAGE AND HANDLING OF MATERIALS

a) **Bricks**

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded, to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) **Stones**

Stones shall be stored at site in manner approved by the Engineer. Dressed stone for wall facing, paving etc. shall be stored with special care to avoid defacement of faces and edges or damp and rust stains.

c) **Lime**

Lime shall be stored in weatherproof sheds.

d) **Cement**

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

e) **Coarse and Fine Aggregates**

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass or any other injurious substances at any stage. Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

f) **Reinforcement**

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

TECHNICAL SPECIFICATION
FOR
XIV) ANTI-TERMITE TREATMENT

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
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3.00.00	ACCEPTANCE CRITERIA
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XIV) ANTI-TERMITE TREATMENT

1.00.00 **SCOPE**

The scope of work is to set up a chemical barrier against attack by subterranean termites while the building is under construction.

2.00.00 **EXECUTION**

2.01.00 **General**

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

2.02.00 **Chemicals and Rate of Application**

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals		**Concentration by Weight, Percentage**
Chlorpyrifos Emulsifiable (IS 8944 - 1978)	:	1.0
Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978)	:	0.5
Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)	:	1.0

2.02.01 **Treatment of Column Pits, Wall Trenches and Basement Excavations**

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface & sides of excavation (up to a height of about 300mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres/M^2 of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres/M^2 of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding

the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

2.02.02 **Treatment of Top Surface of Plinth Filling**

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres/M^2 of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.02.03 **Treatment of Soil Surrounding Pipes, Wastes and Conduits**

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

2.02.04 **Treatment of Expansion Joints**

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.02.05 **Treatment at Junction of the Wall and the Floor**

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.

A small channel 30x30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.00.00 **ACCEPTANCE CRITERIA**

The Contractor shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period at no extra cost to the owner.

4.00.00 **I.S. CODE**

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981: Code of Practice of Anti-Termite Measures in Buildings

Pre-constructional chemical treatment measures.

TECHNICAL SPECIFICATION
FOR
XV) MASONRY AND ALLIED WORK

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	I.S. CODE

XV) MASONRY AND ALLIED WORK

1.00.00 SCOPE

This specification covers supplying, Laying, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied work for use in structures and locations covered under the scope of the Contract.

2.00.00 INSTALLATION

2.01.00 Soling

2.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of Item. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

2.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling shall be 230mm thick or as directed by the site engineer as per site condition. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

2.02.00 Brick Edging

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

2.03.00 Masonry

2.03.01 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

2.03.02 Mortar

Mix for mortar shall be as specified in the general specification of Architectural work unless mentioned otherwise mortar shall be cement sand mortar of proportion as specified in schedule of item.

If cement lime and sand mortar is specified in the schedule of item lime shall be hydrated lime and shall be mixed with water to form putty and stored with care to prevent evaporation for at least 24 hours before use. Quick lime shall be slaked with enough water to make a cream, passed through a No. 10 sieve and stored avoiding evaporation for seven days before use.

Lime putty and sand in proper proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in a mortar mill. This mix shall be transferred to a mechanical mix, required quantity of cement added and the content mixed for at least 3 minutes. Mixtures of lime putty and sand may be stored avoiding drying out.

For cement sand mortar cement and sand in requisite proportions shall be mixed dry in a mechanical mixer and then water added and mixed further. Minimum quantity of water shall be added to achieve working consistency.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct to add additional cement and same shall be made without any extra cost. No mortar, which has stood for more than half an hour, shall be used.

2.03.03 **Brick Masonry**

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

2.03.04 **Exposed Brickwork (Not Used)**

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by especially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of windowsills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule and string. All brickwork shall be cleaned at the end of days work. If face bricks are specified in the Schedule of Item, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of

work shall be rubbed down, washed clean and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

2.03.05 **Reinforced Brickworks**

Reinforcements shall be as specified in the General Specification of Architectural work. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. Columns or welded to steel stanchions.

2.03.06 **Stone Masonry (Not Used)**

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. Al least two stones shall run the full width of the wall for every square meter of surface area.

2.03.07 **Exposed Stonework (Not Used)**

Stonework, which is to be kept exposed, shall be as shown on drawing or described in the Schedule of Items. Especially skilled mason shall execute it. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or the Schedule of Items or instructions. A sample wall, 10 sq.m. In area shall be built and approved by the Engineer and all works shall match with this sample.

2.03.08 **Hollow and Solid concrete block Masonry (Not Used)**

Hollow and solid concrete block shall conform to the requirement of I.S 2185. Hollow concrete block shall be sound, free from broken edges; free from cracks, honeycombing and other defects, which may give a defective work, impaired the required strength.

Dimensional stability: concrete masonry units shall be made of proper sizes and shape to suit the construction need and shall be in neutral of the following sizes:

The nominal size of concrete block /solid concrete block.

Length : 400,500,600.

Height : 200,100

Width : 50,75,100,150,200,250,300.

In addition block shall be manufactured in half-length of correspondence to full length. Maximum tolerance of length shall be (±) 5mm and in height &with shall be ± 3mm.

The average crushing strength shall be determined as per I.S 2185 and shall be of Load bearing wall density of block shall be not less than 1500 kg /mm^3 and minimum average compressive strength of units shall be 3.5 to 7 N/mm^3 and minimum strength of individual unit shall be 2.8 to 5.6 for block density less than 1500 kg /mm^3 but not less than 1000 kg /mm^3 average compressive strength of units shall be 2.0 to5 N/mm^3 and minimum strength of individual unit shall be 1.6 to 4.0 N/mm^3

For non load bearing wall block density shall be not less than 1000kg / mm^3 and minimum average compressive strength of units shall be1.5 N/mm^3 and minimum strength shall be 1.2 N/mm^3**.**

2.03.09 **Composite Masonry (Not Used)**

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and intervels as desired by the Engineer.

2.03.10 **Expansion & Separation Joints**

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

2.03.11 **Moldings, Cornices, Drip Course**

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with carborandum stone.

2.03.12 **Curing**

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

2.03.13 **Embedding of fixtures**

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required and shall be grouted with concrete.

2.03.14 **Encasing of Structural Steel**

This shall be done by building masonry work round flanges, webs etc. and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer.

The minimum lap in chicken wire mesh shall be 50 mm. Architectural standard details shall be referred for encasement details.

2.04.00 **Damp Proof Course**

Unless otherwise specified Damp-proof course shall be 50 mm thick PCC in proportion 1:1-1/2:3 cemen :sand: stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

2.05.00 **Damp Proof Membrane**

Damp proof treatment using fiber or Hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as mentioned in the Schedule of Items. Sequence or work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150mm lap under slabs on grade.

3.00.00 **I.S. CODES**

Some of the important relevant codes for this section are:

IS: 1127 : Recommendations for dimensions and workmanship of natural building stones for masonry work.

I.S 2185 : Code Practice for hollow concrete block.

IS: 1597 : Code of Practice for Construction of stone Masonry.

IS: 1609 : Code of Practice for laying Damp-proof treatment using bitumen felts.

IS: 2212 : Code of Practice for Brickwork.

IS: 2250 : Code of Practice for preparation and use of Masonry Mortar.

IS: 5134 : Bitumen Impregnated Paper & Board.

TECHNICAL SPECIFICATION
FOR
XVI) FINISH TO MASONRY AND CONCRETE

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XVI) FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.00 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be brushed down with stiff wire brush to remove all loose dust from joints and thoroughly washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 Plastering

2.02.01 Mortar

Mortar for plastering shall be as specified in the General Specification and design criteria for Architectural work.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 **Application of Plaster**

Plaster, when more than 15 mm thick, shall be applied in two coats - a base coat followed by the finishing coat. For 20 mm thick external plaster Thickness of the base coat shall be sufficient to fill up all unevenness in the surface and shall be 12 mm thick and mortar shall be 1:1 Cement Sand plaster. Top coat shall be 8 mm thick with cement sand mortar 1:3. No single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat as indicated in the General Specification and design criteria for Architectural work. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be thrown on rather than applied by trowel.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, door jambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, moldings and cornices as required or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. Drip course shall be provided over all windows, ventilators, louvers and all external doors, rolling shutters and External openings where such course is required for dripping of the water or as instructed by the site engineer. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.02.03 **Finish**

Generally, the standard finish shall be used unless otherwise indicated in the General specification or Standard Architectural drawings attach to the documents or directed by the site Engineer. Wherever any special treatment to the plastered surface is indicated in the General Specification for Architectural work, the work shall be done to the entire satisfaction of the Engineer regarding the texture, colour and finish.

a) **Standard Finish**

Wherever punning is indicated, the interior plaster shall be finished rough. Otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) **Neat Cement Finish**

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. Per Sq.M and rubbed smooth with a trowel. Unless otherwise indicated in the General Specification of Architectural work minimum 300 high neat cement finish shall be provided over plastered external surface from top of plinth protection level.

c) **Coloured Plaster Finish (Not Applicable)**

This shall be done, if indicated in the General specification for Architectural work, in the same way as specified in clause **2.02.01** but using coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest edition.

Samples of colouring material shall be submitted to the Engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) **Pebble-dash Finish (Not Applicable)**

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering clause **2.02.01**. While the mortar is still plastic small pebbles or crushed stone of size generally from 10 mm to 20 mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) **Rough-Cast Finish (Not Applicable)**

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 mm as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) **Scraped Finish (Not Applicable)**

Ordinary plaster as described under Clause **2.02.01** after being levelled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) **Textured Finish (Not Applicable)**

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause **2.02.01** Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) **Textured Finish with Granules**

Surface where Textured granules finish specified shall be prepared Specially as per approved manufacturer's specification and recommendation. Granules shall be mixed thoroughly in colour pigmented resin and shall be applied uniformly with devices as per manufacturer recommendation and by the authorized applicator of the manufacturer. Texture and shade shall be as approved by the owner during detail engineering stage. Textured finish brand shall be HERITAGE or SPECTRUM or Approved Equal.

2.02.04 **Curing**

All plastered surfaces after laying, shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 **Pointing to Masonry (Not applicable)**

All joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 **Plaster with Metal Lath**

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 BG thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two layers. The mortar for plastering shall consist of 1 part cement, and 4 parts sand by volume, mixed

as specified in plastering, Clause 6.1.2.2.1. The application, finish etc. shall be as specified under relevant clause above. Where called for in the Schedule of Items, a 2 mm Plaster of Paris punning shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

Brick encasing of steel beams shall be plastered over wire mesh provided during encasing of Steel beam with bricks.

2.05.00 **Lime Punning (Not Applicable)**

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punning shall be applied by skilled workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 **Plaster of Paris Punning (Not Applicable)**

a) Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. area and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

b) **Wall Putty Finish to interior & Exterior Surfaces.**

Plastered surfaces, where specified shall be finished with wall putty of approved manufacturer. Wall putty shall be white cement based with a mix of high performance special chemicals and polymers and shall be suitable for both internal and external finishes. Wall putty finishes shall be 1.5 mm -2mm thick as per the condition of the surfaces to be treated.

Wall putty shall be water, fungus and algae resistant. Wall putty manufactured by Birla Cement/ MYK Laticrete India shall be provided for the work.

2.07.00 **Stone Facing**

a) Stone facing where specified shall be done as shown on design drawings & approved shop drawings. The stone shall be as specified e in the General Specification for Architectural work. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawing for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 20-25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern approved by the owner. They shall be fastened to wall with suitable noncorrodable anchorage as approved by the Engineer or as indicated in the General specification. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanised (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer. The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Alternately Stone slab shall be fixed with Laticrete 254 platinum thin set adhesive of MYK Laticrete India Pvt. Ltd. or approved equal over plastered surface with 2mm joints in between. Joints shall be filled with matching colour filler grout of the same manufacturer. Thickness of adhesive shall be according to size and weight of the slab and manufacturer specification shall be strictly followed. This alternative fixing system if not indicated in the general specification for Architectural work can be adopted with the approval of owner.

b) **Wall finishes with Vitrified, Ceramic and Terracotta tile**

Wall tile facing where specified shall be done as shown on design drawings and approved shop drawings. The Tiles shall be as specified on drawings and/or schedule of items. Samples of Tiles shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawing for the Engineer's approval before commencing the work.

The thickness of facing tiles shall be as specified in the schedule of items or in drawing. Tile shall be fixed over Plastered surfaces with approved Chemical mortar of high bonding strength of approved manufacturer.

c) **Wall finish with Aluminium Composite Panel (ACP)**

Wall facade interior or exterior surface shall be plastered prior to installation of ACP. The exterior plaster surface shall be specially treated with water proof treatment with SIKA top seal or two coats of EMUFAL TE rubberized modified bituminous emulsion of TEXSA or approved equivalent prior to installation of ACP. Water proof treatment shall be made as per manufacturer specification and by manufacturer's authorized applicator.

ACP cladding system shall be based on rain screen principle, with provision for natural ventilation of the space between cladding panels and wall.

Panels shall be fixed as per general arrangement shown in approved drawing. Each panel shall be fixed over extruded aluminium sections as per approved manufacturer details and shall be fastened to Sub structure.

All fasteners shall be concealed within the panel joints. No silicon or similar sealant shall be used within the panel joints. All joints shall be of toughened acrylic adhesive similar to PERMABOND F-245 or as recommended by the manufacturer. All fixing and joint details shall be designed to provide for the expected thermal expansion and contraction and to accommodate structural movement.

Design criteria:

All aluminium composite panel shall be designed to meet the specified performances required to for the prevailing weather conditions.

Design wind load shall be 20N/Sq.m. no cladding element shall sustain permanent deformation or failure under loading equivalent to 1.5 times the design wind pressure specified.

Deflection: deflection of any aluminium frame shall not exceed 1/150 of the clear span.

All cladding shall be minimum 4.0mm thick for external use and minimum 3mm thick for interior paneling and shall conform the approved manufacturer recommendation.

Aluminium composite panel (ACP) shall comprise of polyethylene core sandwiched between two skins of aluminium alloy. Skin shall be of approved shade.

Finish shall be factory pre-finished with a PVDF (Flurocarbon) coating of super polyester coating and shall be suitable to withstand most aggressive climate. DFT of coating shall be minimum 20 micron. Finished surface shall be protected with self adhesive peel off foil. The reverse side of the panel shall be standard factory finish.

Vendors shall furnish general arrangement drawing with details of fixing and also furnish samples for ACP, structural stability assurance with necessary calculation and manufacturer guide lines for fixing and recommended specifications for selection and approval of the material.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 **I.S. CODE**

Important relevant code for this Section:

a) IS: 1661: Code of practice for cement and cement-lime plaster finish on walls and ceilings.

b) IS: 4101: Code of practice for external facings and veneers.

TECHNICAL SPECIFICATION
FOR
XVII) SINGLE SHEET / SANDWICH / DOUBLE SKIN METAL CLADDING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	GENERAL
2.00.00	PRODUCTS
3.00.00	DOUBLE SKIN INSULATED METAL CLADDING
4.00.00	EXECUTION

XVII) SINGLE SHEET / SANDWICH / DOUBLE SKIN METAL CLADDING

1.00.00 **GENERAL**

1.01.00 **Description**

1.01.01 This section covers the furnishing and installation of sandwich i.e., double skin metal / single sheet metal cladding with or without insulation for wall/roof as shown in contract drawings including making cut outs for various openings for doors, windows, ducts, pipes etc and fixing of such components with the cladding arrangement with necessary flashing, sealant as required as per contract drawings. The contractor shall furnish all labour, materials, tools and equipment required to complete the work.

1.02.00 **Applicable Codes and Standards**

1.02.01 The following codes and standards are intended to provide an acceptable level of quality for materials and products. The contractor may propose alternative codes and standards provided they give an equivalent degree of quality as the referred codes and standards and are submitted for consultants/ owner's approval.

1.02.02 ASTM American Society for Testing Materials

1.02.02.1 A446 Zinc-coated (Galvanized) steel sheets of structural quality. Coils and cut lengths.

1.02.02.2 A611 Steel, cold rolled sheet.

1.03.00 **Submittals**

1.03.01 The contractor shall submit to the owner the following items for review before commencing work.

1.03.01.1 Samples

Three 300x300 mm pieces of each type of precoated and preformed metal sheet for top skin and bottom skin. Bottom skin is required for sandwich cladding only.

Type of insulation proposed for use and its thickness in case sandwich cladding.

Fabricated sandwich metal cladding. Sample size shall be 300 x 300 mm three nos.

Edge sealing and flashing.

1.03.01.2 Manufacturer's literature indicating the nature of preformed profiled, colour coating, manufacturer's recommended installation, instructions and maintenance procedure.

1.03.01.3 Manufacturer's certification of compliance with each delivery.

1.03.01.4 Shop Drawings

Showing fabrication details of sandwich/double skin/Single metal cladding with or without Insulation as the case may be, preformed sheet profile and total colour thickness for profiled top skin and slightly ribbed bottom skin, thickness and nature of insulation in case of sandwich cladding, installation and erection, anchorage, fasteners and details of accessories, metal flashing and its fixing including various openings for doors, windows, louvres, pipes etc.

1.03.02 Test Reports

Two copies of Test Reports and Source of Quality Control Tests.

1.03.03 Supplier Certificates

Two copies of technical data showing that the proposed finish product is suitable for the environmental conditions of the job site and that the materials meet specification requirements.

1.04.00 **Product Handling**

1.04.01 Delivery of Materials to job site in manufacturer's original unopened packaging.

1.04.02 Identify contents with name of manufacturer, brand name, thermal value and applicable standard.

1.04.03 Store materials in an area protected from adverse climatic conditions, moisture and open flame or spark and shall be stored off the ground with one end elevated for drainage. The sheets shall be protected from inclement weather with a waterproof covering with ventilation to avoid condensation.

2.00.00 **PRODUCTS**

2.01.00 **General**

2.01.01 all goods and products covered by these specifications shall be procured from manufacturer duly approved by the owner

2.01.02 Roof insulation in case of sandwich roof cladding shall have a minimum R-value of 2.083 M2 oK/Watt. Thickness of sandwich cladding shall be as required to meet the specified "R" values.

2.01.03 Sandwich material shall be of "Rib and Flute" design to ensure wide spanning and quick recovery after being subjected to excessive load. Double skin materials shall be as per approved manufacturer sheet profile and sizes and inner sheet shall be mild rib & flute type profile to ensure quick recovery after being subjected to excessive load.

2.01.04 Material

2.01.04.1 Base Material — High tensile steel

2.01.04.2 Metal protection — Galvalume. This shall be steel sheet with Zinc Aluminium coating offering high corrosion resistance.

2.01.04.3 Organic coating — Silicon Modified Polyester (SMP) or Fluoro polymer (PVF2) and plastisols to resist aggressive climate of the jobsite or as per approved manufacturer's specification and recommendation.

2.01.05 Material shall be single skin or sandwich as per contract requirement in case of sandwich cladding material shall be prefabricated sandwich panel with polystyrene insulation/ resign bonded high density rock wool insulation shall be conformed to relevant ASTM or alternative codes and standard. Insulation shall be bonded to steel sheet with industrial grade adhesive. Sheeting material shall be preformed and precoated profile sheeting of thickness 0.5 mm to 0.55 mmTCT (Total coated thickness) or as recommended by manufacturer to resist the climate of the jobsite. Top skin (Weather side) and Bottom skin or inner side slightly ribbed type and minimum 0.5 mm thick or as recommended by manufacturer of similar pre coated panel. Single skin metal Cladding shall be similar to external top skin specified for Sandwich metal cladding.

2.01.06 Insulating core shall vary from 25 mm to 100 mm thick according to the climatic requirements of the site and shall be either polystyrene block or rock wool slab made to profile of the sheet. The maximum density shall be 32.35 Kg/M3 for polystyrene and shall have minimum R-value 2.083 M2 oK/Watt. And for Rock wool insulation density shall be 48kg/ M3 as per IS: 8183.

2.01.07 Panel size shall be largest available size.

2.01.08 Warranty for precoated profiled metal single skin/ sandwich /double skin cladding shall be for a minimum period of 40 years.

2.01.09 Sealants

Penetration and end laps in sheeting shall be sealed with a non-hardening approved sealant as recommended by the manufacturer.

2.01.10 Profile HDPE Filler

2.01.10.1 Profile HDPE Filler shall be die cut in profile to match the profile of the sheet.

Metal flashing shall be of similar material and match the colour of top skin.

3.00.00 DOUBLE SKIN INSULATED METAL CLADDING

3.01.00 General

3.01.01 Metal cladding may be of double skin separated by an approved insulation in between.

3.01.02 External cladding both for single and Double skin/sandwich wall cladding shall be comprising of external panels manufactured out of0.5mm to 0.55 TCT sheet or as per approved manufacturer sheet detail. Zinc Aluminium coated steel sheet (Galvalume sheet) shall have Coating comprised of 55% Aluminium, 43% Zinc and 1.5% silicon. Coating shall be of class AZ-150 as per AS: 1397, which means 150 gms/sq.m minimum coating mass total of both sides. The base material is steel which shall be high tensile steel of 550MPa. Coating on both sides shall be organic coating as indicated above in cl. No. 2.01.04.3. Coating thickness shall be as per manufacturer specification to resist most aggressive climate. Sheet shall be of approved shade with profile depth 28mm and 195mm pitch with two small additional ribs in between two profiles. Sheet shall be clipped on to the concealed runners and shall be overlapped with each other. The inner sheeting incase of sandwich cladding shall be Hi Rib minimum 0.5mm TCT silicon modified polyester coated galvalume steel (AZ-150 gsm aluminium-Zinc alloy metal metallic coating of total 550 Mpa yield stress as per AS-1397).The external panels shall be of profile mentioned above. The inner sheet shall have 1000-1020 mm cover width 28-30 mm high crests @250-255mm c/c with side laps. The inner sheet shall be fixed to structural system by means of corrosion protected self-drilling, self-tapping fasteners. The sub girts of size 50mmx50mmx50mm manufactured out of 16 G G.I (1.6mm) 'Z' shape shall be fixed to inner sheeting on face side at purline locations. The external panels shall be fixed with the help of concealed runners 34.5 wide x48mm deep out of 0.95 mm thick aluminium strip with cut outs to hold the panels in a module of sheet width as per approved manufacturer standard product and details fastened on side girts @ 1600c/c minimum. The runners shall be concealed and no fasteners are to penetrate the panels. An insulation of 50mm thick resin bonded rock wool insulation of density 48kg/m3 shall be fixed in the cavity between two sheets. Contractor shall make cut out of doors, windows, louvres, pipe, ducts or other cut outs as required as per contract drawings along with flashing, leak proof sealing etc as required for these cut outs/wall openings.

4.00.00 EXECUTION

4.01.00 Inspection

4.01.01 The contractor shall examine the area, which will be covered, and the masonry wall where the edge of the single sheet cladding /sandwich/double skin cladding will be fixed and the structural alignments.

Contractor shall correct any unsatisfactory conditions prior to start of work.

4.02.00 **Installation**

Single sheet panel/Sandwich panel shall be fixed over structural members with joints overlapped and fastened using stainless steel fasteners self-drilling type or as recommended by the manufacturer.

Wall cladding shall be installed strictly as per manufacturer specification and details.

All end laps of profiled sheeting and joints of flashing shall be sealed properly with non-hardening natural cure silicon sealant or as recommended by the manufacturer.

Accessories like fasteners, tape, and foam fillers, flashing etc. as required shall be provided as per recommendation of manufacturer.

4.03.00 **Clean-Up**

Remove sealant splatters and smears remove steel particles generated by drilling to avoid damage.

TECHNICAL SPECIFICATION
FOR
XVIII) CARPENTRY AND JOINERY

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XVIII) CARPENTRY AND JOINERY

1.00.00 **SCOPE**

This shall include supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, paneled or flush doors, windows, shutters, partitions, wall paneling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for in the schedule. This shall also include the supply and fixing of all hardware and fixtures.

2.00.00 **INSTALLATION**

2.01.00 **Materials**

a) **Timber**

Unless otherwise specified, all timber shall be best quality well seasoned C P teakwood free from large or loose, knots cracks or other defects. Where specified, timber shall be treated with approved wood preservative before use. Before starting the carpenter's work, the Tendered shall have the rough timber approved by the Engineer.

b) **Plywood**

Plywood shall be commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde resin of BWR grade conforming to IS: 848.

c) **Decorative Laminated Plastic Sheets**

The colour, pattern, finish and texture shall be approved by the Engineer and the bulk supply procured in sheet sizes which will ensure the least number or joints in one surface.

d) **Flush Doors**

Flush doors shall be hollow or solid core doors with commercial or decorative faces and hardwood edges. The core for solid core doors shall be of block board or wood particleboard. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is phenol formaldehyde of BWR grade, conforming to IS: 848. The thickness shall be as specified in the "Schedule of Items".

e) **Panel Doors**

Panel door shall be of teakwood shutter frame unless otherwise noted and panels with teakwood/commercial ply/teakwood particleboard as per "Schedule of Items". Other considerations shall be as mentioned in item (d) above.

f) **Fixtures**

Fixtures for doors, windows, furniture, etc. shall be as shown on drawing or specified in the “Schedule of Fixtures”.

2.02.00 **Workmanship**

2.02.01 **General**

Skilled carpenters as per details shown on drawing or instructed by the Engineer shall do the work.

Framing timber and other work shall be close-fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc. that will come in contact with masonry after fixing shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particleboard. The edge of all plywood, block board and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing for frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long MS holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M. S. grills or guard bars shall be provided to windows where called for in the drawings or schedule of items.

2.02.02 **Finish**

All carpentry work after finishing shall be sand papered smooth. Prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.02.03 **Surface Treatment**

When shown on drawings or called for in Schedule, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of approved brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer’s instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 Door and Window Frames

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 Door and Window Shutters

Shall be of proper size, shape and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 Partitions, Paneling, Pelmets, Furniture, etc.

3.03.01 General

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.03.03 Pelmets

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.04 Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 Drawers

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 Loose Furniture

When placed on a level surface tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 **IS CODES**

Some of the important relevant Codes for the Sections are:

IS: 4021	-	Timber door, window and ventilator frames
IS: 1003	-	Timber paneled and glazed shutters.
IS: 2191	-	Wooden flush door shutter (Cellular and hollow core type)
IS: 2202	-	Wooden flush door shutters (Solid core type)

TECHNICAL SPECIFICATION
FOR
XIX) METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	INFORMATION TO BE SUBMITTED
5.00.00	I.S. CODE

XIX) METAL DOORS, WINDOWS, VENTILATORS, LOUVRES, ETC.

1.00.00 SCOPE

The work in general shall consist of supplying and erecting and installing of all metal doors, windows, ventilators, louvres, glazed partitions, etc. as stipulated here or as specified elsewhere in the general specification for architectural work with all materials complete including supply of glass and glazing and all other materials as required. The scope of work shall also include the assembly of various components.

2.00.00 INSTALLATION

2.01.00 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified in Architectural standard drawing.

Steel sheets for frames, shutters, louvre blades etc. shall be of gauge/ thickness mentioned here or as indicated in the drawing attached or General specification of Architectural work.

For pressed steel door frames steel shall conform to IS 513.

Aluminium sections for fabricating doors, windows, partitions, etc. shall be extruded sections conforming to sections manufactured by HINDALCO.

Hardware and fixtures of the best quality from approved manufacturers shall only be used. The bidder shall l specifically state the particular manufacturer's materials he proposes to use. Best quality fixtures as per approved sample shall be provided and fixed in true alignment. Improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor's responsibility and shall be replaced without any extra cost.

All hardware and fixtures shall be able to withstand repeated use. Door closers shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated elsewhere in this document. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the door closer replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance requirements & endurance test stated in IS: 3564 Appendix-A.

The Contractor shall submit samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for verifications of bulk supply. The samples shall be returned to the Contractor towards the end for incorporation in the job.

The caulking /sealant shall be of best quality from a manufacturer approved by the Engineer. In general, Polysulphide or silicon sealant as approved by the Engineer shall be provided.

2.02.00 **Fabrication**

2.02.01 **Steel Doors, Windows, Ventilators, Louvres, etc.**

a) **Door Frames**

Frames shall be fabricated from 1.6 mm thick steel sheets. They shall be mortised, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties/weather bars installed in place.

b) **Double Plate Flush Door Shutters**

Door shutters shall be 45 mm thick, completely flush design and shall comprised of two outer sheets or 1.25 mm thick steel sheets, rigidly connected and reinforced inside with continuous vertical 1mm thick steel stiffeners, spot welded in position at not more than 150 mm on centers.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting stile edges beveled or rebated. Where shown on drawing or called for in the schedule of items the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push-plates and other surface hardware where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown in drawing, provision shall be made for fixing glazing, vision panels, louvres etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louvres blades shall be V or Z shaped and made out of 1.6 mm thick steel sheets.

c) **Single Sheet Door Shutters**

Single sheet doors shall be made from best quality 1.25 mm thick mild steel sheets and shall present a flush surface on the outside. The inside shall be stiffened with semi-tubular edge and central stiffening rail, which shall convey the lock and other furniture. The frames shall be made from best quality 1.6 mm thick mild steel sheets.

Wherever required for vision panel, louvers for air inlet for ventilation through toilet doors provisions for fixing glass panes louvres, etc. shall be made.

The manufacturing shall be done as specified in **2.02.01 b** "Double Plate Flush Door Shutters".

d) **Sliding Doors**

Sliding doors shall be double plate construction made out of 1.25 steel sheets with adequate stiffeners. The Contractor shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. The Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) **Fire Proof Door**

Fire proof doors shall be provided at all fire exit points and also restrict spread of fire generated either in internal or external area.

These doors shall conform to the requirements as stipulated in IS: 3614 (Part I & II) and shall have minimum 2 hours fire rating or as required as per fire rule of the statutory authority.

Fire proof doors shall be of approved manufacturer and shall be double plated metal door with core Packed tightly with insulation or teak wood or yellow pine boards shall include panic exit devices as hardware.

f) **Door Threshold**

Door threshold shall be provided for all external doors. Doors without threshold shall have bottom tie of approved type.

g) **Steel Windows, Sashes, and Ventilators etc.**

These shall conform in all respects to IS:1038 and IS:1361 latest editions and as shown on drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc.

All welds shall be dressed flush on all exposed and contact surfaces.

Where composite unit openings are required the individual window units shall be joined together with requisite transoms and mullions as per IS 1038/1361. All windows shall be outside glazed fixed with putty or metal glazing beads. Where aluminium glazing beads are specified they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (HIndalco Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer over unexposed side before fixing to windows.

h) **M.S grill**

Mild steel grill shall be provided for windows in specified areas for security reasons. M.S flats of minimum size 20x5 mm shall be used. Opening size shall not be more than 75 mm. all joints of the grill shall be properly welded. Grill shall be fixed to the window frame by welding. Steel primer shall be applied before installation.

2.02.02 **Aluminium Door, Windows and Frames**

Extruded sections of HINDALCO shall be used. All sections shall be approved by the Engineer before fabrication is taken up. Doors, frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 15 micron thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent cover shall be applied to the sections before shipment from the factory.

All work shall be fitted and shop assembled to a first class job and ready for erection. Shop joints shall be made to hairlines and then welded or braced by such method as will produce a uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.03.00 **Shop Coat or Paint**

The shop paint for steel doors, windows, etc. shall be best quality two pack epoxy primer enriched with metallic Zinc of approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

All steel doors, windows etc shall have one shop coat and one site coat and two coats of finishing paint unless indicated in these specifications.

Portions of aluminium frame which come in contact with masonry construction shall before shipment from workshop be protected with a heavy coat of alkali paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.04.00 **Handling & Storage of Fabricated Material**

All metal doors, windows, etc. shall be packed and crated properly before dispatch to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

All metal doors, windows, etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminum products by rust, mortar, etc.

2.05.00 **Assembly & Erection at Site**

In general, the fixing of steel doors, windows, ventilators, louvres, etc. shall conform to IS:1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvres, etc. including transoms and mullions for composite units in respective places as shown on drawing keeping proper lines and levels, and in approved workman like manner to give trouble free and leak-proof installations. The installation shall be done according to the instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take every precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good with the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the mastic cement in original sealed containers of manufacturer and shall apply it as per the instructions. Caulking shall be done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metre from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

3.00.00 **ACCEPTANCE CRITERIA**

3.01.00 **For Fabricated Items**

a) Overall dimensions shall be within ±1.5 mm of the size shown on drawings.

b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ± 1.5 mm from the axis of the member.

c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 1.5 mm.

d) Door leaves shall be undercut where shown on drawings.

e) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.

f) All welds shall be dressed flush on exposed and contact surfaces.

g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures.

h) Provisions for hardware and fixtures to be installed at site.

I) Glazing beads shall be cut with mitered corners.

j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.

k) Shop coats shall be properly applied.

l) Exposed aluminium surfaces shall be free from scratches, stains and discolouration. Anodised surfaces shall present a uniform and pleasing look.

m) Glass shall be as per specification for “Glass and Glazing” given elsewhere in this document

3.02.00 **For Installed Items**

a) Installations shall be at correct location, elevation and in general on a true vertical plane.

b) Fixing details shall be strictly as shown on drawings or as per manufacturer details.

c) Assembly of composite units shall be strictly as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.

d) All frames on external walls shall be caulked with sealant either polysulphide or silicon sealant as per type of materials to prevent leakage through joint between frames and masonry.

e) All openable section shall operate smoothly without jamming.

f) Locks, fasteners, etc. shall engage positively. Keys shall be non-interchangeable.

g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.

h) Aluminium doors, windows, etc. shall be free from scratches stain or discolouration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 With Tender

a) Names of manufacturers for doors, windows, etc.

b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 After Award

a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.

b) He shall submit a programme of work to be done for the approval of the Engineer.

c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by the Engineer for verification of bulk supply and returned to the Contractor towards the end for final incorporation in the job.

5.00.00 I.S. CODES

Following are some of the important I.S. Codes as relevant to this section:

Steel doors, windows and ventilators	-	IS: 1038
Steel windows for industrial buildings	-	IS: 1361

Aluminium doors windows and ventilators	-	IS: 1948
Aluminium windows for industrial buildings	-	IS: 1949
Steel doorframes	-	IS: 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows, And ventilators.	-	IS: 1081

TECHNICAL SPECIFICATION
FOR
XX) ALUMINIUM FRAMED GLAZED CURTAIN WALLS AND STRUCTURAL GLAZING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XX) ALUMINIUM FRAMED GLAZED CURTAIN WALLS AND STRUCTURAL GLAZED WALL

1.00.00 SCOPE

This specification covers supply, erection & installation of Aluminium framed glazed curtain wall/ Structural glazing work for wall including fabrication and erection of tubular aluminium frames for large panel glazing work.

It also includes furnishing and installation of glass, aluminium frames, aluminium brackets, angles, tubes, sheet, Shadow box to hide the floor beams and other members as required, adhesive of approved quality, Toughened heat reflecting tinted imported glass etc. For the completion of curtain wall or structural glazing work, a firm specialised in executing similar type of work and duly approved by the Engineer shall be engaged to execute such work.

2.00.00 INSTALLATION

2.01.00 System and Materials

Curtain Wall is a façade with visible supporting frame work for fixing glass. The frame Consist of vertical mullion and horizontal transoms.

Supporting system shall be fixed in one of the following method as per schedule of item.

- **Stick wall system**

  In this system the mullions are first installed to the slabs of the building and then transoms are fixed with or without connecting brackets.

- **Ladder or semi-unitized system**

  In this system Prefabricated mullion and transom frames are taken to site and installed in units of 3 or 4 frames in the same way of stick system.

- **Unitized system**

  Prefabricated frames with split mullions are installed frame by frame between slabs.

Supporting frame and glass fixing arrangement shall consist of mullions, Transom, purlins i.e., continuous cross bars, brackets as connector for mullions and transoms, wall brackets for fixing mullion to slab, pressure plate/ glazing plate to hold the glass, Cap/Cover plate to cover glazing plate and fixing screws.

Aluminium sections for curtain walls with or without doors, windows etc. Shall be approved extruded sections from alluminium alloy of HINDALCO.

Hardware and fixtures shall be of approved manufacturer. Doors, windows and frames shall also conform to the technical specification of "Metal, Doors, Windows, Ventilators, Louvers" inserted in this document.

All aluminium-extruded sections shall have dark brown electro coloured coating irrespective of any indication in General Specification for architectural work. Glass shall be tinted glass as per approved sample as indicated in General specification for Architectural work.

Glazing and insulating gaskets shall be EPDM. Fasteners exposed to outside and inside shall be stainless steel. Brackets and reinforcement shall be aluminium flashing shall be aluminium 16 G. Sheet. Glass and glazing shall conform to the technical specification of "GLASS AND GLAZING". All aluminium members shall be isolated from dissimilar metals/concrete etc. and unexposed surface coming in contact with other structures, walls, etc. shall be painted with a coat of zinc chromate primer.

Water proofing on the rafters shall be achieved by means of continuous slip in gasket above and below the glass. Under no circumstances glass shall come in contact with metal. Weep holes shall be provided at the lower portion of the aluminium bar for drainage of condensed moisture.

Contractor shall provide hardware; fix doors, and windows so that perfect operation is assured. Doors shall stand in any position to operate smoothly.

Silicon sealant shall be used at expansion joints, gasket joints and gaps between the surrounding wall and the glazing members to make the system waterproof.

Aluminium finish shall be electro colored of approved shade conform to minimum 15 microns thick or as recommended by the manufacturer to witness aggressive climatic conditions.

Structural glazing

Structural glazing is a façade without any visible external element ie supporting member profiles. Glass panels are fixed with the frames by using a structural Silicone sealant.

The sealant contract dimension and thickness shall be designed to :

i) Provide a method of structural support to glass

ii) Provide airtight and weather tight seal.

iii) Provide a flexible rubber anchorage that absorbs differentials movements between dissimilar materials from thermal or seismic loading.

Structural glazing shall also be fixed any of the three system as stated for Curtain wall fixing above.

Both Curtain wall and structural glazing shall be designed by the approved vendor. General arrangement showing location and type of windows and doors if required and structural system considering most aggressive climatic condition including sizing of supporting members, required glass thickness and panel size and contact adhesive dimensions etc. shall be submitted for approval. Vendor's drawing with necessary structural design calculation are to be submitted by the vendor for approval of the owner.

3.00.00 INFORMATION TO BE SUBMITTED BY CONTRACTOR

3.01.00 After award of contract

After award of contract and prior to construction contractor shall furnish vendor drawings based on GA drawings and technical data given with details of assemblies, flashing, anchorage, expansion joints, accessories and other necessary items for approval of the owner.

Samples of materials are to be submitted for approval prior to construction and a prototype 750 mmx750 mm In size curtain wall/structural glazing finished in all respect shall be submitted for approval of the Engineer-in-Charge. The samples shall be retained by the Engineer for comparison of supply and returned to the contractor towards the end of the construction.

Vendor drawing shall be submitted prior to fabrication. Shop drawing shall indicate the following information.

i) Plans, elevations and sections of all aluminium curtain walls/ Structural glazing .

ii) Detail of frames and glazing.

iii) Details of hardware locations with dimensions.

Approval of vendor drawings by the owner's side shall be for arrangement only and not for structural system and its stability and shall not relieve the contractor of his responsibilities for errors, omissions or the accuracy of his own dimensions, structural strength and stability, flexibility to thermal condition, weather conditions and other movements.

4.00.00 ACCEPTANCE CRITERIA

4.01.00 For fabricated items

Refer technical specification of Metal Doors, Windows, and Ventilation etc.

4.01.01 For installed items

Refer technical specification of Metal Doors, Windows etc.

5.00.00 **I.S. Code**

IS-12118: 1987: (Part I & II)	Specification for two parts polysulphide based sealants

TECHNICAL SPECIFICATION
FOR
XXI) ROLLING STEEL SHUTTERS AND GRILLS

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXI) ROLLING STEEL SHUTTERS AND GRILLS

1.00.00 **SCOPE**

This specification covers the design, supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.00.00 **INSTALLATION**

2.01.00 **Components**

a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 m wide and not less than 2.25 mm thick for shutters 5.5 m wide and above, machine rolled at 75 mm rolling centres, interlocking with each other. The profile, will be such as to prevent excessive deflection under specified wind load.

b) Rolling grills shall be constructed out of 6 mm dia. rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6 mm dia. rods.

c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise in the Schedule.

d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.

e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.M or as specified in Schedule.

f) Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.

g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.

h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as described in Schedule or as described by the Engineer.

i) Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in Schedule or drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

j) Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.

k) Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

2.02.00 **Manually Operated Shutters / Grills**

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general manually operated shutters shall be push pull type for openings upto 9 sq.metre in area. Larger shutters shall be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as described in Schedule or as desired by the Engineer.

2.03.00 **Power Operated Shutters / Grills**

These shall be operable from a push butten station conveniently located beside the door or as shown on drawings. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for in Schedule, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 **Shop Coat**

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

2.05.00 **Erection**

Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.

3.03.00 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.00.00 I.S. CODE

IS:6248 - Metal rolling shutters and rolling grills.

TECHNICAL SPECIFICATION
FOR
XXII) GLASS AND GLAZING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXII) GLASS AND GLAZING

1.00.00 SCOPE

The work in general shall consist of supplying and fixing all glass and glazing including all clips, putty, mastic cement etc. wherever required as stipulated here or elsewhere in the General specifications for Architectural work. Architectural standard drawings including supply of snap glazing beads, EPDM gaskets and all materials as required for completion of the work.

2.00.00 INSTALLATION

2.01.00 General

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvres, miscellaneous glazing and partitions from approved manufacturer & shall have uniform refractive index and free from flaws, specks and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials

a) Glare reducing or heat absorbing glass if provided shall be of approved manufacturer and special care shall be taken to grind smooth and round off the edges before fixing.

b) Clear glass shall be float glass and shall be at least 6 mm thick. for windows and for doors shall be minimum 6mm thick or as indicated in the General specification of Architectural work. Glass for Seamless glazed door shall be 12 mm thick.

c) Wired glass shall be 6mm thick rolled glass with centrally embedded wire mesh of Georgian type. This may be of clear glass.

d) Obscure/ground glass shall have a cast surface in one side.

e) Colour glass shall be as per approved sample.

f) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing. Quick setting putty glass is used where it shall be non-setting type.

g) EPDM gaskets with snap-fit glazing shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.

2.02.00 **Glazing, Setting and Finish**

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing clips shall be provided per glass pan, except for large panes where six or more clips shall be used as per Engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by the Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where moulding or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Necessary glazing clips, putty, mastic cement etc. shall be supplied by the Contractor. After completion of glazing work, the Contractor shall remove all dirt stains, excess putty etc. clean the glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the Contractor's own cost.

3.00.00 **ACCEPTANCE CRITERIA**

a) All installation shall be free from cracked, broken or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked or underground edges.

b) Glazing shall be carefully done to avoid direct contact with metal frames.

c) All glass shall be embedded in mastic or fixed by EPDM gaskets to give a leak proof installation.

d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

c) No separate payment shall be made for cutting of glass to require size, edge finishing etc. if the glass is supplied by the Contractor.

d) Payment shall be made for cutting of glass to required size edge finishing etc. if the glass is supplied by the Owner.

e) No separate payment shall be made for cleaning the glass after installation.

4.00.00 **I. S. CODES**

Following are some of the important I.S. Codes relevant to this Section :

IS : 3548 - Code of practice for glazing in building.

IS : 1083 - Code of practice for fixing and glazing metal doors, windows and ventilators.

TECHNICAL SPECIFICATION
FOR
XXIII) FLOOR FINISHED AND ALLIED WORK

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXIII) FLOOR FINISHED AND ALLIED WORK

1.00.00 **SCOPE**

This specification covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes and allied items of work as listed below :

a) **In Situ Finishes**

i) Integral finish to concrete base

ii) Red Oxide of Iron finish

iii) Terrazzo finish

iv) Granolithic finish

v) Patent Stone

vi) Metallic Hardener like “Ironite” finish

vii) Non Metallic hardener finish

viii) Mastic Asphalt finish

ix) Chemical Resistant finish

b) **Tiled Finishes**

i) Terrazzo tile

ii) Chequered tile

iii) Glazed tile

iv) Tesserae (Mosaic etc.)

v) Chemical Resistant

vi) Rubber, Vinyl etc.

vii) Stone slab

viii) Vitrified tile finish

1.01.00 **Base**

The base to receive the finish is covered under other relevant specifications.

1.02.00 **Sequence**

Commencement, scheduling and sequence of the finishing work shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damage whatsoever till handing over.

2.00.00 **INSTALLATION**

2.00.01 **Special Materials**

Basic materials are covered under Specification “Properties Storage and Handling of Common Building Materials”. Special materials required for individual finishing items are specified under respective items. In general, all such materials shall be as per relevant I.S. Codes where available. In all cases these materials shall be of the best quality available indigenously, unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialised manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain the construction schedule.

2.00.02 **Workmanship**

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer’s permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.00.03 **Preparation of the Base Surface**

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado & similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirt, grease etc. with water & hard brush & detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification under individual item.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be done dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 **In Situ Finishes**

2.01.01 **Integral Finish to Concrete Base**

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and leveled but the concrete is still green a thick slurry made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin a possible by using 2.2 kg. of cement per sq.m. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after laying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings. The marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.01.02 **Red Oxide of iron finish (Not Applicable)**

It shall consist of an underbed and a topping over already laid and matured concrete base.

a) **Thickness**

Unless otherwise specified the total thickness of the finish shall be minimum 50 mm or as per schedule of item for horizontal and 20 mm or as per schedule of item for vertical surface of which the topping shall (not less than 10 mm) while the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finishes. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius off 25 mm.

b) **Mix**

i) **Underbed**

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 2 parts coarse sand and 4 parts 10 mm down graded stone chips by volume. For vertical and similar surfaces the mix shall consist of 1 part cement to 3 parts coarse sand by volume.

ii) **Topping**

For the topping cement, screened through a fine mesh and red oxide of iron pigment powder similarly screened shall be dry mixed thoroughly in right proportions to produce the desired colour when laid. The mix shall then be prepared with 1 part cement (mixed with pigment) and 3 parts coarse sand by volume. The whole quantity required for each visible area shall be prepared in one batch to ensure uniform colour.

c) **Laying**

The underbed shall be laid in panels of mixing area 5 Sq.M. each and no side shall be more than 2.5 along. For outdoor locations the maximum area shall be 2.0 Sq.M. The forms for the panels shall have perfectly aligned edges to the full depth of the total thickness of finish. If specified aluminium or glass dividing strips shall be used.

The panels shall be laid in alternate bays or in chequered board pattern. No panel shall be cast in contact with another already laid until the contraction of the latter has taken place. The underbed shall be laid, compacted, levelled and brought to proper grade with a screed or float. The topping shall be placed after about 24 hours while the underbed is still somewhat 'green' but firm enough to receive the topping. The surface of the underbed shall be roughened for better bonding. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water to achieve a compact dense mass fully bonded with the underbed. The topping shall then be levelled up by trowelling and finished smooth with a slurry made with already prepared cement and pigment mixture. About 2.0 kg. of the mixture shall be consumed/ per sq.m. for horizontal surface and 1.0 kg. for vertical surface. The surface shall be cured for seven days by keeping it moist.

d) Polishing

About 36 hours after laying when the surface has hardened sufficiently it shall be polished with polishing stone till a smooth shiny surface to the satisfaction of the Engineer, is achieved. The finish shall be washed and cleaned just before handing over.

2.01.03 **Terrazo Finish : In Situ (Not Applicable)**

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) **Thickness**

Unless otherwise specified the total thickness of the finish shall be minimum 50 mm for horizontal and 20 mm or as per schedule of items for vertical surface of which the topping shall be not less than 10 mm or as per schedule of items. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary

slopes. The vertical surface shall project cut 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radious of 25 mm.

b) **Mix**

i) **Underbed**

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 1.½ parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) **Topping**

The mix for the topping shall be composed of cement, colour pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or grey or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1½ parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from white marble and shall be finer than IS Seive No. 30. The size of marble chips may be between 1 mm to 20 mm.

Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) **Laying**

The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat “green” but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.

d) **Curing**

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) **Grinding and Polishing**

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no. 60) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no. 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no. 320) to get smooth surface without any pinhole. The grinding shall be done by a suitable machine. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no. 60), second rubbing with medium grade (no. 80) and final rubbing and polishing with fine grade (no. 120).

The surface shall be cleaned with water, dried and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. sq.m. water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy but not slippery.

2.01.04 **Granolithic Finish**

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) **Thickness**

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) **Mix**

The mix shall consist of 1 part cement : 1 part coarse sand : 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) **Laying of Monolithic Topping**

The concrete base shall be laid as per specification “Cement Concrete” and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully “green” the topping shall be laid evenly to proper thickness & grade. If considered necessary the surface of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly & work vigoraously and quickly to secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stonechips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) **Laying of Topping Separately on Hardened Base**

The base concrete shall be prepared as stated in clause 2.01.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

e) **Curing**

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) **Grinding**

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.03 (e) shall be followed. However, the ultimate polish required shall be decided upon by the Engineer.

g) **Finishing**

Where specified, sodium silicate or magnasium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as specified in the Schedule of Items. The concentration and method of application of the solutions shall be as specified in IS:5491.

2.01.05 **Patent Stone**

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) **Thickness**

The patent stone finish shall have thickness as stipulated under clause 2.01.03(a) except that the topping shall be 6 mm thick.

b) **Mix**

i) **Underbed**

The mix shall be as stipulated under clause 2.01.03 (b).

ii) **Topping**

The mix for the topping shall consist of 1 part cement and 1 part fine sand by volume.

c) **Laying**

The Patent Stone finish, including the underbed shall be laid in alternate bays or in chequered board pattern. No panel shall be as in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M long.

A cement grout shall be applied and worked into the surface to receive the finish, the underbed then laid, compacted and levelled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.01.06 **Metallic Hardener Like "Ironite" Finish**

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is "Green".

a) **Thickness**

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) **Material**

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the engineer, actual samples shall be tested.

c) **Mix**

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) **Laying**

The concrete floor shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The forms, if any shall remain sufficiently projecting to take the finish. The surface shall be roughened by wire brush as soon as possible.

The finish shall be laid while the concrete underbed is still very "green" within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.06(A) **Non Metallic Hardener Like SIKA' Chapdur' Finish**

Non metallic hardener shall be of hard granules of mineral origin. Floor hardener shall be laid by authorized applicator of the Manufacturer as per specification and recommendation of the manufacturer. For heavy duty finish 5.5 to 6kg/Sq.m for a thickness of 3mm surfacing shall be provided. The ready made Chapdur compound of SIKA shall be spread over newly laid smooth concrete surface at a stage when a nail mark of 3 to 4 mm will be obtained at standard pressure. Spreading shall done by hand @ of approximately 6.0 kg/Sq.m for heavy duty finish.

While the mixture will be uniformly moistened by the surface water the surface shall be made smooth with the mechanical hand trowel.

Curing shall be made to protect the surface from rapid drying. Curing shall be made for at least for 3 days by means of wet guny bags or pooling water on the surface.

Floor using time shall be as per manufacturer recommendation.

2.01.07 **Mastic Asphalt Finish (Not used)**

This is a one layer treatment on concrete or brick base.

a) **Thickness**

The thickness shall be as specified in the drawing or schedule of items.

b) **Materials**

Bitumen shall be industrial bitumen of the grades 90/15 and 75/15 conforming to IS:702.

Mineral filler shall be dry stone dust passing through 75-micron IS Sieve.

Fine aggregate shall be crushed and graded natural lime stone or other hard-work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick and 10 mm chips for thicker finish.

c) **Composition**

Bitumen mastic shall conform to IS:1195 and shall be either brought to site in blocks weighing about 25 Kg. or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers & coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205^{o}C.

d) **Laying**

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 15 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.08 **Chemical Resistant in Situ Finish (Not used)**

Chemical resistant in situ finish shall be an epoxy resin with suitable filler material over a primer or called for in the Schedule of Items. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The Contractor shall get it done by a specialised manufacturer, get guarantee of performance from the organisation and pass it on to the Owner in addition to his own guarantee.

2.02.00 **Tiled Finish**

These shall include finish tiles, stone slabs and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 **Terrazzo Tile Finish**

The finish will consist of manufacture terrazzo tile and an underbed.

a) **Thickness**

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) **Tiles : Terrazzo**

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.Cm.

Each tile shall bear on its back permanent and legible trade mark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform

throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the thickness ± 3 mm. Face of the tile shall be plane, free from pin holes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary grey cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.03 (b).

The tile shall be cured at the shop for at least 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) **Mix : Underbed**

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

d) **Laying**

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.01.02 (c) may be used for dividing the work into suitable panels.

c) **Grinding and Polishing**

Procedure shall be same as Clause 2.01.03(e). Grinding shall not commence earlier than 14 days after laying of tiles.

2.02.02 **Heavy duty Cement Concrete (Carborundum) tile**

Heavy duty concrete tile shall be procured from reputed manufacturers only. This tile shall be produced in a well set up factory under strict quality control. Tiles should be compressed under a high pressure of about 0.15 t/sq.cm. Samples of the tile shall be submitted to the Engineer for approval before starting regular production.

IS:1237 shall be followed as general quidance for the specification of heavy duty concrete tile.

Size of the tile shall be 300x300 mm unless otherwise specified. Minimum thickness shall be 22 mm. However, actual thickness shall be as per designed strength requirement.

Store grit shall be used in the bottom layer of tile and the mix shall not be leaner than 1:3. Thickness of wearing layer shall be not less than 8 mm. For top layer nominal proportion of cement to aggregate shall be 1:1.5 unless otherwise agreed. Distribution of chips appearing over top surface should be uniform for aesthetic appearance. For darker shade of colours, 50% white cement of the total cement content shall be used. However, for lighter shade of colours, only white cement shall be used. Aggregate shall be hard stone chips of different colours. Carborundum, granite, quartzite chips shall be used. Properly graded-aggregate upto 10 mm size shall be used. Marble chips shall not be used unless specifically approved by the Engineer and shall not exceed 10% of the total quantity. Only good quality pigment having durable colour shall be used. Organic colours and lead pigments shall not be used. Manufacturer should ensure durability of the colour against possibility of any colour fading. Matching of colour between different batches shall be ensured. Physical properties and dimensional tolerance of the tile shall be as per IS:1237. However, surface hair cracks shall not be acceptable. For slipperage prone areas, rib tile/fluted type or chequered tiles shall be used. Tile shall be supplied with initial grinding (preferably twice) at factory premises. For laying and finishing of tile, IS:1443 shall be followed for general guidance.

For bedding, Lime-surkhi mortar shall be used as specified for Terrazo tiles.

Joints between tiles shall be filled with matching grouting same as used in topping and shall be supplied by the manufacturer of the tiles.

Grinding shall be done as per recommendations of the manufacturer including use of special type grinding stone. At least two additional grindings shall be done at site after laying, besides the initial grinding at factory premised. Oxalic acid polishing shall be done after grinding.

2.02.02 (A) **Chequered Tile Finish**

The finish shall consist of manufactured grey or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) **Thickness**

Thickness shall be same as in clause 2.01.03(a).

b) **Tiles : Chequered**

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm c/c, Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.02.01 (b) except that these may have the topping in terrazzo or plain grey cement or colour pigment added to cement as specified.

c) **Underbed**

As per clause 2.01.03 (c).

d) **Laying**

As per clause 2.01.03 (d).

e) **Grinding and Polishing**

As per clause 2.01.03 (e) except that the tiles shall be ground and polished by hand after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 **Glazed Tiles/Ceramic Tiles Finish**

This finish shall be composed of glazed earthenware tiles/Ceramic tiles with an underbed laid over a concrete or masonry base.

a) **Thickness**

The total thickness shall be 50 mm including Underbed for floor.

The total thickness shall be between 20 mm and 25 mm including underbed for wall finish.

The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) **Tiles : Glazed/ mat finish Ceramic tiles**

The floor tiles shall be of earthenware, covered with mat white or coloured, plain or with designs, of nominal sizes 300x300 mm 7.2 mm minimum thick approximately as per approved manufacturer product unless otherwise specified. The tolerance shall be $\pm$ 1.5 mm for length and breadth and $\pm$ 0.5 mm for thickness specials like internal and external angles, beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be matt unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

For wall finishes Tiles shall be ceramic tiles Matt / glazed as per General specification of Architectural work and size of tiles shall be 300x200x5 to 6mm thick or 300x450x7.2 mm - 10 mm thick approximately of approved manufacturer. Tile shall be laid over prepared base in 15 mm thick cement sand mortar 1:3 including cement slurry and jointing with approved matching filler.

c) **Mix : Underbed**

The mix for the underbed for floor shall consist of 15mm 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified. Under bed with 1:2:4 PCC shall be provided as required for total floor thickness of 50 mm.

d) **Laying**

Same as clause 2.02.01 (d).

e) **Finishing**

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully and wiped with soft cloth to prevent scratching before handing over.

2.02.03 (A) **Vitrified tiles**

Vitrified tiles shall be of approved manufacturer and premium quality. Size of tiles shall be 600x600x10 mm thick. Tiles shall be made from special quality ball clay and high quality minerals and shall be formed by compression in a PH3590 T press and fired in a kiln at an ultra high temperature of 1200 degree salcius for vitrification.

Tiles shall be absolutely non porous and water absorbtion shall not be more than 0.05% and shall be high resistance to chemicals, stains and free from bacteria breeding. Edges of the tiles shall be perfectly in right angles, perfectly flat and straight to give hair joints between two tiles and shall be dimensionally perfect. The hardness of the tiles shall be 8 on MOH scale. Deviation in length shall be limited to +/- 0.08% and in thickness +/- 2%.

Straightness of sides +/- 0.1%. Tiles shall be pre polished, ready to use and of high gloss.

Tiles shall be fixed over under bed with minimum 15mm thick cement sand mortar of 1:3 and necessary cement slurry.

Joints shall be filled with approved filler.

2.02.04 **Tesserae Finish (Mosaic etc.) (Not Used))**

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

a) **Thickness**

The total thickness including the underbed shall be between 16 mm and 25 mm.

b) **Tesserae Finish**

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass or similar hard wearing, strong and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

c) **Mix : Underbed**

Same as clause 2.01.03(b)

d) **Laying**

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.01.03(d) shall generally be followed. However, instead of grey cement the slurry shall be made with white cement to fix the panels. The paper mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.02.05 **Chemical Resistant Tiled Finish**

This shall include all varities of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) **Tiles**

The chemical resistant tiles as detailed in the Schedule of items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour and textures.

Glazed tiles if permitted to act as chemical resistant finish shall be considered under clause 2.01.03.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/Cm2. The surface shall be abrasion resistant and durable.

b) **Laying**

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.06 **Rubber, Vinyl or Vinyl Asbestos Tiles Finish**

This shall include various types of tiles manufactured from rubber, vinyl, etc. set with a adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) **Thickness**

The thickness of the tiles shall be mentioned in the Schedule or in drawing.

b) **Tiles**

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trade mark, the thickness, sizes, batch number and date of manufacture.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) **Mix : Underbed**

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty : 1 part cement : 4 parts coarse sand mixed with just sufficient water to make it workable.

d) **Laying**

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive

squeezed out through the joints shall be removed immediately.

e) **Finishing**

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried and polished with an approved type of polish just before handing over.

2.02.07 **Store Slab Finish : Marble, Stone and Similar Fine Grained Stone**

a) **Thickness**

The underbed shall be composed of PCC 1:2:3 and Cement Sand mortar !:3 minimum 15 mm and average 20 mm thick remaining portion shall be PCC underbed. The slabs may be 20-25 mm, 30 mm or 40 mm thick as specified.

b) **Stone Slab**

The stone slabs shall be made from selected stock which are hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of $\pm$ 5 mm in dimensions and $\pm$ 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm or as specified elsewhere in the documents.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) **Mix : Underbed**

Same as clause 2.01.03 (c).

d) **Laying**

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed clean before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, a thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, grey/white/mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid

and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) **Polishing, Finishing**

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.01.03 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08 **Stone Slab Finish : Sand Stone & Similar Coarse Grained Stone Finish**

Generally clause 2.01.03 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto $\pm$ 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to $\pm$ 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement.

2.02.09 **Base and Sub base for Flooring**

Ground Floor shall consist of the following:

i) Well compacted (90-95%) earthen sub grade.

ii) 230 mm thick dry rubble soling on rammed earth. Rubble shall be hand packed as directed by the Engineer. This shall be laid closely in position on sub grade. The stones for soling shall be selected on the basis of thickness of soling as directed by the Engineer. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

iii) 75 mm thick PCC 1:4:8 or as specified elsewhere in this document with 40mm nominal size stone aggregates laid over compacted rubble soling.

iv) RCC floor slab shall be laid over PCC

v) Floor finish 50 mm thick including under bed as specified shall be laid over RCC floor slab.

3.00.00 **ACCEPTANCE CRITERIA**

The finish shall be checked specially for :

a) Level, Slope, Plumb as the case may be

b) Pattern and Symmetry

c) Alignment of joints, dividing strip etc.

d) Colour, texure

e) Surface finish

f) Thickness of joints

g) Details at edges, junctions etc.

h) Performance

i) Precautions specified for durability

4.00.00 **I.S. CODES**

Important relevant codes for this section :

IS : 777	:	Glazed earthenware tiles
IS : 1196	:	Code of practice for laying bitumen mastic flooring.
IS : 1197	:	Code of practice for laying of rubber floors
IS : 1237	:	Cement concrete flooring tiles
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.
IS : 3461	:	PVC asbestos floor tiles
IS : 4860	:	Specification for acid resistant bricks
IS : 5518	:	Code of practice for laying of flexible PVC sheet and tile flooring.
IS : 5491	:	Code of practice for laying in situ granolithic floor topping.

TECHNICAL SPECIFICATION
FOR
XXIV) FALSE FLOORING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	EXECUTION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXIV) FALSE FLOORING

1.00.00 **SCOPE**

This specification covers supplying, installation, repairing, finishing, testing, protection and maintenance till handing over of removable free access false flooring systems consisting of an assembly of panels mounted on adjustable pedestal and supporting steel grid system to provide an under floor space.

The entire Access floor system shall be made from steel cementation in filled access floor tile and shall provide for adequate fire properties, acoustic barrier and air leakage resistance and antistatic floor system.

2.00.00 **FALSE FLOORING SYSTEM**

2.01.00 **Base**

The system shall be placed over a base of R.C.C. floor slab and with necessary grouting etc. to fix the supporting structure.

In general solid feel UFP laminated HPL/PVC panel with rigid under structure support system shall be provided. The Access floor shall be minimum 600 high finish floor from concrete sub floor.

2.02.00 **Supporting Structure**

The supporting structure shall conform CISCA 1986-87 and MS comprise of fabricated jacks made out of 25.5mmOD and 22.5mm ID with 2 mm embossed steel base plate 100x100x2 mm and pedestal head make out of size 75mmx75 mmx4 mm thick steel plate with 45 mm long steel pipe size 27mm ID x32 mm OD tag welded to the head plate and rest on the pedestal with 2 no MS Check nut speedy assembly and removal for relocation and maintenance. Pedestal base shall be secured firmly in position on sub floor.

Stringer:

Stringer channel made of 1.2mm thick galvanized steel sheet and the size of stringer shall be 575 x28mmx20mm.

The pedestal shall be equipped with conducting grounding pad. All MS members shall be treated with steel protective paint. The concrete sub floor shall be painted with two coats of synthetic enamel pain.

2.03.00 **Floor Panel**

2.03.01 Panels shall be made from steel. The bottom of the panel shall be embossed in hemispherical shape to give strength and flexural rigidity. The top sheet shall be plain and resistant welded at various location after the top and bottom sheet have been degreased and phosphate to form a single composite unit (as per CISCA 1986-87). The entire panel shall be coated with epoxy coating on the exposed surface and then the hollow panel shall have factory laminated Antistatic HPL/PVC with 6mm beading on all the sides for

edge protection. Panels shall remain flat, through and stable unaffected by humidity or fluctuation in temperature throughout its normal working life. Panels shall provide for impact resistance top surfaces minimal deflection, corrosion resistance properties and shall not be combustible or aid surface spread of flame. Panels shall be insulated against heat and noise transfer. Panels shall provide qualities of concrete slabs. Panels shall be of size 600x600mm fully interchangeable with each other within the range of specified layout. Panels shall be free standing (Simple supported) onto the understructure.

2.04.00 **Strength**

Each 600 mm x 600 mm floor panel must be capable of supporting an uniform minimum live load of 1220 Kg/Sq. or a concentrated minimum load of 450 Kg. applied through a phenolic caster 75 mm in diameter and 45 mm wide, or a rolling minimum load of 450 Kg. at any point with a maximum deflection of 2 mm.

2.05.00 **Surface Finish**

All removable panels shall have the top surface finished with 2.5 mm thick Anti static Vinyl Flooring bonded to the surface with adhesive as per manufacturer's specification.

2.06.00 **Skirting**

Skirting shall be of the same Antistatic Vinyl tiles, 150 mm. high and 2.5 mm. thick, completely matching with the false flooring surface and shall be fixed with the plastered wall surface as per manufacturer's specification.

2.07.00 **Installation**

All steel surface are to be protected by pointing over a primer as per schedule of items and any damage to the paint during installation shall be made good. Finished floor surface, when specified by the Engineer-in-Charge shall be protected by the Contractor with kraft paper taped and sealed at edges to prevent tearing.

Any damage to the sub floor during installation of the false flooring system shall be made good by the Contractor without any extra cost to the owner.

3.00.00 **ACCEPTANCE CRITERIA**

The false flooring system shall be checked specially for :

a) Level
b) Alignment of joints
c) Thickness of joints
d) Surface finish
e) Colour and texture

TECHNICAL SPECIFICATION
FOR
XXV) PAINTING, WHITE WASHING AND POLISHING ETC.

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXV) PAINTING, WHITE WASHING AND POLISHING ETC.

1.00.00 SCOPE

This specification covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plastered surfaces finished with plaster of paris/ wall putty, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items as shown on drawings, schedule or as directed by the Engineer.

Copper, bronze, chromium plate, nickel, stainless steel, aluminium and monel metal shall generally not be painted or finished except if otherwise specified.

The painting Contractor shall inspect the work of others prior to the application of paint. If surface to be finished cannot be put in suitable condition for painting by customary preparatory methods, the painting contractor shall notify the Engineer in writing or assume responsibility for and rectify unsatisfactory finishing that results.

Before commencing painting, the painting contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage, disfiguration or staining by other trades. He shall also undertake normal precautions to prevent damage, disfiguration or staining to work of other trades or other installations.

2.00.00 INSTALLATION

2.01.00 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint or one shade is obtained the same manufacturing batch. All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognised manufacturers and shall be approved by the Engineer.

All colour shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) **White Washing (Not Used)**

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the Engineer, and shall conform to IS:712 latest edition. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank of water for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100grams of gum to 6 litres of white wash water and a little quantity of indigo or synthetic ultramarine blue shall be added to the lime.

b) **Dry Distemper (Not Used)**

Shall be made from suitable pigments, extenders, lime proof tinters, water soluble binders etc. and shall conform to IS:427.

c) **Oil Bound Washable Distemper (Not Used)**

Shall be of oil emulsion type, containing suitable preservatives and shall conform to IS:428.

d) **Waterproof Cement Paint**

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS:5410.

e) **Acrylic Emulsion Paint internal and external use.**

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide. It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild detergent and water without any deterioration in colour, or without showing flaking, blistering or peeling.

f) **Acrylic Washable distemper.**

Acrylic washable distemper shall be similar to **e)** above. The paint, after it is dried, shall be able to withstand washing with mild detergent and water without any deterioration in colour, or without showing flaking, blistering or peeling.

f) **Synthetic Enamel Paint**

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and interior surfaces. White and pastel shades shall resist yellowing and darkening with aging. The paint shall conform to IS:2932 and IS:2933.

g) **Aluminium Paint**

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS:2339.

h) Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) **French Polish (Not Used)**

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well known approved manufacturer. The material shall conform to IS:348.

French polish shall not be used on bare wood. It shall only be used as finishing coat on wood after the wood is pretreated with a liquid wood filler conforming to IS:345 is applied and rubbed out.

2.02.00 **Storage**

The contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement and stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.03.00 **Preparation of Surface**

Before starting the work the contractor shall obtain the approval of the Engineer regarding the soundness and readiness of the surface to be painted on.

2.03.01 **Wood**

All surfaces shall be free from dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails and screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly and extended 25 mm beyond the area. All large, loose or resinous knots shall be removed and filled with sound wood. All work shall be done as perIS:2338.

2.03.02 **Masonry, Concrete and Plastered Surface**

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of re-surfacing may lead to the finishing paint being different in shade from the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with mildew or efflorescence shall be treated as below :

a) **Mildew**

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80 ml. liquor ammonia and diluted to 1 litre with water or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.03.03 **Metal**

All metal surface shall be absolutely clean, dry and free from wax, grease or dried soap films. In addition, all steel and iron surfaces shall be free from rust, surfaces shall be cleaned by mechanical power tools to remove mill scales unless otherwise approved by the Engineer for exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanised iron surfaces shall be pretreated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat.

2.04.00 **Application**

2.04.01 **General**

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings if used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor holes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to be free of sags, runs, crawls or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoats for painting shall be applied by brush only and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable for production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered properly by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall be done as per IS:1477 (Part 1 & 2). The total dry thickness of the film should not be less than 120 micron.

2.04.02 **White Washing (Not used)**

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before application of the lime solution.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer f eels that one or more coats are required the contractor shall do so without any extra cost to the owner. No brush marks shall show on the finished surface.

2.04.03 **Dry Distemper (Not Used)**

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1 part vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement plastered surface, the surface shall be washed with a solution of 100 gms. of zinc sulphate to 1 litre of water and then allowed to dry.

Dry distempering shall be done as per manufacturer's instruction. In applying the distempers the brush should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long as otherwise brush marks may result.

2.04.04 **Oil bound Washable Distemper (Not Used)**

The distemper shall be applied after surface is primed with an alkali resistant primer and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.04.05 **Waterproof Cement Paint**

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.04.06 **Acrylic Emulsion Paint**

Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be strictly as per manufacturer's specification.

2.04.07 **Synthetic Enamel Paint**

Shall be applied on properly primered surface. Subsequently coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.04.08 **Aluminium Paint**

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.04.09 **Clear Synthetic Varnish * Not Used)**

The varnish shall be applied on wood surface after (a) filling, (b) staining and (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbour hood. Damp atmosphere and draughts shall be avoided and exposure to extreme heat or cold and dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid fronthing. It shall be allowed to flow on while the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has began to set, shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dry hard and be flatted down before applying the next coat. Sufficient time must be allowed between coats to get a hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.04.10 **French Polish (Not Used)**

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted. The pores in the wood shall be filled up with a paste of whiteing in water or methylated spirit with a suitable pigment like burnt sienna or amber.

After application of the filler paste, the french polish shall be applied with a pad of woolen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.04.11 **Chemical Resistant Paint**

For chemical resistant paints, epoxy, chlorinated rubber or vinyl butyl paint system shall be used manufacturer's recommendation regarding the paint system exposed to moderately severe corrosive condition and subject to acid/alkali spillage and fumes, shall be followed.

2.04.12 **Epoxy coating/painting**

On the clean surface of concrete after properly drying of the following system is to be adopted as per manufacturers specification:

One coat of primer of following proportion to be applied over clean and dried concrete surface by brush application.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 840 - 50 Parts by weight

Over the primer, the uneven surface of concrete should be filled with levelling putty as mentioned above. The cost of putty is included in the item rate without fixing prior limit to consumption of putty. Two top coats of the protective treatment to be applied over the prepared smooth surface in the following proportion.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 830 - 45 Parts by weight

HARDENER BY 850 -15 Parts by weight

SILICA FLOUR - 20 Parts by weight

FLOW CONTROL - 2 Parts by weight
AGENT

Pigment may be added if desired by Engineer. The first top coat is applied over the primer and is left to reach a tack free state. At this stage, the final top coat is applied.

2.05.00 **Protection**

Furniture and other movable objects, equipments, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipments shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.06.00 **Cleaning up**

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been spilled, splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 **ACCEPTANCE CRITERIA**

a) All painted surfaces shall be uniform and pleasing in appearance.

b) All varnished surfaces shall be of uniform texture and high glossy finish.

c) The colour, texture etc. shall match exactly with those of approved samples.

d) All stains, splashes and splatters of paints and varnishes shall be removed from surrounding surfaces.

4.00.00 **I.S. CODE**

Important relevant IS Codes for this Sections are listed below :

IS:348 : Specification for French Polish

IS:427 : Specification for Distemper, dry colour as required.

IS:428 : Specification for Distemper oil emulsion, colour as required.

IS:1477 (I & II)	:	Code of Practice for painting of ferrous metal in buildings.
IS:2338 (I & II)	:	Code of Practice for finishing of wood and wood based materials.
IS:2339	:	Specification for Aluminium Paints for general purposes in dual containers.
IS:2395	:	Code of Practice for painting concrete, masonry and plaster surface.
IS:2932	:	Specification for enamel, synthetic, exterior, type-I.
IS:5410	:	Specification for cement paint, colour as required.

TECHNICAL SPECIFICATION
FOR
XXVI) SUSPENDED CEILING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

XXVI) SUSPENDED CEILING

1.00.00 **SCOPE**

The work under this Section shall include the supply and insulation of suspended ceiling using insulation / acoustic boards, Gypsum board, Metal linear interlocking strips etc. together with the suspension system as per manufacturer standard details with all materials complete. The work shall also include providing of openings in the ceiling for lighting, air conditioning diffusers, fir fighting detector etc. as shown required or instructed by the Engineer.

Aluminium linear ceiling similar to luxalon shall be provided.

2.00.00 **INSTALLATION**

2.01.00 **Suspension System**

2.01.01 **General**

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural walls, slabs and beams or trusses.

All members of the suspension system shall be of sufficient strength and rigidity to carry the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be securely fixed to walls. All drillings of structural concrete or welding to steel for installation of the suspension system shall be included in the rate. All M S sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer. All wood supports shall be painted with two coats of “fire resistant paint.

2.01.02 **Metal Grid Suspension System**

Metal grid suspension system shall be provided as per manufacturer specification and details. For gypsum board suspension system of India Gypsum board shall be followed. In case of Linear metal strip interlocking system details of manufacturer shall be followed.

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hangers. Main runners shall be hung by M S flats angles or 12 g or heavier galvanized tie wire hangers at maximum 1.2 centers. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as per manufacturer specification of the respective materials.

The cross tees shall intersect main runners in pattern shown on drawing and positively looked together with intersection clips. All perimeter areas shall

have angle moldings fixed to vertical wall surfaces and end tees shall rest on the moldings, unless otherwise specified.

2.01.03 **Timber Grid Suspension System (Not used)**

Unless otherwise shown on drawings, the suspension system shall consist of 50 mm x 50 mm pretreated teakwood batten grid suspended in the same manner described for metal grid system. The spacing of timber battens shall be as shown on drawing. Extra battens shall be provided where necessary for openings for light fixtures A C grills etc.

2.02.00 **Ceiling Panels**

2.02.01 **Materials**

Ceiling panels shall be best quality material in thickness and properties and as specified. The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of the following types:

a) Gypsum boards of India gypsum with concealed suspension system.

b) Expanded polystyrene insulation boards (Not Used)

c) Fibre insulation boards (Not Used)

d) Wood particle boards (Not Used)

e) Glass fibre reinforced polystyrene sheets (Not Used)

f) Pre coated (Dry film thickness of coating 15-20 micron thick) aluminium alloy linear interlocking strips of size 84x12.5 deep x 0.5mm thick with concealed suspension system.

Acrylic plastic sheets translucent or figured glass sheets moulded plastic louvres etc. shall be from approved manufacturers and in thickness specified in schedule.

2.02.02 **Installation of Ceiling Panels**

Installation of ceiling panels shall be strictly as per manufacturer's instruction and specification.

For exposed grid ceiling system, tile hold down clips shall be used at the rate of min. 1 per 1.2 meter length of perimeter. These shall however be omitted in access panels which shall be located as per the instruction of the Engineer.

For concealed grid ceiling system, tiles shall be fixed to the supporting grid in manner as specified by the manufacturer. Where V joints in tiles are called for, these shall begin true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Surface of ceiling boards shall be finished in a true and even surface without undulations with putty to make the surface suitable for subsequent painting. Special care shall be taken to neatly finish the ceiling at junctions

with walls, light fixtures, diffusers etc. All hangers shall be fixed to the RCC ceiling with Anchor Fastener.

For interlocking ceiling system carrier shall be roll formed 32 mm wide and 39 mm deep out of 0.9 mm thick aluminium and magnesium alloy with cut up prongs to hold the panels in module 100 mm at maximum 1.6 m center to center. Carrier shall be suspended from roof / truss by galvanized steel rod 4mm dia. in required length with height adjustment galvanized turn buckle. Hanger shall be fixed with the ceiling with anchor fastener.

3.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards, joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cutouts for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

4.00.00 I. S. CODES

IS:2441 - Code of Practice for fixing ceiling coverings.

TECHNICAL SPECIFICATION
FOR
XXVII) SHEET WORK IN ROOF AND SIDING

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE

SHEET WORK IN ROOF AND SIDING

1.00.00 SCOPE

This specification covers the erection of asbestos, C.G.I., aluminium or other sheet covering to roof and side walls at various elevations and the fabrication and/or installation of asbestos, C.G.I or aluminium gutters, flashings etc

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All materials shall be stored by the Contractor in proper way to prevent all damage. If the materials are issued at site by the Owner, the Contractor shall at the time of issue, satisfy himself about the condition of issued sheets, gutters, etc. and no complaints shall be entertained later.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a water tight finish to the satisfaction of the Engineer fixing of gutters and down pipes shall be according to IS:2527.

2.02.01 Asbestos Sheeting

Asbestos sheets of profiles as stated in the Schedule of Items, shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification Hook bolts or J-bolts shall be 8 mm dia. at 305 centres 6 mm dia galvanised iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stiching ridge cappings, corner pieces, ventilators, north light curves etc.

2.02.02 C.G.I. Sheeting and Aluminium Sheeting

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall be minimum 150 mm for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used the end laps shall be minimum 100 mm. Holes in C.G.I sheets shall preferably be made on the ground the sheets should be placed on trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washets. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum 305 mm apart. The length of the hook or J-bolts shall be to suit the sections of the bearers.

Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanised iron seam bolts and G.I. flat washers and bituminous washers.

2.02.03 **Fibre Glass Reinforced Plastic Sheeting**

This shall be of thickness and profile as mentioned in the Schedule of Item. Colour and light transmittance shall be as mentioned in drawings and or schedules. Where used in conjunction with C.G.I. or asbestos sheeting the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads as mentioned in schedule of items. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure as mentioned in Schedule.

2.02.04 Precoated metal sheeting for roof shall be of precoated cold rolled sheet of total coated thickness (TCT) 0.58 to 0.68 mm of approved manufacturer. The sheet shall be metallic hot deep coated with an alloy of 55% aluminium, 43% zinc and 1.55 silicon coating mass shall be 150 gms/sq.m. sheet shall be fixed with fastening clip and self tapping fastener. Ridge for slope roof shall be of similar material and shall be fixed with necessary self tapping screws as per manufacturer details.

Thermally insulated sandwiched metal cladding for external facaade shall be of approved manufacturer. Sheeting shall Hi Rib 0.5 mm troughed sheeting manufactured from aluminium alloy high tensile steel (550Mpa) coated with fluro polymer (PV F2 or equivalent) and shall have life span sustenance against aggressive weathering action. Inner profiled sheet shall be with profile sheet of .6 mm thick (total coated thickness) permanently coated galvanised sheet.

Galvanised coating shall be not less than 120 gm/sq.m. and sandwiched insulation of 25 mm thick or as per design requirement shall be bonded mineral wool blanket or equivalent conforming to IS: 8183 (minimum density of 32/kg/cum for glass wool and 48/kg/cum for rock wool) having minimum coefficient of thermal conductivity of 0.49 mW/cm deg C (at 50 degreeC) Cladding shall be fixed to supports/rails by nuts, bolts, hooks, washers self tapping screws of stainless steel Austentic grade) conforming to IS:1367 (part 14) including sealents, gaskets, PVC tape 0.25 mm thick, flashing, black synthetic rubber external trough filler and 25X3 mm aluminium earthing.

2.02.05 **Poly Carbonate Roofing vault etc.**

Poly carbonate sheet shall be translucent thermomoclear multiwall sheet similar to LEXAN of GE Plastic with both side UV protection and thermal insulation properties. Sheet shall be of thickness varying from 6mm to 32 mm thick and shall be multi wall. Sheet shall be fixed over light tubular structure of square hollow steel tube painted with two coats of synthetic enamel paint over coat of zinc chromate primer. Structure shall be of the shape as indicated in General Specification. LEXAN Polycarbonate sheet

Shall be fixed with aluminium flat section 50mm wide 4 mm thick With stainless steel screws. EPDM gasket and shall be sealed with Silicon sealant. Thickness of sheet shall be as specified in the General specification of Architectural work and unless otherwise indicated shall be minimum 8mm thick /2 RS structure.

3.00.00 ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked :

a) Side and end laps

b) Absence of cracks, holes or damages in sheet

c) Spacing of bolts

d) Provision of double washers (G.I. and asbestos or bituminous washers)

e) Proper installation of flashing

4.00.00 IS CODES

The following are some of the important IS Codes relevant to this sections :

IS : 3007 : Code of practice for laying of asbestos cement sheets

IS : 2527 : Code of practice for fixing rain water gutters and down pipes for roof drainage

IS : 1626 : Specification for asbestos cement building pipes gutters and fittings

IS : 277 : Specification for galvanised steel sheets (plain and corrugated)

TECHNICAL SPECIFICATION
FOR
XXVIII) ROOF WATER PROOFING, INSULATION AND ALLIED WORK

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	ACCEPTANCE CRITERIA
4.00.00	I.S. CODE AND STANDARDS

XXVIII) ROOF WATER PROOFING, INSULATION AND ALLIED WORK

1.00.00 **SCOPE**

This specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof water-proofing, insulation and allied work for buildings and at locations covered under the scope of the Contract.

2.00.00 **INSTALLATION**

2.01.00 **Grading Underbed**

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 100 and as directed by the Engineer. Upto an average thickness of 25 mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete.

The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 The grading plaster shall be average 25mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The same and cement shall be throughly mixed dry and them water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.02.00 **Concrete**

The concrete shall be used where the subgrade is more than average 25mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.03.00 **Insulation**

The Tenderer shall along with the tender send specification of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation the surface shall be made ready as required to receive the treatment as specified, unless otherwise indicated in the General Specification of Architectural work if any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12mm and it shall be cured for seven days

2.04.00 **Foam Concrete (Not Used)**

This shall be of light weight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m degree C. The weight of the insulating material shall be from 0.3 to 0.5 gm/cm.

Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to make the usual work load and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.05.00 **Expanded Polystyrene Blocks**

The expanded polystyrene block insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 KCl m/m degree C. and density Maximum 32.35 Kg/M^3 It must be strong enough to withstand without deformation the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturers' supervision at no extra cost to the Owner.

2.06.00 **Fillets**

Fillets at junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix by volume.

2.07.00 **Waterproofing**

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with Bitumen Felts shall be done following relevant IS:1346. Bitumen felt shall conform to IS:1322 and Bitumen primer to IS:3384.

The bonding materials shall consist of blown type conforming to IS:702 or residual bitumen to IS:73 or a mixture of the two to withstand local conditions or prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples of pea sized gravel shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two layers of felt or Extra Heavy treatment with three layers of felt shall be indicated in the Schedule of Items. Brief details of the various treatments shall be as follows:

a) Normal Treatment : Four courses :

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Hessian base self finished felt, type 3, grade 1

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Pea sized gravel at the rate of 0.006 mU2

b) Heavy Treatment : Six Courses :

With Hessian base felt

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Hessian base self-finished felt, type 3, grade 1

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Hessian base self-finished felt, type 3, grade 1.

5) Hot applied bitumen at the rate of 1.2 kg/m

6) Pea sized gravel at the rate of 0.006 mU2

Or

With fibre base felt

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Fibre base self-finished felt, type 2, grade 2

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Fibre base self-finished felt, type 2, grade 2

5) Hot applied bitumen at the rate of 2.5 kg/m and

6) Pea sized gravel at the rate of 0.008 mU2

c) Extra Heavy Treatment : Eight courses :

With fibre based felt

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Fibre-base self-finished felt type 2, grade 1

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Fibre base self-finished felt type 2, grade 1

5) Hot applied bitumen at the rate of 1.2 kg/m

6) Fibre base self-finished felt type 2, grade 1

7) Hot applied bitumen at the rate of 2.5 kg/m and

8) Pea sized gravel at the rate of 0.008 mU2.

Or

With Hessian base felt

1) Hot applied bitumen at the rate of 1.2 kg/m

2) Hessian base self-finished felt, type 3, grade 1.

3) Hot applied bitumen at the rate of 1.2 kg/m

4) Hessian base self-finished felt, type 3, grade 1

5) Hot applied bitumen at the rate of 1.2 kg/m

6) Hessian base self-finished felt, type 3, grade 1

7) Hot applied bitumen at the rate of 1.2 kg/m

8) Pea sized gravel at the rate of 0.006 mU2

However, in special cases, more courses or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the pea sized gravel or any other existing top course shall be completely removed and all damaged felts or other defects required.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that loose gravels, felt cuttings etc. do not find their way into rain water down comers.

2.08.00 **Waterproofing by epoxy resin based application**

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin based application shall be throughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration from fire, sun, light traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labours for the application. This item shall carry a guarantee as specified under the relevant item in the Schedule.

2.09.00 **Flashing**

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer, instead of being finished with pea-sized gravel, shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified on drawings or directed by the Engineer, metal flashing shall be provided. The metal flashing shall be done as shown on the drawings. The materials shall be 18g or 22g G.I. sheets, as specified on the drawings and/or as directed by the Engineer.

2.10.00 **Elastromeric Membrane**

2.10.01 **Primer Coat**

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush /spray with airless spray equipment over the prepared bed as an adhesion coat with an application rate of 6-8 sq.m per litre depending on the surface porosity.

The primer shall be allowed to dry for a minimum period of 2 to 4 hours time before the successive finishing coats of P.U. liquid membrane are applied. In any case successive finishing coat shall be applied within 24 hours.

The substrate shall be properly prepared by removing all loose materials by vigourous brushings, fungal growth with proprietary fungitide as recommended. Priming coat shall not be applied to damp substrate.

2.10.02 **Finishing Coats**

The finishing coats shall consist of two successive liquid coatings of high solid content urethane pre-polymers or equivalent material to form an elastomeric membrane. Application shall be with brush or spray to form an uniform jointless elastomeric membrane. The overall dry film thickness shall be 1.5 mm subject to minimum 750 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for minimum of 150 mm over the finished roof surface or fillet with suitable tucking into the vertical wall surface. It shall be continued into rain water pipes by atleast 100 mm.

The final coat of PU liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a layer of polyscrim cloth/fabric are to be embedded between 2 finishing coats.

The entire work shall be carried out under the suspension of approved authorized agency and as per manufacturer specification.

2.10.03 **Water Proof Membrane**

One coat of Approved water proof chemicals with rubberized bituminous primer (water base) similar to EMUFAL TE manufactured by TEXSA @ 0.300 ltr/ Sq.M. shall be applied.1.5 mm thick self adhesive water proof membrane similar to Texself H.D. of Texsa or approved equivalent over chemical treatment shall be laid including flashing minimum 300 high over parapet wall and shall be secured in a groove in RCC parapet. Area of contact with RCC parapet shall also be treated with the chemical treatment similar to Roof. If specified in the General specification of Architectural Specification the water proof membrane shall be protected with 25 mm thick PCC with 0.56 dia. chicken wire mesh. The PCC shall be cast in panels of size 1.2M x1.2M size and joint shall be sealed with the same material.

The entire work shall be carried out by the Manufactutrer authorized representative and specification.

2.10.03 **Surface Finish**

Areas of roof treatment shall be provided with wearing course consisting of minimum 25 mm thick PCC 1:2.4(using 12.5 mm size aggregate) cast in panel of maximum size of 1.20 m x 1.20 m and reinforced with 0.56 mm diameter galvanized chicken wire mesh and sealing of joints using polysulphide sealant or similar water proof membrane or elastomeric compound for elastromeric water proofing as per General specification of Architectural work.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided. The tiles shall be laid as per IS 1443.

3.00.00 ACCEPTANCE CRITERIA

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The Contractor shall give a guarantee in writing for all work executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water-proofing treatment work. The guarantee shall be for materials and workmanship for a period of minimum 10 years. The mode of execution of the guarantee shall be acceptable to the Owner.

4.00.00 I.S. CODES AND STANDARDS

a) IS:73 : Paving Bitumen

b) IS:702 : Industrial Bitumen

c) IS:1203 : Methods of testing tar and bitumen

d) IS:1322 : Bitumen felts for waterproofing and damp proofing

e) IS:1346 : Code of Practice for waterproofing of roofs with bitumen felts

f) IS:3384 : Bitumen primer for use in waterproofing and damp proofing.

XXIX) WATER SUPPLY

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3.00.00	TESTING AND ACCEPTANCE
4.00.00	I.S. CODE

XXIX) WATER SUPPLY

1.00.00 **SCOPE**

This section includes supply of all materials, labour and incidentals for water supply for residential, business and industrial and other types of buildings. The water supply system of a building or premises covers service pipes and the necessary connecting pipes, fittings, control valves and all appurtenances in or adjacent to the building or premises.

1.01.00 **Materials**

All materials, fittings, fixtures and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence order are to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets and similar items shall be specially protected till final installation. Brass and other expensive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

1.02.00 **Pipes and Pipe Fittings**

Under scope of this specification, pipes and pipe fittings may be any or a combination of the following types :

a) Cast Iron

b) Steel : lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanised.

c) Reinforced Concrete

d) Prestressed Concrete

e) Asbestos Cement

f) Lead (Not to be used for potable water)

g) P. V. C.

h) Copper

i) Brass

j) Wrought iron

1.03.00 **Water Reservoirs**

Water reservoirs like pressed steel tanks and G.I. tanks shall come under scope of this specification. Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

1.04.00 **Related Works**

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply systems shall come under scope of the Contractor unless specifically excluded. These works are not detailed out in this Specification.

1.05.00 **Regulation**

The work which is required to be carried out under the scope of this section, shall be executed by a licensed plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc. from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities. The fee paid to the Authorities shall be reimbursed by the Owner.

2.00.00 **INSTALLATION**

While basic layouts may be available in the drawings provided by the Owner, the details might have to be supplemented by the Contractor for approval of the Engineer.

Special attention shall be given by the Contractor to economy. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs and replacements of pipes, fittings and fixtures must be conveniently possible.

2.01.00 **Pipe Lines**

2.01.01 **Laying**

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacings as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction & easy maintenance. Pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer.

2.01.02 **Back Flow**

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely water-tight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

2.01.03 **Contamination**

There shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose.

No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

2.01.04 **Underground Pipings**

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable.

The size and depth of the trench shall be as approved by the Engineer. Back-filling shall be done with selected fine earth, unless otherwise permitted in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support.

The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

2.01.05 **Concealed Piping**

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, conduits as necessary. However, the Contractor will rectify if required the chases, openings and conduits, supplement and make good after laying and testing of the concealed pipelines.

2.01.06 **Jointing of Pipes**

Jointing of pipes shall be completely leakproof and durable. Instruction of the manufacturer shall be followed unless desired otherwise by the Engineer. However, usually recommended practices are stated below for guidance :

a) **Cast Iron**

i) **Spigot and Socket Joints**

Lead joint : The joint is made by first caulking in clean spun yarn upto half depth and filling the reminder by running in molten lead taking care that no dross enters the joint and then thoroughly caulking the lead. The lead need not extend into the joint further than the back of the groove formed in the socket. After completing the joint it shall not be allowed to move. For rectification the joint shall be completely redone.

ii) **Flanged Joints :** Flanged joints shall be made by jointing rings of good quality, smooth and hard compressed fibre board of thickness not less than 1.5 mm and of such width as to fit inside the circle of bolt. Diagonally opposite bolts shall be tightened in pairs and in stages so that degree of all bolts in a joint are similar. Damaged gaskets shall be replaced.

b) **Steel**

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove any burr from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

c) **G I Pipes**

Threads shall be cut with sharp tools, and before jointing all scales shall be removed from pipes by suitable means. The screw / threads of the pipe shall be cleaned out and the joint made by screwing the fittings after treating the threads with approved pipe jointing compound. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

d) **Asbestos Cement Pipes**

Socket and spigot ended pipes shall be jointed by caulking with tarred gaskets and grouted with 1:3 cement sand mortar.

e) **Lead**

Lead and lead alloy pipes shall be jointed with wiped solder joints.

f) **Concrete**

Concrete pipes may be socket and spigot ended collar or band jointed. Joints shall be effected by caulking with 1:3 cement sand mortar.

g) **P. V. C.**

Manufacturer's instruction shall be followed. For heating approved equipment with adequate control shall be used.

h) **Tyton Joint**

The manufacturer's instruction shall be strictly followed in making such joints. Tyton joints shall be made by push-on type specification stipulated by the pipe manufacturer. The tools specified by the pipe manufacturer shall be used to secure the jont fully.

2.01.07 **Painting**

Where mentioned in the Schedule, underground steel and cast iron pipes shall be given 2 coats of bituminous paint on the outside after laying, when painting is to be done above ground G.I. pipes shall be given a coat of zinc chromate primer, C.I. & M.S. pipes shall be given one coat of red lead or zinc chromate primer. Top coats shall be minimum 2 coats of best quality paint.

2.02.00 **Storage Tank - Pressed Steel Tank**

Unless otherwise mentioned, water storage tanks shall be pressed steel tanks of nominal size and capacity as mentioned in the Schedule and fabricated with all flanges external, all flanges internal, or bottom flange internal and side flanges external, as shown on drawings or schedule of items. The fabricator shall supply 6 prints of fabrication drawings to the Engineer for prior approval showing thickness of plates, method of jointing the plates, all supports, stays, gussets etc. Pads, cleats etc. required for supporting the tanks shall be supplied by the manufacturer. Inlet, overflow vent pipes, manholes etc. shall be arranged and provided as shown on drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50 mm above the bottom of the tank and there shall be a 150 mm free board at the top of the tank.

All tanks shall be supplied with mosquito-proof covered top with manhole not less than 450 mm diameter. Tanks deeper than 1.00 Metre shall be provided with m.s. internal access ladder adjacent to the manhole. Water level indicator shall be provided if asked for. Two coats of anti-corrosive paint over a suitable primer shall be applied to both internal and external surface of tanks. Such paint if used shall not impart any taste or odour to water and be of lead free composition..

Erection of tanks shall be in accordance with detailed drawings and manufacturer's instructions. The two finishing coats of paint shall be applied to outside after erecting is complete.

2.02.01 **G. I. Water Tank**

G. I. water tanks shall be procured from a reputed manufacturer. The design shall be good enough to withstand the loads safely. Galvanised iron water storage tank shall be made of minimum 2 mm thick galvanised iron sheet. Plain sheets shall be fixed at the corner to angle iron frames by means 6 mm

rivets at 40 mm pitch for tanks upto 1000 litres capacity and 8 mm rivets at 35 mm pitch for tanks above 1000 litres capacity. Tanks above 1000 litres shall have 20 mm dia. galvanised/iron stay rods, one fixed to angle framing at top and two in the body of the tank for extra strength. Holes for rivetting shall be drilled and not punched. White lead shall be applied to the joints before rivetting.

In case it is desired by the Engineer that corners of tank should be welded instead of rivetted then the sheets shall be welded to form a tank will not have angle iron frame.

Tanks shall have 400 mm dia. holes at the top with hinged covers. The covers shall be made of galvanised iron sheet with angle iron frame. The cover shall be just loose but close fitting to keep out dust and mosquito and will not be airtight. It shall be complete with lockable arrangement.

Tanks shall be provided with rising main inlets of 40 mm dia. galvanised iron pipe or as shown on Drawing and 25 mm dia. G.I. overflow pipe. The rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing.

The ball valve permits the entry of water when the tank is empty and disconnects the supply when the tank is full. It consists of a hollow floating ball made of copper, plastic or hand Tubber, 110 mm in diameter, attached to an arm which is so pivoted that the end near the pivot closes the orifice of the main when the ball is raised to the required height of water in the tank and opens the main as soon as the ball drops with the fall of water level as it is drawn off through the distribution pipes. The ball valve shall be fixed to the tank independent of the inlet pipe and set in such a position that the body of the ball valve cannot submerge when the tank is full upto the water line. The ball valve shall be so adjusted as to limit the level of the water line. The level of the water in the tank to 75 mm below the lip of the overflow pipe. Free surface shall be about 150 mm above the maximum water filled level.

2.03.00 **Valve, Cocks, Taps**

All valves, stop cocks, taps etc. shall conform to relevant Indian Standard Specification and shall be of best quality from approved manufacturers. These shall be suitable for working pressures mentioned in the Schedule. Nominal size and material shall be as per schedule.

2.04.00 **Protection**

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets or spigot are not damaged and no foreign material can find its way into the pipe line.

Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.00.00 TESTING AND ACCEPTANCE

3.01.00 Inspection Before Installation

All pipes, fittings and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

3.02.00 Testing of Mains After Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/CM^2 or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

3.03.00 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely water-tight. All pipings, fittings and appliances shall be checked for satisfactory support and protection from damage, corrosion and frost.

400.00 I.S. CODES

Important relevant IS Codes for this Specification are listed below :

Latest editions shall always be consulted.

IS:2065	:	Code for Practice for water supply in buildings
IS:1172	:	Code of basic requirements for water supply, drainage and sanitation
IS:1200	:	Laying of water and sewer lines including (Pt.XVI) appcurtnant items.
IS:1239 (Pt. I & II)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter)

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:3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter)
IS:3589	:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter)
IS:784	:	Prestressed concrete pipes
IS:458	:	Concrete pipes (with or without reinforcement)
IS:783	:	Code of Practice for laying of concrete pipes
IS:1592	:	Asbestos cement pressure pipes
IS:1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types)
IS:404	:	Lead pipes
IS:3076	:	Low density polyethylene pipes for potable water supplies
IS:4984	:	High density polythylene pipes for potable water supplies
IS:2501	:	Copper tubes for general engineering purposes
IS:407	:	Brass tubes for general purposes
IS:1230	:	Cast iron rain water pipes and fittings
IS:804	:	Rectangular pressed steel tanks

TECHNICAL SPECIFICATION
FOR
XXX) DRAINAGE AND SANITATION

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	INSTALLATION
3.00.00	TESTING AND ACCEPTANCE
4.00.00	CODES AND STANDARDS

XXX) DRAINAGE AND SANITATION

1.00.00 SCOPE

1.01.00 This section covers the layout and construction of drains for roof water, surface water and sewage together with all fittings and fixtures and inclusive of ancillary works, such as connections, manholes and inspection chambers used within the building and from the building to the connection to a public sewer or to treatment work, septic tank and soak pit dispersion trenches.

2.00.00 INSTALLATION

2.00.01 General

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipe lines, fittings and fixtures shall be installed leakproof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

2.01.00 Rainwater Downcomers

Rainwater downcomers shall be standard Cast Iron or PVC Pipes. In case where specifically desired, M.S. pipes, GI pipes may also be used. M.S. pipes and GI shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater downcomers shall run along and be secured to walls, columns etc. Where desired by the Engineer these may have to be installed in chases cut in the structure.

All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type or perforated strap iron type and for PVC pipes as per manufacture detail and as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

2.02.00 **Gutters**

The gutters shall be made of G.I. or A.C. All gutters shall be supplied by reputable specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no reflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by rivetting, bolting or soldering. All joints between successive lengths of gutters shall have on overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

2.03.00 **Soil and Drainage Pipes**

2.03.01 **Gradients**

If not specified the minimum gradients of soil and drainage pipe line shall be as follows :

100 mm nominal dia	:	1 in 35
150 mm nominal dia	:	1 in 65
230 mm nominal dia	:	1 in 120
300 mm nominal dia	:	1 in 200

2.03.02 **Relation with water supply pipe lines**

Unless specifically cleared by the Engineer, under no circumstances shall special drainage and soil pipes be allowed to come close to water supply pipelines.

2.03.03 **Laying**

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

2.03.04 **Support and Protection on Pipelines**

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooh surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows :

a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.

b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.

d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

2.03.05 **Entry into structures**

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When

openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

2.03.06 **Ducts**

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin or backflow.

2.03.07 **Traps and Ventilating Pipes**

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap.

Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-syphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer.

2.03.08 **Manhole and Inspection Chambers**

The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. In addition, at every change of alignment gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise.

Manhole shall be constructed so as to be watertight under test. The bending at the sides shall be carried out in such a manner as to provide no lodgement for any splashings in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Manholes shall be provided with standard C.I. covers. The covers shall be close fittings so as to prevent gases from coming out. Suitable heavy duty covers shall be used where necessary as decided by the Engineer.

2.03.09 **Cutting of Pipes**

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

2.03.10 **Jointing**

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and water-tight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) Cast Iron Pipes :

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centered in the socket of the next pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leakproof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete Pipes

Care shall be taken to place the collar centrally over the joint.

c) Glazed Stoneware Pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar of 1:1 proportion. Then the socket is filled, a fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. with the barrel of the pipe. The newly made joints shall be protected, until set and shall be covered with damp cloth or other suitable materials.

d) Vitrified clay pipes

These shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact and glazed to make them acid resistant and impervious, and shall be obtained from approved manufacturer.

Special care shall be taken in handling these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, Specification for Building it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1) which shall have very little water and levelled to form a splayed fillet at an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead Pipes

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm. and 9 cm. respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) PVC Pipes

The joints shall be thermo-welded or bolted or joints with rubber lubricant and shall be strictly as per as per manufacturer's instructions and specification.

g) Jointing Cast Iron Pipes with Stoneware Pipes

Where any cast iron soil pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe or drain communicating with a sewer, the beaded spigot end of such cast iron soil pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe or drain and the joint made with mortar consisting of one part of cement and one part of clean sharp sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

h) Jointing Stoneware with Cast Iron Pipes

Where any water closet pan or earthware trap connected to such a pan is to be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fibre.

2.04.00 **Trenches and other excavations**

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during handpacking with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimise inconvenience of traffic where applicable.

2.05.00 **Fixtures**

The Tenderer shall mention in his bid the type and make of the fixtures he intends to use enclosing manufacturer's current catalogues. In the absence of any such agreement, the Engineer shall be at liberty to choose any type and make.

All fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to the site must bear indentification marks of the type of the manufacturer. Procurements shall be made well in advance and inspected and approved immediately by the Engineer. All fixtures shall be adequately protected, covered and plugged till handed over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The connecting lead pipes and bends shall weigh at least 3 kg. per 25 mm dia per meter length. Where PVC or similar pipes are allowed the Contractor shall produce the test reports and convince the Engineer about their durability.

Unless specified in the contract the fixtures shall be as specified hereinafter.

2.05.01 **Water closet**

a) Raised type

It shall include glazed vitreous china basin with siphon, open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valveless fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as desired by the Engineer.

b) Squatting type

It shall include glazed vitreous china pan with foot rests and high level cast iron flushing cistern with valveless fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The foot rests shall be made of white glazed vitreous china with chequered surface. The flushing cistern shall be painted as desired by the Engineer.

2.05.02 **Urinals**

It shall consist of wall type glazed vitreous china urinals, cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Automatic flushing shall be approximately once every five minutes. For a number of urinals located together may be served by one cistern of adequate capacity. All fittings shall be chrome plated.

2.05.03 **Wash basin**

It shall be made of glazed vitreous china. The basin shall be flat back, wall hung by painted cast iron brackets and complete with pattern with hot and cold brass faucets with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste complete with necessary fittings. All fittings including faucets shall be chromium plated.

2.05.04 **Sink**

It shall be made of glazed stoneware. It shall be wall hung by painted cast iron brackets and complete with one brass faucet with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste with necessary fittings. All fittings including faucets shall be chromium plated.

2.05.05 **Bathroom mirror**

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws and other fittings shall be chromium plated.

2.05.06 **Glass shelves**

Glass shelves shall consist of 6 mm thick clear glass with guard rails and shall be wall mounted with brackets. All brackets, guard rails and screws shall be chromium plated.

2.05.07 **Towel rail**

Towel rails shall be 20 mm dia. chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

2.05.08 **Soap holder**

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium plated screws.

2.05.09 **Liquid soap dispenser**

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

2.05.10 **Toilet roll holder**

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screws shall be chromium plated.

2.05.11 **Installation**

All plumbing fittings and fixtures shall be installed in most workmanlike manner by skilled workers. These shall be perfect in level, plumb, plane, location and symmetry. All items shall be securely anchored to walls and floors. All cuttings in walls and floors shall be made good by the Contractor.

2.06.00 **Septic tank & effluent disposal**

2.06.01 **Septic tank**

Septic tank shall consist of the tank itself with inlet and outlets therefrom complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating pipe of at least 100 mm dia. whose top shall be provided with a suitable mosquito proof wiremesh and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

2.06.02 **Effluent Disposal**

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed SW pipes laid in a trench filled with broken bricks.

2.06.03 **Soak pit**

The soak pit shall be complete as shown on drawing. It shall consist of a 900 mm dia. pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks set in cement mortar (1:6) and filled with brick bats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

2.06.04 **Open joined SW Pipe / dispersion trenches**

Minimum dia. of the SW pipes shall be 150 mm nominal. The trench for laying the pipes shall be minimum 600 x 600 mm pipes. The joints of the pipes shall be left unsealed. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well graded coarse aggregate. Ordinary soil is used for filling the top of trench.

2.06.05 **Commissioning septic tank**

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.00.00 TESTING AND ACCEPTANCE

3.01.00 Inspection before installation

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

3.02.00 Testing of Pipelines

Comprehensive tests of all pipe lines shall be made by simulating conditions of use. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below :

a) Smoke test

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

b) Water test

For pipes other than Cast Iron

Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may due to one or more of the following cases:

a) Absorption by pipes and joints

b) Sweating of pipes or joints

c) Leakage at joints or from defective pipes

d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

For cast iron pipes

Cast iron sewers and drains shall be tested as for glazedware and concrete pipes. The drain plug shall be suitably strutted to prevent their being forced out of the pipe during the test.

c) For straightness

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball with roll down the invert of the pipe end emerge at the lower end; and

ii) By means of a mirror at one end of the line and lamp at the other. If the pipe line is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipe line is not straight.

3.03.00 **Testing Septic Tank**

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm.

3.04.00 **Fixtures etc.**

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

4.00.00 **CODES AND STANDARDS**

Some of the important Codes and Standards relevant to this specification shall be followed : Latest editions shall always be consulted.

IS:1172 - Code of basic requirements for water supply drainage and sanitation.

IS:1200 - Laying of water and sewer lines including appurtenant (Pt. XVI) items.

IS:1239 - Mild Steel Tubes and Mild Steel Tubulars and other (Pt.I & II) wrought steel pipe fittings.

IS:1536 - Centrifugally cast (Spun) iron pressure pipes for water gas and sewage.

IS:1537 - Vertically cast iron pressure pipe for water, gas & sewage.

IS:3486 - Cast Iron spigot & socket drain pipes.

IS:1742 - Code of Practice for building drainage.

IS:5329 - Code of Practice for sanitary pipe work above ground for buildings.

IS:2470 - Code of Practice for designs and construction of septic tank for small and large installations.

IS:3076 - Low density polythelene pipes for potable water supplies.

IS:4984 - High density polythelene pipes for potable water supplies.

IS:1537 - Vertically cast iron pressure pipes for water, gas and sewage.

IS:1538 - Cast Iron fittings for pressure pipes for water, gas & sewage.

IS:1230 - Cast Iron rain water pipes and fittings.

IS:3889 - Centrifugally cast (spun) iron spigot & socket soil waste and ventilating pipes, fittings and accessories.

IS:1729 - Sand cast iron spigot & socket soil, waste and ventilating pipes and accessories.

IS:1626 - Asbestos cement building pipes, gutters and fittings (spigot & socket types).

IS:458 - Concrete pipes (with and without reinforcement)

IS:783 - Code of Practice for laying of concrete pipes.

IS:784 - Prestressed concrete pipes.

IS:651 - Salt glazed stoneware pipes & fittings.

IS:4127 - Code of practice for laying of glazed stoneware pipes.

IS:1726 - Cast Iron manhole covers and frames intended for use in drainage works.

IS:5961 - Cast Iron gratings for drainage purposes.

IS:5219 (Part 1) - 'P' & 'S' traps.

IS:771 - Glazed earthen-ware sanitary appliance.

IS:772 - General requirements of enamelled cast iron sanitary

appliances.

IS:774 - Flushing cistern for water closets & urinals (valveless siphonic type).

IS:775 - Cast Iron brackets & supports for wash basins and sinks.

IS:2548 - Plastic water closet seats & covers.

IS:2527 - Code of Practice for fixing rain water gutters and down-pipes for roof drainage.

TECHNICAL SPECIFICATION
FOR
XXXI) BOILER DRAIN DIVERSION

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	SYSTEM DESCRIPTION
2.00.00	SCOPE OF WORK
3.00.00	DETAILED SPECIFICATION

ATTACHMENTS

ANNEXURE-I	ALTERNATE ROUTE FOR BOILER DRAIN
ANNEXURE-II	EXISTING BOILER DRAIN - SECTIONS

XXXI) BOILER DRAIN DIVERSION

1.00.00 SYSTEM DESCRIPTION

1.01.00 Existing boiler drains of unit #1 to unit #7 need to be diverted for installation of 1 x 800 MW Supercritical Unit #8.

1.02.00 The diverted drain will be connected to a Settling Tank, which shall be located near existing Cooling Tower for unit 7 (between Grids W-100 & W-200) area shown in the Plot Plan drawing of unit #8 (Dwg. No. K9213R-DWG-M-002 Rev- 4).

1.03.00 Pumping System need to be installed in Settling Tank for recirculation as well as discharge of decanted water.

2.00.00 SCOPE OF WORK

The scope of work shall include complete supply, erection, installation & commissioning of diverted boiler drain as detailed hereunder. The minimum requirement of the system have been indicated, however, EPC Contractor shall provide all items/ facilities to make the system complete & suitable for the satisfactory operation.

a) A new RCC channel shall be erected for diversion of boiler drain of Unit #1 to 7.

b) Settling Tank - One (1) no. for unit no. 1 to unit no. 7

c) 3 x 50 % drain pumps to be installed at Settling Tank.

d) Necessary piping, valves, instrumentation for recirculation as well as discharge of decanted water.

e) All Civil and Structural work associated with the scope of work described in ‘a’ to ‘e’ above.

3.00.00 DETAILED SPECIFICATION

A. Drain Channel :

Covered RCC channel shall be provided for boiler drain diversion. Tentative routing of diverted drain has been shown in the Plot Plan drawing (Dwg. No. K9213-DWG-M-002 Rev. 4). Alternate route for diverted drain has been shown in enclosed Annexure – I. Actual routing shall be finalized by the Contractor.

The capacity of diverted boiler drain shall be adequate to cater waste water discharge from unit-1 to unit-7. Waste water discharge from unit-1 to unit-7 shall be considered as approximately 475 m3/hr.

Details of existing boiler drain are attached herewith in Annexure – II. However, Contractor shall design & finalize the channel section as required.

B. Settling Tank :

A 12m x 30m x 6.2m deep Settling Tank of RCC construction shall be provided, which shall be connected with the diverted drain. Size of settling tank given here is the minimum requirement. However, EPC contractor shall provide the same of required capacity to make the system complete and suitable for satisfactory operation. Settling Tank shall be located near existing Cooling Tower for unit 7 (between Grids W-100 & W-200) area shown in the Plot Plan drawing for Unit #8 (Dwg. No. K9213-DWG-M-002 Rev. 3). This location will be nearer to the utility location of recirculation water. Settling tank should be provided with baffles and clear water sump at the end of settling tank and pre-settling chamber at shallow depth at the entry, so that heavy particles settle in pre-settling chamber.

C. Drain Pumps :

3 x 50 % capacity drain pumps shall be provided at Settling Tank for discharge of water.

The pump parameters shall be as follows :

a) Rated Capacity (Cu. M/Hr). : By Bidder.

b) Rated Head (MWC) : By Bidder

[NOTE : Capacity of pumps shall be designed considering waste water discharge from unit-1 to unit-7 as 475 m3/hr. A minimum margin of 10% shall be considered on pump capacity and 20% margin shall be considered on pump head.]

Material of Construction of Pumps :

a) Casing : 2.5% Ni-CI as per IS : 210 FG 260.

b) Impeller : Stainless Steel Grade – 316

c) Shaft : Stainless Steel Grade - 410

D. Drain Piping :

Concrete / Steel piping, valves, & instruments as required from the discharge of drain pumps upto the final discharge points (for re-use of water and/or for discharge into the river) shall be provided by the Bidder. For re-use of water piping from the discharge of drain pumps shall be connected to the existing system of re-circulation from existing settling tank to existing plant. The approximate distance is 25 to 30m. The work also includes isolation of existing line for connection. Detailed routing and terminal points shall be finalized during Detail Engineering stage.

TECHNICAL SPECIFICATION
FOR
XXXII) GEO-TEXTILE FABRIC

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	GENERAL
3.00.00	EXECUTION
4.00.00	ACCEPTANCE CRITERIA

TECHNICAL SPECIFICATION
FOR
XXXII) GEO-TEXTILE FABRIC

1.00.00 SCOPE

The supply, design and construction of Geo-synthetic/Geo-textile lining system with protective earth cover and turfing (or precast concrete blocks/ Brick tiles) shall be under the scope of Contractor. The design of Geo-synthetic lining system shall be done by approved manufacturer or specialized agencies and to be submitted to owner for approval. Laying of Geo-textile grid and covering the same with soil shall be done by the agencies specialized for this type of work.

2.00.00 GENERAL

2.01.00 Work to be provided by the Contractor

Work to be provided by the Contractor unless specified otherwise will include, but not limited to the following:

a) Furnish all labour, supervision, services, materials, scaffolds, equipment, tools and plant, transportation, necessary approaches etc. required for the work.

b) Prepare detail drawing, if needed, for the work, fencing of area for protective measure, provide dewatering arrangement by pumping, if required, etc.

2.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract or prior approval of the Owner is taken in this respect.

2.03.00 Conformity with Designs

The Contractor is to carry out the work as per the specification, drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or Engineer's instructions. If any deviation is likely to occur, then the Contractor should take Engineer's prior approval before starting of such work. Under no circumstances, the work to be performed should deviate from the specification or drawings unless approval of Engineer is taken.

2.04.00 **Materials to be used**

2.04.01 **General**

All materials to be used for the Work, must meet the specification requirements or the provisions of IS Code and should be of best quality available and approved by the Engineer. In case of bought-out items, certificate from the supplier or its deputed agency must be produced along with samples and approval taken from the Engineer before the items are bought.

Decision of the Engineer in cases of bought-out items shall be final.

2.04.02 **Geo-textile**

Property	**Test Method**
Non-woven Geo-textile :	
Tensile Strength	ASTM D1682
Puncture Strength	ASTM D751
Woven Geo-textile :	
Tensile Strength	ASTM D4595
Tensile Elongation	ASTM D5035
Thickness	ASTM D1777
Mass per Unit Area	ASTM D5621
Resiliency	ASTM D1777
UV Resistance at 1,000 hours	ASTM D4355

3.00.00 **EXECUTION**

The Work shall be strictly executed according to the provisions of this specification, final drawings, instructions of the Engineer at site, and/or catalogues of the approved manufacturer of Geo-textile.

All equipments necessary for the placing of Geo-textile fabric shall be approved before the work will be permitted to begin.

The installation of geo-textile shall be in accordance with the manufacturer's recommendation. Overlaps at ends of rolls and at roll widths shall be in accordance with the manufacturer's recommendations or as directed by the Engineer.

4.00.00 **ACCEPTANCE CRITERIA**

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be specifically checked :

a) Geo-textile fabric against mechanical damage if any.
b) Laying of Geo-textile fabric.
c) Method of jointing (Heat sealing).
d) End sealing or, anchoring of Geo-textile fabric.
e) Laying and joints of cover tiles/blocks.

TECHNICAL SPECIFICATION
FOR
XXXIII) LANDSCAPING WORK

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	MATERIAL
3.00.00	LANDSCAPING WORK
4.00.00	MAINTENANCE
5.00.00	ACCEPTANCE CRITERIA
6.00.00	I.S. CODE

TECHNICAL SPECIFICATION
FOR
XXXIII) LANDSCAPING WORK

1.00.00 SCOPE

The work in general shall consist of preparation of earth/ground including supply & plantation of grass, saplings, plants of trees, shrubs, foliage plants, hedges and potted plants for soft landscaping work. Excavation and removal of top soil up to 300/600 mm depth and Supply and filling with Good earth, if the top soil found to be unsuitable for plantation, are included in the scope of work. Manures, sludge, oil cake, PVC Water supply pipelines & sprinklers with necessary mechanical arrangement like pump & equipment etc for irrigation systems are also included in the supply, preparation and installation work.

Scope of Work also include supply, erection, installation fitting & fixing colored concrete interlocking pavers blocks over well compacted rigid base with 50mm thick sand bed, street furniture like signage, sitting place, trellis made of MS tubes duly painted with anticorrosive paint and electrical fittings and fixtures of approved design and quality for illumination of garden and landscaped area.

Maintenance of Landscape area and landscape elements provided in the work for six(6) months from the date of completion of landscaping work are also included in the scope of work.

Approximate area for both hard and soft landscaping work will be 50,000 Sq.M of ground area spread all over the new plant area. Approximately 5% of this area shall be considered for Hard landscaping.

2.00.00 MATERIAL

i) Good Earth: The earth shall be suitable for gardening and free from kankar, moorum, shingle, rocks, stones, brickbats, building rubbish and any other foreign matter. The earth shall be free from clods or lumps of size bigger than 75 mm in any direction. It shall have PH value, ranging from 6 to 8.5.

ii) Oil cake: (neem or Castor or as available locally) The cake shall be free from husk, dust, grit and any other foreign matter. Sludge: It shall be obtained from approved disposal work.

iii) Grass : grass shall be Mexican grass /Burmese grass type and shall be procured in rolled form from approved nursery.

iv) Foliage plant: Bagonia acutifolia, Cordyline terminails (fire brand), pileas or similar widely used foliage of the region duly approved by the site in charge.

v) Ground cover: Sanscieria trifasciata (snake plant), Helxine soleiroli (baby tears), Gynura, Setecreasea purpurea, Ficus elastacia (rubber plant), Monstera pertusa. In case of non availability of these plants similar ground cover plants available in the region shall be provided with the approval of Site in charge.

vi) Climbers: Philodendron scandens, ficus pumila or similar Climbers available in the region with the approval of site in charge.

vii) Flowering plants: Begonia, impatiens petersiana, Anthuruim, Scherezranium, Hibicus rosa sinensis, Chrysanthemum (Seasonal) or locally available flowering plants with the approval of Site in charge.

viii) Hedges: Ponsettia euphorbia, Coleus (herbaceous), dadonia, duranta, clerendendron, lantana camera, Acalypha. Or available hedges of the region with the approval of site in charge,

ix) Concrete interlocked pavers tiles 60mm thick of two matching colors, for narrow walk ways in the landscaped area and terracing work in the greeneries.

x) Trees: The yellow silk cotton tree, local name kadachogund, The barna local name Varno, the temple tree local name dholo champo and other trees suitable for region like Neem, Ashoka, etc

xi) Earthen Pots with grown up plants: Plants in earthen pots shall be of ornamental variety with color foliages, flowers etc.

Earthen pots shall be made of good earth duly baked and of regular size and shape and free from any crack and defects. Sizes of earthen pot shall be approximately 300 mm high x 300 mm top dia x 200 mm bottom dia. or similar type as available locally. 500 no of pots with grown up plants shall be considered for supply and landscape work.

xii) PVC pipe lines net work shall be of required diameter with approved pop up nozzles sprinklers system at various locations for irrigation of the landscaped areas.

xiii) Electrical fittings and fixtures shall be similar to PHILIPS outdoor luminaries type HCS 370 1xPL-L 18 including lamp 1xPL-L 18 W with all electrical wiring and connections as necessary. Spacing and no of illumination fixtures shall be sufficient to illuminate the landscape area.

3.00.00 LANDSCAPING WORK

3.01.00 Suitability of the soil of the site for landscaping work shall be verified prior to start of the work. For unsuitable soil the top bad soil shall be removed and filled with good earth suitable for plantation. PH value of soil shall be between 6-8.5. Top soil fill up shall be minimum 300 for grassing and minimum 600 for plantations.

Preparation of earth shall be made by trenching of soil. Trenching shall be done to the depth of 300 for grass and 600 for plantations. Trenching of soil shall be done to loosen the soil and turn over and buried the top layer containing weeds etc, in the base and to bring up the lower layers of earth to form a proper medium for plantation.

The trenched ground shall be flooded with water to enable to soil to settle down.

Weeds or other vegetation which will appear on the ground shall be up rooted and removed and disposed off. Trenching shall be done dividing the plot in narrow strips of about, 1.5m width or as directed by the site in charge. Sludge shall be spread evenly over the surface to the required thickness of not less than 75 mm and shall be flooded with water.

After 10 days and within 15 days of flooding the weeds which will appear shall be removed.

The site shall be given fine dressing.

Beds for hedges, shrubberies, plantation shall be generally prepared to width of 750mm to 1250mm and 5 to 6 metres length or as per approved landscape design. The beds shall be excavated to a depth of 600 mm and excavated soil shall be stacked on the sides of the bed. Excavated bed then shall be re excavated for another 300mm and shall be rough dressed. The top earth shall be mixed with manure in the proportion of 8:1 (8 parts earth & 1 part manure). The mixed earth shall be refilled in to the bed and watered profusely. The surface after full subsidence shall again refilled with remaining excavated earth and manure mixture, watered and allowed to settle and finally fine dressed to the level of 50mm below the adjoining ground level. Surplus earth if any shall be removed from site as directed by the site in charge.

Stone brick bats and other foreign matter if met during these activities shall be stacked and disposed off as directed by the site in charge.

Same procedure for preparation of soil shall be made for grass lawn. Grass shall be brought in rolled form from the nursery and spread over the prepared soil.

Earth mound with a small tree at the top of mound and seasonal flowering bed/ foliage bed around the tree may be one of the general features of landscaping.

The retaining wall at coal yard side shall be provided with 750 high IRC Mesh welded to 25 x25 mm hollow steel tube frame. Hollow steel tube post shall be provided @ 1500 c/c and embedded in concrete and shall be provided with anti corrosive paint. Climbing flowering creepers shall be provided from base of the retaining wall up to the top of the Fabric net over retaining wall. This is required to stop the air borne coal dust spreading over the landscaped area.

The embankment around the site shall be landscaped with foliage, seasonal flowering bed and grass. Both sides of the internal roads shall be provided with Hedges of 500 heights and colored flowering plants and dense foliage

bed behind.

Available Spaces around the power house entrance, Service & technical building, Canteen building, fire station building, store building ND Cooling tower area, triangular vista between roads, road dividers shall be landscaped delicately with proper bio aesthetic planning. The Landscaping shall link up building masses in a harmonious whole and enhance their Architectural appeal by presenting a foil of texture, color and form by way of contrast.

Spacing of plants, trees, foliage plants etc shall be as required as per the type and character of the plants and trees. Horticultural norms of the region shall be followed in general.

4.00.00 MAINTENANCE

Details of maintenance schedule shall be as follows:

i) Regular watering of the plants, saplings, trees, grass lawn, hedges and foliages.

ii) Regular weeding of plants to keep the landscaped area free from Weeds.

iii) Supplying manure to plants, trees, shrubs, grass lawn, hedge beds, etc as and when necessary.

iv) Regular lawn mowing.

v) Replacement of dead / ill trees, plants, shrubs, on ground and in pots.

vi) Regular trimming of plants and shrubs and hedges.

vii) Regular cleaning of tree basins and pots.

viii) Earth removal and refill of plants in ground as well as in pots.

ix) Removal of dried leaves and branches of trees and plants.

x) Spraying of insecticides, pesticides as and when required/advised.

5.00.00 ACCEPTANCE CRITERIA

i) Landscaped area shall be neat, and lush green with hue. Free from any debris, scattered earth, brick bats, and any unpleasant elements.

ii) All plants, trees and potted plants shall be well blossomed and shall give a fresh pleasing appearance.

iii) Entry to all important buildings shall be inviting with sprawling greeneries.

iv) Arrangement of plants, ground cover, plant foliage, flowering plants with flower shall give a harmonious blend of hue of colors and greeneries.

v) Drainage system of Large landscaped area shall be such that there shall not be any pocket with stagnant water. The slope of the surface shall be such to drain out all rain water to near by area drainage.

vi) Landscape design work shall be entrusted to a well experienced landscape designer with architectural back ground and registered with the Council of Architecture. Specialized agency experienced in the implementation of landscaping work shall be engaged for the work. .

6.00.00 I.S. CODE

Following are some of the important I.S. Code relevant to this section;

IS : 4919 Glossary of terms applicable to landscape and horticulture work.

SECTION – C4

SPECIFIC TECHNICAL REQUIREMENTS (C&I)

WANAKBORI TPS UNIT-III, (1 X 800 MW)

CONTROL AND INSTRUMENTATION FOR NATURAL DRAUGHT COOLING TOWER

Specific Technical Requirements (C&I):

1.1 Bidder to supply the following items as a minimum
i) One no. Pressure Gauge and One no. Temp Gauge at Hot Water pipe header at T.P..

ii) One no. of Anemometer for measurement of wind velocity.

iii) One no. of Psychrometer.

iv) Removable type Pitot Tube at each hot water inlet- piping header to measure the flow (during performance Guarantee test only). The Pitot Tube shall be left with customer after the completion of the test.

v) Local Control Panel for Sump Pumps (Submersible Type).

vi) Level switches for sump/tank level high/normal/low/very low interlocks.

1.2 The detailed specification of instruments is given in detail as below.

1.3 The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable.In case of any conflict and repetition of clauses in the specification,the more stringent requirements among them are to be compliedwith.

1.4 Drawings/Documents and data to be furnished after award of the contract as per deliverables list.

C&I DELIVERABLES LIST

Sl. No.	Drawing No.	DRAWING/DOCUMENT TITLE		
INSTRUMENTATION				
1.	PE-V9-408-165-I901	INSTRUMENT DATA SHEETS		
2.	PE-V9-408-165-I903	INSTRUMENT QP / CHECK LIST		
RELAY BASED LCP				
1.	PE-V9-408-165-I950	LOCAL CONTROL PANEL DATA SHEET		
2.	PE-V9-408-165-I951	WIRING DIAGRAM		
3.	PE-V9-408-165-I952	PANEL GA DRAWING		
4.	PE-V9-408-165-I956	BILL OF MATERIAL		
5.	PE-V9-408-165-I957	LOCAL CONTROL PANEL QUALITY PLAN		
6.	PE-V9-408-165-I958	RELAY BASED PANEL O & M MANUAL		

FIELD & MEASURING INSTRUMENTS

	19.	Preferred Features	:	a) Test plug connection and cutout terminals physically separated from other electronics. b) Electronic Damping facility (adjustable).
1.04.00		Mass Flow meter		
1.04.01		Sensor		
	01.	Measuring Principle	:	Coriolis Mass flow.
	02.	Primary Element	:	Flow Tube of 316SS or better
	03.	Heating Arrangement	:	Integral.
	04.	Temperature Control	:	For heavy fuel oil application.
	05.	Process Connection	:	Flanged of rating as per process requirement.
	06.	Drain	:	Self-draining facility
	07.	Enclosure	:	Stainless steel
	08.	Accessories	:	Counter flanges, Mounting nuts, bolts, gaskets etc.
1.04.02		Transmitter		
	01.	Measured quantities	:	Mass Flow rate, Total Mass Flow, Density.
	02.	Input Signal Processing	:	Digital Processing.
	03.	Display	:	Digital Display (LCD).
	04.	Output	:	2 off. isolated 4-20mA DC output.
	05.	Load	:	< 750 ohms.
	06.	Power supply	:	240V AC, 50 Hz.
	07.	Turn Down	:	100:1
	08.	Accuracy	:	$\pm$ 0.2 % of measured value
	09.	Housing	:	IP 65
	10.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
	11.	Accessories	:	a) Handheld configurator b) Mounting U-bolts, nuts, bolts, prefab cable etc. c) ½"NPT cable gland
1.05.00		Pressure Gauge and Differential Pressure Gauge		
	01.	Type	:	Bourdon/Bellows/Diaphragm
	02.	Sensing & Socket	:	AISI-316 SS
	03.	Movement Material	:	AISI-304 SS
	04.	Case Material	:	Stainless steel. IP-65.
	05.	Dial Size	:	Generally 150 mm
	06.	Scale	:	Black lettering on white in 270 ^{O} arc.

07.	Window	:	Shatterproof glass
08.	Range Selection	:	Normal process pressure: 50~70 % of range
09.	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero.
10.	Adjustment	:	Micrometer screw for zero. Internal micrometer screw for range.
11.	Element Connection	:	Argon welding
12.	Process Connection	:	1/2" NPT (M) Bottom for local, back for panel mounting.
13.	Performance	:	Accuracy of $\pm$ 1.0 % of span or better.
14.	Operating ambient	:	0 - 50 ^{O}C
15.	Safety Feature	:	Blow out disc /diaphragm at the back
16.	Accessories	:	a) Snubbers and Glycerin filled for pulsating fluid applications and at pump discharge. b) Stainless steel Diaphragm seals for viscous fluids. c) 3-Way SS316 Gauge cock for pressure gauges. d) 5-valve SS316 manifold from barstock for differential pressure gauge. e) Siphons for steam and hot water services.
17.	Applicable standard	:	IS-3624 / 1996
18.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

1.06.00 Temperature Gauge

01.	Type	:	Bimetallic or gas filled.
02.	Sensing Element Material	:	Bourdon - AISI-316 SS
03.	Capillary Armoring	:	Stainless steel flexible
04.	Movement Material	:	AISI 304 SS
05.	Bulb / Stem Diameter	:	12 mm
06.	Bulb / Stem Material	:	AISI 316
07.	Capillary	:	Stainless Steel
08.	Connection to well	:	½" NPT
09.	Case Material	:	Stainless steel
10.	Dial Size	:	150 mm in general
11.	Scale	:	Black lettering on white in 270 ^{O} arc.
12.	Mounting	:	Surface/Panel
13.	Over range Protection	:	125 % of range or more

14.	Instrument connection	:	Bottom for local and back for panel mounting.
15.	Range	:	Normal temperature–50~70% of range.
16.	Zero adjuster	:	Micrometer screw adjustable from front.
17.	Window	:	Shatterproof glass.
18.	Accuracy	:	± 1 % or better
19.	Enclosure Class	:	IP-65
20.	Capillary	:	5 meters (local surface)/15.0 meters (local panel) - armoured stainless steel
21.	Compensation	:	Capillary and Case Compensation
22.	Accessories	:	a) Forged barstock thermowell screwed as per ASME PTC code. Process connection M 33X2 (M). Material of construction of Thermowell: - SS 316: In general - Inconel: For flue gas application - Tungsten carbide: For coal mill application.
23.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

1.07.00 Thermocouples

01.	Type	:	a)	Type-J (Iron Constantan) / Type-K (Chromel Alumel) / Type-R (Pt.-Rhodium Pt.) / Type-S (90% Pt – 10% Rhodium). [As per application]
			b)	Duplex
			c)	Ungrounded
02.	Wire gauge	:	16 AWG for Type-K, 24 AWG for Type-R	
03.	Standard	:	ANSI-MC 96.1.	
04.	Protecting Tube :-			
	i) O.D.	:	8 mm	
	ii) Material	:	316-SS Seamless	
	iii) Filling	:	Magnesium Oxide (Purity above 99.4%)	
05.	Response time	:	a)	< 20 seconds for measurement.
			b)	< 10 seconds for control.
06.	Accuracy	:	± 1.1^0 C up to 300 ^{0} C & 0.4% of measured temperature range above 300 ^{0} C.	
07.	Head:			
	i) Type	:	IP-65 universal screwed type.	
	ii) Material	:	Die cast aluminum or better	
	iii) Terminal blocks	:	Nickel plated Brass - screw type/ silver plated	

iv) Instrument connection to well : ½" NPT

v) Cable connection : ½" NPT gland and grommet.

vi) Others : Terminal head cover with SS chain and suitable gasket. All thermowells in the high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safe size and design of thermowells.

08. Accessories :
a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT (M)] with thermowell connection
b) Compression fittings/unions
c) Flanges etc. (for flanged connections only)
d) Forged barstock thermowell as per ASME PTC code. Process connection M 33X2 (M) in general or 1½" Flanged for Flue gas/Furnace/Air etc. application.

Material of construction of Thermowell:

SS 316: In general

Inconel: For flue gas application

Tungsten carbide: For coal mill application.

09. Nameplate : Tag number, service engraved in stainless steel tag plate

1.08.00 Resistance Temperature Detector

01. Type : Platinum (Duplex), Ungrounded
02. Resistance : 100 ohm at 0 ^{O}C
03. Base : Wound on ceramic (anti-inductive)
04. Wiring : 3 /4 Wire
05. Protecting Tube :-
i) O.D. : 8 mm
ii) Material : SS-316, Seamless
iii) Filling : Magnesium oxide (Purity above 99.4%).
06. Response time :
a) $<$ 20 seconds for measurement.
b) $<$ 10 seconds for control.
07. Calibration : DIN 43760
08. Accuracy : $\pm$ 0.5%
09. Head :

	i) Type	:	IP-65 universal screwed type.
	ii) Material	:	Die cast aluminum or better
	iii) Terminal blocks	:	Nickel plated Brass-screw type / silver plated
	iv) Cable connection	:	½" NPT gland and grommet.
	v) Others	:	Terminal head cover with SS chain and suitable gasket. All thermowells in the high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safe size and design of thermowells
10.	Accessories	:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT (M)] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) Forged/barstock thermowell as per ASME PTC code. Process connection M33X2 (M). Material of construction of Thermowell: SS 316: In general Inconel: For flue gas application Tungsten carbide: For coal mill application.
11.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
1.09.00	Pressure Switch		
01.	Type	:	i) Piston for high pressure application ii) Bellow / Diaphragm for low pressure application
02.	Sensing element material	:	AISI SS-316. All other wetted part SS316.
03.	Case Material	:	Die-cast aluminum alloy, neoprene gasket.
04.	Setter Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points.
05.	Over range	:	150 % of maximum pressure
06.	Adjustments	:	a) Internal Set Point b) Differential adjustment
07.	End Connection	:	1/2" NPT (M) bottom connected
08.	Switch configuration	:	Two SPDT
09.	Switch Rating	:	240V, 5A AC/220V, 0.5A DC

10.	Switch Type	:	Snap acting, shock & vibration proof
11.	Terminal Block	:	Suitable for full ring lugs.
12.	Cable connection	:	½" NPT conduit connection.
13.	Enclosure Class	:	IP-65.
14.	Performance	:	a) Repeat accuracy ± 1.0% b) Accuracy of Setting Indication of ± 1.5%
15.	Ambient temperature	:	0 – 50 Deg.C
16.	Nameplate	:	Tag number, service engraved in SS tag plate
17.	Accessories	:	a) Remote diaphragm seal with SS-316 capillary for viscous & corrosive application. b) Siphons for steam and hot water services. c) Retention ring and screws for surface mounting. d) 1/2" NPT 2 Valve SS-316 barstock manifold e) ½" NPT cable gland

1.10.00 Differential Pressure Switch

01.	Type	:	Bellows / Diaphragm / Piston actuated
02.	Sensing element material	:	AISI SS-316. For all other wetted part SS 316
03.	Case Material	:	Die-cast aluminum alloy with neoprene gasket.
04.	Setter Scale	:	Black graduation on white scale with 0-100% graduation and provided with red pointer for set point adjustment
05.	Over range	:	Static pressure on any one side, the other side being open to atmosphere.
06.	Adjustments	:	a) Internal set point adjustment b) Differential adjustment
07.	Process Connection	:	1/2" NPT (M) bottom / back connected.
08.	Switch configuration	:	Two SPDT
09.	Switch rating	:	240V, 5A AC/220V, 0.5A DC.
10.	Switch type	:	Snap acting type contacts, shock and vibration proof.
11.	Terminal Blocks	:	Suitable for full ring lugs for cable connection.
12.	Cable Connection	:	½" NPT conduit connection or compression gland.
13.	Performance	:	a) Repeat accuracy ± 1.0% b) Accuracy of set point Indication: ±1.5%

14.	Operating Ambient	:	0 - 50 ^{O}C (Maximum Continuous)
15.	Enclosure	:	IP-65
16.	Accessories	:	a) Snubbers for pulsating fluid application. b) Syphons for steam and hot water services. c) Retention ring and screws for surface mounting. d) 1/2" NPT 3-Valve SS-316 manifold constructed from barstock e) 1/2" NPT Cable gland
17.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
18.	Remote Seal type for special application	:	a) Silicone oil / fluorolube filled remote diaphragm seal for dirty / viscous / corrosive fluid. b) SS armoured capillary at least 3 meters each. c) Adapter flanges with nuts, bolts and gaskets for instrument and process side.

1.11.00 Level Switch

01.	Type	:	External cage float operated. Magnetically coupled.
02.	Float Material	:	AISI-316 stainless steel or better
03.	Other wetted parts	:	AISI-316 stainless steel or better
04.	External Cage	:	Carbon steel / Stainless steel as per process requirements, welded type / flanged construction. Cage pressure rating shall equal or exceed the rating of the main vessel.
05.	External cage mounting	:	Side-Side.
06.	External cage connection	:	25 NB socket welded.
07.	Switch housing	:	Epoxy coated die-cast aluminum alloy with neoprene gasket conforming to IP-65.
08.	Type of switch configuration	:	2 SPDT (two nos.)
09.	Contact rating	:	5A, 240V/AC, 0.25A, 220V DC
10.	Accessories	:	a) Counter flange, nuts & bolts, suitable gasket etc.

				b) Steel globe type drain valve.
				c) ½"NPT cable gland
				d) Stainless steel nameplate with alpha-numeric engraved for service and tag.
	11.	Preferred feature	:	Switch operating point marked on cage
	12.	Mounting	:	On standpipe
1.12.00		Conductivity Type Level Switch		
	01.	Type	:	Conductivity discrimination.
	02.	Application	:	Drain pots viz. on CRH line
	03.	Mounting	:	Flanged – on external cage.
	04.	Probe MOC	:	Stainless steel with high purity ceramic.
	05.	Probe rating	:	> Maximum design pressure of vessel.
	06.	Input	:	Four independent channel with selectable switching threshold for water conductivity.
	07.	Relay Output	:	Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
	08.	Contact type & rating	:	2SPDT or 1 DPDT @ 5A 30V DC.
	09.	Local Display	:	Coloured LEDs for Hi, Lo, Hi-Hi, Lo-Lo, Power & fault.
	10.	Power supply	:	Dual 240V AC, 50 Hz, 1Ph.
	11.	Enclosure	:	IP–65, corrosion resistant & wall mounting type (Explosion proof for NEC Class-1, Division-1 area).
	12.	Accessories	:	a) PTFE cable from probe to electronics
				b) Mounting accessories
				c) External cage
				d) Washer & gasket
	13	Test pressure	:	Two times rated pressure
	14.	Cable connection	:	½" NPT with cable gland
1.13.00		Orifice Plate		
	01.	Application	:	Low fluid velocity flow measurement
	02.	Design Standard	:	BS-1042, Part-I
	03.	Number of Tapings	:	As required plus one additional pair of taps
	04.	Diameter Ratio	:	Between 0.4 to 0.7
	05.	Thickness	:	3 mm for main pipe diameter up to 250 mm, 6 mm for main pipe diameter above 250 mm and 10 mm for main pipe diameter of 500 mm and above.

07.	Calibration	:	a)	Self calibration with internal reference
			b)	Zero & Span calibration
08.	Programming	:	Handheld programmer & Local keypad	
09.	Process Connection	:	Flanged /screwed	
10.	Electronic Housing	:	Epoxy painted Die-Cast aluminium alloy	
11.	Antenna / Flange assembly	:	316 SS or Hestalloy (as required)	
12.	Output Indicator	:	Digital Integral Display	
13.	Accuracy	:	5 mm or 0.1% of probe length	
14.	Accessories	:	a)	Programming tool kit
			b)	Gasket

1.24.00 Temperature Switch

01.	Type	:	Bimetallic or gas filled.
02.	Sensing Element Material	:	Bellow / Bourdon AISI SS-316
03.	Bulb Material	:	AISI SS-316
04.	Capillary	:	Stainless steel armored
05.	Movement Material	:	AISI SS-304
06.	Case material	:	Epoxy coated steel plate or die-cast aluminum alloy with neoprene gasket and clear glass where applicable cover conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
07.	Scale	:	Black lettering on white background
08.	Over range Protection	:	120 %
09.	Instrument connection	:	Bottom
10.	Switch configuration	:	Two SPDT
11.	Switch rating	:	240V, 5A AC/220V, 0.5A DC
12.	Switch type	:	Snap acting, shock and vibration-proof.
13.	Adjustability	:	Internal Set point adjustable over span range
14.	Cable connection	:	3/4" ET conduit connection or compression gland.
15.	Compensation	:	a) Capillary compensation with invar wire throughout the capillary length.
			b) Case compensation
16.	Performance :		
	i) Scale Accuracy	:	±1.0 % of full scale
	i) Repeatability	:	< 0.5 % of full range
	ii) Response time	:	Less than 40 seconds with thermowell
17.	Capillary length	:	5 meters (minimum) for local mounting/15 meters for local panel mounting.

18.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
19.	Accessories	:	Mounting accessories, 3/4"ETcable gland.

1.25.00 Rotameter

01.	Type	:	On-line up to 2". By-pass above 2"
02.	Metering tube	:	Borosilicate glass
03.	Float	:	AISI 316-SS unless the process fluid demands some other material.
04.	Body MOC	:	AISI 316-SS
05.	Scale	:	Graduated- Engraved black on white background.
06.	Process connection	:	Flanged
07.	Accuracy	:	± 2% of full scale detection or better for on-line type and ±4% of full-scale detection or better for by-pass type.
08.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
09.	Accessories	:	Slip-on orifice plate of 316-SS and taps of Stainless Steel as per application requirements. Applicable SS Isolation valves and SS Range Orifice - for bypass type rotameters.

1.26.00 I/P Converter

01.	Type	:	Electro-pneumatic (Outdoor Type)
02.	Input level	:	4-20 mA DC
03.	Output range	:	0.2 to 1.0 Kg/Sq. cm With 'Fail Freeze' feature. (i.e in case of wire snapping the last good value of pneumatic signal out put will hold for at least six hours)
04.	Split range	:	For typical application wherever required.
05.	Control Action	:	Selectable air to close, air to open and fail freeze application
06.	Supply pressure	:	1.2 to 1.6 Kg/cm^2 (1.4 typical)
07.	Max. supply pressure	:	7 Kg/ sq.cm.
08	Response Time	:	5 Seconds for 0 to 90% output pressure
09.	Housing	:	IP 55
10.	Repeatability	:	±0.1% of span
11.	Accuracy	:	± 0.25% of span
12.	Supply pressure effect	:	Less than 1%
13.	Span and Zero adjustments	:	Screw
14.	Pneumatic connection	:	¼" NPT

17.	Preferred feature	:	a) Solenoid valve directly integral to actuator body shall have NAMOOR interface for uniformity b) Local indication for power

1.29.00 Sight Glass

01.	Type	:	Flap-type
02.	End connection	:	Screwed / Flanged
03.	Material:		
a)	Body	:	CS/SS as per process medium
b)	Indicator	:	Stainless steel
04.	Sight Glass	:	Toughened Borosilicate
05.	Gasket	:	Neoprene
06.	Bolts & Nuts	:	High tensile steel
07.	Hydraulic Test Pressure	:	1.5 times maximum working pressure
08.	Accessories	:	As required

1.30.00 Flow Indicating Switch

01.	Type	:	On line metal tube Rotameter
02.	End connection	:	Flanged
03.	Material:		
a)	Body	:	CS/SS as per process medium
b)	Float	:	Stainless steel
c)	End fittings/flange	:	Stainless steel
d)	Other wetted part	:	Stainless steel
b)	Casing	:	Di cast Alluminium
04.	Accuracy	:	+/- 2.0% of FSR
05.	Rangeability	:	10:1
06.	Electrical connection	:	¾" ET
07.	Switch type	:	Snap acting hermitically sealed 2 nos. SPDT
08.	Contact rating	:	5A, 240V AC
09.	Protection class	:	IP-65
10.	Accessories	:	As required

2.00.00 **CLOSED CIRCUIT TELEVISION SYSTEM**

2.01.00 Closed Circuit Television System

2.01.01 Closed Circuit Television System (CCTV) with all equipment and accessories shall be installed for the purpose of surveillance of major plant areas. Also, cameras shall be installed at the Main plant (TG Hall, Boiler ESP) and other common auxiliary plants.

2.01.02 The CCTV system shall meet the specific functional & design requirements towards collecting live video information from the various areas of the plant and displaying that information at monitors.

CCTV network configuration shall be built on the Stackable Managed Ethernet switches for better control of data traffic & performance and future expansion. Switch configuration shall be redundant with seamless changeover without any upset in the CCTV operation. MTBF of the switch shall be more than 20 Years. Configuration shall be automatic.

3.00.00 CONTROL PANEL/DESK MOUNTED INSTRUMENTS AND ELECTRICAL SYSTEM ACCESSORIES

3.01.00 Coupling Relay

01.	Type	:	Octal base plug-in type/ DIN rail Mounting
02.	Coil voltage	:	24 V D.C. in general / other as required
03.	Contact	:	2 NO & 2 NC (Minimum)
04.	Contact rating	:	250 V/5A (A.C)/220V/2A (D.C)
05.	Operating range	:	70 to 110% of rated voltage.
06.	Insulation	:	2 KV for 1 minutes between terminal & earth.
07.	Mechanical life	:	20 million operations
08.	Coil protection	:	Diode
09.	Indication	:	Coil on LED
10.	Enclosure	:	Transparent cover
11.	Connection	:	Screw terminals.
12.	Mounting	:	Projection mounting inside panel / DIN rail mounting

3.02.00 Bar graph Indicator

01.	Type	:	Bar graph
02.	Number of channels	:	One / Two (as required)
03.	Input	:	4-20 mA/1-5 V/Thermocouple/RTD
04.	Indication	:	Green LED / LCD
05.	Scale	:	100 mm vertical one for each channel graduated in engineering unit (linear scale)
06.	Readable Distance	:	3 meters (minimum)
07.	Mounting	:	Flush panel
08.	Face Dimension	:	36(W) x 144(H) mm (approx) / 72 x 144 (H) mm
09.	Resolution	:	1% of scale or better
10.	Power Supply	:	240V, 1 Phase, 50 Hz AC
11.	Operating Conditions :-		
	a) Temperature	:	0-50 ^{O} C
	b) Relative Humidity	:	5%-95%
	c) Supply Voltage	:	-15% to +10%
12.	Connection between		

	Indicator and Tray	:	Prefab Cable
13.	Accessories	:	i) Mounting Tray ii) Engraved phenolic nameplate affixed to front flange to identify each indicator by tag number and each point by measured variables.
14.	Alarm Facility	:	1 HI and 1 LO for each channel independently adjustable over span. Voltage free outputs
15.	Reference Junction Compensation	:	Built-in cold junction compensation for thermocouple inputs
16.	Feature	:	i) Alarm level indication by flashing cursor ii) Green Digital display of parameter value in front panel with a 3.1/2 digit display.

3.03.00 Valve Position Indicator

01.	Input	:	4-20 mA DC/1-5 Volts DC
02.	Indication	:	Pointer and Scale. Moving Coil Meter
03.	Readable Distance	:	3 meters (minimum)
04.	Pointer Deflection	:	90 Deg Sector or linear
05.	Mounting	:	Flush Panel (Horizontal/vertical)
06.	Accuracy	:	$\pm$1% or better
07.	Protection Class	:	IP-42
08.	Operating Ambient Temp.	:	0-50 ^{O}C
09.	Scale	:	0-100%
10.	Bezel Size	:	DIN Standard

3.04.00 Digital Indicator

01.	Type	:	Four and half digit LED seven-segment display with sign.
02.	Face Dimension	:	72 x 144 mm / 48 x 96 mm (as applicable)
03.	Display Character	:	13.8 mm, Green (LED)
04.	Accuracy	:	0.1% of reading, $\pm$2 digit
05.	Input	:	4-20mA DC/1-5 V DC/RTD/Thermocouple
06.	Mounting	:	Flush Panel
07.	Power Supply	:	240V $\pm$10%, 50 $\pm$2.5 Hz
08.	Output Contact	:	2 nos SPDT, contact rating 5A at 240V AC/ 0.25A at 220V DC
09.	Power/Signal Connection	:	Screwed

Large Display (150x300 mm) indicators shall be provided for MW, MVAR and frequency indications.

3.05.00 Push Button

01.	Type	:	Shrouded square format
02.	Face Dimension	:	32 x 32 mm (maximum)
03.	Contact Configuration	:	2 NO + 2 NC
04.	Contact Addition	:	Add-on block up to 4 each with 2 pairs of contacts
05.	Contact Material	:	Hard Silver Alloy
06.	Contact Rating	:	500V / 10 A
07.	Utilization Category	:	AC11 / DC11
08.	Insulation Voltage	:	2 KV for 1 minute between terminals and earth
09.	Mechanical Life	:	1 million operation
10.	Construction	:	Aluminum shrouding with plastic lens
11.	Colors	:	Red, Green, Yellow, Black, etc.
12.	Connection	;	Screw terminals
13.	Enclosure Class	:	IP-52
14.	Legend	:	Engraving

3.06.00 Illuminated Push Button

01.	Type	:	Square format
02.	Face Dimension	:	32 x 32 mm (maximum)
03.	Contact Configuration	:	2 NO + 2 NC (minimum)
04.	Contact Addition	:	Add-on-Block up to 4 each with 2 pairs of contacts
05.	Contact Material	:	Hard Silver Alloy
06.	Contact Rating	:	500 V/ 10A
07.	Utilization Category	:	A C11 / DC11
08.	Insulation Voltage	:	2 KV for 1 minute between terminals and earth
09.	Mechanical Life	:	1 Million Operation
10.	Lamp	:	LED with built-in resistors as required
11.	Lamp Rating :-		
	a) Voltage	:	240 V AC
	b) Watt	:	2 Watt (approx.)
12.	Lamp and Lens Replacement	:	From front
13.	Construction	:	Transparent Plastic Lens
14.	Color	:	Red, Green, Amber, Yellow etc.
15.	Connection	:	Screw terminals

	16.	Enclosure Class	:	IP-52
	17.	Legend	:	Engraving
3.07.00		Selector Switch		
	01.	Type	:	2/3/4 position stay put type with rotary lever actuator.
	02.	Face Dimension	:	32 x 32 mm (maximum)
	03.	Contact Configuration	:	4 pair of contacts
	04.	Contact Addition	:	Add-on-Block up to 4 each with 2 pairs of contact
	05.	Contact Material	:	Hard silver Alloy
	06.	Contact Rating	:	500 V/10 A
	07.	Utilization Category	:	AC11 / DC11
	08.	Insulation Voltage	:	2 KV for 1 minute between terminals and earth
	09.	Mechanical Life	:	1 million operation
	10.	Construction	:	Aluminum shrouding
	11.	Connection	:	Screw terminals
	12.	Enclosure Class	:	IP-52
3.08.00		Indicating Lamp		
	01.	Type	:	LED with built-in resistor
	02.	Face Dimension	:	32 x 32 mm (maximum)
	03.	Voltage	:	240 V AC
	04.	Watt	:	2.5 Watt (approximate)
	05.	Lamp and Lens		
		Replacement	:	From front
	06.	Construction	:	Transparent Plastic lens
	07.	Color	:	Red, Green, Amber, Yellow etc.
	08.	Connection	:	Screw terminals
	09.	Legend	:	Engraving
3.09.00		Indicating Meters (A.C)		
	01.	Type	:	Rectifier type
	02.	Face Dimension	:	96 x 96 mm
	03.	Scale	:	Radial arc of 240 Deg.
	04.	Accuracy	:	1.5% of full scale.
				±0.5 Hz for frequency meter
	05.	Input	:	0-1/0-5A for current measurement, 0-240V, 50 ± 2.5 Hz for voltage / frequency measurement
	06.	Zero Adjustment	:	Screw on meter face

	07.	Enclosure	:	Shielded Case
	08.	Mounting	:	Flush Panel
	09.	End Scale Suppression	:	6 times the measuring range only for motor ammeters

3.10.00 Indicating Meters (D.C)

	01.	Type	:	Taut band moving coil
	02.	Face Dimension	:	96 x 96 mm
	03.	Scale	:	Radial arc of 240 Deg.
	04.	Accuracy	:	1.5% of full scale
	05.	Input	:	0-75 mA for current measurement. Direct reading for voltage measurement.
	06.	Zero Adjustment	:	Screw on meter face
	07.	Enclosure	:	Shielded case
	08.	Mounting	:	Flush Panel
	09.	End Scale Suppression	:	2 times the measuring range only for motor ammeters.

For electrical system's meter and for synchronization, Bidder shall refer to electrical volume of the specification

3.11.00 Auxiliary Relay

	01.	Type	:	Electromagnetic
	02.	Coil voltage	:	240 V A.C / 220V DC. For any other voltage bidder to make his own arrangement.
	03.	Contact Configuration	:	2 NO & 2 NC (Minimum), additional contacts as per requirement with provision for additional contact block expansion
	04.	Contact rating	:	250V/5A (A.C/D.C.)
	05.	Operating range	:	80 to 110% of rated voltage
	06.	Insulation	:	2 KV for 1 minute between terminals & earth.
	07.	Mechanical life	:	20 million operations
	08.	Coil protection	:	Diode/surge suppressor
	09.	Connection	:	Screw terminals.
	10.	Mounting	:	Projection mounting inside panel

3.12.00 Electrical Transducer

Transducers shall be provided for conversion of AC electrical quantities such as voltage, current and power. Transducer shall be suitable for 220V DC auxiliary supply. Transducers shall be of low burden type having 4 – 20 mA DC linear galvanically isolated output compatible with secondary indicating instrument. Transducer shall be dual channel type. Accuracy class of Transducers shall be as per IS14570:1998 or IEC688:992

3.13.00 Synchroscope

Synchroscope shall be designed to provide an illuminate and indication of phase and frequency difference between bus voltage and Generator voltage. It shall denote the actual frequency difference corresponding to the inverse of time taken for one rotation of the illuminated vector spot. The instrument shall be designed for industrial applications, which require precise, reliable and robust instruments for the display range and indication. Synchroscope shall be designed as per the DIN / IEC / BS standards.

4.00.00 **CONTROL VALVES, ACTUATORS & ACCESSORIES**

General Technical Guidelines for the Control Valves shall be as follows :

a) Bidder shall exercise caution in selecting severe service control valves like BFP recirculation valves, HP & LP bypass valves, superheater & reheater attemperator valves, PRDS valves for Boiler & Turbine, Soot blower steam pressure control valve, control valves whose down stream are connected to vacuum such as HP/LP heater emergency level control, condenser make up water control valve, separator level control and CEP minimum flow control valve. For such critical applications, Bidder shall offer valves which are proven for similar application. Above valves shall have leakage class equal or better than class-V with metal-to-metal seating.

b) Wherever, steam conditioning calls for Pressure reducing & desuperheating, combined PRDS type valves shall be offered.

c) Bidder shall provide redundant control valves for Main condensate flow control, Superheat attemperation control and Reheat attemperation control as a minimum for high availability. For other application, if the availability criteria for the plant cannot be met even with the best established product, redundant control valves shall be provided.

d) Control valves shall be located near floor or platform for ease of access and with adequate clearances for maintenance and lay-down and shall be placed as station with upstream motorized isolating valve, down-stream isolating valve, inching duty motorized bypass valve and manual drain valves. Each redundant control valve shall have its upstream motorized and down-stream manual isolating valves. Where quick shut off requirement is foreseen such as in case of SH & RH attemperation valves, upstream isolation valve shall be pneumatic type.

4.01.00 General

4.01.01 Control valves for regulating service shall normally be globe body, preferably cage guided, metal-to-metal seated, pneumatically operated and shall be provided with characterized plugs having ANSI leakage class-IV except for the control valves indicated above.

4.01.02 Where the operating time is critical for the operation of the plant, as in case of HP or LP bypass valves, hydraulic actuators with electro-hydraulic interface shall be offered.

4.01.03 Bonnet joints for all control valves shall be of flanged and bolted type.

4.01.04 Flanged valve shall be rated at no less than class 300 lbs.

4.01.05 Valve Body / End Connections

4.09.00 Valve Accessories

Accessories shall include side mounted hand wheels, limit switches, junction boxes, airlock relays etc.. Solenoid valve wherever required shall be furnished.

5.00.00 **CONTROL DESK / PANEL / RACK**

5.01.00 Convenient and logical approach to operational interfaces and aesthetics in the overall view of the panel /desk shall be considered.

5.02.00 For items susceptible to vibration, suitable anti-vibration padding shall be provided to prevent damage or malfunction.

5.03.00 All items inside the panels/cabinets shall be neatly arranged with easy access/ maintenance approach.

5.04.00 Incoming power supply feeders shall be duplicated. Alarm shall be provided for failure of a power supply feed.

5.05.00 Desk / panel shall be provided with interior illumination, utility receptacles with plug and cooling fan.

5.06.00 Panel / Desk shall have gland plate at cable entry to panel. Thickness of gland plate shall not be less than 3 mm.

5.07.00 Wire shall be routed / laid through covered trough.

5.08.00 Crating of the panels and desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. Mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.

5.09.00 Nameplate

a) Nameplate shall be provided for instrument or device mounted on the panel.

b) Nameplates for panels shall be provided both in front and rear.

5.10.00 Control Desks

5.10.01 Devices mounted on the desks shall be flush type. Devices shall be so mounted that their removal and replacement can be accomplished without interruption of services to others.

5.10.02 Desk shall be ergonomically designed to suit working on a 24 X 7 basis. Aesthetics, ergonomics and illumination shall be considered while positioning of the desk, large video screen and panels in control room.

5.10.03 Control desk shall be free standing floor mounting type of table-top design with compartments for locating the hardware. Desk shall be constructed from aluminum extrusion with high pressure laminate MDF board for work surface of approved colour. Aluminium structure shall be anodized or powder coated paint finish.

5.10.04 Monitors with retractable keyboard, emergency push buttons shall be provided on the desk. Desk shall be arranged in arc-like shape without any sharp edges. Edges shall be extruded PVC or rounded post-formed laminate..

5.10.05 Desks shall be of modular, scalable and industrially ruggedized design and shall have Telephones and Intercom connections.

5.10.06 Desks shall have concealed cable trays for wire dressing.

5.10.07 Design shall include Earthing bolts.

5.10.08 Back installed items shall be suitably concealed from front view.

5.11.00 Back Up Panel

5.11.01 Construction shall be from sheet steel of thickness not less than 3mm.

5.11.02 Electrical upright Panel construction & design shall be similar to back up panel. Control switches, meters, indicators, synchronizer, excitation control switch, annunciation window etc. along with associated mimic diagram, as recommended, shall be provided for manual synchronization of generator.

5.12.00 Cabinets / Enclosure / Panels

01.	Material of construction	:	Cold rolled steel sheet
02.	Thickness of Sheet	:	a) 3.0 mm for faces supporting instruments / terminals. b) 2 mm for other sides and top.
03.	Construction	:	Welded throughout as per approved National Standards.
04.	Panel height	:	2300 mm (approx)
05.	i) Corners	:	7 mm inner radius
	ii) Dimensional Tolerances	:	a) In height & length - 3 mm b) In height between adjacent sections - 2 mm. c) Total for a group - 6 mm
06.	Doors	:	Double, recessed, turned back edges
	i) Thickness of Sheet	:	2 mm
	ii) Hinges	:	Stainless steel
	iii) Door latches	:	Three point type
	iv) Door gaskets	:	Neoprene rubber on fixed frame to result dust proof/weatherproof enclosure.
	v) Opening of the doors	:	Outward
	vi) Louvers	:	With removable wire mesh to ensure dust and vermin proof.
07.	Color of interior	:	Brilliant white
08.	Colour external	:	RAL 7032
09.	Painting	:	Epoxy powder coated or better
10.	Gland plates	:	Removable 4 mm thick (bottom)
11.	Cable entry	:	Bottom
12.	Hardware	:	a) Anti vibration pad- 15 mm b) Predrilled base channel ISMC - 100 or equivalent for all sides.

c) Stainless steel buff- finished 2 mm thick kick plate for all sides.

d) Stainless steel scratch strips along desk edges fixed with pan-head recessed screws.

e) Rubber strips to ensure air tightness between kick plate and finished floor.

f) Lifting hook / Eye bolt

g) Drawing pocket

h) Door switch, lamps, thermostat, heaters and fans

13. Enclosure Protection : As per environment condition of the area of installation. Refer section-I of this vol.

5.13.00 Local Instrument Racks & Enclosure

5.13.01 General Requirements

a) Devices located in the field shall be grouped and installed in the enclosure (Open / Closed Rack) in Boiler and TG Building.

b) Racks and enclosure shall be factory prefabricated & painted and shall complete with internal piping, tubing, manifold, isolation valves, blowdown valves, integral junction box, illumination etc.

c) No more than six instruments shall be grouped in a single rack / enclosure.

d) Racks shall be installed above the tapping points for air, flue gas and coal air mixture application whereas for applications such as for water and steam, racks to be installed below the source point.

e) Attention shall be paid in the layout to avoid air traps in liquid piping and water accumulation in air /gas piping.

f) Welding of impulse lines shall comply with the provisions of the latest applicable ANSI Code for Pressure Piping.

g) Instrument piping and tubing shall be hydrostatically tested at one and one-half times the maximum system pressure except for low pressure and vacuum measurement for which the test pressure will be as per piping standard.

h) Service air connection shall be provided for continuous and intermittent purging of impulse pipe in dusty medium. Continuous purging shall be adopted for differential pressure measurement such as flue gas and coal air mixture application. Pressure measurement shall have only intermittent purging whenever required. In case of continuous purging, an air header shall be formed this shall receive service air through isolation valve and air filter regulator. Air shall be fed from the air header to both the impulse pipes near to take off points through isolation valves and flow regulators. Air header shall be constructed from stainless steel. Impulse pipe for such applications shall have a four-way valve. One port of the valve shall have an adaptor to connect flexible stainless steel braided nylon hose to the service air. Rating of the hose shall not be less than 10 Kg/sq.cm.

Four way valve shall have two position operations. One position for service and other one for purging. Required pressure gauges shall be provided for monitoring of air pressure. Complete purging arrangement shall be integral to the enclosure and racks.

i) Gate or ball type (full ported) instrument isolation valve and globe type blow down drain valve adequate for duty requirement and for withstanding continuous design pressure and temperature of main process medium shall be provided in the hook up plumbing. For process pressure equal or above 40 kg / sq.cm single instrument isolation valve and double blowdown valves shall be used before connecting to blowdown header. Whereas for line pressure less than 40 kg/ sq.cm, single instrument isolation valve and single blow down valves can be used before connecting to blow down header. Instrument manifolds shall be non integral and shall be installed close to the instrument.

j) Drawing K9213R-DWG-I-0200 shall be referred for typical arrangement of Local instrument enclosure and rack.

5.13.02 Closed Instrument Rack

a) Enclosure shall be free standing type. Racks shall be adequately reinforced to ensure true surfaces and to provide support. Major load-bearing posts shall be suitably supported by gusset plates or moment members.

b) Enclosure outer shall be constructed from at least 3 mm thick steel plate and epoxy painted to shade gray. Base frame shall be made of ISMC 100 and black colour finish.

c) 2” NB galvanized pipes shall be laid horizontally and supported at two end channels to mount transmitters at accessible height. Center posts or any member, which would reduce access, shall be avoided.

d) Double leaf interlocking front opening doors with three point locking shall be provided and shall be arranged for maximum possible access to the interior. Key shall be of identical for all enclosures.

e) Doors shall have concealed quick removal type pinned stainless steel hinges and locking handles. Gaskets shall be used between all mating sections to achieve dust and weather proof enclosure rated for IP-65 including the internal junction box.

f) Removable type bulkhead plates of thickness not less than 6 mm shall be mounted at the racks with suitable high temperature gasket Impulse lines within the enclosures shall be properly clamped.

g) All internal wirings between the instruments and junction box shall run through flexible conduits.

h) Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Header shall be of 2” NB ASTM A 106, Sch-80 Gr. C installed at a slope of 1:25 and extended beyond the rack for connection to plant drain header.

i) Each rack shall be provided with one receptacle, light fixtures each at instrument & Junction box compartments with wire guard.

5.13.03 Open Instrument Rack

a) Rack shall be free standing type constructed from 6 mm thick steel channel frame provided with a canopy to protect the instrument from dripping water or falling objects and shall be epoxy painted. Rack Major load-bearing posts shall be suitably supported by gusset plates or moment members. Suitable protective grill shall be welded to the end-posts of the rack to outline a boundary beyond which no mounted equipment shall project. Canopy shall be of CRCA steel sheet of at least 3 mm thickness. Center posts or any member, which would reduce access, shall be avoided.

b) 2" NB galvanized pipes laid horizontally and supported at two end channels shall be employed at working accessible height for mounting of instruments.

c) All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings are admissible.

d) All racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Header shall be of 2" NB ASTM A 106, Sch-80 Gr. C installed at a slope of 1:25 and extended beyond the rack for connection to plant drain header.

5.13.04 Junction Box

Junction boxes of FRP construction with protection class conforming to IP 55.

a) Junction box shall be provided at a dry compartment at one side of the enclosure / rack with front opening type door. Earth stud shall be furnished at rack for safety grounding.

b) Terminals shall be screwless cage clamp type of reputed make and 20% spare terminals shall be furnished in the junction box.

6.00.00 DISTRIBUTED CONTROL SYSTEM (DCS)

6.01.00 System Functional Description

6.01.01 Integrated functionally distributed and hierarchically structured real time control (both binary and modulating), Data acquisition, Man machine interface, Historization units and Management Information System (MIS) system synthesized from one general family of identical interchangeable multifunction hardware has been envisaged.

6.01.02 System shall be highly reliable with the availability of not less than 99.7% with adequate redundancy and fault tolerant configuration.

6.01.03 The system shall be unitized and connectivity with other plant control system.

6.01.04 Remote input output stations as a data concentrator for acquisition and monitoring of Boiler metal temperature are foreseen. RIO shall be industrially ruggedized and shall be provided with integral air conditioner considering the harsh environment.

6.01.05 For Power supply to system refer Volume IIE Section I.

6.01.06 Controls of some plant auxiliaries for CW & ACW Pumps and Fuel oil heating & pressurizing system controls shall be realized in DCS through Remote I/O (RIO) cabinets.

6.01.07 Off-site & BOP plants such as Coal Handling Plant, Ash Handling Plant, Raw water & Pretreatment plant, Compressed Air System, Mill Reject System and Demineralized water plant etc. having microprocessor based or PLC based

f) Cards, in a sub rack, shall be uniformly grouped, type-wise and functionality wise.

7.03.02 Termination & Relay Cabinet

a) Incoming cables originating from beyond the control room and control equipment room area shall be routed through the termination cabinets (Optional) (TC) / or system cabinet located in Electronic Equipment Room except for the cases like special cables, network / hiway cables, thermocouple cables where standard termination concepts are not applicable.

b) Termination cabinets shall be free standing, closed type, bottom entry, front and rear accessible cabinets with terminal blocks arranged in vertical rows on side walls and partition walls. Panels shall be provided with internal illumination operated through door switch. Adequate area shall be provided for glanding field cables.

c) In no case the number of terminal blocks accommodated in each section shall exceed 1000. Terminal blocks shall preferably be arranged in four vertical rows in two sidewalls with two sets of cable troughs (one for incoming and one for outgoing) arranged on two sides of the terminal block. At least 20% terminal blocks shall be left as spare. This shall be in addition to the terminal blocks for 20% wired channel.

d) Troughs shall be slotted PVC type. The gland plate shall be removable and shall be in sections. Signals of different voltage levels shall be clearly segregated by providing separate rows to each type of signal and by using terminal blocks of different color for each type of signal and by providing barrier strips between them.

e) Terminal assignment in the termination cabinet will be such that cables originating from a field junction box shall be terminated in one termination cabinet only. This will facilitate use of multi-core cable for field wiring. For each incoming cable an additional terminal block shall be provided adjacent to signal wire termination point for termination and continuation of cable screen.

f) Relay used for interfacing with other system shall be modular, plug in type and provided with snap on transparent cover. Rating shall be of 24V DC and shall have at least 2 changeover contacts. All contacts of the relay shall be terminated in terminal blocks. Each relay shall be provided with “Coil on” indication LED and coil protection diode. At least 10% of installed capacity shall be kept as spares.

g) Panel specification is described elsewhere in this volume.

7.03.03 Printed Circuit Cards

a) Printed Circuit cards shall be suitable for operation at 50 °C (maximum) and 95% RH (non-condensing) ambient condition.

b) Card failure status shall be indicated in the module front panel.

c) Cards/module shall be polarized to eliminate possibility of wrong insertion.

d) Similar and interchangeable cards may be marked similarly.

e) Modules shall be replaceable from front and hot replaceable.

h) High voltage test

Core to core- 1.5 KV for 1 min.

Core to screen- 1.0 KV for 1 min.

i) Rodent & Termite repulsion test
(Presence of lead shall be confirmed)

23. Colour of core for Instrumentation Cable (As per IS-9938)

PAIR	CORE	COLOR
1st	1st	Blue
1st	2nd	Red
2nd	1st	Gray
2nd	2nd	Yellow
3rd	1st	Green
3rd	2nd	Brown
4th	1st	White
4th	2nd	Black

Above 4 Pairs, 4 Pairs making a unit shall have indelible printed colour coded bands like Pink for 1st unit, Orange for 2nd unit and Violet for 3rd unit and so on. In addition band marking, for example single band for 1st. unit, double band for 2nd. unit and so on, shall be provided on each conductor for identification of unit. Band marking on individual core shall be provided at regular intervals not exceeding 50 mm.

9.07.00 Cables near high temperature zone shall be capable of withstanding high temperature and terminated in junction box / panel in normal temperature zone. Teflon insulated and sheathed thermocouple extension cables and copper conductor cables shall be used in high temperature zone. Conductor and sheath shall be extruded FEP (Teflon) as per VDE 0207 Part 6 and ASTMD 2116. These cables shall be pair, multipair, triad, multitriad and twisted & shielded.

9.08.00 Control & power Cable

Bidder shall refer to Volume IIF of the electrical specification for detail.

10.00.00 **ERECTION HARDWARE**

This section provides the general technical guidelines for the erection materials for instruments. All erection materials shall be of good quality and conform to the operating environment of the corresponding instrument.

10.01.00 Electrical Accessories

Electrical conduit and associated materials shall conform to the requirements of the articles which follow :

a) Rigid Steel Conduit

i) Conduits up to and including 25 mm shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 19 mm.

ii) Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushing at both ends.

iii) All rigid conduit couplings and elbows shall be hot dip galvanized rigid mild steel in accordance with ANSI C 80.1 and UL6. The conduit interior and exterior surfaces shall have a continuous zinc coating with an over coat of transparent enamel or zinc chromate. Conduits shall be furnished in standard length of 3 meters, threaded at both ends.

iv) All conduit fittings shall conform to the requirements of ANSI C 80.4 and UL-514 where these standards apply.

b) Flexible Conduit

i) Flexible conduit shall be of three layer construction of very high quality of lead coated steel. Outside and inside layer shall be reinforced with heat resistant material.

ii) Lead coating outside and inside of the conduit steel surface shall provide a non-corrosive characteristic particularly in acidic atmosphere. Besides flexibility, this shall be strong enough to stay at the desired profile without support and shall be durable and strong so as to offer sufficient mechanical protection. It shall also be fully liquid dust and air tight and shall withstand a continuous hydraulic pressure up to 2 Kg/Sq. cm and temperature up to 200 °C.

c) Special Fittings

i) Conduit sealing and fittings shall be provided as required and shall be consistent with the area and equipment with which they are installed.

ii) Double locknuts shall be provided on all conduit terminations not provided with threaded lugs and couplings. Locknuts shall be designed to securely bond the conduit to the enclosure when tightened. Locknuts shall not loosen due to vibration.

10.02.00 Electrical Junction Box

1.	Type of Enclosure	: Dust tight & weatherproof conforming to IP 65
2.	Material	: 3 mm sheet steel
3.	Type of Cover	: Solid unhinged with retention chain
4.	Paint	: RAL 7032
5.	Mounting	: Surface
6.	Cable Entry	: 3 mm (min) Gland plate
7.	Gasket	: Neoprene
8.	Grounding	: Brass earth lug with green screw head External-2 nos , Internal-1no.M6
9.	Number of Drain Holes	: Two at bottom capped
10.	Identification	: Label for JB and Tags for cable

11.	Accessories	: Rail mounted cage clamp type screwless terminals with markers, Cable gland, Ferrules, Canopy at top

10.03.00 Cable Gland

1.	Type	: Double compression
2.	Entry Thread	: NPT
3.	Material	: Brass
4.	Finish	: Cadmium Plated.
5.	Protection	: IP 54 or better
6.	Accessories	: Neoprene gasket, locknuts, reducers etc

10.04.00 Cable Tray

1. Material : Mild steel, slotted
2. Thickness : not less than 2.0 mm
3. Finish : Hot dip galvanized
4. Perforation : As per MFR standard
5. Cover : Suitable for tray

10.05.00 Process Hook Up Accessories & specification

Material and rating of the hook up items shall suit the piping and fluid condition. Hook up materials shall be IBR certified for applicable cases. Bidder shall furnish hook up drawings and the drawings for open racks & closed racks for owner's approval.

10.05.01 Seamless Stainless Steel Pipe

1. Reference : ASTM A-312 TP 316
2. Material Grade : TP 316
3. Type : Seamless /Plain end
4. Size : ½" NB
5. Schedule : 40
6. Standard Length : 5 meter

10.05.02 Stainless Steel Pipe Fittings

1. Reference : ASTM A-182 F 316 / ANSI B16.11

	2.	Type	: Forged
	3.	Rating	: 3000 lbs / 6000 lbs / 9000 lbs
	4.	Size	: ½" NB
	5.	End connection	Generally socket weld
	6.	Type of Fittings	: Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

10.05.03 Seamless Stainless Steel Tube

	1.	Reference	: ASTM A-213 TP 316
	2.	Material Grade	: TP 316
	3.	Size	: ½" OD X 2.1 MM Thick
	4.	Type	: Cold drawn annealed, pickled, passivated, de-scaled,hydraulically cleaned seamless tube.
	5.	Properties	: The tube shall be free from scratches and suitable for bending and capable of being flared by hardened and tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80.
	6.	Test Pressure	: 400 Kg/Sq. cm (minimum)
	7.	Tolerance	: ± 0.13 mm for outside diameter
			: ± 15 % for wall thickness
	8.	Standard Length	: 5 meter
	9.	Test	: Flare, Hardness, Ball and Bubble Test

10.05.04 Stainless Steel Tube Fittings

	1.	Reference	: ASTM-A-182
	2.	Type	: Double ferrule double compression
	3.	Material	: 316 Stainless steel forged
	4.	Ferrule	: 316 Stainless Steel
	5.	Type of Fittings	: Male / female connector, elbow, cross /equal tee, straight connector, bulkhead union, ferrule etc. as required to suit installation.
	6.	Size	: To suit SS tubing and NPT end connection

10.05.05 C.S. Pipe

1.	Reference	: ASTM-A 106 Gr. C
2.	Material	: Cold drawn seamless black C.S.
3.	Type	: Seamless / Plain ends
4.	Size	: ½" NB
5.	Schedule	: 80, 160, XXS as required
6.	Standard Length	: 5 meter

10.05.06 C.S. Pipe Fittings

1.	Reference	: ASTM-A 105 / ANSI B16.11
2.	Type	: Forged
3.	Rating	: 3000 lbs / 6000 lbs / 9000 lbs
4.	Size	: ½" NB
5.	End connection	: Generally socket weld
6.	Type of Fittings	: Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

10.05.07 A.S. Pipe

1.	Reference	: ASTM-A 335 P22 AS PER ANSI B 36.10
2.	Material	: Cold drawn seamless A.S.
3.	Type	: Seamless / Plain ends
4.	Size	: ½" NB
5.	Schedule	: XXS
6.	Standard Length	: 5 meter

10.05.08 A.S. Pipe Fittings

1.	Reference	: ASTM-A 182 F22 AS PER ANSI B 16.11
2.	Type	: Forged
3.	Rating	: 9000 lbs
4.	Size	: ½" NB
5.	End connection	: Generally socket weld

	6.	Type of Fittings	: Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

10.05.09 Carbon Steel Globe Valve

	1.	Reference	: ASTM A-105
	2.	Type	: Globe
	3.	Construction	: Forged Body Cadmium Plated
	4.	End Connection	: ½" Socket Weld
	5.	Rating	: Cl. 800 / CL. 2500
	6.	Material	: Body - Carbon steel
			: Stem - Hardened Steel
			: Plug - AISI 316 SS
			: Seat- Stainless steel stellited
	7.	Packing	: Teflon / Grafoil as required
	8.	Yoke	: ASTM A105
	9.	Hand wheel	: Carbon steel
	10.	Design standard	: As per ANSI B 16.34

10.05.10 Stainless Steel Globe Valve

	1.	Reference	: ASTM A-182 F316
	2.	Type	: Globe
	3.	Construction	: Forged Body
	4.	End Connection	: Socket Weld
	5.	Proof Pressure	: 400 Kg/Cm2
	6.	Material	: Body - Stainless steel
			: Stem - Hardened Steel
			: Plug - AISI 316 SS
			: Seat- Stainless steel stellited
	7.	Packing	: Teflon as required
	8.	Yoke	: ASTM A182 F316

	9.	Handwheel	: Carbon steel
	10.	Design standard	: As per ANSI B 16.34

10.05.11 Alloy Steel Globe Valve

	1.	Reference	: ASTM A-182 F22
	2.	Type	: Globe
	3.	Construction	: Forged Body
	4.	End Connection	: ½" Socket Weld
	5.	Rating	: CL. 2500
	6.	Material	: Body - Alloy steel
			: Stem - Hardened Steel
			: Plug - AISI 316 SS
			: Seat- Stainless steel stellited
	7.	Packing	: Grafoil as required
	8.	Yoke	: ASTM A182 F22
	9.	Handwheel	: Carbon steel
	10.	Design standard	: As per ANSI B 16.34

10.05.12 Condensate Pot

	1.	Reference	: ASTM A182 F22 /ASTM A105
	2.	Material	: Alloy steel / carbon steel as per application
	3.	Construction	: Drilled from barstock
	4.	End connection	: 3 nos. ½" socket weld end
	5.	Accessories	: Vent valves

10.05.13 Instrument Valve Manifold

	1.	Type	: Two valve manifold
			: Five valve manifold
	2.	Mounting	: Remote 2" Pipe Mounting
	3.	Construction	: Single block (bar stock)
	4.	Material	: Forged body and bonnet AISI 316 stainless

steel

5.	Ports	: 1/2 " NPT (F)
6.	Rating	: 420 Kg/Sq. cm at ambient
7.	Operating Temperature	: (-)30 to (+)170 Deg C
8.	Packing	: PTFE Wafer
9.	Seat & Stem	: AISI 316 SS
10.	Plug	: AISI 316 SS free to turn on stem / 17-4 PH
11.	Handle Bar	: AISI 316 SS
12.	Connection	: Straight
13.	Accessories	: Plugs for all ports, Mounting Bracket , bolts , nuts

10.06.00 Pneumatic Hook Up Accessories

10.06.01 Air Header

Technical Particulars	**For Panel**	**For Field**
Material of Construction	: Stainless steel	: Stainless steel
Inlet Connection	: 2" NPT (M)	: 1" NPT (M)
Header Take-off Material	: ainless steel	: tainless steel
Take off connection	: 1 / 2” NPT (M)	: 1/ 2” NPT (M)
Take-off Valves Material	: stainless steel	: stainless steel
Tube Take-off	: Tube adapter on valve	: Tube adapter on valve
Drain	: SS drain valve at lowest point	: SS drain valves at lowest point

10.06.02 Seamless Stainless Steel Tube

1.	Reference	: ASTM A-269 TP 316
2.	Material Grade	: TP 316
3.	Size	: ¼” OD X 0.049” wall thickness

4.	Type	: Cold drawn annealed, pickled, passivated, de-scaled,hydraulically cleaned seamless tube.
5.	Properties	: The tube shall be free from scratches and suitable for bending and capable of being flared by hardened and tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80.
6.	Test Pressure	: 400 Kg/Sq. cm
7.	Tolerance	: ± 0.13 mm for outside diameter
		: ± 15 % for wall thickness
8.	Standard Length	: 5 meter
9.	Test	: Flare, Hardness, Ball and Bubble Test

11.00.00 **SPECIAL TOOLS & TACKLE AND TEST EQUIPMENT FOR AND OTHER SYSTEMS**

11.01.00 Bidder shall supply a complete set of new, unused and reliable type of special tools and tackle and test equipment which are necessary or convenient for erection, commissioning, maintenance and overhaul of the plant and equipment provided under this specification.

11.02.00 The tools & tackle and Test Equipment shall be shipped in separate container, clearly marked with names of the equipment for which they are intended.

11.03.00 Bidder shall furnish list of tools & tackle and test equipment proposed to be supplied along with the bid.

TYPICAL INSTRUMENT INSTALLATION DIAGRAM

PRELIMINARY
TENDER PURPOSE ONLY

GP	AT	SD		0	21.04.10
APPROVED	CHECKED	DRAWN	DESCRIPTION	REV.	DATE

TYPICAL INSTRUMENT INSTALLATION DIAGRAM

1x800MW SUPER CRITICAL THERMAL POWER PROJECT
(UNIT #8 AT WANAKBORI THERMAL POWER STATION, GUJARAT)

GUJARAT STATE ELECTRICITY CORPORATION LIMITED
VADODARA, GUJARAT

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA · MUMBAI · CHENNAI · NEW DELHI

JOB NO. DCPL–K9213R | SCALE NIL | SHT. 1 OF 20

DWG. NO. K9213R–DWG–I–0060 | REV. 0

K9213-DWG-I-0060-1-20-REV-0

A4_H (08–'06) [297 x 210]

NOTES :

1..PROVISION OF SINGLE OR DOUBLE ROOT VALVE AND DRAIN VALVE SHALL BE IN ACCORDANCE WITH THE PRESSURE/TEMPERATURE REQUIREMENT. FOR LINE PRESSURE EQUAL TO OR GREATER THAN 40 KG/SQ.CM 2 NOS ROOT VALVE AND 2 NOS DRAIN VALVE SHALL BE REQUIRED.

2..MATERIAL, SIZE AND RATING OF THE PROCESS HOOK UP ITEMS SHOWN IN THE DRAWING ARE INDICATIVE ONLY. ACTUAL REQUIREMENT SHALL BE AS PER PROCESS CONDITION & SPECIFICATION VOL.II–E.

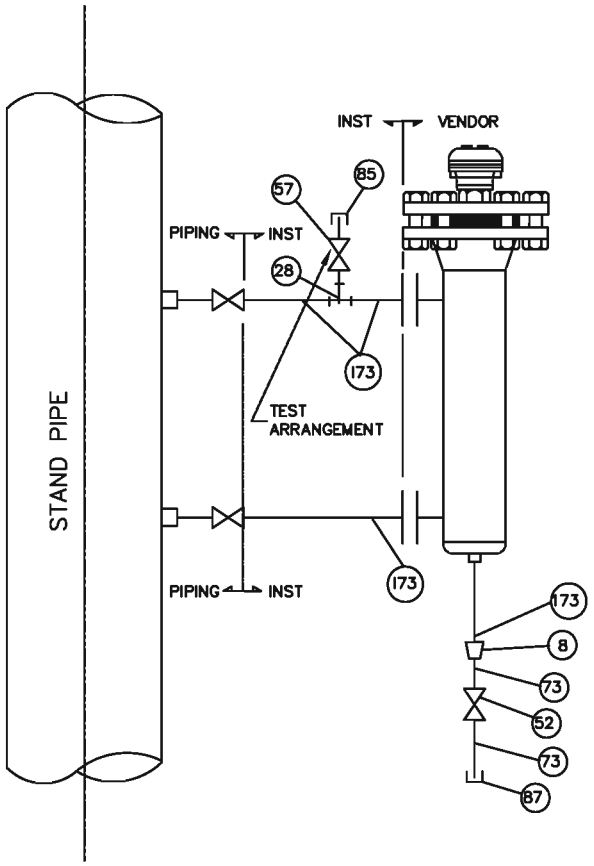
3..DRAIN PIPE IN RACK AND ENCLOSURE SHALL BE 2" NB SCH 80.

PRELIMINARY
TENDER PURPOSE ONLY

						TYPICAL INSTRUMENT INSTALLATION DIAGRAM	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA · MUMBAI · CHENNAI · NEW DELHI
						1x800MW SUPER CRITICAL THERMAL POWER PROJECT (UNIT #8 AT WANAKBORI THERMAL POWER STATION, GUJARAT)	JOB NO. DCPL–K9213R SCALE NIL SHT. 2 OF 20
GP	AT	SD		0	21.04.10	GUJARAT STATE ELECTRICITY CORPORATION LIMITED VADODARA, GUJARAT	DWG. NO. K9213R–DWG–I–0060 REV. 0
APPROVED	CHECKED	DRAWN	DESCRIPTION	REV.	DATE		

K9213-DWG-I-0060-2-20-REV-0

FLOAT OPERATED LEVEL SWITCH



BILL OF MATERIALS		
ITEM NO	QTY/ INST	DESCRIPTION
52	1	GLOBE VALVE 1/2" SW 600lbs
73	0.5Mtrs	IMPULSE PIPE 15 NB SCH.80
87	1	PULG 1/2" NPT(M) 3000lbs
28	2	EQUAL TEE (FEMALE) 1" SW 3000lbs
173	1 Mtrs	IMPULSE PIPE 25 NB SCH.80
8	1	REDUCER 1" SW X 1/2" SW 3000lbs
57	1	GLOBE VALVE 1" SW 600 lbs
85	1	PLUG 1" NPT(F) 3000 lbs

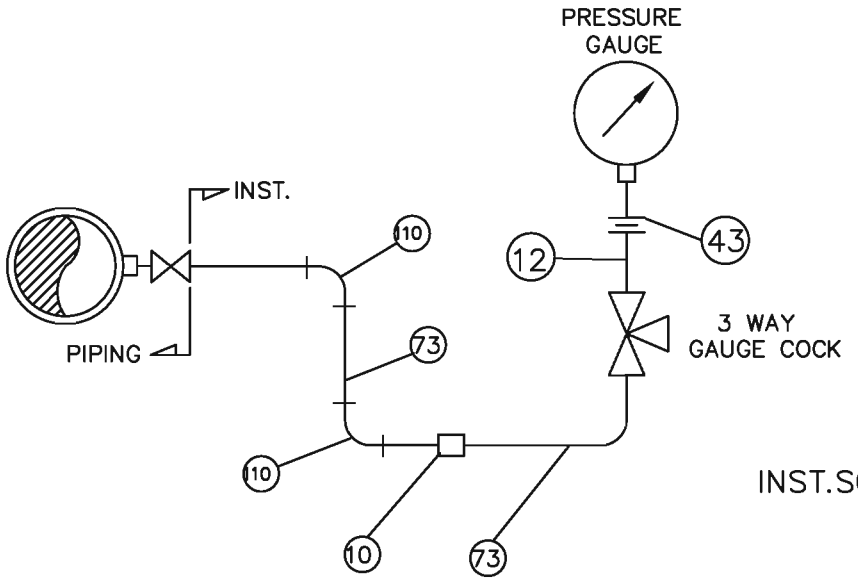
SERVICE : CONDENSATE

PRELIMINARY
TENDER PURPOSE ONLY

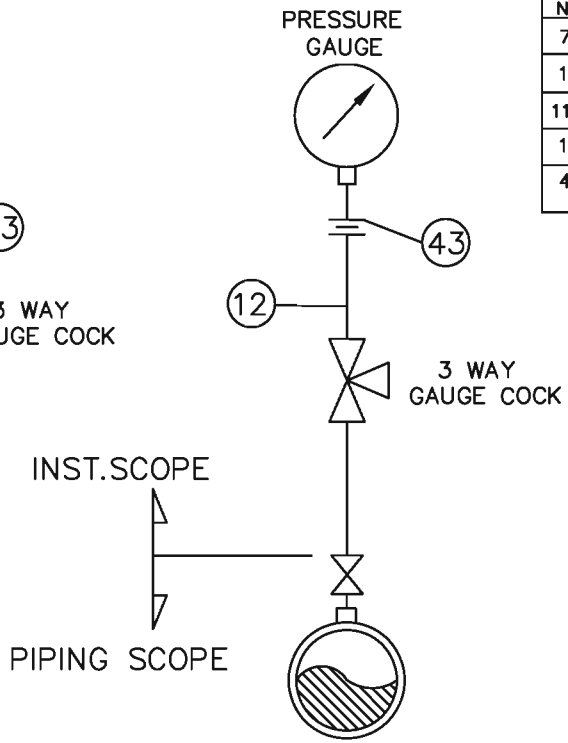
						TYPICAL INSTRUMENT INSTALLATION DIAGRAM	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA · MUMBAI · CHENNAI · NEW DELHI
						1x800MW SUPER CRITICAL THERMAL POWER PROJECT (UNIT #8 AT WANAKBORI THERMAL POWER STATION, GUJARAT)	JOB NO. DCPL-K9213R SCALE NIL SHT. 10 OF 20
GP	AT	SD		0	21.04.10	GUJARAT STATE ELECTRICITY CORPORATION LIMITED VADODARA, GUJARAT	DWG. NO. K9213R-DWG-I-0060 REV. 0
APPROVED	CHECKED	DRAWN	DESCRIPTION	REV.	DATE		

A4_H (08-'06) [297 x 210]

K9213-DWG-I-0060-10-20-REV-0



REMOTE MOUNTING



ON TAP MOUNTING

BILL OF MATERIAL		
ITEM NO.	QTY./ INST	DESCRIPTION
73	15Mtrs	IMPULSE PIPE 15 NB SCH.80
10	1	FULL COUPLING 1/2" SW 3000lbs
110	2	90° ELBOW 1/2" SW 3000lbs
12	1	1/2" NPT(M) X 1/2" PE 4" LONG NIPPLE
43	1	NUT & TAIL FITTING WITH CU WASHER 1/2" NPT(F) X 1/2" PE

SERVICE : WATER, CONDENSATE ETC.

PRELIMINARY
TENDER PURPOSE ONLY

GP	AT	SD		0	21.04.10
APPROVED	CHECKED	DRAWN	DESCRIPTION	REV.	DATE

TYPICAL INSTRUMENT INSTALLATION DIAGRAM

1x800MW SUPER CRITICAL THERMAL POWER PROJECT
(UNIT #8 AT WANAKBORI THERMAL POWER STATION, GUJARAT)

GUJARAT STATE ELECTRICITY CORPORATION LIMITED
VADODARA, GUJARAT

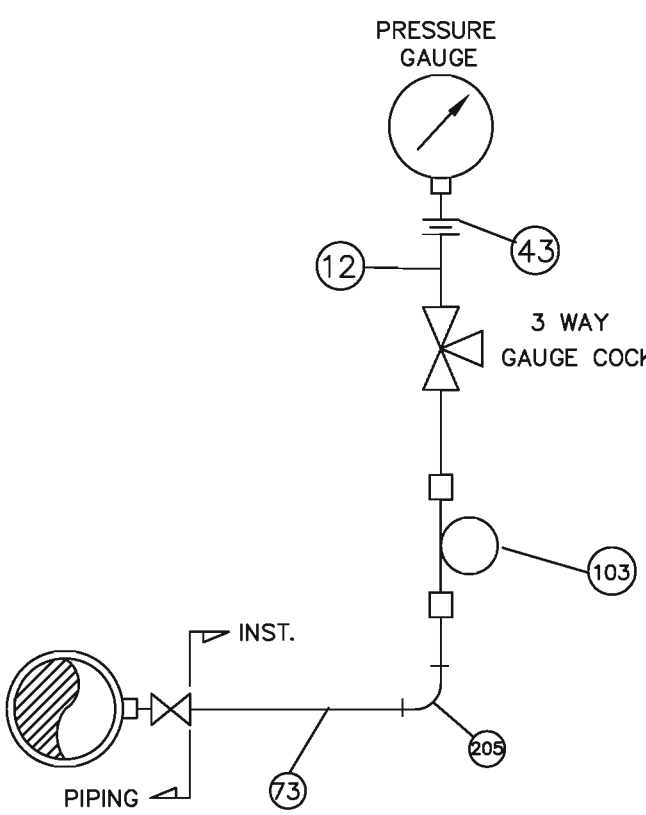
DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA · MUMBAI · CHENNAI · NEW DELHI

JOB NO. DCPL–K9213R | SCALE NIL | SHT. 11 OF 20

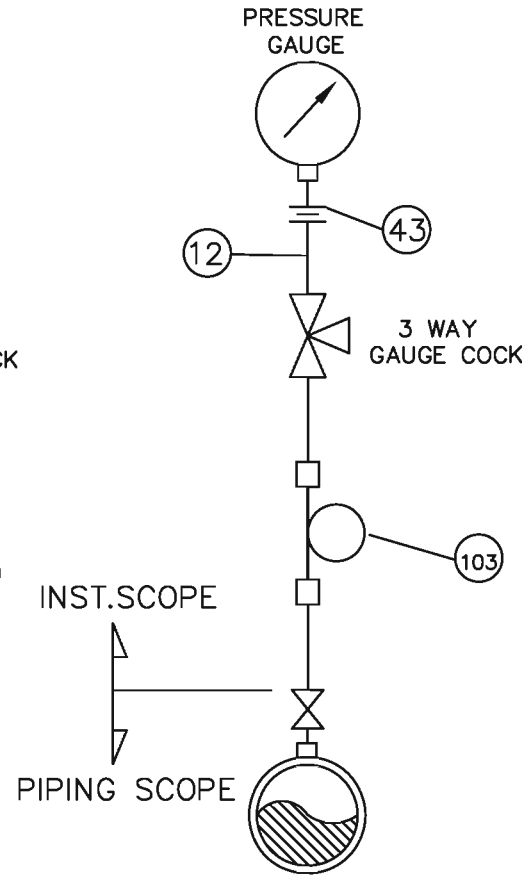
DWG. NO. K9213R–DWG–I–0060 | REV. 0

A4_H (08–'06) [297 x 210]

K9213-DWG-I-0060-11-20-REV-0



REMOTE MOUNTING



ON TAP MOUNTING

BILL OF MATERIAL		
ITEM NO.	QTY./ INST	DESCRIPTION
73	15Mtrs	IMPULSE PIPE 15 NB SCH.80
205	2	90° ELBOW 1/2" SW 6000lbs
12	1	1/2" NPT(M) X 1/2" PE 4" LONG NIPPLE
43	1	NUT & TAIL FITTING WITH SS WASHER 1/2"NPT(F) X 1/2" PE
103	1	SYPHON 1/2" OD SCH.80

SERVICE : STEAM, FEED WATER

PRELIMINARY
TENDER PURPOSE ONLY

GP	AT	SD		0	21.04.10
APPROVED	CHECKED	DRAWN	DESCRIPTION	REV.	DATE

TYPICAL INSTRUMENT INSTALLATION DIAGRAM

1x800MW SUPER CRITICAL THERMAL POWER PROJECT (UNIT #8 AT WANAKBORI THERMAL POWER STATION, GUJARAT)

GUJARAT STATE ELECTRICITY CORPORATION LIMITED VADODARA, GUJARAT

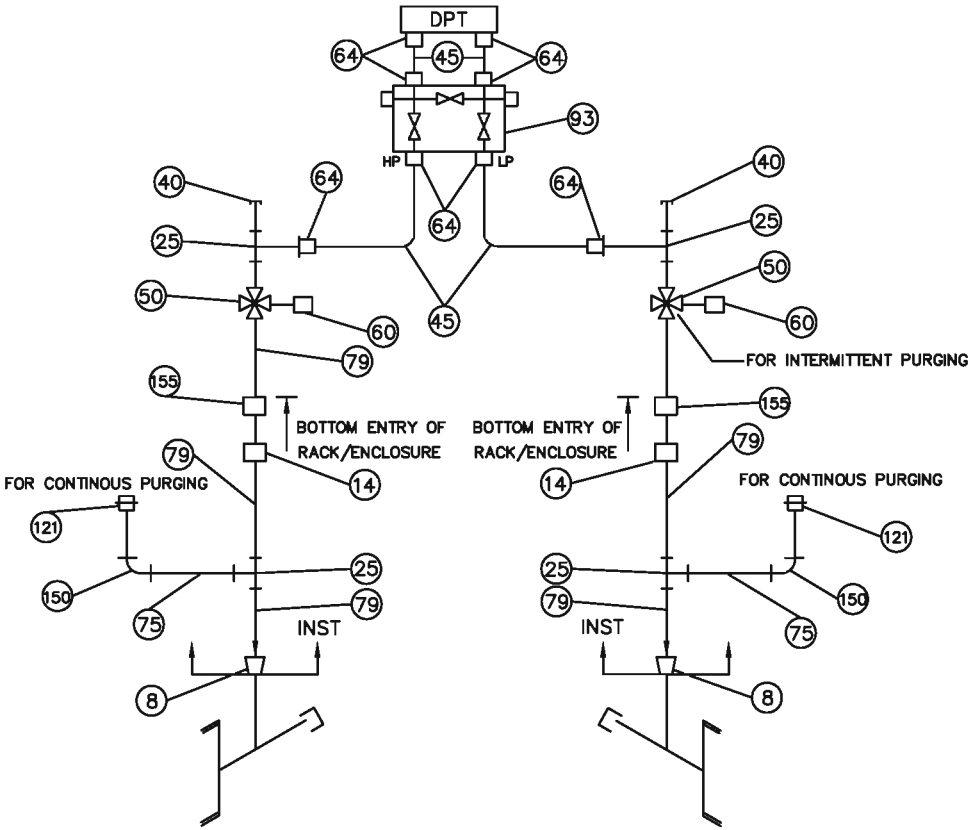
DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA · MUMBAI · CHENNAI · NEW DELHI

JOB NO. DCPL–K9213R | SCALE NIL | SHT. 12 OF 20

DWG. NO. K9213R–DWG–I–0060 | REV. 0

K9213-DWG-I-0060-12-20-REV-0

A4_H (08–'06) [297 x 210]



BILL OF MATERIAL		
ITEM NO.	QTY./ INST	DESCRIPTION
8	2	REDUCER 1" BSPF X 3/4" NB–SW CL 3000
14	2	FORGED COUPLING 3/4" SW CL 3000/AS PER ANSI B16.11
25	4	FORGED UNEQUAL TEE AS PER ANSI B16.11 SIZE : 2 X 3/4" NB–SW X 1/2" NPTF/CL3000
40	2	NIPPLE & CAP 3/4" NB–SCH 80/CAP–3/4" NPTF
45	6 Mtrs.	SEAMLESS TUBE 1/2" OD X 2.1 MM THK.
50	2	FOUR WAY VALVE SIZE :(2 X 3/4" NB–SW)X(2 X 1/2"NPTF) CL:800
60	2	QUICK DISCONNECTING FITTING SIZE:1/2"NPTM
64	8	MALE CONNECTOR 1/2" NPT(M) X TO SUIT 1/2" OD TUBE
79	30Mtrs	SEAMLESS PIPE/3/4" NB SCH 80
75	A/R	PIPE AS PER IS–1239 SIZE :1/2" NB–HEAVY GRADE
93	1	3 VALVE MANIFOLD 1/2" NPT(F)
150	2	GALVANISED ELBOW CL 3000 SIZE :1/2" NPTF
155	2	BULK HEAD COUPLING CL 3000 SIZE :3/4" NB SW /CL 3000/AS PER ANSI B16.11
121	2	BULK HEAD COUPLING CL 3000 SIZE :1/2" NPTF /AS PER ANSI B16.11

SERVICE : FLUE GAS, FURNACE ETC.

PRELIMINARY
TENDER PURPOSE ONLY

GP	AT	SD		0	21.04.10
APPROVED	CHECKED	DRAWN	DESCRIPTION	REV.	DATE

TYPICAL INSTRUMENT INSTALLATION DIAGRAM

1x800MW SUPER CRITICAL THERMAL POWER PROJECT
(UNIT #8 AT WANAKBORI THERMAL POWER STATION, GUJARAT)

GUJARAT STATE ELECTRICITY CORPORATION LIMITED
VADODARA, GUJARAT

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA · MUMBAI · CHENNAI · NEW DELHI

JOB NO. DCPL–K9213R | SCALE NIL | SHT. 17 OF 20

DWG. NO. K9213R–DWG–I–0060 | REV. 0

K9213-DWG-I-0060-17-20-REV-0

A4_H (08–'06) [297 x 210]

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	DIAL SIZE						
	MODEL NO./TAG NO./TYPE						
	RANGE/SCALE						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	HYSTERESIS						
3	OVER TEMP. TEST			P	W	V	
4	AMBIENT TEMP. COMPENSATION CHECK	1 OF TYPE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	THERMOWELL						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	THERMOWELL	SEE NOTE-1 BELOW	AS PER APPD DWG		V	V	
	MATERIAL TC & DIMN. CHECK						
	HYD.TEST						
	OVER RANGE TEST						

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. IBR certificate to be provided if called for in specn.
5. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE & DP GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	SENSOR TYPE						
	DIAL SIZE						
	MODEL NO/TAG NO						
	RANGE/SCALE						
	SWITCH CONTACT RATING & NOS.						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	SET POINT ADJUSTMENT						
3	OVER PRESSURE & LEAK TEST			P	W	V	
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE		P	W	V	
5	REVIEW OF TC FOR	FOR LOT		V	V	V	
	MATERIALS OF SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. When material corelation is not available, MFR's compliance to be provided
5. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR FLOAT OPERATED LEVEL SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	MODEL NO/TAG NO						
	TYPE						
	END CONNECTION						
2	ON/OFF DIFFL			P	W	V	
3	REPEATABILITY			P	W	V	
4	IR TEST			P	W	V	
5	HV TEST			P	V	V	
6	PR. TEST ON CHAMBER	SEE NOTE-5		P	V	V	
7	MATL. TC FOR CHAMBER & FLOAT	FOR LOT	---	V	V	V	
8	CONTACT CONFIG. & RATING FOR MICROSWITCH	FOR LOT	---	V	V	V	
9	TC FOR DEGREE OF PROTECTION	TYPE TEST	---	V	V	V	
10	MANUFACTURER TO ENSURE WELDING PROCEDURE,WELDERS & NDT AS PER ASME FOR PR >40 KG/CM2		---	P	V	V	
11	CHECK FOR TEMP. SUITABILITY FOR MICROSWITCH AND LEAD WIRE	SEE NOTE-1 BELOW	---	V	V	V	
12	ACCESSORIES AS APPLICABLE		APPROVED SPEC./ DATA SHEETS	V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. When material corelation is not available, MFR's compliance to be provided
5. IBR certificates shall be provided wherever required.
6. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

SUMP PUMP

CONTROL & INSTRUMENTATION FOR SUMP PUMP SYSTEM

Introduction-

Sump pumps are used to dewater various sump pits to nearest surface drain in the power house and other plant areas to ensure general housekeeping.
The system shall normally have 2 pumps. The measuring instruments recommended are level switches(float/displacer type) for level measurement and control of the system and pressure gauges at pump discharge for local pressure measurement. Any other instruments can be included dependent on the requirement or if demanded by the customer.
The sump pumps can be fixed submersible type where the pumps are fixed and submerged or can be portable submersible type where the pumps are trolley based and can be moved as per the need. In fixed type the level switches can be mounted at a suitable mounting place while in portable type the level switches are ported to the sump along with the pumps. The mounting of switches and location of LCP shall be chosen so as to have minimum cable length between the level switches and the LCP.

CONTROL WRITEUP
The operation of Sump pumps(fixed and portable type) shall be as follows:
Sump Pumps shall be controlled through a starter cum control panel. The local control panel shall be front opening, relay based. The starter cum control panel shall be suitable for indoor or outdoor as per the location of the sump pumps. Normally one pump will be running and the other shall be on auto standby. The following controls/interlocks shall be provided in the local control panel.
Controls philosophy

CONTROLS
(a) Start/stop facility for each pump from LCP.
(b) Selector switch for main/standby selection.
(c) Auto/Manual selector switch for each pump.
AUTO START/STOP
a) One number level switch (high level) provided in the sump shall start one number sump pump in the event of high water level in the sump.

b) One number level switch (very high level) provided in the sump shall start second sump pump in the event of very high water level in the sump.

c) One number level switch (low level) provided in the sump shall stop the running pumps in the event of low water level in the sump.

d) If any of the working sump pumps trips the standby sump pump will come into operation automatically provided the very low level signal is not present.
Indications
a) Sump pumps status (ON/Off/Trip).
b) Level indications(Low,High,V.High)

General requirements for measuring instruments

Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experience manufacturers (from BHEL/customer approved vendor list) of specified type and range of equipment.. Further, all instruments shall be of proven reliability,accuracy, repeatability requiring a minimum of maintenance. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications,ranges, makes/ numbers as approved by BHEL during detailed engineering.

1. Every panel-mounted instrument, requiring power supply, shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a ground terminal and shall be suitably connected to panel grounding bus.

2. The necessary root valves, impulse pipings and all the other accessories required for mounting/erection of local instruments shall be furnished even if not specifically asked for.

3. Instruments shall be terminated up to LCP with control cable (1.5sqmm). The LCP shall be fully wired. All the necessary cables, flexible conduits, junction boxes and accessories for the above purpose shall be included.

LOCAL PANEL

	SPECIFICATION FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS –999- 145 –054A	
		VOLUME II B	
		SECTION D	
		REV. NO. 03	DATE : 16-09-2013
		SHEET 1 OF 6	

1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site, supervision, erection, and commissioning at site of Local Panels required for control and monitoring of the Auxiliary Plant & Equipment.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 As a minimum requirement, the following standards shall be complied with:

a)	IS-6005 : 1998	:	Code of practice for phosphating of iron and steel.
b)	IS-5 : 2007	:	Colors for ready mixed paints and enamels.
c)	IS-1248:2003	:	Direct Acting Indicating Analog Elec Measuring Instruments.
d)	IS/IEC 60947:Part 1:2004	:	Low Voltage switchgear & control gear: Part-I (General Rules)
e)	IS-8828:1996	:	Circuit breaker for household and similar installations.
f)	IS-13947 (Part-I):1993	:	Low Voltage switchgear & control gear : Part-I (General Rules)
g)	ISA-18.1:1979	:	Annunciator Sequences and Specification
h)	NFPA-496:2003	:	Purged & Pressurised Enclosure for Electrical Equipment in Hazardous Locations.

3.0 TECHNICAL REQUIREMENTS

3.1 Panel Construction

3.1.1 The local panels shall house the secondary instruments, annunciation system, Single loop controller, Control switches / push buttons, indicating lamps/LED cluster, relays, timers and other devices required for operation and monitoring of the equipment locally.

3.1.2 The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure or folded construction by sheet metal formation depending upon the equipments to be mounted on it. The panels shall be robustly built and stiffeners as necessary shall be provided.

3.1.3 The panel shall be suitably reinforced to ensure adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth.

3.1.4 The salient features of construction shall be:

Sheet material: Cold rolled sheet steel
Frame thickness: Not less than 3.0mm
Enclosure thickness: Not less than 3.0 mm for load bearing sections (Mounted with instruments) 2.0 mm for doors and Not less than 2.0 mm for others
Panel Height: Not less than 2365 mm (Refer data sheet-A (No. PES-145A-DS1-0)
Gland plate thickness: 3.0mm
Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.1.5 The panel shall be provided with rear doors with integral lockable handle. The door when locked shall be held at minimum three places. The door width shall not be more than 550mm.The doors shall be provided with suitable stiffeners to prevent buckling. The handle shall be on the right side of the door. The door shall be removable type with concealed hinges to facilitate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings / documents. Double door shall be provided with suitable glass windows, as per the requirement.

3.1.6 Suitable neoprene gasket shall be provided on all doors and removable covers. Suitable ventilation system along with louvers shall be provided at bottom and top of the doors covered with removable wire mesh.

3.1.7 The class of protection shall be in accordance with IP-55 unless otherwise specified in the data sheet – A (No. PES-145-54A-DS1-0).

3.1.8 All steel surfaces shall be cleaned by sand / pellet blasting, treated for pickling, degreasing and phosphating etc. by seven tank method. The panel shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy / synthetic enamel based final paint of color shade and finish as given in data sheet-A (No. PES-145A-DS1-0). Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.

3.1.9 The cable glands of the required size and type as given in data sheet-A (No. PES-145A-DS1-0) shall be supplied alongwith the Panel.

3.1.10 All operable and indicating devices shall be mounted on the front of the panel while aux. Relays / timers MCBs etc. required for realization of control logics shall be mounted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function.

No operable or indicating devices shall be mounted below 750 mm and above 1800 mm (w.r.t. finished ground level). The devices shall be located in such a way so as to ensure easy access for operation / maintenance.

3.1.11 Single / dual control power supply feeders of voltage class as specified in data sheet-A (No. PES-145A-DS1-0) shall be provided by the purchaser. In case redundant power supply feeders are provided then auto changeover unit shall be mounted on the panel are in the panel supplier's scope. Where DC control power supply is specified an additional 240V, 50 Hz AC supply feeder for powering of space heater and lighting shall be provided by the purchaser. Suitable arrangement shall be provided inside the panel to receive and terminate the power supply feeder(s). For this purpose MCBs of suitable current rating shall be provided by the vendor. A supervisory relay along with a pilot lamp to indicate control supply 'ON' shall be provided on the panel. Any other power supply required for the operation of the devices mounted in the panel shall be arranged by the vendor.

3.1.12 The internal wiring shall be carried out with 1100 volt grade PVC insulated copper multi strand wire / flexible of 1.5mm2 size. AC & DC wires shall be kept separate from each other. Separate coloured wires to be used for AC and DC circuits. All wires shall be properly numbered and identified with ferrules as per the Control scheme / wiring diagram. Wires shall be routed and run through PVC troughs.

3.1.13 Terminal blocks shall be clip on type, 1100 volts grade. Separate terminal blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm2 to 2.5mm2 external cables. The TB points in terminal block shall be cage clamp type / screw type. The terminal for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The terminal shall not be mounted below 250 mm height from finished floor. The panel shall have ten (20) percent spare terminal.

3.1.14 The interior of each panel shall be suitably illuminated through fluorescent lamps / tube lights with shrouded cover of minimum 15W operable on 240V 50 Hz AC power supply through panel door switch. A 15 Amp. 3-pin Power receptacle shall be provided.

3.1.15 Suitable space heaters operable on 240 Volts 50 Hz AC power system shall be provided at the panel bottom. These shall be designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and control devices comprising of MCB, thermostat etc. shall be provided for the space heater.

3.1.16 The panel shall be provided with a copper earth bus of 25 x 6 mm size running throughout the width of the panel. It shall be terminated internally with 10 mm bolts at extreme ends for connection to; main station earth. The panel mounted equipments / devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm2 size.

3.1.17 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 20 mm height. The individual devices on the panels shall be as provided with separate name plate with inscription of 3 mm height. The instrument / devices shall be provided with stick on label plates inside the panel. The material of the main and individual labels shall be three (3) ply 3 mm thick Traffolyte

Sheet / 2 mm Anodised Aluminium Plate. The inscription shall be with white letters on black background on traffolyte sheet. The labels shall be fixed by self tapping non-rusting screws.

3.1.18 Vendor shall furnish electric load and heat load list (in case panel is to be placed in ac environment) of each panel.

3.2 Hazardous Area Panel Requirement

3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-496 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurisation falls below 2.5 mm of water column. Protection shall be of type Z of NFPA-496. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-496. Vendor must provide a protective device on the panel to protect the panel from over pressurisation.

3.2.2 Vendor shall supply pressurisation kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rotameter etc. Pressurisation kit shall be surface mounting on a metal board and located outside the local panel. Pressurisation kit shall further consist of solenoid valve flow switch, timer blow off safety device etc., so as to make purging fully automatic. However final start shall be manual. Panel protection against over pressure to be provided as per NFPA-496.

3.2.3 Pressurised local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-496.

3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc., which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.

3.2.5 All push buttons etc. requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurisation bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painted metallic parts shall be of stainless steel material.

3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits / components which are powered from motor control centre or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).

3.3 Control & Monitoring devices

3.3.1 Instruments like Indicators, recorders, single loop controllers etc. as applicable and specified elsewhere for the plant / equipment shall be supplied and mounted on the panel.

3.3.2 Alarm Annunciator System

It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) percent spare windows or minimum two (2) windows along with electronics.

3.3.3 Relays

The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.

3.3.4 Timers

The timers shall be electronic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However, minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable.

3.3.5 Control / Selector Switches

Switches shall be Rotary Cam type with minimum of 5 Amps AC & 2 Amp DC continuous current rating. Selector switches shall be stay put type while control switches shall be spring-return-to-neutral type. Contact configuration and rating shall be as per the control function requirement. The switches shall be lockable type wherever specified. Each switch shall be provided with engraved plates indicating the switch position / functions.

3.3.6 Push Buttons / Indicating Lights

The push buttons shall be momentary action self-resetting type, however stop P.B. for unidirectional drives shall be provided with manual reset facility. Its contact configuration & rating shall be as required for the control function but minimum 2 NO + 2 NC of 5 Amp. AC rating. It shall have round coloured projecting tab and engraved escutcheon plate / inscription plate. Colour coding of push buttons shall be as under:

RED	Motor OFF / Valve CLOSE	YELLOW	Alarm acknowledge	Left Hand Side
GREEN	Motor ON / Valve OPEN	BLACK	Lamp test	Right Hand Side

Indicating lights shall be suitable for direct connections across specified power supplies. It shall be fitted with built in resistance to prevent circuit tripping on shorting of lamp filament. It shall be fitted with LED cluster type lamp replaceable from front.

GREEN	Motor OFF / Valve CLOSED condition	AMBER	Motor tripped	Left Hand Side
RED	Motor ON / Valve OPEN condition	WHITE	Normal / healthy	Right Hand Side

3.3.7 Ammeters

Ammeter shall be 96 x 96 mm size, 90 deg. deflection, 1.5% accuracy, 1 Amp. CT operated or with 4-20mA input and Flush mounting type as called for in the data sheet-A (No. PES-145-54A-DS1-0). Ammeters for motors shall have six (6) times folded scale at upper end to enable motor starting current indication

3.3.8 Miniature Circuit Breaker (MCB)

These shall be instantaneous magnetic trip type for short circuit in addition to current time inverse delayed thermal trip feature for over current protection. The housing of MCB shall be made of non-ignitable, high impact material. It shall have minimum short circuit rating of 9 KA for AC Voltages and 4 KA for DC Voltages.

3.3.9 Makes of various instruments / devices shall be as given below

1.	Alarm Annunciators	:	Procon / IIC
2.	Ammeters	:	AEP / IMP
3.	Control / Selector Switches	:	Alsthom / Kaycee / Siemens / L&T
4.	Push Buttons / Indicating Lamps	:	Siemens / L&T / Teknic / Alsthom
5.	Auxiliary Relays	:	Jyoti / Siemens / L&T / OEN
6.	Timers	:	L&T / Alsthom / Bhartiya Cutler Hammer
7.	MCBs	:	S&S Power Engg. / Indo Asian / MDS
8.	Terminal Blocks	:	Jyoti / Elmex

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 BHEL's standard Quality Plan for LCP is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

4.3 The vendor shall conduct the following tests as a minimum requirement:

4.3.1 Routine Tests

1. High Voltage (H.V.)
2. Insulation Resistance (I.R.)
3. Functional

4.3.2 Type Tests

1. Enclosure Class Test

5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

5.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

5.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

1. Data Sheet no. PES-145A-DS1-0
2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plan.

6.2 The vendor shall furnish the following documents in required number as agreed after the award of contract:

1. Data Shee No. PES-145A-DS2-0
2. GA Drawing indicating layout of instruments, construction details, foundation details, cable gland plate alongwith cable glands and all details mentioned in this specification.
3. Control Schematic Diagram along with grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. "As Built" Drawing.
7. CDs.

7.0 MARKING AND PACKING

7.1 Panel with all instruments / devices mounted on it shall be suitably packed & protected for the entire period of despatch, storage and erection against impact, abrasion, corrossion, incidental damage due

to vermin, sunlight, high temperature, rain moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in Transit and storage in open.

8.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

- Data sheet A&B for Local Panels : Data sheet no. PES-145A-DS1-0
- Data sheet C for Local Panels : Data sheet no. PES-145A-DS2-0

7.12.00 Panels, Cubicles and Enclosures

7.12.01 General

a) All panels, cubicles and enclosures shall be furnished complete with integral piping, internal wiring, convenience outlets, internal lighting, grounding, ventilation, space heating, vibration isolating pads and other accessories.

b) Unless otherwise specified cable entry for panels / desks / cabinets shall be through bottom via glanding plate. Fireproof seal shall be used to seal the bottom to prevent entry of dust.

c) Panels and cabinets shall be constructed from steel sheet reinforced as required to provide true surface and adequate support for devices mounted thereon. Thickness of the steel plate shall conform to the requirements of UL 50 or equivalent standard. Panels and cabinets shall be of adequate strength to support mounted components during shipment and to support a concentrated load of 100 Kilograms on their top after erection.

d) Panel /cabinet shall have eyebolt on top for lifting.

7.12.02 Surface Preparation and Painting

Sheet metal exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below:

a) Suitable filler shall be applied to all pits, blemishes and voids in the surface. The filler shall be sanded so that surfaces are level and flat; corners are smooth and even. Exposed raw metal edges shall be ground burr-free. The entire surface shall be blast clean to remove rust and scale. Oil, grease and salts etc. shall be removed from by one or more solvent cleaning methods prior to blasting.

b) Two spray coats of epoxy primer surfacer shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish color (Catalyzed epoxy or polyurethane) shall be applied to all surface of dry film thickness 2.0 Mil. The finish colors for exterior and interior surfaces shall conform to the following shades:

   i) Exterior – RAL 7032.

   ii) Interior - Brilliant White.

c) Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections shall not be acceptable.

7.12.03 Wiring

Wiring within the panels shall conform to NEC standards and shall be factory installed and tested at the works. All interior wiring shall be installed neatly. Features shall not be limited to the following :

a) All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks.

b) Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized print shall be used with cross- identification.

c) Wire termination shall be made with insulated sleeve and crimping type lugs. All external connections shall be made with one wire per terminal. Wire shall not be spliced or tapped between terminals. Open-ended terminal lugs shall not be used.

d) Internal wiring should be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables.

e) Thermocouple lead wires, analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low milli volt or micro volt shall be electrically and physically isolated from other AC and DC wiring.

f) All low-level signal cables shall be separately bundled from control cable.

g) Wires shall be dressed and run in troughs with clamp-on type covers. Wirings shall be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on termination.

h) Shield wires shall be terminated on separately.

i) Common connections shall be limited to two wires per terminal.

j) Wiring to door mounted devices shall be provided with multi-strand wires of (49 strands minimum) adequate loop lengths of hinge-wire so that multiple door openings will not cause fatigue to the conductor.

k) Wiring shall be arranged to enable instruments or devices to be removed and/or serviced without disturbing the wiring. No wire shall be routed across the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices.

l) Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 48V, 110V AC, 240V AC, 220V DC etc.

m) Panels /cabinets /desks shall be provided with removable gasketted cable gland plates and cable glands. Split type grommets shall be used for prefab cables.

n) Wire shall be multistranded annealed flexible high purity copper conductor with heat resistant FRLS PVC insulation and shall pass vertical flame test per IPCEAS-1981.

o) Wire sizes used for internal wiring shall not be lower than the followings :

Control wiring (switches, pushbuttons etc.)	: 1.5 Sq.mm
Power supply/receptacle /illumination wiring	: 2.5 sq. mm or higher as per load
4-20mA DC current and low voltage signal upto 48V DC	: 1.0 Sq. mm

p) Identification of conductors shall be done by insulation color-coding identified on drawings or by printed wiring lists.

7.12.04 Grounding

a) System cabinet AC and DC ground shall be electrically isolated from each other and also electrically isolated from the Instrumentation signal ground. All the above ground shall be individually connected to the single point on the ground pit. Dedicated redundant earth pit shall be provided which shall be away from the HV equipment. This earth pit shall not be shared with other electrical equipment ground and shall also be insulated from other electrical system ground to ensure single point grounding of the system. Grounding resistance shall be better than 1.0 ohm. IEEE guideline shall be followed while designing the grounding system.

b) Panels and cabinets shall be provided with a continuous tinned copper ground bus bar of minimum 25 mm x 3 mm cross section, extending along the entire length of the panel / desk / cabinet assembly. The ground bus shall be bolted to the panel structure and effectively ground the entire structure.

c) The panel /desk /enclosure /JB ground shall have two (2) bolt drilling with GI bolts and nuts at each end to connect to GI/ copper flat ground riser by means of insulated copper ground cable of required cross section with lug.

d) Circuits requiring grounding shall be individually and directly connected to the panel ground bus.

e) For electronic system cabinets, the electronic system ground bus shall be similar but insulated from the cabinet and shall be separately connected to the system ground. Signal cable shields shall be grounded at the panel end only and shall not be left open. The ground in between panels of a shipping section shall be firmly looped.

f) Electrical meters, relays, transmitters and switching devices, operating at a voltage less than 50V may be grounded through the steel structure.

7.12.05 Panel / Cabinet/ Desk/Enclosures Environmental Protections

a) Panels, cabinets, desks, distribution boxes, junction boxes, terminal boxes and all other field mounted equipment / enclosures shall suit the environmental condition of the area and shall not be inferior than the requirement indicated in the following table.

SL. NO.	LOCATION	ENCLOSURE TYPE
1.	Indoor type non- ventilated enclosure in non-hazardous area	IP-54
2.	Indoor type ventilated enclosure in non-hazardous area	IP -42
3.	Enclosure in Air conditioned area	IP-22 with suitable canopy at top to prevent ingress of dripping water.
4.	Outdoor type in non-hazardous areas	IP-55
5.	Outdoor in hazardous areas	As per requirements of the NEC Code for the location

b) The construction of electrical enclosures located in areas subject to conditions classified in the National Electrical Code (NEC) as hazardous shall be of a type designated suitable for the environment in which they are located.

7.12.06 Terminal Blocks

a) Terminals shall be chromated galvanized DIN rail mounted screwless cage clamp type. Terminals shall have screwed connection for conductor cross-section above 2.5 mm^2. Terminal blocks shall conform to IEC 947-7-1.

b) The characteristics of the terminal blocks shall be as follows.

i) High contact force, independent of conductor cross-section and large contact surface area.

ii) Self-loosening protection.

iii) Resistant to thermal aging and vibration.

iv) Low and constant voltage drop

c) Tension spring shall be made of high quality, non-rusting, acid-resistant steel. The current bar shall be of tin-lead plated copper or brass.

d) Terminals shall be of non flammable suitable thermoplastic material such as polyamide.

e) Terminal blocks shall be mounted vertically in panels and cubicles with clearance for at least 100 mm between two sets and between wall and terminal block.

f) Terminal blocks shall be provided with white marking strips / self-adhesive marker cards. Power terminals shall have protection covers.

g) At least 10%percent spare unwired terminals shall be provided for all panels /cabinets /desks /junction box etc.. This shall be in addition to 10%spare wired terminals of spare IO channels and 10% wired spare modules.

h) Bottom of the terminal block shall be at least 200 mm above the cable gland plate for bottom entry type panels.

i) For extending 24 V / 48 V DC supply to panels, the size of the terminals shall be decided based on voltage drop and not based on current.

j) Other requirements of the terminal blocks are as follows:

i) The last block in a rail-mounted assembly shall be closed with an end plate and end bracket.

ii) For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.

iii) Design shall permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections.

iv) It shall be possible to use jumper plugs through the test plug socket to connect adjacent terminals.

v) Where more than one connection to a terminal block is required, two tier terminals shall be used.

vi) Terminal blocks shall be of different colors depending on voltage levels.

7.12.07 Nameplates and Labels

a) Each item shall have permanently attached to it, in a prominent position, a rating plate of non-corrosive material upon which is to be engraved the manufacturer's name, equipment, type / model number, range, serial number, together with details of the loading conditions under which the item of plant in question has been designed to operate.

b) Such nameplates or labels are to be of white non-hygroscopic material with engraved black lettering, or alternatively of transparent plastic

material with suitably colored lettering engraved on the back.

c) The nameplates shall be held by self-tapping screws. The size of nameplate shall be approximately 20 mm x 75 mm for equipment and 40 mm x 150 mm for the panels.

d) Items of plant such as valves, which are subject to handling, are to be provided with an engraved chromium plated nameplate or label with engraving filled with enamel, suitably mounted or affixed with strong rustproof chain.

e) All such nameplates, instruction plates, lubrication charts etc. shall be with English inscriptions.

8.00.00 METERING BASES AND CHART UNITS

The following system of units shall be followed for various displays and scales unless otherwise mentioned:

i)	Pressure	: Kg/cm^2
	Differential Pressure	: mm of H_2O column / Kg/cm^2
ii)	Draught	: mm of H_2O column
iii)	Vacuum	: Kg/cm^2 (abs)/mm of Hg column
iv)	Temperature	: Degree Celsius (^{O} C)
v)	Flow (Steam, Water)	: Tonnes / hr, M^3/Hr
vi)	Flow (Oil)	: M^3 / Hr, Litter/Hr
vii)	Flow Air	: Tonnes / hr / M^3 / Hr.
viii)	Density	: gms / c.c.
ix)	Level	: mm /%
x)	Conductivity	: µS / cm or mS/cm
xi)	Gas Analyzer	: Percentage by weight or as specified in respective case.
xii)	Dissolved Oxygen / Silica / Sodium	: ppm /ppb

9.00.00 PROCESS CONNECTION & INSTRUMENT HOOK UP

9.01.00 Instrument connection to the process system (piping, vessel etc.) shall be according to the process & piping specification upto and including the root valves. Root valves shall be installed as close as possible to the piping or vessel.

9.02.00 Each instrument shall have its own independent connection to the process except for instruments located on standpipe. Each instrument shall be connected independently to the standpipe through isolation valve.

9.03.00 Isolation and blowdown drain valves adequate for duty and capable of withstanding continuous design condition of main process shall be provided. Instrument blow down valve near to the instrument shall be of gradual opening type. For process pressure equal or above 40 kg/ sq.cm double blowdown valves shall be used connecting to blowdown header. Instrument manifold / gauge valve shall be installed close to the instrument.

9.04.00 The nominal size of the takeoff connections on line shall not be less than NPS ½" for source conditions not in excess of either 900 psi or 425OC and NPS ¾" (for adequate physical strength) for design conditions exceed either of these limits. Where the size of the main is smaller than the limits given above, the takeoff connections shall not be less than the size of the main line.

9.05.00 Process connection for instruments lines and vessels shall be in accordance to standards such as ASME or other recognized international standards. Table below indicates the type of connection generally to be used.

INSTRUMENTS	**EQUIPMENT / PIPE SIDE**	**INSTRUMENT SIDE**
Level Instruments		
Internal Displacer	4" - Flanged	4" - Flanged
External Displacer	2" - Flanged	2" - Flanged
Level gauge	¾" -Flanged	¾" - Flanged
DP Type	½" (min.)-welded 1" – welded for vessel like HP heaters, LP heaters, De-aerator etc. application	½"- NPT
External cage Level switch	1"- welded	1"- welded
Flow Instruments		
DP Type	½" - welded in general 1" – welded for high pressure / temperature main steam, feed water, PRDS etc. application	½" - NPT
Pressure Instruments		
Conventional	½" (min.)-welded 1"- welded for high pressure/	½" - NPT

INSTRUMENTS	EQUIPMENT / PIPE SIDE	INSTRUMENT SIDE
	temperature main steam, feed water, PRDS etc. application	
Diaphragm type-HFO application	3"- Flanged	3"- Flanged
Temperature Instruments		
Thermowell	Generally - M 33 X2 (M); 1½" Flanged- For air/FG path application	½" NPT
Analyzer		
Liquid analyzer	½"- 1" - welded	½"

9.06.00 Size of impulse pipe for pressure measurement in air and flue gas duct path of boiler shall not be less than ¾" NB.

9.07.00 Separate stubs and take-off points with thermo well / root vlves shall be provided for performance guarantee test.

9.08.00 Impulse pipes shall be clamped at suitable interval not exceeding 1.5 meter. Process pipe shall not be used for supporting the impulse pipe.

9.09.00 Fittings shall conform to ANSI B 16.11. Threads of piping component shall be of tapered construction.

9.10.00 Instrument blowdown header shall in no case be lower than the material grade ASTM A 106 Gr. C.

9.11.00 Impulse pipe shall be laid at least with slope of gradient 1:10 to avoid any air pocket or water accumulation.

9.12.00 Expansion loop shall be provided at least at every 2.5 meter interval without affecting the gradient of slope in long run impulse pipe to avoid stress on the piping.

9.13.00 Siphon shall be provided in the impulse pipe or tube to protect the instruments where fluid temperature is 100 OC or more.

9.14.00 Orientation of tappings shall be as follows :

a) For liquid service — within 45 ^{O} at lower half of the pipe horizontal plane.

b) For gas service — within 90 ^{O} at upper half of the pipe horizontal plane.

c) For steam service — within 45 ^{O} at upper half of the pipe horizontal plane.

As a rule tap orientation of high and low pressure side should be parallel and symmetrical.

9.15.00 Pressure & Differential pressure instruments in steam and liquid services shall be located below the taps and the piping shall be sloped to avoid formation of air pocket.

9.16.00 Pressure & Differential pressure instruments in air and flue gas service shall be located above the taps and the piping shall be sloped back to process to avoid formation of any liquid.

9.17.00 Impulse pipe including taps for furnace, flue gas and coal mill application shall be provided with air purge connection. Differential instruments for such application shall have continuous and as well as intermittent purging. Whereas, pressure measurement shall have only intermittent purging.

9.18.00 Material of impulse pipe for the instruments mounted on rack and enclosure shall be same as that of main process pipe except stainless steel tube of Gr. 316 or better shall be provided for connection in between impulse pipe (from tee connection on impulse pipe) and instrument manifold valve & instruments. Impulse pipe, tubes, fittings and accessories shall have the same design pressure and temperature applicable for the related main pipe.

10.00.00 **POWER SUPPLY SYSTEMS**

10.01.00 Instrumentation power supply system shall include all conditioning equipment required to accommodate normal variations in the electrical supply. All panels and cabinets shall accept redundant power feeds from two different sources.

10.02.00 Type of power supply systems envisaged for the various I & C system including DCS are as follows:

a) 240V AC Redundant UPS system HMIs, Main Plant Field devices / equipment, CCTV, EWLI, CEMS, SWAS etc. and PLC of package System

b) 24V / 48 VDC Supply for DCS

11.00.00 **ENVIRONMENTAL CONSIDERATIONS**

I & C components should operate properly with no degradation in expected lifetime or in operation parameter in the normal power plant environment. I & C system shall be designed considering all the operating conditions which may be encountered during installation and operation.

11.01.00 Temperature

11.01.01 Where the environmental extreme exceeds the capabilities of the selected system, Bidder should take appropriate steps to control the environment.

11.02.00 Humidity

11.02.01 I & C system shall be designed to withstand the humidity limits specified for the project. Condensation shall not be allowed to form in the cabinets nor

FORM NO. PEM-6666-0

	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.: PES-145-054A
		VOLUME
		SECTION
		REV. NO. 01 DATE: 22.03.2011
		SHEET 1 OF 2

TAG No. …… Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet A & B

			DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL	MANUFACTURER			
	CONSTRUCTION		☐ FOLDED ☐ WELDED (As per requirement EDN)	
	ENCLOSURE SHEET THICKNESS	FRONT	■3.0 mm(FOR FACES SUPPORTING INSTRUMENTS/TERMINALS)	
		OTHER	■ 2.0 mm (FOR OTHER SIDES AND TOP)	
		DOOR	■ 2.0 mm	
		HEIGHT	☐ 2365 mm for stand alone panels. (THIS SHALL BE DECIDED BY BHEL DURING DETAILED ENGG.)	
		OTHER	☐	
TECHNICAL	INPUT POWER SUPPLY *		☐ 240V 50 Hz AC ☐ 220V DC ☐ 415V 3 PHASE 3W ☐ 415V 3 PHASE 4W	
	NO. OF FEEDERS		☐ ONE ■ TWO	
	CONTROL SUPPLY		☐ 110V AC ☐ 220V AC ☐ 220V DC ☐ Other. (As per requirement)	
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		_____NOS. (AS REQUIRED)	
	PAINT TYPE		☐ EPOXY ENAMEL ■ EPOXY POWDER COATED OR BETTER (THIS SHALL BE DECIDED BY BHEL DURING DETAILED ENGG.)	
	PANEL COLOUR (EXTERNAL)		☐ LIGHT GREY (Shade 631 IS-5) ☐ OPALINE GREEN (Shade 275) . ■ RAL 7032 (THIS SHALL BE DECIDED BY BHEL DURING DETAILED ENGG.)	
	FINISH (EXTERNAL)		☐ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	PANEL COLOUR (INTERNAL)		☐ WHITE ☐ CREAM ☐ OFF WHITE ■ BRILLIANT WHITE	
	FINISH (INTERNAL)		☐ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	CLASS OF PROTECTION		☐ IP-42 (FOR INDOOR SERVICE) ■ IP-55 (FOR OUTDOOR SERVICE) ☐ ANY OTHER	
	CONTROL HARDWARE		■ RELAY BASED	
	FOUNDATION ARRANGEMENT		☐ FOUNDATION BOLTS ☐ ANCHOR FASTENERS	
	WEIGHT OF PANEL (Kg.)			
	PANEL TYPE		☐ PRESSURISED ☐ UNPRESSURISED As per Requirement	
	CABLE GLAND		☐ DOUBLE COMPRESSION	
	AMMETER (TYPE OF INPUT) *		☐ 1 Amp CT ☐ 4-20 mA	

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	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.: PES-145-054A	
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TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet A & B

DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

* TO BE CO-ORDINATED WITH PEM ELECTRICAL

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME				NAME:
SIGNATURE				SIGNATURE:
DATE				DATE:

FORM NO. PEM-6666-0

	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.: PES-145-054A
		VOLUME
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		SHEET 2 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER			
	CONSTRUCTION		☐ FOLDED ☐ WELDED (As per requirement EDN)	
	ENCLOSURE SHEET THICKNESS	FRONT		
		OTHER		
		DOOR		
		HEIGHT		
		OTHER		
TECHNICAL	INPUT POWER SUPPLY			
	NO. OF FEEDERS			
	CONTROL SUPPLY			
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)			
	PAINT TYPE			
	PANEL COLOUR (EXTERNAL)			
	FINISH (EXTERNAL)			
	PANEL COLOUR (INTERNAL)			
	FINISH (INTERNAL)			
	CLASS OF PROTECTION			
	CONTROL HARDWARE			
	FOUNDATION ARRANGEMENT			
	WEIGHT OF PANEL (Kg.)			
	PANEL TYPE			
	CABLE GLAND			
	AMMETER (TYPE OF INPUT)			

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME	Shiv Kumar	Anisha B Singhal	Anisha B Singhal	NAME:
SIGNATURE				SIGNATURE:
DATE				DATE:

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	1 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
	INCOMING											
1.0	Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	IS:1079 IS:513	IS:1079 IS:513	Test Certificate	3	---	2	
		2. Bend Test	CR	Mech. test	Sample	IS:1079 IS:513	IS:1079 IS:513	Log Book	2	---	---	
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---	
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---	
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1	
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	IS:2062	IS:2062	Log Book	2	---	---	
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---	
		4. Mill marking	MA	Visual	100%	IS:2062	IS:2062	Log Book	2	---	1	
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	

LEGEND:
* CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.
1 - BHEL; 2 - Vendor; 3 - Sub-vendor

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

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SHEET	2 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
		3. Conductor a) Resistance b) Size c) Sheet colour	 MA MA MA	 Electrical Measurement Visual	 100% 100% 100%	 BHEL Spec. and IS:1554 or IS:694	 BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	3	---	2	
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type	CR	Visual	Sample	BHEL Spec. and BOM	BHEL Spec. and BOM	Log Book	2	---	---	
		2. Verification of Test Certificates	CR	Scrutiny of Type / Routine T.Cs.	100%	Relevant IS	Relevant IS	Log Book	2	---	---	
		3. Operation / Functional check	CR	Electrical	Sample+ 100%@	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	+ for relay & contactors only
		4. I.R.	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	@ for all components except relays & contactors.
		5. H.V.	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	
		6. Calibration	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	1	
		7. Pick up / Drop off Voltage	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		2. Surface defects	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		3. IR / HV on Terminal Blocks	MA	Electrical	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
	IN PROCESS											
6.0	Blanking / Bending / Forming	1. Dimensions	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Surface defects after bending	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	---	
7.0	Nibbling / Punching	1. Cutout Sizes	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Deburring	MA	Visual	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
	ASSEMBLY											
8.0	Frame Assembly & Sheet fixing	1. Dimensions	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		2. Alignment	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		3. Welding Quality	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		4. Surface defects	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		4. Surface quality after every dip	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
10.	Panel Wiring	1. Wiring Layout	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		2. Wiring Termination (Crimped Lugs)	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		3. Ferrule numbers	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		4. Colour of wiring	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
		5. Size of Conductor	MA	Measurement	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
11.	Component Mounting	1. Correct components	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
		2. Fixing	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
	FINAL											
12.	Final Inspection	1. Workmanship	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		3. Components identification Marking / Name plates	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1	
		11. Wire Termination	MA	Pulling manually	Sample	-----	Firm termination	Inspection Report	2	1	1	
		12. Continuity	MA	Electrical	100%	-----	Continuity OK	Inspection Report	2	1	1	

At Random by BHEL, based on 100 % internal test reports by Mfr.

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

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SHEET	7 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
13.	TYPE TEST	Degree of Protection	CR	Mech. Protection	Sample	BHEL approved spec., drg relevant IS-13947 Part-1, IS-2148.	BHEL approved spec., drg relevant IS-13947 Part-1, IS-2148.	Type Test Certificate	3	---	1	
14	ROUTINE TEST	IR before & after HV Test	CR	Electrical	100%	BHEL approved spec., drg., BOM & relevant IS.	BHEL approved spec., drg., BOM & relevant IS.	Test Report	2	1	1	
15	FUCTIONAL TEST	1. Control Logic Operation	CR	Electrical	100%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		2. Instrument Calibratio	CR	Electrical	10%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		3. Temperature rise	CR	Electrical	100%	BHEL approved spec/drg. & relevant IS.	BHEL approved spec/drg & relevant IS.	Inspection Report	2	1	1	

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ACTUATORS

VOLUME : IIF/1

SECTION-III

TECHNICAL SPECIFICATION FOR ELECTRIC MOTOR ACTUATORS

1.00.00 SCOPE

1.01.00 This Section covers the general requirements of Electric Motor Actuators for valves, dampers and gates.

1.02.00 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification.

2.00.00 STANDARDS

2.01.00 All electrical equipment shall conform to the latest applicable IS, ANSI and NEMA Standards, except when stated otherwise herein or in driven equipment specification.

2.02.00 Major standards, which shall be followed, are listed below. Other applicable Indian Standards for any component part even if not covered in the listed standards shall also be followed

i) IS-9334

ii) IS-325

3.00.00 SERVICE CONDITIONS

3.01.00 The actuator shall be suitable for operation in hot, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash.

3.02.00 Unless otherwise noted, electrical equipment/system design shall be based on the service conditions and auxiliary power supply given in the general specification.

3.03.00 For actuator motor installed outdoor and exposed to direct sun rays , the effect of solar heat [manufacturer to decide] shall be considered or overhead shed shall be provided locally to avoid direct sun rays.

4.00.00 RATING

4.01.00 For isolating service, the actuator shall be rated for three successive open-close operation of the valve/damper or 15 minutes, whichever is longer.

4.02.00 For regulating service, the actuator shall be suitably time-rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour.

5.00.00 **PERFORMANCE**

The actuator shall meet the following performance requirements:

5.01.00 Open and close the valve completely and make leak-tight valve closure without jamming.

5.02.00 Attain full speed operation before valve load is encountered and impart an unseating blow to start the valve in motion (hammer blow effect).

5.03.00 Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.

5.04.00 The motor reduction gearing shall be sufficient to lock the shaft when the motor is de-energised and prevent drift from torque switch spring pressure.

5.05.00 The entire mechanism shall withstand shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

6.00.00 **SPECIFIC REQUIREMENT**

6.01.00 **Construction**

6.01.01 The actuator shall essentially comprise the drive motor, torque/ limit switches, gear train, clutch, hand wheel, position indicator/ transmitter, in-built thermostat for over load protection, space heater and internal wiring. Actuator shall be non integral type.

6.01.02 The actuator enclosure shall be totally enclosed, dust tight, weather-proof suitable for outdoor use without necessity of any canopy.

6.01.03 All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

6.01.04 The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

6.02.00 **Motor**

6.02.01 The drive motor shall be three phase, squirrel cage, induction machine with minimum class B insulation and IPW-55 enclosure, designed for high torque and reversing service. Canopy shall be provided for outdoor service.

6.02.02 The motor shall be designed for full voltage direct on-line start, with starting current limited to 6 times full-load current.

6.02.03 The motor shall be capable of starting at 85 percent of rated voltage and running at 80 percent of rated voltage at rated torque and 85 percent rated voltage at 33 percent excess rated torque for a period of 5 minutes each.

6.02.04 Motor leads shall be terminated in the limit switch compartment.

6.02.05 Motor actuators for valves/dampers shall be non-integral type with separate starter units and operable from remote.

6.02.06 Earthing terminals shall be provided on either side of the motor.

6.03.00 **Limit Switches**

Each actuator shall be provided with following limit switches: -

6.03.01 2 torque limit switches, one for each direction of travel, self-locking, adjustable torque type.

6.03.02 4 end-of-travel limit switches, two for each direction of travel.

6.03.03 2 position limit switches, one for each direction of travel, each adjustable at any position from fully open to fully closed positions of the valve/damper.

6.03.04 Each limit switch shall have 2 NO + 2 NC potential free contacts. Contact rating shall be 5A at 240V A.C. or 0.5A at 220V D.C.

6.04.00 **Hand Wheel**

Each actuator shall be provided with a hand wheel for emergency manual operation. The hand wheel shall declutch automatically when the motor is energized.

6.05.00 Position Indicator/Transmitter

The actuator shall have:

6.05.01 One (1) built-in local position indicator for 0-100% travel.

6.05.02 One (1) position transmitter, potentiometer type, for remote indicator.

6.06.00 **Space Heater**

A space heater shall be included in the limit switch compartment suitable for 240V, 1 phase, 50 Hz supply.

6.07.00 **Wiring**

All electrical devices shall be wired up to and terminated in a terminal box. The internal wiring shall be of sufficient size for the power rating involved but in no case less than 1.5 Sq.mm copper. All wiring shall be identified at both ends with ferrules. All wires shall be fire resistance type.

6.08.00 **Terminal Box**

The terminal box shall be weather proof, with removable front cover and cable glands for cable connection. The terminal shall be suitable for connection of 2.5 Sq.mm copper conductor.

7.00.00 **ACCESSORIES**

As required for the driven equipment, the actuator shall be furnished with starting equipment mounted on the actuator. This shall include:

7.01.00 One (1) triple pole MCCB for local isolation near the actuator

7.02.00 One (1) reversing starter with mechanically interlocked contactors, 3 thermal overload relays, 2 NO + 2 NC auxiliary contacts for each contactor.

7.03.00 One (1) remote-local selector switch.

7.04.00 CLOSE-STOP-OPEN oil tight push buttons with indication lights.

7.05.00 415/240 V or 415/110V control transformer with primary protected by fuse & secondary protected by Miniature Circuit Breaker (MCB).

8.00.00 **TEST**

The actuator and all components thereof shall be subject to tests as per relevant Standards. In addition, if any special test is called for in equipment specification, the same shall be performed.

9.00.00 **DRAWINGS, DATA & MANUALS**

9.01.01 To be Submitted with Bid

Data sheet for each type of actuator shall be furnished along with internal wiring diagram, suggested control schematic and torque limit switch contact development and manufacturer's catalogues.

9.01.02 To be Submitted after Award of Contract

a) Actuator Data Sheet

b) Internal wiring diagram and suggested control schematic

c) Torque switch and limit switch contact development

d) Manufacturer's Catalogue

e) Instruction manual indicating clearly the installation methods, check ups and tests to be carried out before commissioning of the equipment.

f) Any other relevant drawings, documents or data necessary for satisfactory installation , operation and manufacturing.

9.02.00 The Bidder may note that the drawings, data and manuals listed herein are minimum requirements only. The Bidder shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment are submitted with his bid.

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	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.: PE-ID-408-145-I902 VOLUME II B SECTION D REV. NO. 00 DATE: 04.04.15 SHEET 1 OF 4

Data Sheet A & B

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		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL*	* PROJECT		
	OFFER REFERENCE		
	* TAG NO. SERVICE		
	* DUTY	☐ ON / OFF ☐ INCHING	
	* LINE SIZE (inlet/outlet): MATERIAL		
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY	
	* OPENING / CLOSING TIME		
	* WORKING PRESSURE		
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%	
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY	
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY	
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY	
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IPW:55	
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL	
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.	
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.	
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER **FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM.**	
HANDWHEEL	* REQUIRED	■ YES ☐ NO	
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED	
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.		
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY	
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY	
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF **I.S.** TOLERANCE	
	ACTUATOR APPLICABLE WIRING DIAGRAM	■ ENCLOSED (BIDDER TO CONFIRM) A: ☐ DRG. NO. 3-V-MISC-24227 R00 B: ☐ DRG. NO. 3-V-MISC-24550 R00 C: ☐ DRG. NO. 3-V-MISC-24283 R00 D: ■ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram	
	COLOUR SHADE	☐ BLUE (RAL 5012) ☐ ……. (TO BE DECIDED BY BHEL DURING DETAIL ENGG.)	
	PAINT TYPE **(## Refer Notes)**	☐ ENAMEL ☐ EPOXY ☐ ……. (TO BE DECIDED BY BHEL DURING DETAIL ENGG.)	
	SHAFT RPM	BIDDER TO SPECIFY	
	OLR SET VALUE	BIDDER TO SPECIFY	
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY	
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY	

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.: PE-ID-408-145-I902 VOLUME II B SECTION D REV. NO. 00 DATE: 04.04.15 SHEET 2 OF 4

Data Sheet A & B

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		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC	
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ■ 110 V	
	@ ENCLOSURE CLASS OF MOTOR	■ IP 65 ☐ FLAME PROOF	
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B	
	@ WINDING TEMP PROTECTION	■ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ■ ---THERMOSTAT- 1 NO+1 NC CONTACT ---------- ----------	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED	
INTEGRAL STARTER	INTEGRAL STARTER	☐ REQUIRED ■ NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	☐ CONTACTORS ☐ THYRISTORS	
	TYPE	☐ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	IF SMART		
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED	
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐.....	
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC	
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED	
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐.....	
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED	
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP	
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED	
	STEP DOWN CONT. TRANSFORMER	☐ REQUIRED	
	OPEN / CLOSE PB	☐ REQUIRED ☐ NOT REQUIRED	
	STOP PB	☐ REQUIRED ☐ NOT REQUIRED	
	INDICATING LAMPS	☐ REQUIRED ☐ NOT REQUIRED	
	LOCAL REMOTE S/S	☐REQUIRED ☐ NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	☐ REQUIRED ☐ NOT REQUIRED	
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY)	
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	☐ INTERPOSING RELAY ☐ OPTO COUPLER ☐ EITHER	
	QUANTITY	☐ 2 NOs. ☐ 3 NOs.	
	DRIVING VOLTAGE	■ 20.5 – 24V DC ☐ _____V DC	
	DRIVING CURRENT	■ 125mA MAX ☐ _____mA MAX	
	LOAD RESISTANCE	■ > 192 ohms - <25 k ohms ☐ > _____ohms - < _____ohms	
TORQUE SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	■1 No. ☐2Nos. / ■1 No. ☐2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	5A 240V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.: PE-ID-408-145-I902 VOLUME II B SECTION D REV. NO. 00 DATE: 04.04.15 SHEET 3 OF 4

Data Sheet A & B

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		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
LIMIT SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN : INT : CLOSE	☐1 No ■2 Nos. / 2 Nos. (ADJ.) / ☐1 No. ■2Nos.	
	CONTACT TYPE	2 NO + 2 NC	
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC	
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	■ REQUIRED ☐ NOT REQUIRED	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	■ ELECTRONIC (2 WIRE) R/I CONVERTER ☐ ELECTRONIC (2 WIRE) CONTACTLESS	
	SUPPLY	■ 24V DC ☐	
	OUTPUT	■ 4-20mA	
	ACCURACY	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	230V AC,1 PH.,50 Hz	
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY	
	@ RATING	decided as per load data received tender stage	
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@☐ IP 68 @☐.....	
	@ EARTHING TERMINAL	REQUIRED	
	PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	☐ REQUIRED ☐ NOT REQUIRED☐ ☐ 2 NOS. ☐ ----------	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE: decided as per load data received tender stage	
	@ SPACE HEATER CABLE GLAND	SIZE: decided as per load data received tender stage	
	OTHER CONTROL CABLE GLANDS-1	☐ 1No. for BFV of CW PUMP(Cable size 2Px1.5mm2)	
	OTHER CONTROL CABLE GLANDS-2	QUANTITY & SIZE :----------	

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BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.: PE-ID-408-145-I902 VOLUME II B SECTION D REV. NO. 00 DATE: 04.04.15 SHEET 4 OF 4

Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

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WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.

NOTES:

1. **SCOPE**: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
2. **CODES & STANDARDS**: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATION STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
   IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722
3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.
5. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION.THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
6. THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%.
7. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.
8. CANOPY FOR OUTDOOR SERVICES SHALL BE PROVIDED.

$$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE.

EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.

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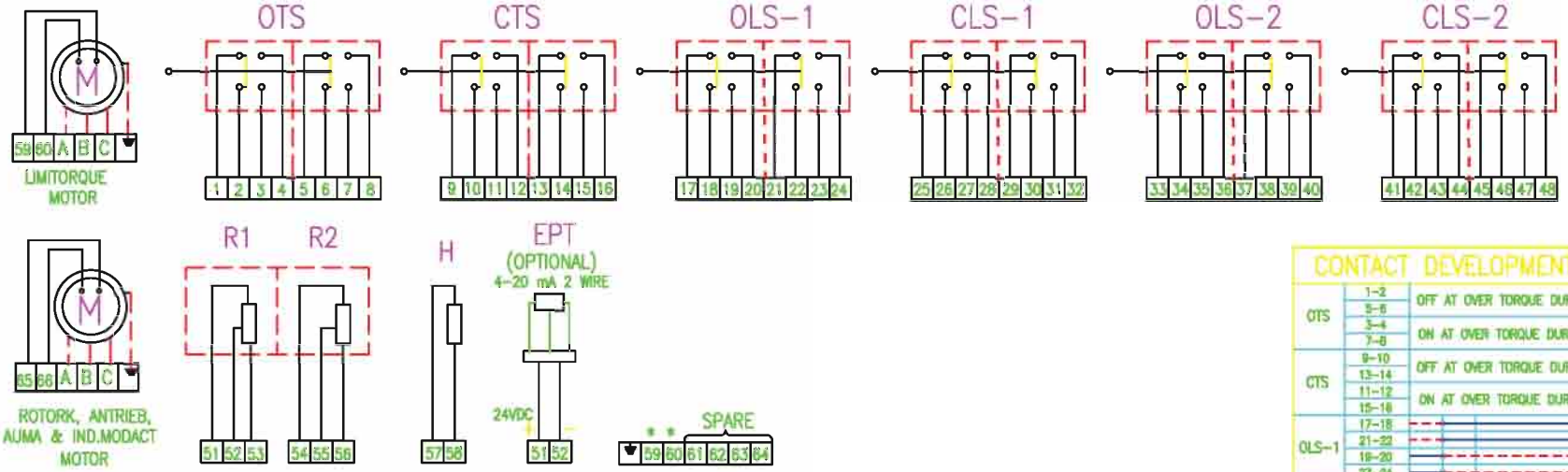
	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @= TO BE FILLED BY ES



* – SPARE FOR ROTORK, AUMA, ANTRIEB & IND.MODACT

SWITCHES – ALL ARE POTENTIAL FREE AND TWO PAIR OF CONTACTS CAN BE USED FOR DIFFERENT SUPPLY

THERMOSTAT – 65-66 (ROTORK, AUMA, ANTRIEB & IND.MODACT), 59-60 (LIMITORQUE).

EPT – ELECTRONIC POSITION TRAMSMITTER (POTENTIOMETRIC TYPE, FOR INCHING DUTY)

THERMOSTAT TERMINALS – TERMINATED IN MOTOR TB IN ANTRIEB & IND.MODACT AND IN MAIN TB IN OTHER MAKES

CTS – TORQUE SWITCHES FOR CW ROTATION (CLOSE) – 2 NO+2 NC

OTS – TORQUE SWITCHES FOR CCW ROTATION (OPEN) – 2 NO+2 NC

OLS-1, OLS-2 – LIMITSWITCHES FOR POSITION OPEN – 2 NO+2 NC

CLS-1, CLS-2 – LIMITSWITCHES FOR POSITION CLOSE – 2 NO+2 NC

OTS, CTS – TWO INDEPENDENT SWITCHS IN ANTRIEB & LIMITORQUE

OLS-2 & CLS-2 – CAM DISC IN ROTORK & ANTRIEB

R1-R2- POTENTIOMETER 2 x 100 OHMS

H – SPACE HEATER 1ø 240V AC SUPPLY

M – MOTOR 3ø 415V 50 Hz AC SUPPLY

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS	CTS	@

@ – CLS NOT TO BE CONNECTED IN TRIP CIRCUIT

NOTE:

1. BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)
2. CONNECT THERMOSTAT WITHOUT FAIL IN THE STARTER CIRCUIT

CONTACT DEVELOPMENT DIAGRAM

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

REV	DATE	CHED	APPD	DESCRIPTION
11	09.09.2000			CONTACT DEV. DIAGRAM ADDED.

365-139

BHARAT HEAVY ELECTRICALS LTD.
UNIT: HIGH PRESSURE BOILER PLANT.
TIRUCHIRAPALLI 620014.

DRAWN	N.P.ESWARI
CHECKED	K.ARUNACHALAM
APPROVED	P.LOGANATHAN
DATE	09.09.2000

TITLE

INTERNAL WIRING DIAGRAM

FOR

ELECTRICAL VALVE ACTUATORS (AC)

(DRAWN FOR INTERMEDIATE POSITION OF VALVES)

DRAWING No. 4-V-MISC-90271 REV 11

RETRACED WITH REVISION 11

SECTION D1

STANDARD TECHNICAL SPECIFICATION (MECHANICAL)

STANDARD TECHNICAL SPECIFICATION FOR NDCT

DATASHEET A

DOCUMENT DISTRIBUTION SCHEDULE FOR BELLARY PROJECT

STANDARD QUALITY PLANS

DATASHEET B

1.0 GENERAL:

1.1 This standard specification covers the design, manufacture and assembly, inspection and testing at the Vendor's and/or his sub-vendor's works, suitable painting and packing requirements for transportation, erection, commissioning and testing at site of all materials and equipments inclusive of complete electrical and civil works for the Natural Draft Cooling Tower complete with all accessories as specified hereinafter.

2.0 CODES AND STANDARD:

2.1 The design, manufacture, inspection and testing and performance of the Cooling Tower as specified hereinafter shall comply with the requirements of all applicable latest Indian/British/American Standards and Codes of practice. The latest editions of the following standards and publications shall be followed in particular.

a) Cooling Tower Institution of USA, Bulletin ATP-105: Acceptance Test Code for Industrial Water Cooling tower.

b) PTC-23: ASME Performance Test Code for Atmospheric Water Cooling equipment.

c) For Electrical, Civil Codes/ Standards refer respective Specification.

d) BS-4485 – Specification for Water Cooling Tower.

2.2 In case of any conflict between the above codes/ standards and this specification, the later shall prevail and in case any further conflict in the matter, the interpretation of the specification by the Engineer shall be final and binding.

3.0 DESIGN REQUIREMENTS:

3.1 The Cooling Tower shall be designed for continuous operation to cool not less than the design flow of water from specified inlet temperature to outlet temperature at a design ambient wet bulb temperature as indicated under Data Sheet-A enclosed to this specification.

3.2 All the components shall be capable of safe, proper and continuous operation at all cooling water flows up to and including those specified under Data Sheet-A and shall be designed with regard to ease of maintenance, repair, cleaning and inspection.

3.3 The cooling tower shall be Natural Draft cross flow/ counter flow type as per enclosed Data Sheet-A.

3.4 The vendor under this specification shall assume full responsibility in proper design and operation of each and every component of the cooling tower as well as the cooling tower as a whole unit.

3.5 The Cooling tower shall be suitable for handling the fluid as per Data Sheet-A and also for achieving the specified parameters in Data Sheet-A.

3.6 The Cooling tower shall be designed such that the drift losses and the evaporation losses are limited to the values as specified in Data Sheet-A.

3.7 The Cooling Tower structure shall be of adequate strength to withstand the wind load and the effect of earthquake on the structure. Design wind pressure and horizontal/vertical seismic coefficient shall be taken as mentioned in the specification for civil works enclosed to this specification.

4.0 CONSTRUCTIONAL FEATURES:

4.1 Casing and Louver (If required):

4.1.1 The Louvers shall be designed for air entry to the tower with low velocity for minimum pressure drop and less chance of recirculation of moist air. To eliminate splash out, louvers shall slope to shed water inwards.

4.1.2 The louvers and casing shall be made of material as specified in the Data Sheet-A.

4.2 Partitions:

4.2.1 Partitions shall be provided so that one section can be taken out of service without affecting the operation of capacity of other section.

4.3 Fill:

4.3.1 Cooling tower fills type and material shall be as specified in Data Sheet-A.

4.3.2 Design and arrangement of the fills shall be so as to expose high air/ water surface with minimum air pressure drop.

4.4 Fill Supports:

4.4.1 Fills shall be supported at frequent intervals, which shall minimise sag. Possibility of dislodgement and damage to fill materials as a consequence of induced vibration in the fill.

4.5 Drift Eliminations:

4.5.1 Multipass drift eliminators with minimum two-pass zig zag path type shall be provided so as to limit the drift loss to that specified in Data Sheet-A.

4.5.2 The eliminator frame shall be of rugged construction and shall be firmly secured to the structural

frame to arrest vibration. Suitable access to the eliminator frame work from the basin should be provided for any maintenance or physical replacement of eliminator blades etc., when the particular cell is taken out for maintenance.

4.6 **Hot Water Distribution System:**

4.6.1 Motorised/Manual valves (as indicated in Data sheet A) shall be provided in the hot water distribution piping such that each section can be isolated without affecting the operation of other section.

4.6.2 The pipes and valves in hot water distribution system shall be designed to take care of the possible thermal stresses due to temperature variation. This could be achieved by providing sliding supports for supporting all the pipes fabricated from carbon steel.

4.6.3 The hot water distribution piping and valves shall be designed for the design pressure as indicated in the Data Sheet-A.

4.7 **Cold Water Basin:**

4.7.1 The cooling tower basin shall be constructed in RCC (unless otherwise specified in Data Sheet-A). The capacity of the cooling tower basin shall be as indicated in Data Sheet-A.

4.7.2 The cold water basin shall be partitioned into two chambers or as specified in Data Sheet-A. The two sections of the Cooling Tower basin should be separate water tight compartments, which can be isolated one at a time for cleaning/maintenance purposes.

4.7.3 Sludge pits with isolating valves and spool pipe having flanged ends shall be provided for individual basin chamber for connection to drainage pipe.

4.7.4 For each basin chamber, there shall be a cold-water outlet channel. In the connection between basin chamber and cold water outlet channel there shall be a stationary coarse bar screen and gate in the absence of any specific preference under Data Sheet-A.

4.7.5 Each basin chamber shall have an overflow arrangement and scouring arrangement.

4.8 **Submersible sludge Pumps:**

4.8.1 The submersible type sludge pumps complete with electric motors, discharge side valves, piping, supports, hangers and clamps etc. shall be supplied at the option of the purchaser for each cooling tower for basin draining/ desludging. The quantity, design parameters and the materials of construction of the vertical sludge pumps shall be as per Data Sheet-A. Each pump shall be non-clog type, self water lubricated. The vertical sludge pumps shall be treated as an optional item and are to be offered if asked for in the Data Sheet-A enclosed to this specification.

4.9.0 **Screens & Gates in Cold Water outlet Chamber:**

4.9.1 The screens shall be vertical stationary type; the opening size and the mesh aperture shall be as per Data Sheet-A. The guides for the screens to be embedded in the concrete shall be of material as per Data Sheet-A.

Lifting lugs or eye bolts shall be provided on top of the screen frame for ease of handling.

4.9.2 For handling screens, one set of monorail with supporting structure and chain pulley hoist complete with lifting chain and trolley for mounting the hoist shall be furnished. The chain pulley hoist shall be manually operated and shall conform to IS-3832 class-II.

4.9.3 The gates fixed in vertical sections in cold water outlet chamber shall be as per standard practice and quality, material and type shall be as given in Data Sheet-A.

4.9.4 The isolating valves on the scour lines within the sludge pits shall conform to class I of IS-780 and shall be of reputed make.

4.10 **Hardware:**

4.10.1 All nails and fastening bolts, nuts and washers etc used in the cooling tower which are coming in direct contact with water or humid air shall be made of stainless steel 304, all others nuts & bolts etc. shall be made of HDG steel.

4.11.0 **Access:**

4.11.1 Two R.C.C. staircases for approach to the hot water distribution level

4.11.2 Doors for entrance into Cooling Tower Distribution level shall be provided as specified in Data Sheet -A.

4.11.3 Two external ladders for approach to top of cooling tower from water distribution level.

4.11.4 Access/platforms for inspection and maintenance of hot water distribution system along with spray nozzles.

4.11.5 Suitable arrangement for supporting walkways inside the cooling tower shall be made and loading of such arrangement shall be independent of the fill material.

4.11.6 Whether specifically mentioned in the data sheet or not, steel components and fittings used in walkways, handrails and access doors shall be hot dip galvanised after fabrication.

5.0 **INSPECTION AND TESTING:**

5.1 The inspection/ testing of cooling tower and its various components shall be as per the approved Quality Plans.

5.2 Hydrostatic test for the hot water distribution piping shall be conducted at site after complete erection. The test pressure and duration shall be as per Data Sheet-A.

6.0 **TEST AT SITE:**

6.1 The Cooling Tower as a whole shall be tested at site to check and ascertain that the performance meets the requirements of the specification. It is the responsibility of the vendor to conduct the performance test of the cooling tower and prove the specified parameters to the satisfaction of the purchaser. The test shall be witnessed by the purchaser/ customer's representative or both, for which 15 days clear notice will be given to purchaser by the vendor.

6.2 The performance test of the cooling tower shall be carried out in accordance with cooling tower Institute Bulletin No. ATP 105 Acceptance test for Industrial Cooling Tower.

The details of the proposed test procedure shall be submitted by the vendor sufficiently in advance of the commencement of test for the review and approval of the purchaser.

6.3 Necessary correction curves required for correcting the test results for any difference in test and guaranteed design condition shall be furnished by the supplier for approval along with the proposed test procedure.

6.4 All testing and calibrating instruments required for the site performance test shall be arranged by the cooling tower supplier without any extra cost. All instruments used by the supplier shall be duly calibrated from a recognised Institution and the same is to be arranged by the supplier.

7.0 **PERFORMACNE GUARANGTEE, TOLERANCE & PENALTIES:**

7.1 Each equipment shall be guaranteed to meet the performance requirement as specified.

7.2 The tests shall be conducted at the manufacturer's works/ site in accordance with this specification and rectification of all defects shall be satisfactory done without charging any extra amount to purchaser.

7.3 The performance test shall be carried out at site as specified and all defects shall be satisfactorily rectified within a time period decided by purchaser. No extra amount shall be charged to purchaser for such rectification. After rectification, retesting will be done by purchaser/ customer's representative without any extra cost to purchaser till satisfactory performance is achieved.

7.4 The vendor shall submit performance curves for the cooling tower showing variation in performance from the design duty point with change in approach to wet bulb temperature,

cooling range, water loading of the tower.

7.5 The vendor shall guarantee the performance of the whole cooling tower plant to meet the specifications when tested in accordance with cooling tower institute acceptance test code ATP-105, performance curves as per ATP-105 shall be furnished by the vendor.

7.6 If any defects are observed, the bidder shall rectify the same without extra cost to the purchaser. Even after rectification if the guaranteed performance is not achieved, then for every increase of 0.5 degree C or part thereof in the cold water temperature over design conditions, a sum as specified in data Sheet-A shall be paid by vendor to the purchaser for shortfall of guarantee, for the cooling tower.

7.6.1 In case the cold water temperature exceeds the acceptable limits of purchaser, the whole plant will be rejected and the vendor shall refund the entire money paid to him together with any penalty levied otherwise.

8.0 SPECIAL CLEANING PROTECTION & PAINTING:

8.1 All equipment shall be neatly finished. All exposed metal/ concrete/ wooden surface shall be smooth and free from burrs/ projections.

The metal surfaces to be painted should be accessible, suitable for priming and affording maximum protection throughout the life of the plant. The surface preparation shall be done either mechanically or chemically by one or more of the methods as given in IS-1477 (Part-I) and shall include the following:

a) Removal of oil, grease, dirt and swarf etc., as per Section 6.1 of IS-1477 (Part-I).

b) Removal of rust and scale etc., as per Section 6.2 of IS-1477 (Part-I).

c) Sand blasting/ shot blasting as per Section 6.2.4 of IS-1477 (Part-I) or wire brushing and picking as specified in Data Sheet-A.

8.2 INSIDE SURFACE OF PIPING & VALVES IN HOT WATER RISERS:

8.2.1 The inside surfaces of the piping and the valves which are in contact with water and which are not made of stainless steel or other corrosion resistant materials shall be painted with coal tar based epoxy paint of approved make and quality over a coat of Zinc Chromate Primer. The thickness of cured coating shall be as specified in Data Sheet-A.

8.3 Outside Surface of Piping (Buried):

8.3.1 Surface treatment as specified in Data Sheet-A.

8.3.2 Coating/ wrapping/ concrete lining as specified in Data Sheet-A.

8.4 **Outside Surface or Piping (Exposed):**

8.4.1 Surface treatment as specified in Data Sheet-A.

8.4.2 One coat of red oxide primer.

8.4.3 Synthetic enamel paint of approved shade, make and quality. The thickness of cured coating shall be as specified in Data Sheet-A.

8.5 All steel parts used for cooling tower construction shall be hot dip galvanised as per IS-4736 after shop fabrication. The external surfaces of the flow regulating valves access platform, access door and also the hoisting derrick subjected to hot water fumes shall also be thoroughly cleaned and treated and shall be coated with rust preventing paints.

8.6 All parts shall be properly boxed, crated or otherwise protected for transportation. Exposed metal finished surfaces shall be thoroughly greased before transportation.

8.7 The external and internal surfaces of the tower shall also be painted.

9.0 **DRAWING AND DATA AFTER AWARD OF CONTRACT:**

The vendor shall furnish drawings and other technical documents as given in Data Sheet-C, enclosed with the specification.

10.0 **SPECIAL TOOLS & TACKLES**:

Special tools & tackles, if any, shall be included in scope of supply by the vendor. A list giving description of such tools & tackles shall be furnished by vendor.

DATA / DOCUMENTS TO BE FURNISHED BY VENDOR AFTER AWARD OF CONTRACT

1. General Arrangement drawing of complete cooling tower (showing plan, front elevation and side elevation) incorporating principal dimensions limits of scope of supply of piping, limits of civil works included, showing extent of platforms, walk ways, handrails, access doors staircase, end wall derrick etc. and the limits of scope of supply of electrical works.

2. General Arrangement drawing of Cooling Tower basin indicating overflow and desludging arrangement.

3. General Arrangement and Sectional Assembly drawings pertaining to the following components of the Cooling Tower.

   a) Tower fill with supporting arrangement.

   b) Drift eliminator installation and details.

   c) Complete hot water distribution system including flow regulating valves, distribution basin/ pipes and nozzles etc.

4. Arrangement drawing of the cold water outlet chambers and sludge pits incorporating also the arrangement of screens, gates, valves and piping terminal details.

5. Cooling tower performance curves showing wet bulb temperature V/s. cold water temperature for design cooling range, 90% cooling range and 110% cooling range at 90% ,100% and 110% of design flow.

6. Detailed GA and sectional assembly drawing of BF valves in hot water risers indicating materials of construction of various components.

7. General Arrangement and cross-sectional assembly drawings of sludge pumps and motor drives along with their performance curves.

8. Electrical drawings and data.

   i) Cable Schedule
   ii) Cable tray and trench layout.
   iii) Drawing on illumination system of cooling tower structure including wiring diagram showing conductor and conduct sizes and design calculation.
   iv) Drawing on Aviation Obstruction Lighting System.
   v) Drawing on grounding system inclusive of lighting protection system.

vi) Drawing of lighting sub-distribution board & junction boxes.

10. Drawings, data and calculation on civil works :

I) Design calculations for strength and suitability showing justification for size of members chosen for all structural components of cooling towers inclusive of prestressed concrete fill where applicable. All civil and structural design calculations shall be furnished by the supplier for approval of the purchaser.

ii) Load drawings setting out clearly and concisely the various loads taken into consideration for design.

iii) Civil drawings for cold water basin, sludge sumps, connecting channels, partitions, louvers, end walls, longitudinal beams, hot water distribution basin, its covering, staircase, platforms, cable trenches, etc. all complete.

iv) Bar bending details for all reinforced concrete structures.

v) Insert details, anchor bolt details.

vi) Final painting schedule.

vii) Other drawings & data as necessary.

11. Test procedure along with details of tests to be conducted for the offered cooling tower.

12 Quality Plan along with complete details of the testing and inspection requirements of mechanical and electrical items of the cooling tower in BHEL format.

13. Operation and Maintenance Manuals

14. Field Quality Plan for site activities – viz. Civil works & Erection.

15. Cooling tower performance test procedure.

1.0	**GENERAL INFORMATION**		
	No. of Cooling Towers required	:	One (01) no
	Location		Out door
	Duty		Continuous
	Type		Natural draft counter flow with PVC Film fills
	Basin Sill level		EL (+) 0.0 M (RL 72.3 M)
	Finished ground level		EL (-) 0.3 M (RL 72 M)
2.0	**DESIGN PERFORMANCE FOR EACH COOLING TOWER**		
2.1	Design Cooling water flow	:	92000 M^3/hr.
2.2	Design ambient wet bulb temp.	:	28.0 ^oC
2.3	Design inlet air wet bulb temperature.	:	28.0 ^oC
2.4	Approach w.r.t. design inlet air wet bulb temperature (viz. 28.0^oC)	:	5.0 ^oC
2.5	Cold water temperature	:	33 ^oC
2.6	Hot water inlet temperature	:	42.5 ^oC
2.7	Cooling Range	:	9.5 ^oC
2.8	Design ambient Relative Humidity	:	65 %
2.9	Liquid Handled	:	Clarified water (refer details of cooling water analysis)
	a) Total CW Pumping head permissible viz. static head plus frictional losses as below: • Static head w.r.t. FGL • Frictional losses within bidders T.P. with 10% margin • Velocity head	:	Not to exceed 13.5 MWC
2.10	Maximum permissible drift loss	:	Max. 0.005 %
2.11	Design pressure for hot water distribution system	:	5 kg/cm^2(g)
2.12	Max permissible Cooling Tower Plan dimensions at **'FGL'**	:	Basin Diameter should not exceed 140 meter. Raft diameter should not exceed 155 meter
2.13	Maximum Cooling tower flow capacity to be considered for design of hot water distribution and cold water channel	:	Min 120% of design CW flow.

3.0	**SPECIAL FEATURES**		
3.1	Basin type		Sectionalized (two compartment) by partition wall. Each basin chamber shall have overflow arrangement and sludge pit end with necessary dewatering arrangement
3.2	Whether fills are removable	:	Yes
3.3	Fills supporting by nailing acceptable	:	NO Only bottom supported arrangement on RCC is acceptable
4.0	**Cold Water Basin Details**		
4.1	Finished ground level	:	EL(-) 0.3 M (RL 72 M)
4.2	Maximum water level	:	EL(-) 0.3 M (RL 72 M)
4.3	Min. Water level	:	EL(-) 0.9 M (RL 71.4 M)
4.4	Storage capacity between Normal and minimum water levels.	:	Shall be suitable to provide a minimum storage of Six (6) minutes (between maximum and minimum water levels) of cooling tower design flow.
4.5	Invert level of CT Basin	:	EL (-) 1.4 M (RL 70.9 M) – At centre EL (-) 1.95 M (RL 70.35 M) – At basin edge
4.6	Invert level of CW duct near CT level	:	EL (-) 4.9 M
4.7	a) Depth of Sludge pit	:	Suitable for complete dewatering. To include sludge pump submergence & clearance depth below basin/ channel invert level
	b) Submersible type sludge pumps	:	1 working + 1 standby (of Min capacity of 200 cub M / hr
4.8	Number of sludge pits	:	Common sludge pit with inter connection with both compartments of CW basin.
4.9	Number of cold water outlet channels	:	One for each compartment of CW basin. Cold water outlet shall be designed for flow velocity through them with in 1.2 m/s during the rated flow from cooling tower, with the minimum water level in the cold water basin. At T.P bidder to match same as per T.P. drg.
4.10	Depth of CW channel		4.6 M from FGL (Ref Annexure-2)
4.11	Number of screens and gates in common outlet channel	:	One for each compartment of CW basin
4.12	Maximum allowable effective velocity		1.2 M/Sec.

	through Cold water channel at Min. Water Level	:	
4.13	Maximum allowable effective velocity through gates at Min. Water Level	:	1.2 M/Sec.
4.14	Max. allowable effective velocity through screens at Min. Water Level	:	1.2 M/Sec.
4.15	Length of outlet channel including expansion joint in bidder's scope	:	As per terminal point details in Section C1 and details as shown in the enclosed sketch 1.
5.0	**COOLING TOWER ACCESS DETAILS**		
5.1	Required number of stair cases from ground level upto hot water inlet for convenient access to top & interiors of cooling tower	:	Two (2) Nos.
5.2	Number of cage ladders from ground floor to cooling tower top.	:	Total Four (4) Nos.: Two from reinforced concrete stairs to platform at the top of the tower and other two shall be from ground level itself.
5.3	Internal walkway of platform with hand rails	:	Walkways and platforms shall be provided inside the tower at distribution pipe level. Thease walkways and platforms shall provide safe and clear access to all sprayers and all distribution pipes. Clear width of walkways shall be 1.5M.
5.4	External walkway platform	:	1.2 M width around the circumference at top and at aviation lamp level
6.0	**HOT WATER SUPPLY HEADER TERMINALS**	:	As per terminal point sketch –1 enclosed. CW return piping in BHEL scope 3740mm x 20mm thk shall be terminated with centre line of pipe elevation as shown in sketch. Further Piping from T.P. with isolating B.F. Valves in each riser shall be in bidders scope.
7.0	**SCOPE OF SUPPLY :**		
7.1	Cooling tower basin outlet channels/ sump and sludge pits	:	Yes
7.2	Hot water piping to distribution Duct	:	Yes
7.3	Hot water header isolation valves(motorised) on risers	:	Yes
7.4	Flanges/counter flanges for all flanged connections with bolts, nuts & gaskets etc.	:	Yes
7.5	Screen & guide for each cold water	:	Yes

	outlet sump/ channel		
7.6	Sluice gate with guides and sealing device for each cold water outlet sump/ channel. The sluice gates shall be complete with head stock for manual operation. The head stock shall have pillar, base plate and hand wheel made up of cast iron	:	Yes
7.7	Isolation valves in sludge pit	:	Yes
7.8	Drain Piping from sludge pit to terminal point	:	Yes
7.9	Pulley block for lifting each screen in cold water outlet sump/ channel	:	Yes
7.10	All necessary supports, hangers	:	Yes
7.11	Base plates, foundation plates, anchor bolts, sleeves, inserts, bolts, nuts for all equipments supplied	:	Yes
7.12	Drift Eliminator	:	As per note below. Note: NDCT without drift eliminator is also acceptable, subject to demonstration of permissible drift loss.
7.13	**Electrical**		
	As per electrical plant specification	:	Yes
7.14	All related Civil works included	:	Yes
8.0	**MATERIAL OF CONSTRUCTION**		
8.1	Cold water basin, outlet channel/ sump & sludge pit.		R.C.C.
8.2	Shell/ casing & superstructure	:	R.C.C
8.3	Basin partition walls	:	R.C.C
8.4	Internal walk way	:	R.C.C.
	External walkway platform		R.C.C
8.5	Staircase/ ladders	:	R.C.C./ HDG steel
	Hand rail		Hot dip galvanized steel
8.6	Supporting structures	:	R.C.C.
	Hot water distribution basin		R.C.C
8.7	Hot water distribution nozzles	:	Polypropylene or approved equal
8.8	Fills	:	VIRGIN PVC with minimum spacing of 20mm.
8.9	Fill support col,beams & trussess	:	R.C.C/ HDG steel
8.10	Louvers	:	R.C.C.
8.11	Drift eliminators	:	PVC- UV Stabilized

8.12	Fasteners/wetted parts	:	SS-316
8.13	Piping		**Above 150 Nb** : Carbon steel plates to IS 2062, rolled and welded as per IS 3589 Internally painting of one coat of epoxy resin based red oxide primer followed by adequate no. of finish coats of coal tar epoxy paint to achieve total 200 microns DFT. **Below & 150 Nb** : IS1239 (Heavy grade)
8.14	Hot water distribution pipes (inside CT)	:	HDG steel/ PVC
8.15	Hot water line valves		
	a) BF Valves	:	Body & disc : CI as per IS-210, FG-260 Shaf & spindle: SS304 as per ASTM A-479 Test pressure & duration shall comply with AWWA C504
	b) Sludge pit isolation valves		
	• Body	:	CI as per IS-210, FG-260
	• Spindle & Trim	:	SS316
8.16	Sludge outlet pipe	:	CI IS-1536, LA
8.17	Submersible pumps	:	Casing: CI as per IS-210, FG-260 Impeller : Stainless steel
	Sluice gates in cold water outlet channel	:	As per appropriate class of IS: 3042, all mild steel parts to be galvanised
8.18	Guide for sluice gates	:	SS-316L
8.19	Screen	:	SS 316 with 10X10 Mesh with Heavily Galvanised (as per IS: 2629) carbon steel frame and supports
8.20	Guide for Screen	:	SS- 316L
8.21	Bolts, buts & other hardware	:	SS-316(for wetted) and MS for other

Note:

(a) Carbon /Mild steel parts or structures used in Cooling Tower or its vicinity shall be Heavily Galvanised.
(b) Material of construction for items not specified shall be subject to purchaser's approval during detailed engineering stage, in the event of order.

9.0	Pipe work Painting / Protection of Pipes:	
9.1	Internal surface	Surface preparation : By wire brush Final Paint: one coat of epoxy resin based red oxide primer followed by adequate no. of finish coats of coal tar epoxy paint to achieve total 200 microns DFT.
9.2	External surface – overground piping **:**	Surface preparation : By wire brush Final Paint: One coat of Red lead primer followed

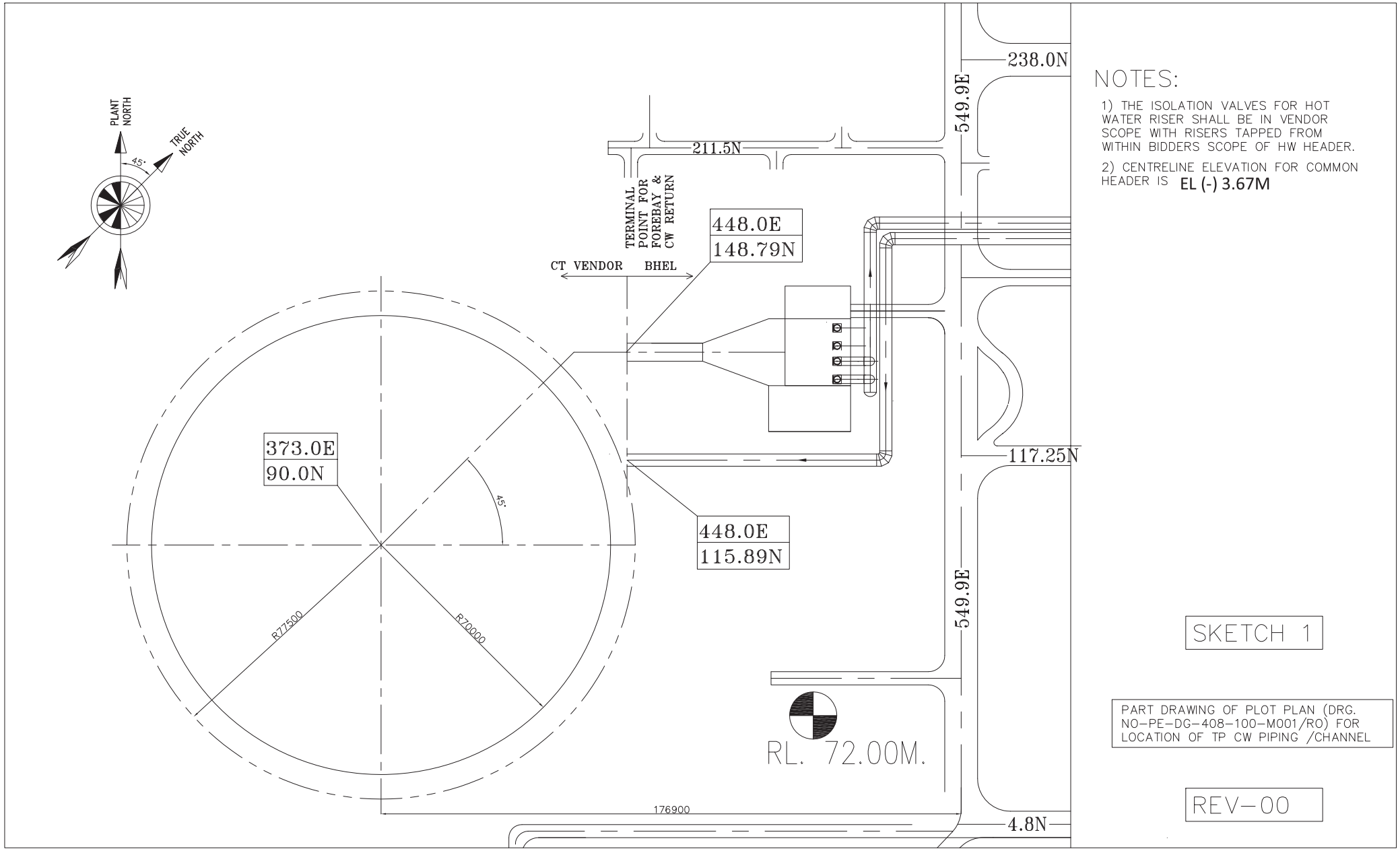
			by adequate no. of finish coats of synthetic enamel paint to achieve total 200 microns DFT.
9.3	External surface – Burried piping :		Surface preparation : By wire brush Final Paint: One coat of Coal Tar primer (Min. 2mm) of approved quality followed by a final coating of epoxy resin & coal tar blend (min 1 mm) and then two layers, each 2 mm thick of coal tar as outer wrap. Coal tar wrap to be used conforming AWWA-C-203/IS10221.
10.0	**INSPECTION AND TESTING**		
10.1	Quality Surveillance by	:	Manufacturer, purchaser and customer
10.2	Material testing and identification	:	Required
10.3	Stage inspection to be witnessed by Purchaser and customer	:	Yes
10.4	Hydrostatic test for piping & valves required	:	Yes
10.5	Hydrostatic test to be witnessed by Purchaser and customer	:	Yes
10.6	Field performance test of individual items and the cooling tower as a whole required	:	Yes
10.7	Field performance test of individual items and the cooling tower as a whole required.	:	Yes
10.8	All testing instruments by supplier	:	Yes
10.9	Commissioning at site by	:	Bidder
11.0	Mandatory spare	:	NIL

Attachments :

a) Plot plan

b) Sketch showing T.P details for hot water riser and discharge channel

ANNEXURE- I



NOTES:

1) THE ISOLATION VALVES FOR HOT WATER RISER SHALL BE IN VENDOR SCOPE WITH RISERS TAPPED FROM WITHIN BIDDERS SCOPE OF HW HEADER.

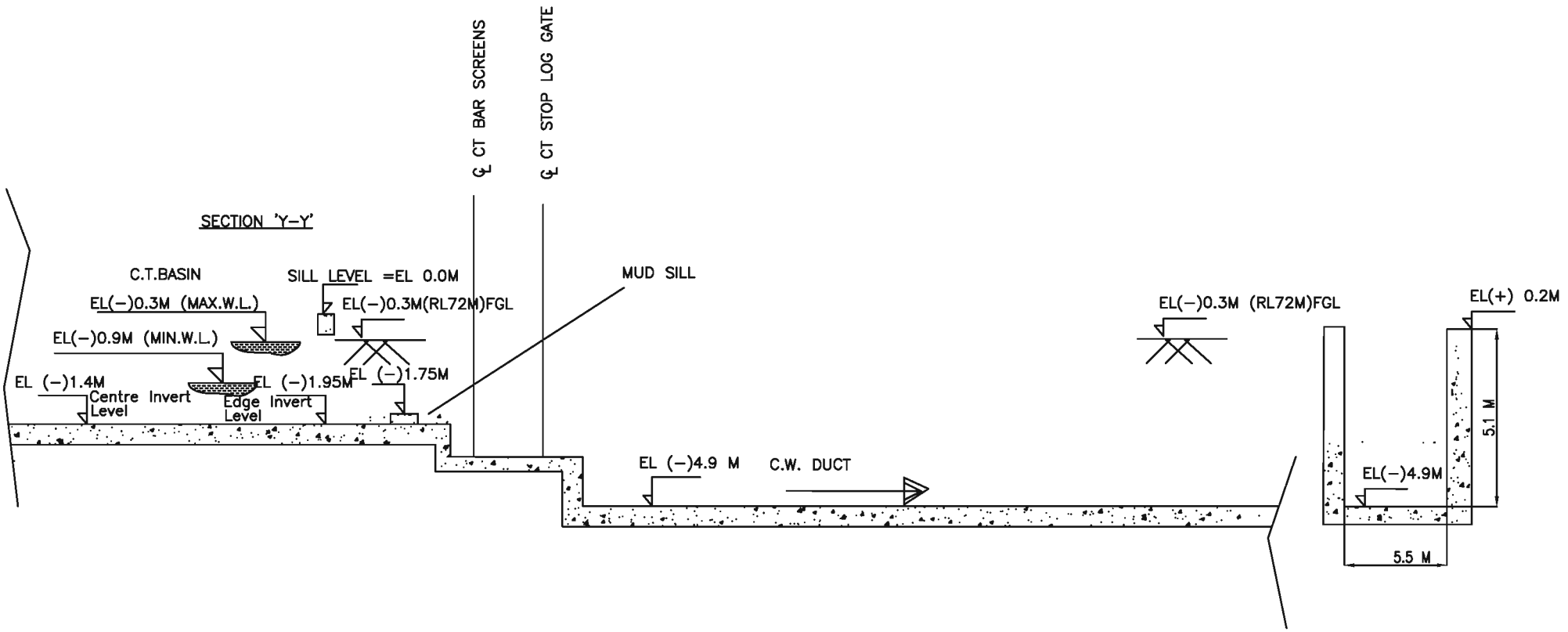
2) CENTRELINE ELEVATION FOR COMMON HEADER IS **EL (-) 3.67M**

SKETCH 1

PART DRAWING OF PLOT PLAN (DRG. NO-PE-DG-408-100-M001/R0) FOR LOCATION OF TP CW PIPING /CHANNEL

REV-00

ANNEXURE – 2



PROJECT: 1X800 MW WANAKBORI TPS, UNIT–8

COOLING TOWER SPECIFICATIONS

COOLING TOWER COLD WATER OUTLET WITH CT BASIN WATER LEVELS

Sl. No.	Equipment/Package Name	Quantity	Remarks
3	Butterfly Valve		
3.1	Complete Assembly	1No. for Each type, Class and Size	Lot Price for applicable items under Sno 3.1 and 3.2
3.2	Electrical Actuators for the Valves as per Electrical List	Item & Quantity same as indicated in Electrical list 'B'	Price Quoted under SL.NO-13 (actuators)of electrical list .

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Sl. No.	Equipment/Package Name	Quantity	Remarks
2	**Sump Pump**		
2.1	Complete set with Level Switch & Motor	10% of the total quantity used in the system for each type and rating or Minimum 1No. whichever is higher	Not Applicable
2.2	Annunciation System	Item & Quantity same as indicated in C&I list 'C'	Not Applicable

BHARAT HEAVY ELECTRICALS LIMITED * NEW DELHI * PS-MKTG.

C&I Mandatory spares

GSECL	BHEL		
Equipment/Package Name	**Remarks**	**Remarks as per post-bid resolution dt 9.01.2013 (BH-29)**	**Name of Unit**
General			
The Bidder shall offer mandatory spares of the same make, model and type for items which are offered in the main offer. Further, offered spare parts shall be of the same grade and shall have same performance as the instruments which they are to replace.			
Field Instruments (Transmitters/temperature elements (TC / RTD) / Gauges / Switches etc. along with relevant accessories)			
10 (ten) percent of total of each type or at least one (whichever is higher) of each type along with accessories.	Lot Price for applicable items		Trichy/ HWR/ HYD/ BAP/ PC Chennai/ EDN

12.0	**Control Panel/Desk Mounted Items**				EDN
12.1	Push Button				
12.1.1	Complete assembly	5Nos for each colour			EDN
12.1.2	Contact Element (1NO + 1NC) Block	20Nos.			EDN
12.2	Selector Switch	10Nos. for each type and rating			EDN
12.3	Meter (Analog or Digital)				
12.3.1	Ammeter	10% for each type and range or minimum one (1) no. whichever is more			EDN

12.3.2	Voltmeter	10% for each type and range or minimum one (1) no. whichever is more			EDN
12.3.3	Frequency	10% for each type and range or minimum one (1) no. whichever is more			EDN
12.3.4	MW	10% for each type and range or minimum one (1) no. whichever is more			EDN
12.3.5	MVAR	10% for each type and range or minimum one (1) no. whichever is more			EDN
12.3.6	Power Factor	10% for each type and range or minimum one (1) no. whichever is more			EDN
12.3.7	Synchroscope	10% for each type and range or minimum one (1) no. whichever is more			EDN
12.4	Indicating Lamps complete assembly	10Nos. for each Colour and type			EDN
12.5	Mimic Lamps	10Nos. for each Colour and type			EDN
12.6	MCB	2Nos. for each type and rating			EDN
12.7	Door Limit Switch	2Nos.			EDN
12.8	Annunciation system				EDN
12.8.1	Lamp Box with Facia & Lamps (LED type)	25Nos.			EDN
12.8.2	Hooter	1No.			EDN
12.8.3	Each type of PCB (for non-PLC driven system)	1(one) no.	Part of DCS		EDN
					EDN
13.0	**Actuator**		(LOT PRICE FOR APPLICABLE ITEMS IN THE LIST OF ITEMS INDICATED BELOW IN SL NO 13.1 TO 13.4, 13.6 & 13.7)		Trichy/ Trichy Valves
13.1	Complete set of Actuator	1No. for each type and rating			Trichy/ Trichy Valves/ BAP
13.2	Limit Switch	2 Nos each type and rating			Trichy/ Trichy Valves
13.3	Torque Switch	2 Nos each type and rating			Trichy/ Trichy Valves
13.4	Auxiliary Contact	1 no each type and rating			Trichy/ Trichy Valves
13.5	Motor	1 no each type and rating	Not envisaged. Hence not offered	Refer Sno 15 of BH-29 attached herewith.	Trichy/ Trichy Valves
13.6	Complete Seal kit	1Set for each type and rating			Trichy/ Trichy Valves
13.7	Complete O-Ring Set	1Set			Trichy/ Trichy Valves
					Trichy/ Trichy Valves

Electrical mandatory spares list for NDCT

IF applicable

18.0	**Motor**				
18.1	**HT Motor (other than BFP Motor)**				
18.1.1	Driving End Bearing	1No. (or 1Set as applicable) for each type and rating of Motor			IS Motors
18.1.2	Non-Driving End Bearing	1No. (or 1Set as applicable) for each type and rating of Motor			IS Motors
18.1.3	Cooling Fan Internal & External	1Set for each type and rating of Motor			IS Motors
18.1.4	Bearing Temperature Gauge Driving & Non-Driving End	1Set for each type and rating of Motor			IS Motors
18.1.5	Phase-Segregated Terminal Box	1Set for each type and rating of Motor			IS Motors
18.1.6	Neutral End Terminal Bushing with Fasteners	1No. for each type and rating of Motor			IS Motors
18.1.7	RTD for Bearing Temperature	1No. for each type and rating of Motor			IS Motors
18.1.8	Motor Space Heater	1No. for each type and rating of Motor			IS Motors
18.1.9	Complete Set of Coupling	1Set for each Application			
					IS Motors

IF applicable

18.3	**415 Volt Motor (above 30KW Rating upto 160KW)**	LOT	(LOT PRICE FOR APPLICABLE ITEMS IN THE LIST OF ITEMS INDICATED BELOW IN SL NO 18.3 . TO 18.3.6 AND 18.4.1 TO 18.4.4)		Trichy/ HWR/ Hyd/ IS Motors/ PEM
18.3.1	End Shield Cover Driving & Non-Driving End	1Set for each type and rating of Motor			Trichy/ HWR/ Hyd/ IS Motors/ PEM
18.3.2	Driving End & Non-Driving End Bearing	1Set for each type and rating of Motor			Trichy/ HWR/ Hyd/ IS Motors/ PEM
18.3.3	Cooling Fan	1No. for each type and rating of Motor			Trichy/ HWR/ Hyd/ IS Motors/ PEM
18.3.4	Motor Space Heater	1No. for each type and rating of Motor			Trichy/ HWR/ Hyd/ IS Motors/ PEM
18.3.5	Motor Terminal Block	1No. for each type and rating of Motor			Trichy/ HWR/ Hyd/ IS Motors/ PEM
18.3.6	Complete Set of Coupling	1Set for each Application			Trichy/ HWR/ Hyd/ IS Motors/ PEM
					Trichy/ HWR/ Hyd/ IS Motors/ PEM
18.4	**415 Volt Motor (Upto 30KW Rating)**		For BFPDT only 1 set for each type and rating being offered		Trichy/ HWR/ Hyd/ IS Motors/ PEM
18.4.1	Driving End & Non-Driving End Bearing	3Set for each type and rating of Motor			Trichy/ HWR/ Hyd/ IS Motors/ PEM

18.4.2	Cooling Fan	2No. for each type and rating of Motor			Trichy/ HWR/ Hyd/ IS Motors/ PEM
18.4.3	Motor Terminal Block	5No. for each type and rating of Motor			Trichy/ HWR/ Hyd/ IS Motors/ PEM
18.4.4	Complete Set of Coupling	1Set for each Application			Trichy/ HWR/ Hyd/ IS Motors/ PEM

20.0	**NDCT Lighting**				PEM
20.1	Medium intensity red flashing light	3 Nos.			PEM
20.2	Low intensity steady red light	3 Nos.			PEM
20.3	Control Unit for aviation warning light	2 Nos.			PEM
20.4	Lighting transformer	1 No.			PEM
20.5	M.C.C.B.	One (1) of each type and rating			PEM
20.6	M.C.B.	Five (5) of each type and rating.			PEM
20.7	Motor	One (1) of each type and rating			PEM
20.8	Indicating meters	One (1) of each type and rating			PEM
20.9	Push Button	Two (2) of each type and rating			PEM
20.10	Contactor	One (1) of each type and rating			PEM
20.11	Control Transformer	One (1) of each type and rating			PEM
20.12	Receptacles	One (1) of each type and rating			PEM

WATER ANALYSIS

TABLE-I

CLARIFIED WATER ANALYSIS

(As Received)

CONSTITUENTS	As	CONTENT	Jan-March	April-June	July-Sept	Oct-Dec
Calcium Hardness	CaCO3	ppm	70	62	57	64
Magnesium Hardness	CaCO3	ppm	63	78	52	65
Sodium + Potassium	CaCO3	ppm	-	-	-	-
Iron in Solution.	CaCO3	ppm	0.032	0.030	0.025	0.032
Manganese in Solution	CaCO3	ppm	-	-	-	-
Hydrogen (FMA)	CaCO3	ppm	64	68	36	40
TOTAL CATIONS	CaCO3	ppm	180	197	147	165
Bicarbonate	CaCO3	ppm	137	145	105	123
Carbonate	CaCO3	ppm	0	0	0	0
Hydroxide	CaCO3	ppm	-	-	-	-
Sulphate	CaCO3	ppm	14	16	18	14
Chloride	CaCO3	ppm	29	35	24	28
Nitrate	CaCO3	ppm	-	-	-	-
Fluoride	CaCO3	ppm	-	-	-	-
TOTAL ANIONS	CaCO3	ppm	200	215	160	185
Colloidal Silica	SiO_2	ppm	-	-	-	-
Dissolved Silica	SiO_2	ppm	18	16	12	20
Conductivity at 25^0C	-	Micro siemens/cm (maximum)	367	400	302	321
pH value at 25^0C	-		7.87	7.76	7.71	7.75
Total Suspended solids	-	ppm (maximum)	294	320	242	257
Turbidity		NTU (maximum)	2	2	5	2

TABLE-I

CLARIFIED WATER ANALYSIS

CONSTITUENTS	As	CONTENT
Calcium	$CaCO_3$	85.0 ppm
Magnesium	$CaCO_3$	94.0 ppm
Sodium + Potassium	$CaCO_3$	75.0 ppm
	$CaCO_3$	
Iron in Solution.	Fe	0.05 ppm
Hydrogen (FMA)	$CaCO_3$	- ppm
TOTAL CATIONS (except iron)	CaCO3	254.0 ppm
Bicarbonate	$CaCO_3$	160.0 ppm
Carbonate	$CaCO_3$	- ppm
Hydroxide	$CaCO_3$	- ppm
Sulphate	$CaCO_3$	20.0 ppm
Chloride	$CaCO_3$	52.0 ppm
Nitrate	$CaCO_3$	22.0 ppm
Phosphate		- ppm
Fluoride	$CaCO_3$	0.0 ppm
TOTAL ANIONS	$CaCO_3$	254.0 ppm
Reactive Silica	SiO_2	22.0 ppm
Colloidal Silica	SiO_2	0.0 ppm
Conductivity at 25°C	-	440 Micro siemens/cm (maximum)
pH value at 25°C	-	7.5 – 8.0
Turbidity		Not to exceed 15 NTU (maximum)

Note: The above Clarified Water Analysis shall be considered for DM Plant Design.

TABLE-II

RAW WATER ANALYSIS
(As Received)

Source : River Mahi (Jack-well/ canal)

(1) Jack-well/Canal Water Parameters

Sl. No.	Parameter	Unit	Result
1	pH	Unit	8.42
2	Turbidity	NTU	2.2
3	Conductivity	µMhos/cm	440
4	Total alkalinity as $CaCO_3$	ppm	152
5	Chloride as Cl	ppm	33
6	Total hardness as $CaCO_3$	ppm	134
7	Calcium Hardness as $CaCO_3$	ppm	52
8	Magnesium Hardness as $CaCO_3$	ppm	82
9	Silica as SiO_2	ppm	20
10	Total Dissolved solids as such	ppm	308.42
11	Sulphate as SO_4	ppm	12
12	Iron as Fe	ppm	0.031
13	Potassium		Not present
14	TSS	ppm	1-2

(2) Hypothetical Combination of Ions

Sl. No.	Parameter	As	CONTENT ppm
1	Calcium Hardness	$CaCO_3$	52
2	Magnesium Hardness	$CaCO_3$	82
3	Sodium	$CaCO_3$	79
4	Iron in Solution.	Fe	-
5	Manganese in solution	$CaCO_3$	-
6	Total Cations	$CaCO_3$	213
7	Bicarbonate	$CaCO_3$	152
8	Carbonate	$CaCO_3$	2
9	Hydroxide		-
10	Sulphate	SO_4	12.5
11	Chloride	$CaCO_3$	46.48
12	Nitrate	NO3	-
12	Fluoride	-	-
13	Total Anions	-	213

1X800 MW WANAKBORI TPS, UNIT-8

DRAWING/ DOCUMENTS DISTRIBUTION SCHEDULE

Sl. No.	Type of Document	Number of Copies	
		For Approval	Final
1	Drawings/Documents/Quality Plans etc.	6 Nos	14 Prints
2	Datasheets	6 Nos	14 Prints
3	Test Certificates & Reports	6 Nos	14 Prints
4	Erection/ Installation/ O&M Manuals	6 Nos	14 Prints
5	As Built Drawings/ Documents	6 Nos	14 Prints

NO	CHARACTERISTICS CHECKED (3)	CATE-GORY (4)	TYPE/METHOD OF CHECK (5)	FREQUENCY OF CHECK (6)	REFERENCE DOCUMENTS (7)	ACCEPTANCE NORMS (8)	FORMAT OF RECORD (9)	AGENCY P	AGENCY X	AGENCY V	SAMPLE SIZE (10)	SAMPLE SIZE (11)
	MATERIAL AND BOUGHT OUT SYMBOL											
	FAN BLADE TECH-NICALLIC)											
1	1.BESIK	CHEK. PROPS.	MA	CHEK. ANALYSIS	11/BATCH	INFR. SPECK.	INFR. SPECK.	INFRS. TC	3	-	2,1	CORRELATION REQD.
2	FAN BLADE (NCTALLIC)	PHYS., CHEK. PROPS.	MA	PHYS., CHEK. ANALYSIS	11/HEAT	IAPPD. DATA SHEET	IAPPD. DATA SHEET	ITC	3	-	12,11	-DO-
3	FAN HUB (CENTRE PORTION, SPOKES BRACES ETC.)	-DO-	CR	-DO-	-DO-	-DO-	-DO-	IIR	372	-	12,1	-DO-
4	DRIVE SHAFT & COUPLING	-DO-	CR	-DO-	-DO-	-DO-	-DO-	IIR	372	-	12,1	-DO-
5	REDUCTION GEAR UNIT - MAIN SHAFT, WHEEL, PINION, BEVEL P ARS, CASING	-DO-	CR	-DO-	11/CASE	-DO-	-DO-	IIR	372	-	12,1	-DO-
	1.SHAFT & GEAR BLANKS	SUB-SURFACE DEFECTS	CR	UT	1001	IASTM A388, BACK-WALL ECHOE 1001	IDEFECT ECHOE NOT MORE THAN 20% OF BACK WALL ECHOE FALL BK BACK WALL ECHOE NOT MORE THAN 20%	IIR	372	12,1	-	IFOR DIA 50MM AND ABOVE

P.NO.	C2S/SDP/12	SIGNATURE	DATE	DATE	DATE
N.NO./DATE	2011-11-05 01/JULY,88	NAME			
GE NO.		PARIT	CUSTOMER/CONSULTANT	BHEL	VENDOR

PROJECT | VENDOR | STANDARD QUALITY PLAN | ITEM | CODE NO./REV.

COMPONENT/SPECIFICATION	CHARACTERISTICS CHECKED (3)	CATEGORY (4)	TYPE/METHOD OF CHECK (5)	EXTENT OF CHECK (6)	REFERENCE DOCUMENTS (7)	ACCEPTANCE NORMS (8)	FORMAT OF RECORD (9)	AGENCY P	AGENCY Y	AGENCY V	REMARKS (11)
PAINTWORKS	1.PHYS., CHEM. PROPS.	KA	PHYS., CHEM. ANALYSIS	IS:2814 TABLE 2	APPD. DATA SHEET	APPD. DATA SHEET	LAB. REPORT	3/2	-	12,1	
	2.DIMENSIONS, VISUAL DEFECTS	KI	DIMENS., VISUAL EXAM.	IS:2654 TABLE 3	INFG. DRG.	INFG. DRG.	LOG BOOK	3/2	-	12,1	
	3.UNIFORMITY, WT., ADHESION, SURFACE DEFECTS OF ZINC COATING	CR	DIP. TEST, STRIP TEST, ADHESION TEST, VISUAL EXAM.	IS:5358	IS:5358, APPD. DATA SHEET	IS:5358, APPD. DATA SHEET	LOG	3/2	12,1	-	
FABRICATION (AT VENDOR COMPONENT)											
1.MATERIAL	1.DEFECTS	KA	VISUAL EXAM.	100%	TECH. SPECN. IS:2372	TECH. SPECN. IS:2372	IR	3/2	12,1	-	
	2.DIMENSIONS	KA	DIMENS.	RANDOM	-DO-	-DO-	IR				
2.PRESERVATIVE TREATMENT	1.PRESERVATIVE RETENTION & PENETRATION:	CR	ANALYSIS	LT/BATCH	IS:2372, IS:401	IS:2372	IR	3/2	12,1	-	
WIRES, WIRE MESH											
1.WIRES	1.PHYS., CHEM. PROPS.	KA	PHYS., CHEM. ANALYSIS, MEAS.	RANDOM	APPD. DATA SHEET	APPD. DATA SHEET	IC	3/2	-	12,1	
	2.UNIFORMITY, WT., ADHESION, SURFACE DEFECTS OF ZINC COATING	CR	DIP, STRIP, ADHESION TESTS, VISUAL EXAM.	IS:4826	APPD. DATA SHEET IS:4826	APPD. DATA SHEET IS:4826	IC	3/2	-	12,1	

P.P.	STRUCTURE	DATE	DATE		PAGE
DWG. NO./DATE	NAME				
REV. NO.	PARTY	CUSTOMER/CONSULTANT		VENDOR	

PROJECT: VINDHYACHAL

QUALITY ASSURANCE

STANDARD QUALITY PLAN

SYSTEM: 11EK.1 - COOLING TOWER

SL.NO. (1)	COMPONENT/OPERATION (2)	CHARACTERISTICS CHECKED (3)	CATEGORY (4)	TYPE/METHOD OF CHECK (5)	EXTENT OF CHECK (6)	REFERENCE DOCUMENTS (7)	ACCEPTANCE NORMS (8)	FORMAT OF RECORD (9)	AGENCY P (10)	AGENCY V (10)	AGENCY W (10)	REMARKS (11)
2.1	2.PIPES - MS,CRWI	11F APPLICABLE	SURFACE DEFECTS, PIN HOLES	CR	VISUAL EXAM., SPARK TEST	100%	IS:1182 PT.IV	IS:1182 PT.IV	TSR	3/7	12,1	-
	3.PIPE BEND		WASH, SIZE, SURFACE DEFECTS	MI	MEAS.,VISUAL EXAM.	RANDOM	INTG. ORG.	INTG. ORG.	MR	3/7	12,1	-
2.2	1.VALVES, GATES, ETC. -SUPPORTS, SPLASH BARS, AND OTHER ACCESSORIES	DIMENSIONS, WORKMANSHIP AND FINISH		-DO-	RANDOM	INTG. ORG./APPD. DATA SHEET	INTG. ORG./APPD. DATA SHEET	TSR	3/7	12,1	-	
2.3	VIBRATION STUDY	1.CONTACT RESISTANCE 2.CONTACT RATING 3.INSULATION RES. 4.DI-ELECTRIC STRENGTH 5.OPTION	MA	ELEC. TESTS	100%	APPD. DATA SHEET/ ORG.	APPD. DATA SHEET/ ORG.	TSR	3/7	12,1	-	
		6.DEGREE OF PROTECTION & VIBRATION TEST	MA	ELEC. TEST	AS PER TSPEC	-DO-	-DO-	CLEAR REPORT	3/7	-	12,1	
2.4	PIPES, FITTINGS	PIPE WORK	REFER STANDARD QUALITY PLAN FOR PIPES, FITTINGS & PIPE WORKS									
2.5	VALVES (ALL TYPES)		REFER RESPECTIVE STANDARD QUALITY PLANS									
2.6	PUMPS		REFER STANDARD QUALITY PLAN FOR CENTRIFUGAL PUMPS									
2.7	LIGHTING PLAN		REFER STANDARD QUALITY PLAN FOR CONTROL PANELS									

P.P.NO.	SIGNATURE	DATE		DATE	DATE
REV.NO./DATE	00/01-11-85	01/20.12.88	NAME		
SHEET NO.	2 OF 4		PARTY	CUSTOMER/CONSULTANT	

NO.	INSPECTION/OPERATION (2)	CHARACTERISTICS CHECKED (3)	CATE-GORY (4)	TYPE/METHOD OF CHECK (5)	EFFECT OF CHECK (6)	REFERENCE DOCUMENTS (7)	ACCEPTANCE NORMS (8)	FORMAT OF RECORD (9)	AGENCY P (10)	AGENCY V (10)	AGENCY W (10)	REMARKS (11)
15	CARDS	1.TYPE TESTS (EXCLUDING PRLS TESTS	KA	VERF. OF TYPE TEST CERT.	ES:1556	STD.SPECS., APPD. DATA SHEET ES:1556,IS:5931	TECH. SPECS., APPD. DATA SHEET ES:1556,IS:5931	TYPE TC	3	-	12,14	
		2.ROUTINE TESTS	KA	SELECT. TESTS	-DO-	-DO- IS:1556	-DO- IS:1556	ROUTINE TC	3	-	12,14	
		3.ACCEPTANCE TESTS	KA	-DO-	-DO-	-DO-	-DO-	ACCEPT. TC	3	-	12,1	
20	IN-PROCESS CONTROL											
21	FINISHED (COILED & ASSEMBLED/ENCASED	1.HARDNESS	KA	PHYS. TEST	SAMPLE	APPD.DATA SHEET/ IS:6560,STD.,IS:10811	APPD.DATA SHEET/ IS:6560,STD.,IS:10811	LOG BOOK/IR	3/2	-	12,14	1) TO 31 FOR GRP/EXP ONLY.
		2.PROFILE	CR	TEMPLATE/MEAS.	SAMPLE	IMFG.STD./DRG.	IMFG.STD./DRG.	IIR	3/2	-	12,1	
		3.DIMENSIONS	KA	MEASUREMENT	SAMPLE	-DO-	-DO-	IIR	3/2	-	12,1	
		4.DEFLECTION/PROOF LOAD CAPACITY	EX	DEFLECTION TEST/ PROOF LOAD TEST	100%	-DO-	IS0 PERM.DEFOR./ NO CRACK	IIR	3/2	12,1	-	
		5.WORKMANSHIP AND FINISH	KA	VISUAL EXAM.	100%	-DO-	-DO-	IIR	3/2	12,1	-	
		6.SURFACE DEFECTS OF HUB ENDS	KA	DPT	100%	INSPN 165	NO SURFACE DEFECT	IIR	3/2	12,1	-	10% NETALLIC BLADES ONLY
22	HUB, DRIVE SHAFT & COUPLING (BEFORE GALVANISING)	1.DIMENSIONS	KA	MEASUREMENT	100%	MFG.DRG./STD.	MFG.DRG./STD.	IIR	3/2	12,1	-	
		2.WORKMANSHIP AND FINISH	KA	VISUAL EXAM.	100%	-DO-	-DO-	IIR	3/2	12,1	-	
		3.SURFACE DEFECTS	KA	DPT	100%	INSPN 165	NO SURFACE DEFECT	IIR	3/2	12,1	-	
		4.STATIC, DYNAMIC RESIDUAL UNBALANCE	CR	STATIC, DYNAMIC BALANCING	100%	IS0 1940 IG 6.3	IS0 1940	IIR	3/2	12,1	-	
2.2.1	HUB, DRIVE SHAFT & COUPLING (AFTER GALVANISING)	1.UNIFORMITY, WT., ADHESION SURFACE DEFECTS OF ZINC COATING	CR	LOT, STRIP, ADHESION TESTS, VISUAL EXAM.	IS/BATCH IS:2633	APPD.DATA SHEET IS:2633	APPD.DATA SHEET IS:2633	IIR		-3/2	12,1	

P.O.	CONTRACT	SIGNATURE	DATE	DATE	DATE
REVISED (DD-MM-YY)		NAME			
PAGE NO. 21 OF 6		PARTY	CUSTOMER/CONSULTANT	DIEL	VENDOR

BUREAU VERITAS ELECTRONICS DIVISION
CORPORATE QUALITY ASSURANCE

PROJECT:
VENDOR:

STANDARD QUALITY PLAN

SYSTEM:
ITEM: COOLING TOWER

S.TA.T.	COMPONENT OR OPERATION	CHARACTERISTICS CHECKED (3)	CATE-GORY (C)	TYPE/METHOD OF CHECK (5)	EXTENT OF CHECK (6)	REFERENCE DOCUMENTS (7)	ACCEPTANCE NORMS (8)	FORMAT OF RECORD (9)	ASSEMBLY P	ASSEMBLY V	REMARKS (11)
(1)											
2.)	[illegible] COMPONENTS	1.WORKMANSHIP AND FINISH, DIMENSIONS	MA	VISUAL CHEK. MEAS.	100%	DWG.SPEC.	DWG.SPEC.	LOG.BOOK/IR	3/2	12,1	
2.1.1	GEARS, WORMS	1.FINAL HEAT TREATMENT CYCLE, HARDNESS, CASE DEPTH	MA	EVERY OF THE CHARGE MEAS.	100% RANDOM	INSPR.SPECK./ APPD.DATA SHEET	INSPR.SPECK./ APPD.DATA SHEET	THE CHART, LOG BOOK	3/2	12,1	
2.1.2	BEARINGS	1.UNIFORMITY OF CONTACT	MA	BLUE-MATCHING	100%	INSPR.SPECK.	INSPN.SPECK.	LOG BOOK	3/2	12,1	
2.1.3	SHAFT AND GEAR	1.SURFACE DEFECTS	MA	VIS.	100%	VISUAL AID	AND SURFACE DEFECTS	IR	3/2	12,1	
2.2	ASSEMBLY CHECK	FINAL TESTS									
2.3	FOR ASSEMBLY	DES WITH PART	CR	STATIC RESIDUAL UNBALANCE	100%	SPECIAL SPECIF.	AND RESIDUAL UNBALANCE	IR	1 2	1 -	
2.4	COMPLETE GEAR	1.GEAR RATIO, ORIENTATION, NOISE, TEMP. RISE, LEAKAGES	MA	VISUAL CHEK. NO LOAD RUNNING FOR 01 HR.	100%	DWG.SPEC., APPD. DATA SHEET	INSPG.SPEC., APPD. DATA SHEET, AND LEAKAGES	IR	3/2	12,1	
2.5	COMPLETE FAN ASSEMBLY	1.AIR DELIVERY 2.POWER CONSUMED 3.FAN EFFICIENCY 4.NOISE, VIBRATION	CR	PERFORMANCE TEST AS PER IS:12	100% AND PT 1,2	APPD.DATA SHEET TYPE-C/BULLETIN FOR COOLING TOWER INSTL. OF USA	TYPE TEST REPORT TYPE-C/BULLETIN FOR COOLING TOWER INSTL. OF USA	IR	2	1 -	IR AT SITE TYPE TEST REPORT, WITNESS WHICH

PREPARED:	SIGNATURE:	DATE:	DATE:	
REVIEWED:	NAME:			

CUSTOMER CONSULTANT: BUEC VENDOR:

STANDARD QUALITY PLAN — SYSTEM: COOLING TOWER

(1)	COMPONENT/ CHARACTERISTICS (2)	CHARACTERISTICS CHECKED (3)	CLASS-I CORT (4)	TYPE/METHOD OF CHECK (5)	CRITERI OF CHECK (6)	REFERENCE DOCUMENTS (7)	ACCEPTANCE NORMS (8)	FORMAT OF RECORD (9)	AGENCY P (10)	AGENCY X (10)	AGENCY Y (10)	REMARKS (11)
1.0	COMPLETE COOLING TOWER											
1.1	COMPLETE COOLING TOWER	PERFORMANCE TESTS, DIMENSIONS, WORKMANSHIP & FINISH	CR	PERFORMANCE TESTS (MEAS. VISUAL (EXAM.	1001	TECH.SPECN./APPD. DATA SHEET/DRG.	TECH.SPECN./APPD. DATA SHEET/DRG.	13	2			AS PER

10.7.80.	SIGNATURE		DATE	DATE	
REV. NO. 01/10/81-31-85	NAME				
PAGE 1 OF 1	STATE	CUSTOMER/CONSULTANT	QUEL	VENDOR	

STANDARD QUALITY PLAN

PROJECT :
VENDOR :

SYSTEM :
ITEM : BUTERFLY VALVES

S N	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9		10		11
1.0	RAW MATERIAL BOUGHT-OUT CONTROL											
1.1	BODY & SHAFT SEAT RING	1 CHEM COMPOSITION & PHYS. PROPS	MA	CHEM. & PHYS TESTS	ONE/HEAT BATCH	TECH SPEC APPD DRG	TECH SPEC / APPD DRG.	LAB REPORT / INSPN REPORT	3/2		2.1	CORRELATION NOT REQUIRED FOR GREY CI FOR OTHER POURING WITNESS BY BHEL
		2 INTERNAL DEFECTS OF SHAFT DIA ≤ 50MM	CR	UT	100%	ASTM A388 & XS 100%		INSPN REPORT	3/2	2.1		MATERIAL IDENTIFICATION OF SHAFTS BY BHEL
												NOTE: COMPLIANCE TO (1) MS & (2) CORRELATION & IDENTIFICATION FOR SS
		3 CASTING DEFECTS/ FORGING DEFECT	MA	1. VISUAL 2. MPI	100% 100%	MSSSP65 TECH. SPEC. APPD DATA SHEET	MSSSP65 TECH. SPEC / APPD DATA SHEET	-DO-	3/2		2.1	
1.2	DISC & SHAFT SEAL	1. VISUAL INSPECTION	MA	VISUAL	100%	TECH SPEC	TECH. SPEC	LOG BOOK	3/2			COMPLIANCE TO
		2. DIMENSIONS	MA	MEAS	100%	-DO-	-DO-	-DO-	3/2			
		3. HARDNESS	MA	MEAS	100%	-DO-	-DO-	TEST CERT.	3/2			
		4. O ZONE RESISTANCE	MA	TESTING	1/BATCH	-DO-, ASTM D1149	-DO-, RELV. STD.	-DO-	3/2			
		5. AGEING TEST	MA	TESTING	-DO-	IS 3400	-DO-	-DO-	3/2			
1.3	COMPRESSED RANGES	1. CHEM., PHYS. PROPERTIES	MA	CHEM., PHYS. TEST	1/HEAT	APPD. DRG. /DATA SHEET	APPD. DRG. /DATA SHEET	LAB. REPORT, INSPN. REPORT	3/2			COMPLIANCE TO FOR MATERIAL IDENTIFICATION BY BHEL

			PREPARED BY	REVIEWED BY	APPROVED BY	ACCEPTED BY
O.P NO	PEM/MSE/SQP/03		PEM	CQS & PEM	PEM	VENDOR
REV. NO/DATE	00/8-10-97	NAME				NAME
		SIGNATURE				SIGN
PAGE NO.	1 OF 7	DATE				DATE

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT :
VENDOR

SYSTEM :
ITEM BUTERFLY VALVES

S NO	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9		10		11
		2 DIMENSION	MA	MEASUREMENT	100%	-DO-	-DO-	INSPN. REPORT	3/2	2/1	-	
		3. INTERNAL DEFECTS FOR THICKNESS 50MM AND ABOVE	CR	UT	100%	ASTM A435	ASTM A435	INSPN. REPORT	3/2	2/1	-	
		4 HEAT TREATMENT		SRM / CHART	100%	STANDARD PRACTICE	STANDARD PRACTICE	CORRELATED SRM / T. CHART	3/2	-	-	
4	RAW MATERIAL (APPD) MAKE	1 VERIFICATION OF MAKE GRADE	MI	VISUAL	100%	TECH SPEC / DATA SHEET	TECH SPEC DATA SHEET	INSPN. REPORT	3/2	2	1	
5	OPERATING SHAFT (GEAR BOX DRIVE)	COMPOSITION	MA	CHEM ANALYSIS	ONE/BATCH	AS PER MATERIAL SPEC	AS PER MATERIAL SPEC	TC'C'	3	3	2/1	
5.1	GEAR WORM SHAFT	HARDNESS	MA	MEAS	SAMPLING	AS PER APPD DRG / MATL SPEC	AS PER APPD DRG / MATL SPEC	TC'C'	3	3	2/1	
		DIMENSION	MA	-DO-	-DO-	-DO-	-DO-	REPORT	3	3	2/1	UT ON GEAR BLANKS
		NDT	MA	UT / MPI	100%	-DO-	-DO-	TC'C'	3	3/2	2/1	UT ON SHAFTS / DIMENSIONAL
5.2	HYDRAULIC TEST OF GEAR BOX AT RATED TORQUE	TORQUE TRANSMITTING	MA	TESTING	ONE/TYPE	AWWA C504 STD 87	AWWA C504 STD 87	TC'C' CMP	3	3/2	2/1	MPI OR LPI ON GEAR & SHAFT AFTER MACHINING
												SEAL DAMAGE TO TEFLON FACE OF GEAR
5.3	ELECTRICAL ACTUATORS	1 TORQUE TESTING & SETTING OF TORQUE SWITCH	MA	MECH / ELEC TESTS	100%	TECH SPEC / APPD DRG / DATA SHEET / IS 9334	APPD DRG / DATA SHEETS / IS-9334	INSPN. REPORT	3	2/1	-	BHEL TO WITNESS : PER TYPE IF QTY IS MORE THAN 10/TYPE

		PREPARED BY	REVIEWED BY	APPROVED BY	ACCEPTED BY VENDOR
Q.P NO	PEM/MMSE/SQP/03	PEM	COS & PEM	PEM	
REV NO/DATE	00/8-10-97	NAME			NAME
		SIGNATURE			SIGN
PAGE NO	2 OF 7	DATE			DATE

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BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT :
VENDOR :

SYSTEM :
ITEM : BUTERFLY VALVES

SR NO	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY	REMARKS
1	2	3	4	5	6	7	8		10		
	2. TRAVEL/STROKE	MA									
	3. TRAVEL TIME	MA									
	4. OPERATION OF LIMIT SWITCH										
	5. MANUAL OPERATION THROUGH HAND WHEEL	MA									
	6. OPERATION TEST WITH POWER SUPPLY VARIATION, ENERGISE TO OPEN/CLOSE, CURRENT DRAWN	MA									
	7. IR : MV, IR	MA									
	8. DEGREE OF PROTECTION	MA	WATER DUST TEST	1/TYPE	-DO-	-DO-	3/6 PARTY TEST CERT	3		2.1	
6	1. CHEM & PHYS. PROPS	MA	CHEM. PHYS TESTS	1/HEAT/ BATCH	APPD. DRG /DATA SHEET	APPD. DRG /DATA SHEET	TEST CERT	3/2		2.1	
	2. HARDNESS	MA	MEAS	100%	-DO-	-DO-	-DO-	3/2		2.1	
	3. DIMENSIONS	MA	MEAS.	100%	MFG. DRG	MFG. DRG.	LOG BOOK	3/2			
	4. LEAK TIGHTNESS	MA	HYDRO TEST	100%	APPD. DATA SHEET	NO LEAKAGE	INSPN. REPORT	3/2	2.1		
	1. CHEM. PHYS. PROPS.	MA	CHEM. PHYS. TESTS	1/HEAT	APPD. DATA SHEET	APPD. DATA SHEET	TEST CERT.	3/2	2	1.1	
	2. DIMENSION	MA	MEASURE-MENT	100%	MFG. DRG.	MFG. DRG.	LOG SHEET	3/2			

			PREPARED BY	REVIEWED BY	APPROVED BY		ACCEPTED BY
			I & C PEM	QOS & PEM	PEM		VENDOR
Q.P. NO	PEM/RISE/SQP/03	NAME				NAME	
REV. NO DATE	00/8-10-97	SIGNATURE				SIGN	
PAGE NO	3 OF 7	DATE				DATE	

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT :
VENDOR :

SYSTEM :
ITEM : BUTTERFLY VALVES

S NO	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
	CASTING	1.0 CHEM PHYS PROPS	MA	CHEM PHYS TESTS	1/BATCH	MATL SPEC /APPD ORG.	MATL SPEC /APPD ORG	LOG BOOK	3/2	2	1	
		2.0 DIMENSIONS	MA	MEAS.	100%	MFG ORG.	MFG ORG	-DO-	3/2	2	1	
		3.0 HARDNESS	MA	MEAS	100%	-DO-	-DO-	TEST REPORT	3/2	2	1	
2.0	IN-PROCESS CONTROL											
2.1	BODY & INSP	1.0 SURFACE DEFECTS	MA	PT	100%	ASTME-165	NO DEFECTS	INSPN REPORT	3/2	2	1	
		2.0 DIMENSIONS	MA	MEAS	100%	MFG ORG	APPD ORG	LOG BOOK	3/2	-	-	
		3.0 LEAK TIGHTNESS OF BODY	MA	HYDRO TEST	100%	TECH. SPEC /APPD ORG'/DATA SHEET	NO LEAKAGE	INSPN REPORT	3/2	-	2.1	
2.2	SHAFT	1.0 DIMENSIONS	MA	MEAS	100%	MFG ORG	APPD ORG	LOG BOOK	3/2	-	-	
		2.0 SURFACE DEFECTS AT DISC	MA	PT	100%	ASTME-165	NO SURFACE DEFECTS	INSPN REPORT	3/2	-	2.1	
2.3	SEAT RING	1.0 DIMENSIONS	MA	MEAS	100%	MFG ORG	APPD ORG	LOG BOOK	3/2	-	-	
		2.0 BOND STRENGTH IN CASE OF RUBBER SEAT	MA	PEEL STRENGTH	ONE/BATCH	ASTMD 429	ASTMD429	TEST REPORT	3/2	-	2.1	
		3.0 HARDNESS	MA	MEAS	100%	MFG ORG	MFG ORG	-DO-	3/2	2	1	

			PREPARED BY	REVIEWED BY	APPROVED BY	ACCEPTED BY
			PEM	COS & PEM	PEM	VENDOR
O.P. NO.	PEM/MSE/SOP/03	NAME				NAME
REV NO/DATE	00/8-10-97	SIGNATURE				SIGN.
PAGE NO.	4 OF 7	DATE				DATE

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT :
VENDOR

SYSTEM :
ITEM : BUTTERFLY VALVES

S NO	COMPONENT OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9		10		11
		1 SURFACE DEFECTS	MA	RT	100%	ASME 165	NC SURFACE DEFECTS	-DO-	W2	2	1	
			MA	PHYS TESTS	100%	ASME IX	ASME IX	FORMATS OF ASME IX	W2	2.1	1	
2.2	WELDED FLANGES-OUTER FLANGES	1 FIT UP	MA	MEAS. TEMPLATE, VISUAL	100%	MFG DRG	MFG DRG	LOG BOOK	W2		2.1	FOR FABRICATED FLANGES ONLY FILMS TO BE SHOWN TO ME/I
		2 INTERNAL DEFECTS OF WELDMENTS	CR	RT/UT	100%	ASME VIII DIV.1	ASME VIII DIV 1	RADIO GRAPH REPORT FILMS	W		2.1	
2.4.1	WELDING PROCEDURE SPECIFICATION	CORRECTNESS	MA	EXAM	100%	ASME SEC IX	ASME SEC IX	QW 482 OF ASME SEC IX	W2		2.1	
2.4.2	WELDING PROCEDURE QUALIFICATION	WELD SOUNDNESS	MA	VISUAL, PHYS. TESTS RT (AS APPLICABLE)	100%	ASME SEC.IX	ASME SEC.IX	QW483 OF ASME IX	W2	2.1		WELDING PROCEDURE APPROVED BY EIL AS WELL AS 3RD PARTY (LLOYDS, BVQI OR EQ.)
2.4.3	WELDER PERFORMANCE QUALIFICATION	WELL SOUNDNESS	MA	-DO-	100%	ASME SEC. IX	ASME SEC.IX	QW484 OF ASME	W2	2.1		

		PREPARED BY	REVIEWED BY	APPROVED BY		ACCEPTED BY
		PEM	QOS & PEM	PEM		VENDOR
Q.P. NO.	PEM/MSE/SQP/03					
REV. NO/DATE	00/0.10-97	NAME				NAME
PAGE NO.	5 OF 7	SIGNATURE				SIGN
		DATE				DATE

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT
VENDOR

SYSTEM :
ITEM : BUTERFLY VALVES

S NO	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY S	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9		10		11
2.4.4	WELD FIT-UPS	1.DIMENSION/ALIGNMENT	MA	MEAS. VISUAL EXAM	100%	WPS, MFG. DRAWING	WPS, MFG. DRAWING	IR/LOG BOOK	W2	-	-	
2.4.5	ROOT RUNS	1 SURFACE DEFECTS	MA	PENETRANT TEST	100%	ASTME 165	NO SURFACE DEFFECT	-DO-	2,3	-	2	
2.4.6	WELDMENTS	1 SURFACE DEFECTS	MA	-DO-	100%	ASTME 165	ASME-VIII, DIV. I,	INSPN. REPORT	W2	2,3	-	
2.4.7	BUTT WELDS	INTERNAL DEFECT	MA	UT/RT	100%			IR	W2	-	2,3	WITNESSING OF U T
2.4.8	SR WELDING	SR		SR	100%	ASME SEC. V	ASME SEC VIII, DIV I	IR	W2	-	2,3	
2.5	FINAL ASSEMBLY											
2.5.1	VERIFICATION OF ALL PREVIOUS TEST AND DOCUMENTS	VERIFICATION OF RECORDS	MA	-DO-	100%	TECH. SPEC.	TECH. SPEC		2	-	1	
2.6	TESTS (HYDRAULIC)	1 BODY TEST 2 DISC STRENGTH 3 SEAT LEAKAGE 4 PERFORMANCE TEST	MA MA MA MA	HYDRO TEST HYDRO TEST -DO- PERFORMANCE	100% 1/TYPE 100% 3 TIMES UNDER NO LOAD/FLOW COND. BOTH MANUAL & THROUGH OPERATORS	TECH. SPEC/REL STD -DO- -DO- -DO-	TECH/SPEC/REL STD -DO- -DO- -DO-	TEST CERT -DO- -DO- -DO-	W2 W2 W2 W2	2,3 2,3 2,3 2,3	- - - -	

			PREPARED BY	REVIEWED BY	APPROVED BY	ACCEPTED BY
O.P NO	PEM/MSE/SOF/03		PEM	COS & PEM	PEM	VENDOR
REV N DATE	00/8-10-97	NAME				NAME
		SIGNATURE				SIGN.
PAGE NO.	6 OF 7	DATE		2.11		DATE

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT
VENDOR

SYSTEM
ITEM BUTERFLY VALVES

	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9				
		3 TESTING OF ACCESSORIES	MA	TESTING	100%	TECH SPEC /REL STD	TECH SPEC /REL STD	TC	3	2		
		4 PROOF OF DESIGN TEST	MA	TESTING	1 TYPE	DO	DO	TC	3	2		NOTE: IF CYCLE LIFE TEST ALREADY CONDUCTED ON SIMILAR SIZE RANGE & TYPE OF VALVE REPORT SHALL BE SUBMITTED
6	SHIPPING RELEASE											
7	FINAL INSPECTION	1 OVERALL DIMENSIONAL	MA	MEASUREMENT	100%	APPD DRG	APPD DRG		3	2		
		2 DOCUMENTATION VIEW	MA	REVIEW	100%	TECH SPEC APPD DRG	TECH SPEC APPD DRG		3			
		3 CLEANLINESS	MA	VISUAL	100%	DO	DO		3	2		
		4 NAME PLATE DETAILS	MA	VISUAL	100%	DO	DO		3			
		5 STAMPING	MA	STAMPING	100%	DO	DO		3			
4	PAINTING	1 SURFACE PREP	M	VISUAL MEAS.	100%	TECH SPEC	TECH SPEC	INSPN REPORT	3		1	
		2 UNIFORMITY & THICKNESS	M	DO	100%	DO	DO	DO	3		1	

			PREPARED BY	REVIEWED BY	APPROVED BY		ACCEPTED BY VENDOR
Q.P. NO.	PEM/MSE/SOP/03		PEM	CQS & PEM	PEM		
REV NO/DATE	00/8-10-97	NAME				NAME	
		SIGNATURE				SIGN	
PAGE NO	7 OF 7	DATE				DATE	

	QUALITY PLAN	CUSTOMER:	PROJECT:		SPEC. NO :
		BIDDER/VENDOR	QP NO.PE-QP-999-100-M004	REV. 00 DT.31.03.99	SPEC. TITLE
	SHEET 1 OF 3	SYSTEM POWER CYCLE/ LP VALVES	ITEM: GATE/ GLOBE VALVE		SECTION VOLUME

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE-GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.0	MATERIALS											
1.1	BODY,BONNET, YOKE,WEDGE/DISC, SPINDLE, BODY SEAT, BACK SEAT, THRUST PLATE	1. PHYS,CHEM,PROPS	MA	PHYS,CHEM. TESTS	ONE/HEAT	APPD. DRG./ TECH.SPEC.	APPD. DRG./ TECH.SPEC.	TEST CERT.	3/2	2	1	CORRELATION REQD. FOR BODY BONNET, SPINDLE - FOR GREY C.I. ONLY PHYS. TEST.
		2. HEAT TREATMENT	MA	REVIEW OF H.T. CHART	100%	-DO-	-DO-	H.T. CHART	3/2	2	1	
		3. SURFACE DEFECTS	MA	VISUAL	100%	MSS-SP-55	MSS-SP-55	INSPN. REPORT	3/2	2	1	
1.2	BODY & BONNET FOR RATING 900 & ABOVE (ALSO FOR LOWER RATING IF REQUIRED IN SPEC.)	1. SURFACE DEFECTS	CR	PT/MT	100%	ANSI B16.34 AND TECH. SPEC.	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	2,1	-	
		2. SUB-SURFACE DEFECTS	CR	RT/UT	100%	ANSI B16.34 AND TECH. SPEC.	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	-	2,1	FILM REVIEW BY BHEL
1.3	ACTUATORS 1. ELECTRIC ACTUATORS	1. TORQUE TESTING & SETTING OF TORQUE SWITCH	MA	}MECH., ELEC. }TESTS	100%	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334	APPD. DRG./ DATA SHEET./ IS:9334	INSPN. REPORT	3	2,1	1 *	*BHEL TO WITNESS IF QTY. MORE THAN 10/ TYPE
		2. TRAVEL/STROKE	MA	}								
		3. TRAVEL TIME	MA	}								
		4. OPERATION OF LIMIT SWITCH	MA	}								
		5. MANUAL OPERATION THROUGH HAND WHEEL	MA	}								
		6. OPERATION TEST WITH POWER SUPPLY VARIATION ENERGISES TO OPEN/CLOSE	MA	}								
		7. IR,HV,IR	MA	}								
		8.DEGREE OF PROTECTION	MA	WATER, DUST TEST	1/TYPE	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334	APPD. DRG./ DATA SHEET/ IS:9334	3RD PARTY TEST CERT.	3	-	2,1	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

	QUALITY PLAN	CUSTOMER:	PROJECT:		SPEC. NO :
		BIDDER/VENDOR	QP NO.PE-QP-999-100-M004	REV. 00 DT.31.03.99	SPEC. TITLE
	SHEET 2 OF 3	SYSTEM POWER CYCLE/ LP VALVES	ITEM: GATE/ GLOBE VALVE		SECTION VOLUME

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE-GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
	2. PNEUMATIC ACTUATORS	1. LEAK TIGHTNESS	CR	PNEUMATIC TEST AT 1.2 X DESIGN	100%	APPD. DATA SHEET/MFG. STD.	NO LEAKAGE	INSPN. REPORT	3	2,1	1*	*BHEL TO WITNESS IF QTY. MORE THAN 10/ TYPE
		2. ACCURACY	CR	CALIBRATION	100%	-DO-	APPD. DATA SHEET/MFG. STD.	CALIBRATION REPORT	3	2,1	1*	
		3. SIMULATION (OPERATION, AIR TO OPEN/CLOSE)	CR	OPERATION AT RATED PRESSURE	100%	-DO-	-DO-	INSPN. REPORT	3	2,1	1*	
2.0	SS/STELLITE DEPOSIT ON DISC / BODY SEAT/BACK SEAT	1. SURFACE DEFECTS	CR	P.T	100%	ASTME:165 & TECH.SPEC.	ANSI B16.34 & TECH.SPEC.	-DO-	3/2	2,1	2,1	FOR 900 CLASS & ABOVE TO BE WITNESSED BY BHEL
3.0	IN-PROCESS INSPECTION											
3.1	MACHINING OF ALL COMPONENTS	1. DIMENSIONS, WORKMANSHIP AND FINISH	MA	MEAS.,VISUAL	100%	MFG.DRG.	MFG.DRG.	LOG BOOK	3/2	-	-	
3.2	WEDGE/DISC, BODY SEAT RING, BACK SEAT, SPINDLE, THRUST PLATE	1. HARDNESS	MA	TESTING	100%	APP.DRG.	APP. DRG./ ANSI B16.34	TEST CERT.	3/2	-	2,1	
3.3	SPINDLE, BODY SEAT RING, WEDGE/DISC, BACK SEAT	1. SURFACE DEFECTS	CR	P.T.	100%	ANSI B16.34 AND TECH. SPEC./	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	-	2,1	
3.4	WEDGE/DISC & SEAT RING, SPINDLE AND BACK SEAT	1. LAPPING	CR	BLUE MATCHING	100%	UNIFORM METAL TO METAL CONTACT		INSPN. REPORT	3/2	-	2,1	
4.0	ASSEMBLY	1. DIMENSIONS	MA	MEAS.	100%	APPD.DRG.	APPD.DRG.	-DO-	3/2	2,1	-	
		2. WEAR TRAVEL	MA	MEAS.	100%	-DO-	-DO-	-DO-	3/2	2,1	-	FOR GATE VALVES ONLY
		3. VALVE LIFT	MA	MEAS.	100%	-DO-	-DO-	-DO-	3/2	2,1	-	
5.0	TESTING											
5.1	BODY, SEAT, BACK SEAT	1. LEAK TIGHTNESS OF BODY	CR	HYDRAULIC TEST	100%	APPD. DRG./ TECH. SPEC.	NO LEAKAGE	I.R./ IBRTC (IF REQD)	3/2	2,1	-	
		2. LEAK TIGHTNESS OF BACK SEAT AND SEAT	CR	-DO-	100%	-DO	-DO-	-DO-	3/2	2.1	-	
		3. LEAK TIGHTNESS OF SEAT	CR	PNEUMATIC TEST	100%	-DO	-DO-	-DO-	3/2	2,1	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

	QUALITY PLAN	CUSTOMER:	PROJECT:		SPEC. NO :
		BIDDER/VENDOR	QP NO.PE-QP-999-100-M004	REV. 00 DT.31.03 99	SPEC. TITLE
	SHEET 3 OF 3	SYSTEM POWER CYCLE/ LP VALVES	ITEM: GATE/ GLOBE VALVE		SECTION VOLUME

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE-GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
5.2	SEAT & BACK SEAT FOR MOTORISED/ PNEU. VALVES WITH ACTUATOR	1. LEAK TIGHTNESS OF SEAT	CR	HYDRUALIC TEST	100%	APPD. DRG./ TECH. SPEC.	NO LEAKAGE	I.R./ IBRTC (IF REQD)	3/2	2.1	-	
5.3	OPERATION AL TESTING											
	1. MANUALLY OPERATED VALVES	1. SMOOTH & FULL OPENING AND CLOSING	CR	MANUAL	100%	TECH. SPEC.	SMOOTH OPERATION OF VALVES & CLEAR BORE	INSPN. REPORT	3/2	2,1	-	
	2.MOTOR /PNEU OPERATED VALVES	1. ASCENDING& DESCENDING LIFT CHARACTERISTIC	CR	ELEC.	100%	APP. DRG./ TECH. SPEC./ IS:9334	APP. DRG./ TECH. SPEC./ IS:9334	INSPN. REPORT	3/2	2,1	-	
		2. LIMIT/TORQUE SWITCH SETTING FOR OPENING AND CLOSING TIME	CR	ELEC.	100%	APP. DRG./ TECH. SPEC./ IS:9334	TECH. SPEC./ APPD.DRG	INSP. REPORT	3/2	2,1	-	
6.0	COMPLETE VALVES	1. OVERALL DIMENSION	MA	MEAS	SAMPLE	APPD.DRG	APP.DRG.	-DO-	3/2	2,1	-	
7.0	END CONNECTION DETAILS	1. DIMENSIONS	MA	MEAS.	100%	APPD. DRG. / RELV.STD	APPD. DRG. / RELV.STD	-DO-	3/2	2,1	-	
		2. SURFACE DEFECTS FOR B.W. ENDS	CR	PT	100%	ASTME:165	NO DEFECTS	TEST CERT.	3/2	2	1	
8.0	FINAL INSPECTION	1. CLEANLINESS & COMPLETENESS	MA	VISUAL	100%	APPD. DRG./ TECH. SPEC.	APPD. DRG./ TECH. SPEC	INSPN. REPORT	3/2	-	2,1	
9.0	PAINTING	1. SURFACE PREPARATION	MI	VISUAL	100%	TECH. SPEC.	TECH. SPEC.	INSPN. REPORT	3/2	-	2,1	
		2. UNIFORMITY & THICKNESS	MI	MEASUREMENT	100%	-DO-	-DO-	-DO-	3/2	2	1	
10.0	PACKING	AS PER BHEL TECH. SPEC	MA	VISUAL	100%	AS PER BHEL TECH. SPEC.	AS PER BHEL TECH. SPEC	-DO-	3/2	-	2,1	

ABBREVIATIONS

CR = CRITICAL CHARACTERISTIC
MA =MAJOR CHARACTERISTIC
MI = MINOR CHARACTERISTIC

P = PERFORMED BY 1 = PURCHASER (BHEL)2

W = WITNESSED BY = VENDOR

V = VERIFIED BY 3 = SUB VENDOR OF THE VENDOR

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

QUALITY PLAN SHEET 1 OF 3	CUSTOMER :	PROJECT :			SPEC. NO
	BIDDER/VENDOR	QP NO.PE-QP-999-100-MO41	REV.00 DT. 31.03.99		VOLUME: II-B
	SYSTEM:	ITEM: PIPES & FITTINGS			SECTION D

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.0.0	MATERIAL CONTROL											
1.1.0	PIPES (MILL MADE)	1. PHY., CHEM. PROPS, DIMENSIONS, SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE), LEAK TIGHTNESS	MA	PHY. CHEM. TESTS MEASUREMENTS, VISUAL EXAM, VERI. OF HT CHART HYDRO TEST	TECH. SPEC., IS:4711	APPD. DATA SHEET/ TECH. SPEC.	APPD. DATA SHEET/ TECH. SPEC.	MFR.TC/ LAB REPORT	3	-	2,1	SAMPLE IDENTIFICATION BY BHEL
1.2.0	FITTINGS	1. PHY. CHEM. PROP.,	MA	PHY., CHEM. TESTS	1/HEAT	-DO-	-DO-	-DO-	3/2	-	2,1	-DO-
		2. DIMNS., SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE)	MA	MEASUREMENTS, VISUAL EXAM, VERI. OF HT CHART	100%	-DO-	-DO-	-DO-	3/2	-	2,1	
1.3.0	PLATE FOR FLANGES, FABRICATED PIPING AND FORGINGS FOR FLANGES	1. PHY. CHEM. PROP.,	MA	PHY., CHEM. TESTS	1/CAST	-DO-	-DO-	-DO-	3	-	2,1	-DO-
		2. DIMNS , SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE)	MA	MEASUREMENTS, VISUAL EXAM VERI. OF HT CHART	100%	-DO-	-DO-	-DO-	3	-	2,1	
2.0.0	IN PROCESS CONTROL											
2.1.0	PIPES, FITTINGS, FLANGES - MACHINING, BENDING	1. DIMNS, INCLUDING THINNING, OVALITY, FINISH, WRINKLES ETC.	MA	MEASUREMENTS, VISUAL EXAM.	100%	MANUFAC-TURING DRG.	MANUFAC-TURING DRG.	I. R	3/2	-	2,1	
2.2.0	WELDING PROCEDURE SPECIFICATION	1. CORRECTNESS	MA	EXAM	100%	IS:7307/ ASME - IX	IS:7307/ ASME - IX	FORMAT OF IS:7307/ ASME - IX	3/2	-	2,1	
2.3.0	PROCEDURE QUALIFICATION AND WELDER'S QUALIFICATION	1. WELD SOUNDNESS	MA	PHY. TESTS	ASME IX IS:7310 IS:7307	IS:7310/ ASME - IX	IS:7310/ ASME - IX	FORMAT OF IS:7310/ ASME - IX	3/2	2,1	-	
2.4.0	WELD FIT-UPS	1. DIMNS.,	MA	MEASUREMENT,	100 %	W.P.S.	W.P.S.	I.R	3/2	2	1	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

BHEL	**QUALITY PLAN** SHEET 2 OF 3	CUSTOMER :		PROJECT :			SPEC. NO					
		BIDDER/VENDOR		QP NO.PE-QP-999-100-MO41	REV.00 DT. 31.03.99		VOLUME: II-B					
		SYSTEM:		ITEM: PIPES & FITTINGS			SECTION D					
S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
		ALIGNMENT, ORIENTATION		VISUAL		APPD. DRGS.	APPD. DRGS.					
2.5.0	**WELDS**											
	A) BUTT WELDS WITH JOINT EFFICIENCY OF 1.0 & 0.9											
	I) ROOT RUN	I) WELD DEFECTS	MA	PENETRANT TEST	100%	IS:3658/ ASTM E 165	ASME VIII DIV.I ASME B 31.1	INSPN. REPORT	3/2	2	1	
	ii) FINAL RUN	I) WELD DEFECTS	MA	-DO-	100%	-DO-	-DO-	-DO-	3/2	2/1	-	
				RADIOGRAPHY TEST	100% FOR JT. EFF. 1.0 & 10% FOR JT. EFF. 0.9	ASME 8 31.1	ASME B 31.1	-DO-	3/2	-	2/1	FILMS TO BE SHOWN TO BHEL FOR APPROVAL
	B) OTHER BUTT WELDS WITH JOINT EFF. LESS THAN 0.9	1. WELD DEFECTS (FOR ROOT RUN & FINAL RUN)	MA	PENETRANT TEST	100%	IS:3658/ ASTM E 165	ASME B 31.1	INSPN. REPORT	3/2	2,1	-	
3.0 0	COMPLETE PIPE WORK & PIPES INCLUDING GALVANIZED/ RUBBER LINED PIPING (BEFORE GALVANIZING/ RUBBER LINING)	1. WORKMANSHIP AND FINISH, DIMNS., ORIENTATION, LEAK TIGHTNESS	CR	MEAS, VISUAL, HYDRO TEST AT 1.5 X DESIGN PRESS.	100%	APPD. DRGS.	APPD. DRGS., NO LEAKAGE	I.R.	3/2	2,1	-	
3.1.0	COMPLETE PIPE WORK (DULY GALVANIZED AS APPLICABLE)	1. FREEDOM FROM SURFACE DEFECTS	MA	VISUAL	100%	IS:4736/ IS 2629 & TECH. SPECN.	IS:4736/ IS 2629 & TECH. SPECN.	INSPN. REPORT	3/2	2,1	-	
		2. UNIFORMITY OF COATING	MA	DIP TEST	SAMPLING AS PER IS	IS 2633 & TECH. SPECN.	IS 2633 & TECH.	-DO-	3/2	2,1	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

	QUALITY PLAN SHEET 3 OF 3	CUSTOMER :	PROJECT :		SPEC. NO
		BIDDER/VENDOR	QP NO.PE-QP-999-100-MO41	REV.00 DT. 31.03.99	VOLUME: II-B
		SYSTEM:	ITEM: PIPES & FITTINGS		SECTION D

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
							SPECN.					
		3. MASS OF ZINC COATING	MA	STRIP TEST	-DO-	IS 4736/ IS 6745 & TECH. SPECN.	IS 4736 & TECH. SPECN.	-DO-	3/2	2,1	-	
		5. ADHESION	MA	ADHESION TEST	-DO-	IS-2629/ IS 4736 & TECH. SPECN.	IS-2629/ IS 4736 & TECH. SPECN.	-DO-	3/2	2,1	-	
3.2.0	COMPLETE PIPE WORK (RUBBER LINING AS APPLICABLE)	——— AS PER QUALITY PLAN FOR RUBBER LINING————										
4.0.0	PAINTING AND PACKING	1. SURFACE PREPARATION, DFT, NO. OF COATS, SOUNDNESS OF PACKING, MARKING ETC.	MA	VISUAL EXAM, MEASUREMENT	100%	APPD. PROCEDURE	APPD. PROCEDURE	I.R, MFRS CHECK LIST	3/2	-	2,1	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

	MANUFACTURERS NAME & ADDRESS	STANDARD QUALITY PLAN			PROJECT
BHEL	(AS PER BHEL APPROVED VENDOR LIST)	ITEM: Chain Pulley Block With Trolley	QP NO		PACKAGE
			REV	0	PROJECT No
			DATE	20.02.2001	CONTRACTOR
			PAGE	1 of 3	

Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY M	AGENCY C	AGENCY N	REMARKS
1	2	3	4	5	6	7	8	9		** 10			11
1	RAW MATERIAL & B/OUT ITEMS:												
1	HOOKS	DIMENSIONS	MA	MEASUREMENT		IS 8610 GR M/	IS 8610 GR M/P	T.C.		P	-	-	
		CHEMICAL COMPOSITION	MI	LAB ANALYSER									
		IDENTIFICATION & CORELATION WITH TC	MA	VERIFICATION		DRAWING	DRAWING & SPECIFCATION						
1	LOAD CHAIN	DIMENSIONS		MEASUREMENT	100%	IS 6216	IS 6216	MFR'S TC		P	-	-	
		BREAKING STRENGTH		TENSILE TEST									
1	RAW MATL FOR GEAR/RATCHET PAWL/RATCHET WHEEL	CHEMICAL COMPOSITION	MA	LAB ANALYSIS	ONE SAMPLE PER LOT	SPECS AS PER APPD. DRG.	RELEVANT STANDARD	TC		P			
1	LOAD CHAIN WHEELS	TENSILE STRENGTH	MA	TENSILE TEST	ONE SAMPLE PER LOT	SPECS AS PER APPD. DRG.	RELEVANT STANDARD	TC		P			

LEGNDS

* RECORDS INDENTIFIED WITH 'TICK'( ) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION

** M: MANUFACTURER/SUBCONTRACTOR
C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL)
N: CUSTOMER
INDICATE 'P' PERFORM"W" WITNESS AND "V" VERIFICATION AS APPROPRIATE " CHP" CUSTOMER SHALL IDENTIFY IN COLUMN"N"

MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	REVIEWED BY	
SIGNATURE			NAME & SIGN OF APPROVING AUTHORITY &SEAL

	MANUFACTURERS NAME & ADDRESS	STANDARD QUALITY PLAN		PROJECT
BHEL	(AS PER BHEL APPROVED VENDOR LIST)	ITEM: Chain Pulley Block With Trolley	QP NO REV 0 DATE 20.02.2001 PAGE 2 of 3	PACKAGE PROJECT No CONTRACTOR

Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY M	AGENCY C	AGENCY N	REMARKS
1	2	3	4	5	6	7	8	9		** 10			11
2	PROCESS												
2	HOOKS	PROOF LOAD	MA	LOAD TEST	100%	IS 8610	IS 8610	IR		P	W		
		DPT AFTER PROOF LOAD	MA		100%	ASTM 709	ASTM 709	IR		P	W		
2	RACHET PAWL/RACHET WHEEL	HARDNESS	MA	HARDNESS TESTER	100%	IS :1832	IS : 3832	IR		P	W		
		SURFACE CRACKES	MA	DPT	100%	ASTME				P	W		
2	LOAD CHAINS	PROOF - LOAD	MA	LOAD TEST	100%	IS : 6216	IS:6216	MFR'S		P			
3	FINAL INSPECTION												
3	COMPLETE ASSEMBLY	PROOF LOAD TEST	CR	LOAD TEST	100%	IS: 3832	IS: 3832	IR		P	W	W	
		OPERATIONAL EFFORT	MA	LOAD TEST	RANDOM	IS: 3832	IS: 3832	IR		P	W	W	
		HEIGHT OF LIFT	MA	MEASUREMENT	100%	IS: 3832	IS: 3832	IR		P	W	W	
		SWIVELLING OF HOOK	MA	VISUAL	100%	IS: 3832	IS: 3832	IR		P	W	W	

LEGNDS

* RECORDS INDENTIFIED WITH 'TICK'( ) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION

** M: MANUFACTURER/SUBCONTRACTOR

C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL)

N: CUSTOMER

INDICATE 'P' PERFORM"W" WITNESS AND "V" VERIFICATION AS APPROPRIATE " CHP" CUSTOMER SHALL IDENTIFY IN COLUMN"N"

MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY &SEAL
SIGNATURE			

	MANUFACTURERS NAME & ADDRESS	STANDARD QUALITY PLAN		PROJECT
	(AS PER BHEL APPROVED VENDOR LIST)	ITEM: Chain Pulley Block With Trolley	QP NO	PACKAGE
			REV 0	PROJECT No
			DATE 20.02.2001	CONTRACTOR
			PAGE 3 of 3	

Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY M	AGENCY C	AGENCY N	REMARKS
1	2	3	4	5	6	7	8	9		** 10			11
3	PAINTING	CLEANED	MA	VISUAL	AT RANDOM	SPEC.	PE	IR		P	-	-	
		SHADE OF PAINT GOLDEN YELLOW	MA	VISUAL	AT RANDOM	SPEC.	PE	IR		P	W	W	
3	NAME PLATE	VERIFICATION	MI	VISUAL	100%	PR	PR	IR		P	W	-	
3	PACKING	VERIFICATION	MI	VISUAL	100%	PR	PR	IR		P	W	-	

LEGNDS

* RECORDS INDENTIFIED WITH 'TICK'( ) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION

** M: MANUFACTURER/SUBCONTRACTOR

C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL) N

INDICATE 'P' PERFORM 'W' WITNESS AND 'V' VERIFICATION AS APPROPRIATE " CHP" NTPC SHALL IDENTIFY IN COLUMN"

MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY &SEAL
SIGNATURE			

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT
VENDOR

SYSTEM
ITEM : SUBMERSIBLE PUMP SET

S NO	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
0	RAW MATERIAL AND BOUGHT OUT CONTROL											
	PUMP CASING, DISCHARGE CASING, SUCTION CASING, MOTOR STAND, BRG. HOUSINGS	1. PHYSICAL, CHEM PROPS	CR	PHYS. CHEM ANAL	1/HEAT/BATCH	APPD. DRG/APPD DATA SHEET	APPD. DRG/APPD DATA SHEET	LAB REPORT	3/2		2.1	COMPLIANCE TC FOR CI & MS, AND TC FOR OTHERS
	IMPELLER	DO	CR	DO	DO	DO	DO	DO	3/2		2.1	COMPLIANCE TC
	BEARING SLEEVE, WEARING RINGS, COUPLING, BEARING BUSHES	DO	MA	DO	DO	DO	DO	DO	3/2		2.1	
	HEAT TREATMENT OF CASTINGS (APPLICABLE FOR CASTINGS ONLY) NORMALISED	1. HEAT CYCLE	MA	VERIFY (TR-H) CHARTS	1/BATCH	DO	DO	CORELATED GRAPH CHARTS	3/2		2.1	
	BARS/FORGINGS FOR PUMP SHAFTS	1. PHYSICAL, CHEM PROPS	CR	PHYS. CHEM ANAL	1/CAST OF HEAT	DO	DO	MILL TC OR LAB REPORT	3/2		2.1	
		2. DIMENSIONS	MA	VE-S	100%	MFR. DRG	MFR. DRG	MR	3/2		2.1	IDENTIFICATION BY BHEL FOR 1 SET/DIA
		3. INTERNAL DEFECT FOR SHAFTS ABOVE DIA 5 MM	CR	UT	100%			UR	3/2			
	CABLE	1. DIMENSIONS	MA	OD	MFR. DRG	MFR. DRG	MFR. DRG	MFR. TC	3/2			CABLES TO BE OF APPROVED MAKES ONLY

		PREPARED BY	REVIEWED BY	APPROVED BY	ACCEPTED BY - VENDOR
		PEM	CQS & PEM	PEM	
O.P.NO	PEM/MSE/SOP/05				
REV NO/DATE	00/8-10-97	NAME			NAME
		SIGNATURE			SIGN
PAGE NO.	1 OF 4	DATE			DATE

BHARAT HEAVY ELECTRICALS LIMITED
PROJECTS ENGINEERING DIVISION

STANDARD QUALITY PLAN

PROJECT
VENDOR

SYSTEM
ITEM SUBMERSIBLE PUMP SET

OPERATION DESCRIPTION	CHARACTERISTICS CHECKED	CAT EQUIP REF	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY R	REMARKS
1	3	4	5	6	7	8	9			
1.0 STATOR	1) MAKE, BEARING & SURFACE FINISH	MA	VISUAL	100%	MFR DRG	MFR DRG	MFR TC	3		TO BE APPROVED BY M/S
1.1 IN-PROCESS CONTROL										
1.2 CONCENTRICITY	1) VISUAL DEFECTS	MA	VISUAL	100%	DO	NO MANUFACTURING DEFECTS	LOG BOOK/QR	3		
	2) DIMENSIONS	MA	MEAS	100%	DO	MFG DRG	DO	3		
1.3 WATER TIGHTNESS OF STATOR HOUSING	1) LEAK TIGHTNESS	CR	HYDRO TEST (STATIC DYNAMIC SEALING ARRANGEMENT)	100%	TECH SPEC DATA SHEET	NO LEAKAGE	TR	3		TEST PRESSURE 1.5 TIMES OF SHUT-OFF HEAD WHICHEVER IS HIGHER
1.4 WELDED ASSEMBLIES & SURFACE	1) SURFACE DEFECT	CR	DP	100%	ASTM E165	NO SURFACE DEFECTS	TR	3	3	WITNESSING OF WELDER SIZE ABOVE SAMPLING
1.5 ROTOR	1) STATIC & DYNAMIC RESIDUAL UNBALANCE	CR	STATIC & DYNAMIC BALANCING	100%	ISO 1940	AS PER ISO G 2.5	TR	3		
1.6 MACHINED SURFACES	1) SURFACE DEFECTS	CR	DP	100%	ASTME 165	NO SURFACE DEFECTS	TR	3	3	
2.0 SUB-ASSEMBLY ASSEMBLY CONTROL										
2.1 IMPELLER ROTORS	1) ECCENTRICITY	MA	MEAS	100%	MFG DRG	MFG DRG	LOG BOOK	3		

		PREPARED BY PEM	REVIEWED BY QCS & PEM	APPROVED BY PEM	ACCEPTED BY VENDOR
QP NO	REV/ISE/SQP/05				
REV NO/DATE	00/8-10-97	NAME			NAME
		SIGNATURE			SIGN
PAGE NO	2 OF 4	DATE			DATE

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT
VENDOR

SYSTEM
ITEM: SUBMERSIBLE PUMP SET

S NO	COMPONENT OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORM OF RECORD	AGENCY P	AGENCY W		REMARKS
1	2	3	4	5	6	7	8	9	10	11		12
4.3	STRIPDOWN AFTER PERFORMANCE TEST	1 UNDUE WEAR TEAR & BREAKAGE	OR	VISUAL EXAM AFTER STRIPDOWN	TYPE SIZE	TECH SPEC	NO UNDUE WEAR TEAR & BREAKAGE		WR			
4.4	COMPLETE PUMP SET UNIT	1 COMPLETNESS CORRECTNESS WORKMANSHIP AND FINISH OVERALL DIMENSIONS	MA	VISUAL EXAM MEAS	100%	APPD GA DRG	APPD GA DRG		WR			
4.5	COMPLETION OF ALL STAGES	1 COMPLETION	MA	VERIFICATION	100%	TECH SPEC APPD DRGS APPD DATA SHEETS	TECH SPEC APPD DRGS APPD DATA SHEETS		W2			
4.6	PAINTING	1 SURFACE PREP		VISUAL MEAS	100%	DO	DO		W2			
		2 UNIFORMITY & THICKNESS		DC	100%	DO	DO		W2			
4.7	PACKING	SOUNDNESS AESTHETIC		VISUAL	100%	MFR STAND	MFR STD		W2			

O.P. NO.	PEM/MSE/SOP/05
REV. NO/DATE	00/8-10-97
PAGE NO.	4 OF 4

	PREPARED BY PEM	REVIEWED BY CQS & PEM	APPROVED BY PEM	ACCEPTED BY VENDOR
NAME				
SIGNATURE				SIGN
DATE				DATE

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJEC
VENDOR

SYSTEM
ITEM : SUBMERSIBLE PUMP SET

COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY V	AGENCY W	REMARKS
1	2	3	4	5	6	7	8				
1.0 MOTOR FOR [illegible]	LEAD DYNAM RESIDUAL UNBALANCE	CP	STATIC DYNAMIC BALANCING	100%	ISO 1940	IS [illegible] G 2.5	IR	3/2	2		WITNESSING ONLY FOR RATING 5 KW & ABOVE
2.0 [illegible] PUMP ASSEMBLY	COMPLETENESS ORIENTATION	MA	VISUAL EXAM	100%	MFG DWG	AS PER DWG	-DO-	3/2		2	-DO-
	ALIGNMENT [illegible] RADIAL PLAY	MA	MEAS	100%	MFG DRG BHEL SPEC	AS PER DWG BHEL SPEC	-DO-	3/2		2	
	[illegible]	MA	FOR SCP MOTORS								
3.0 FINAL INSPECTION, TESTS PACKING DESPATCH CONTROL											
3.1 [illegible]	[illegible] HEAD DISCHARGE EFFICIENCY [illegible]	CP	PERFORMANCE TEST	100% TYPE TEST	TECH SPEC MFG DATA SHEET APPD CURVES IF ANY PLOTTED CURVES DATA SHEET	AS PER TECH SPEC	PERFORMANCE TEST RECORD PLOTTED CURVES DATA TC	3/2		2	MINIMUM 3 POINTS INCLUDING SHUT OFF HEAD TO MINIMUM TECH. OR CONTRACTUAL OPERATING RANGE AS PER DATA SHEET SHALL BE TAKEN
	[illegible]		INSULATION RESISTANCE TEST	100%	-DO-	-DO-	TC	3/2	2		
	[illegible]		HI TEST AFTER IMMERSION	100%	-DO-	-DO-	IR	3/2	2		

		PREPARED BY	REVIEWED BY	APPROVED BY	ACCEPTED BY
		PEM	QAS & PEM	PEM	VENDOR
DOC NO:	REMARKS SUPPS	NAME			NAME
REV NO/DATE	00/8-1-97	SIGNATURE			SIGN.
PAGE NO.	1 OF 4	DATE			DATE

	QUALITY PLAN	CUSTOMER:	PROJECT:		SPEC. NO :
		BIDDER/VENDOR	QP NO.PE-QP-999-100-M004	REV. 00 DT.31.03.99	SPEC. TITLE
	SHEET 1 OF 3	SYSTEM POWER CYCLE/ LP VALVES	ITEM: GATE/ GLOBE VALVE		SECTION VOLUME

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE-GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.0	**MATERIALS**											
1.1	BODY,BONNET, YOKE,WEDGE/DISC, SPINDLE, BODY SEAT, BACK SEAT, THRUST PLATE	1. PHYS,CHEM,PROPS	MA	PHYS,CHEM. TESTS	ONE/HEAT	APPD. DRG./ TECH.SPEC.	APPD. DRG./ TECH.SPEC.	TEST CERT.	3/2	2	1	CORRELATION REQD. FOR BODY BONNET, SPINDLE - FOR GREY C.I. ONLY PHYS. TEST.
		2. HEAT TREATMENT	MA	REVIEW OF H.T. CHART	100%	-DO-	-DO-	H.T. CHART	3/2	2	1	
		3. SURFACE DEFECTS	MA	VISUAL	100%	MSS-SP-55	MSS-SP-55	INSPN. REPORT	3/2	2	1	
1.2	BODY & BONNET FOR RATING 900 & ABOVE (ALSO FOR LOWER RATING IF REQUIRED IN SPEC.)	1. SURFACE DEFECTS	CR	PT/MT	100%	ANSI B16.34 AND TECH. SPEC.	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	2,1	-	
		2. SUB-SURFACE DEFECTS	CR	RT/UT	100%	ANSI B16.34 AND TECH. SPEC.	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	-	2,1	FILM REVIEW BY BHEL
1.3	ACTUATORS 1. ELECTRIC ACTUATORS	1. TORQUE TESTING & SETTING OF TORQUE SWITCH	MA	MECH., ELEC. TESTS	100%	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334	APPD. DRG./ DATA SHEET / IS:9334	INSPN. REPORT	3	2,1	1 *	*BHEL TO WITNESS IF QTY MORE THAN 10/ TYPE
		2. TRAVEL/STROKE	MA									
		3. TRAVEL TIME	MA									
		4. OPERATION OF LIMIT SWITCH	MA									
		5. MANUAL OPERATION THROUGH HAND WHEEL	MA									
		6. OPERATION TEST WITH POWER SUPPLY VARIATION ENERGISES TO OPEN/CLOSE	MA									
		7. IR,HV,IR	MA									
		8.DEGREE OF PROTECTION	MA	WATER, DUST TEST	1/TYPE	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS.9334	APPD. DRG./ DATA SHEET/ IS:9334	3RD PARTY TEST CERT.	3	-	2,1	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

	QUALITY PLAN	CUSTOMER:	PROJECT:		SPEC. NO :
		BIDDER/VENDOR	QP NO.PE-QP-999-100-M004	REV. 00 DT.31.03.99	SPEC. TITLE
	SHEET 2 OF 3	SYSTEM POWER CYCLE/ LP VALVES	ITEM: GATE/ GLOBE VALVE		SECTION VOLUME

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE-GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
	2. PNEUMATIC ACTUATORS	1. LEAK TIGHTNESS	CR	PNEUMATIC TEST AT 1.2 X DESIGN	100%	APPD. DATA SHEET/MFG. STD.	NO LEAKAGE	INSPN. REPORT	3	2,1	1*	*BHEL TO WITNESS IF QTY MORE THAN 10/ TYPE
		2. ACCURACY	CR	CALIBRATION	100%	-DO-	APPD. DATA SHEET/MFG. STD.	CALIBRATION REPORT	3	2,1	1*	
		3. SIMULATION (OPERATION, AIR TO OPEN/CLOSE)	CR	OPERATION AT RATED PRESSURE	100%	-DO-	-DO-	INSPN. REPORT	3	2,1	1*	
2.0	SS/STELLITE DEPOSIT ON DISC / BODY SEAT/BACK SEAT	1. SURFACE DEFECTS	CR	P.T	100%	ASTME:165 & TECH.SPEC.	ANSI B16.34 & TECH.SPEC.	-DO-	3/2	2,1	2,1	FOR 900 CLASS & ABOVE TO BE WITNESSED BY BHEL
3.0	IN-PROCESS INSPECTION											
3.1	MACHINING OF ALL COMPONENTS	1. DIMENSIONS, WORKMANSHIP AND FINISH	MA	MEAS.,VISUAL	100%	MFG.DRG.	MFG.DRG.	LOG BOOK	3/2	-	-	
3.2	WEDGE/DISC, BODY SEAT RING, BACK SEAT, SPINDLE, THRUST PLATE	1. HARDNESS	MA	TESTING	100%	APP.DRG.	APP. DRG./ ANSI B16.34	TEST CERT.	3/2	-	2,1	
3.3	SPINDLE, BODY SEAT RING, WEDGE/DISC, BACK SEAT	1. SURFACE DEFECTS	CR	P.T.	100%	ANSI B16.34 AND TECH. SPEC./	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	-	2,1	
3.4	WEDGE/DISC & SEAT RING, SPINDLE AND BACK SEAT	1. LAPPING	CR	BLUE MATCHING	100%	UNIFORM METAL TO METAL CONTACT		INSPN. REPORT	3/2	-	2,1	
4.0	ASSEMBLY	1. DIMENSIONS	MA	MEAS.	100%	APPD DRG.	APPD.DRG.	-DO-	3/2	2,1	-	
		2. WEAR TRAVEL	MA	MEAS.	100%	-DO-	-DO-	-DO-	3/2	2,1	-	FOR GATE VALVES ONLY
		3. VALVE LIFT	MA	MEAS.	100%	-DO-	-DO-	-DO-	3/2	2,1	-	
5.0	TESTING											
5.1	BODY, SEAT, BACK SEAT	1. LEAK TIGHTNESS OF BODY	CR	HYDRAULIC TEST	100%	APPD. DRG./ TECH. SPEC.	NO LEAKAGE	I.R./ IBRTC (IF REQD)	3/2	2,1	-	
		2. LEAK TIGHTNESS OF BACK SEAT AND SEAT	CR	-DO-	100%	-DO	-DO-	-DO-	3/2	2,1	-	
		3. LEAK TIGHTNESS OF SEAT	CR	PNEUMATIC TEST	100%	-DO	-DO-	-DO-	3/2	2,1	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

	QUALITY PLAN	CUSTOMER:	PROJECT:		SPEC. NO :
		BIDDER/VENDOR	QP NO.PE-QP-999-100-M004	REV. 00 DT.31.03.99	SPEC. TITLE
	SHEET 3 OF 3	SYSTEM POWER CYCLE/ LP VALVES	ITEM: GATE/ GLOBE VALVE		SECTION VOLUME

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE-GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
5.2	SEAT & BACK SEAT FOR MOTORISED/ PNEU. VALVES WITH ACTUATOR	1. LEAK TIGHTNESS OF SEAT	CR	HYDRUALIC TEST	100%	APPD. DRG./ TECH. SPEC.	NO LEAKAGE	I.R./ IBRTC (IF REQD)	3/2	2,1	-	
5.3	OPERATION AL TESTING											
	1. MANUALLY OPERATED VALVES	1. SMOOTH & FULL OPENING AND CLOSING	CR	MANUAL	100%	TECH. SPEC.	SMOOTH OPERATION OF VALVES & CLEAR BORE	INSPN. REPORT	3/2	2,1	-	
	2.MOTOR /PNEU OPERATED VALVES	1. ASCENDING& DESCENDING LIFT CHARACTERISTIC	CR	ELEC.	100%	APP. DRG./ TECH. SPEC./ IS:9334	APP. DRG./ TECH. SPEC./ IS:9334	INSPN. REPORT	3/2	2,1	-	
		2. LIMIT/TORQUE SWITCH SETTING FOR OPENING AND CLOSING TIME	CR	ELEC.	100%	APP. DRG./ TECH. SPEC./ IS:9334	TECH. SPEC./ APPD.DRG	INSP. REPORT	3/2	2,1	-	
6.0	COMPLETE VALVES	1. OVERALL DIMENSION	MA	MEAS	SAMPLE	APPD.DRG	APP.DRG.	-DO-	3/2	2,1	-	
7.0	END CONNECTION DETAILS	1. DIMENSIONS	MA	MEAS.	100%	APPD. DRG. / RELV.STD	APPD. DRG. / RELV.STD	-DO-	3/2	2,1	-	
		2. SURFACE DEFECTS FOR B.W. ENDS	CR	PT	100%	ASTME:165	NO DEFECTS	TEST CERT.	3/2	2	1	
8.0	FINAL INSPECTION	1. CLEANLINESS & COMPLETENESS	MA	VISUAL	100%	APPD. DRG./ TECH. SPEC.	APPD. DRG./ TECH. SPEC	INSPN. REPORT	3/2	-	2,1	
9.0	PAINTING	1. SURFACE PREPARATION	MI	VISUAL	100%	TECH. SPEC.	TECH. SPEC.	INSPN. REPORT	3/2	-	2,1	
		2. UNIFORMITY & THICKNESS	MI	MEASUREMENT	100%	-DO-	-DO-	-DO-	3/2	2	1	
10.0	PACKING	AS PER BHEL TECH. SPEC	MA	VISUAL	100%	AS PER BHEL TECH. SPEC.	AS PER BHEL TECH. SPEC	-DO-	3/2	-	2,1	

ABBREVIATIONS

CR = CRITICAL CHARACTERISTIC P = PERFORMED BY W = WITNESSED BY V = VERIFIED BY
MA =MAJOR CHARACTERISTIC 1 = PURCHASER (BHEL)2 = VENDOR 3 = SUB VENDOR OF THE VENDOR
MI = MINOR CHARACTERISTIC

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

SECTION – D2

STANDARD TECHNICAL REQUIREMENTS (ELECTRICAL)

WANAKBORI TPS UNIT-8, (1 X 800 MW)

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00

1.0 INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS

3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3 Starting Requirements

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for mimimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.5 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.6 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation.
In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.

4.7 **Terminals and Terminal Boxes**

4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.

Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".

4.7.2 unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.

4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.

4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.9 **General**

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 INSPECTION AND TESTING

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

	TITLE	SPECIFICATION NO.
	LV MOTORS	VOLUME II B
		SECTION D
	DATA SHEET-A	REV NO. 00 DATE 23.02.2015
		SHEET 1 OF 1

1.0	Design ambient temperature	:	50 °C
2.0	Maximum acceptable kW rating of LV motor	:	upto 160KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree Of Protection (Indoor/Outdoor)	:	IP54/IP55
5.0	Type of Cooling	:	TEFC/CACA
6.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V ± 10%
	b) Rated frequency (with variation)	:	50 Hz ± 5%
	c) Combined voltage & freq. variation	:	10% (absolute sum)
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal boxes		
	○ Above 110kW (Breaker controlled)	:	50 kA for 1 sec
	○ Upto 110kW (Contactor controlled)	:	50 KA for 0.25 sec.
	f) LV System grounding	:	Solidly
7.0	Class of insulation	:	Class 'F' with temp rise limited to class B
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	80% of rated voltage
9.0	Power cables data	:	Shall be given during Detailed engg.
10.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg.
11.0	Space heater supply	:	240 V, 1Φ , 50 Hz
12.0	Rating up to which Single phase motor	:	Acceptable upto 0.20 kW
13.0	Tests	:	As per Customer motor spec.(enclosed)
14.0	Energy efficient/ Flame proof motor	:	As per Customer spec. requirement
14.0	Makes	:	AS PER ANNUXURE-I

NOTE :

1. Also detail Customer spec. for Motors is to be referred as enclosed with technical spec.

ANNEXURE-I

SUB-VENDOR LIST

The list of approved make of the LT Motors are as mentioned below:

S.No.	LIST OF LT MOTORS
1.	BHARAT BIJLEE LTD.
2.	CROMPTON GREAVES
3.	ASEA BROWN BOVERI
4.	KIRLOSKAR ELECTRIC CO LTD.
5.	NGEF
6.	SIEMENS
7.	MARATHON
8.	GE-POWER
9.	RAJINDRA ELECT INDUSTRIES
10.	LAXMI HYDRAULICS PVT. LTD

However, the final list of makes for the LT Motors is subjected to BHEL/Customer approval, during contract stage, without any commercial implications.

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

NOTES: 1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)

2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V

: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

BHEL VH	LOAD DATA (ELECTRICAL)	JOB NO.	408	ORIGINATING AGENCY		PEM (ELECTRICAL)
		PROJECT TITLE	1 X 800 MW WANAKBORI TPS	NAME		DATA FILLED UP ON
		SYSTEM / S	NDCT	SIGN.		DATA ENTERED ON
		DEPTT. / SECTION	ELECTRICAL	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE

	QUALITY PLAN	CUSTOMER :	PROJECT TITLE :	SPECIFICATION NO. :
		BIDDER/ VENDOR :	STANDARD QP NO. : PE-QP-999-509-E001, REV. 0	SPECIFICATION TITLE:
	SHEET 1 OF 2	SYSTEM EARTHING	ITEM : EARTHING & LIGHTNING PROTECTION MATERIALS	DOC. NO. :

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	**RAW MATERIAL**											
1.1	MILD STEEL (FLATS & RODS) AS PER SPECIFICATION	1.CHEMICAL & PHYSICAL PROPERTIES	MA	VERIFICATION, OF TC'S	100%	IS:2062	IS:2062	MILL TC	3	-	1/2	Refer note in Remark at Sl. No.3
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS - 1730	IS - 1730	QC RECORD	3/2	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	IS : 1079	IS : 1079	QC RECORD	3/2	-	-	
1.2	ZINC	1.CHEM.COMP.	MA	CHEM.TEST	SAMPLE	IS - 209	IS - 209	QC RECORD	3/2	-	1/2	
2.0	**IN-PROCESS**											
2.1	CUTTING, DRILLING	1.DIMENSIONS	MA	MEASUREMENT	100%	APP. DATA SHEET/ APP. DRAWING	APP. DATA SHEET/ APP. DRAWING	QC RECORD	2	-	1	
		2.SURFACE FINISH	MA	VISUAL	100%	FREE FROM DEFECTS & SLAG	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1	
2.2	SURFACE PREPARATION	1.CLEANING PICKLING, RINSING, & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-	
		2.SURFACE QUALITY	MA	VISUAL	100%	IS:2629	IS:2629	QC RECORD	2	-	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

	QUALITY PLAN	CUSTOMER :	PROJECT TITLE :					SPECIFICATION NO. :				
		BIDDER/ VENDOR :	STANDARD QP NO. : PE-QP-999-509-E001 REV. 0					SPECIFICATION TITLE:				
	SHEET 2 OF 2	SYSTEM EARTHING	ITEM : EARTHING & LIGHTNING PROTECTION MATERIALS					DOC. NO. :				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.3	GALVANISING	1.TEMPERATURE OF BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	If vendor doesn't have his own galvanizing plant duly approved by BHEL PEM; then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.
		2. DROSS	MA	VISUAL	PERIODIC	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	
		3. RATE OF IMMERSION	MA	VISUAL/ MEASUREMENT	100%	IS - 2629/ MFRS PRACTICE	IS - 2629/ MFRS PRACTICE	QC RECORD	3/2	-	2	
		4.SURFACE QUALITY	MA	VISUAL	100%	IS - 2629	FREE FROM BURRS, ROUGHNESS, SLAG, FLUX, STAIN ETC.	QC RECORD	3/2	-	-	
3.0	**FINISHED ITEMS**	1. CHEMICAL	MA	CHEMICAL	1 No./LOT/SIZE	IS-2062	IS-2062	LAB TC	2	-	1	Note : Sample shall be selected by BHEL & testing shall be done at NABL/ govt. approved lab
		2.DIMENSIONS	MA	MEASUREMENT	IS 2500 (PART 1 LEVEL S-4	APP. DATA SHEET/ APP. DRAWING	APP. DATA SHEET/ APP. DRAWING	INSP. REPORT	2	1	-	
		3.SURFACE FINISH	MA	VISUAL	IS 2500 (PART 1 LEVEL S-4	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	INSP. REPORT	2	1	-	
		4.MASS OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-6745 / APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		5.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-2633	IS-2633	INSP. REPORT	2	1	-	
		6.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS - 4759	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		6.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP. REPORT	2	1	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
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LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
			BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-558-E001, REV.0			SPECIFICATION TITLE :			
	SHEET 1 OF 5		SYSTEM			ITEM :ILLUMINATION			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10	10	10	11
1.0	LUMINAIRES & LAMPS	1. ACCEPTANCE TEST										
		a) VISUAL	MA	VISUAL	IS 10322 (PART5 SEC1)	IS 10322 / APPD DRG./DATASHEET	IS 10322 / APPD DRG./DATASHEET	TEST CERT	3/2	1	-	AFTER SUCCESSFUL COMPLETION OF 1a, 1b & 1c FURTHER TESTING OF 1d) TO BE DONE BY PAPER INSERTION METHOD.
		b) IR (Dry)	CR	ELECTRICAL	IS 10322	-DO-	-DO-	-DO-	3/2	1	-	
		c) HIGH VOLTAGE	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	1	-	
		d) DUST PROOF	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	1	-	
		e) PHOTOMETRIC	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	1*	-	*: ONE NO. LUMINAIRE OF EACH TYPE TO BE WITNESSED BY BHEL. MAIN VENDOR TO WITNESS AS PER IS-10322.
		2. ROUTINE TEST										
		a) VISUAL	MA	VISUAL	100%	IS 10322 / APPD DRG./DATASHEET	IS 10322 / APPD DRG./DATASHEET	TEST CERT	3/2	-	1	
		b) IR (Dry)	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	-	1	
		c) HIGH VOLTAGE	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	-	1	
		3. TYPE TEST	MA	ELECTRICAL	ONE OF EACH TYPE	IS 10322. IEC-62384/ 61347 FOR LED	IS 10322. IEC-62384/ 61347 FOR LED	TEST REPORT	3/2	-	1**	** Refer note 3 & 4
2.0	LIGHTING PANELS AND LIGHTING DISTRIBUTION BOARDS/ FEEDER PILLAR	1.DIMENSIONS	MA	MEASUREMENT	10%	APPD DRG.	APPD DRG.	INSPT. REPORT	3	2,1	-	COMPONENTS TO BE OF APPROVED MAKE
		2.PAINT SHADE/ THICKNESS	MA	VISUAL/ MEASUREMENT	-DO-	APPD DRG./DATA SHEET	APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		3.DEGREE OF PROTECTION (INCLUDING EXPLOSION PROOF IF ANY)	MA	TESTS	1/ SIZE & RATING	APPD DRG./DATA SHEET RELEVANT IS	APPD DRG./DATA SHEET RELEVANT IS	TEST CERT	-	-	2,1	
		4.FUNCTIONAL TEST	MA	ELECT.	100%	APPD DRG./DATA SHEET	APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		5.HV/IR/HV	MA	ELECT	100%	2.5KV AC FOR 1 MINUTE	2.5KV AC FOR 1 MINUTE	INSPT. REPORT	3	2,1	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

LEGEND : **1 - BHEL/ CUSTOMER** **2 - VENDOR** **3 - SUB- VENDOR** **P - PERFORM** **W - WITNESS** **V - VERIFICATION**

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
			BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-558-E001, REV.0			SPECIFICATION TITLE :			
	SHEET 2 OF 5		SYSTEM			ITEM :ILLUMINATION			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		6. TYPE TEST	MA	ELECT	1/RATING	IS: 8623 (PART-1)/ IEC-439-1/ IS:60947/ APPD DATA SHEET	IS: 8623 (PART-1)/ IEC-439-1/ IS:60947/ APPD DATA SHEET	TEST REPORT	3/2	-	1**	** Refer note 3 & 4
3.0	LIGHTING TRANSFORMER	1. ROUTINE TEST										
		a) TYPE / RATING	CR	VISUAL	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		b) WIND. RESISTANC	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		c) V. RATIO /VECTOR	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		d) Z VOLT/ Z SCKT	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		e) LOAD LOSS/ CURRENT	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		f) NO LOAD LOSS	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		g) SOURCE WITHSTAND	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		h) INDUCED O/V	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		2. TYPE TEST	MA	TEST	1/RATING	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	TEST REPORT	3/2	-	1**	** Refer note 3 & 4
4.0	CONDUITS	1.MATERIAL	MA	VISUAL,MECH, & CHEMICAL	APPD DATASHEET/ IS 9537	IS:9537	IS:9537	INSPT. REPORT	3	2	1	
		2.DIMENSIONS	MA	MEASUREMENT	APPD DATASHEET/ IS 9537	IS:9537	IS:9537	INSPT. REPORT	3	2	1	
		3. MECH. PROPERTIES a) BENDING TEST	CR	TEST	IS 9537-II	IS-9537	IS-9537	INSPT. REPORT	3	2,1	-	
		b) COMPRESSION	CR	TEST	IS 9537-II	IS-9537	IS-9537	INSPT. REPORT	3	2,1	-	FOR SAME MANUFACTURER, 1st LOT WILL BE WITNESSED BY BHEL, SUBSEQUENT LOT CAN BE CLEARED BASED ON TEST WITNESSED BY MAIN VENDOR.
		c) BEND	CR	TEST	BHEL APPPD DATASHEET/ IS 9537	APPPD DATASHEET/ IS 9537	APPPD DATASHEET/ IS 9537	INSPT. REPORT	3	2,1	-	
		4. GALVANISATION TEST a) ZINC COATING	CR	TEST	IS 9537-II	IS-2633	IS-2633	INSPT. REPORT	3	2,1	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**
	NAME	
	SIGNATURE	
	DATE	

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LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
			BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-558-E001, REV.0			SPECIFICATION TITLE :			
	SHEET 3 OF 5		SYSTEM			ITEM :ILLUMINATION			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		b) MASS OF ZINC COAT.	CR	TEST	IS 9537-II	IS-6745/4759/ APPD DATASHEET	IS-6745/4759/ APPD DATASHEET	INSPT. REPORT	3	2,1	-	
		c) COATING THICKNESS	CR	TEST	IS 9537-II	IS-9537/ APPD DATASHEET	IS-9537/ APPD DATASHEET	INSPT. REPORT	3	2,1	-	BY ELCOMETER
		d) EPOXY THICKNESS	MA	VISUAL/PHYSICAL	IS 9537-II	50 MICRONS	50 MICRONS	INSPT. REPORT	3	2,1	-	
5.0	ELECTRIC POLES											
5.1	MATERIAL	1.CHEMICAL COMP.	MA	CHEM. ANALYSIS	IS 2713	IS-2713 IS:228 & IS:1608	IS-2713 IS:228 & IS:1608	-DO-	3/2	-	2,1	
		2.PHYSICAL PROP.	MA	PHY.TESTS	-DO-	-DO-	-DO-	-DO-	3/2	-	2,1	
5.2	FINAL INSPECTION	1.WORKMANSHIP AND FINISH	MA	VISUAL & MEAS	IS 2713	APPD DRG./ IS:2713	APPD DRG./ IS:2713	-DO-	3/2	2,1	-	FOR DEFLECTION & DROP TEST, TC VERIFICATION BY BHEL
		2.DIMENSIONS	MA	-DO-	-DO-	-DO-	-DO-	-DO-	3/2	2,1	-	
		3.WEIGHT	MA	-DO-	-DO-	-DO-	-DO-	-DO-	3/2	2,1	-	
		4.TESTS AS PER IS-2713	MA	-DO-	-DO-	IS-2713	IS-2713	-DO-	3/2	2,1	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

LEGEND : **1 - BHEL/ CUSTOMER** **2 - VENDOR** **3 - SUB- VENDOR** **P - PERFORM** **W - WITNESS** **V - VERIFICATION**

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
			BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-558-E001, REV.0			SPECIFICATION TITLE :			
	SHEET 4 OF 5		SYSTEM			ITEM :ILLUMINATION			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
6.0	HIGH MAST											
6.1	High Mast Shaft	a) Dimensional conformity	MA	MEASURE	10% or Min. 2 Nos	APPD DRG.	APPD DRG.	TEST CERTIFICATE	3	2,1	-	
		b) Galvanising	MA	MEASURE	-do-	DATASHEET	DATASHEET	-do-	3	2,1	-	BY ELCOMETER
6.2	Head Frame	a) Dimensional conformity	MA	MEASURE	-do-	APPD DRG/ DATASHEET	APPD DRG/ DATASHEET	-do-	3	2,1		
6.3	Lantern Carriage	a) Dimensional conformity	MA	MEASURE	-do-	-do-	-do-	-do-	3	2,1	-	
		b) Galvanising	MA	MEASURE	-do-	-do-	-do-	-do-	3	2,1	-	
6.4	Double drum Winch	a)Load Capacity	MA	MEASURE	-do-	-do-	-do-	-do-	3/2	2	1	Test certificate will be submitted by vendor
6.5	Stainless Steel Wire Ropes	a) Breaking Capacity	M	MEASURE	100%	-do-	-do-	-do-	3/2	2	1	Test certificate will be submitted by vendor
6.6	FEEDER PILLAR											Test for feeder pillar shall be as per S. No. 2
7.0	JUNCTION BOXES & RECEPTACLES	1.DIMENSIONS	MA	MEASUREMENT	100%	APPD DRG/ DATASHEET	APPD DRG/ DATASHEET	INSP. REPORT	3	-	2	COMPONENTS TO BE OF APPROVED MAKE
		2.PAINT SHADE/ THICKNESS	MA	VISUAL/MEAS.	10%	APPD DRG/ DATASHEET	APPD DRG/ DATASHEET	-DO-	3	-	2	
		3.HV/IR/HV	MA	ELECT.TESTS	100%	2KV AC FOR 1 MINUTE	2KV AC FOR 1 MINUTE	-DO-	3	-	2	
		4.DEGREE OF PROTECTION	MA	TEST	1/SIZE	IS:2147/ APPD DRG	IS:2147/ APPD DRG	TEST CERT.	3	-	2,1	
		5.SPECIAL TESTS IF ANY,EXPLOSION PROOF/FLAME PROOF	MA	TEST	1/SIZE	IS:2147/ APPD DRG	IS:2147/ APPD DRG	TEST CERT.	3	-	2,1	
		6. OPERATION CHECK	MA	TEST	10%	APPD DRG	APPD DRG	INSP. REPORT	3	-	2	
		7. MECHANICAL INTERLOCK	MA	TEST	10%	APPD DRG	APPD DRG	INSP. REPORT	3	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

LEGEND : **1 - BHEL/ CUSTOMER** **2 - VENDOR** **3 - SUB- VENDOR** **P - PERFORM** **W - WITNESS** **V - VERIFICATION**

	QUALITY PLAN	CUSTOMER :	PROJECT TITLE :		SPECIFICATION NO. :
		BIDDER/ VENDOR :	STANDARD QP NO. : PE-QP-999-558-E001, REV.0		SPECIFICATION TITLE :
	SHEET 5 OF 5	SYSTEM	ITEM :ILLUMINATION		DOC. NO. :

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
8.0	PVC WIRES	1.SURFACE DEFECTS	MA	VISUAL	10%	IS:694 IS:1554	IS:694 IS:1554	INSPN. REPORT & TEST REPORT FROM MANUFACTURER	3	-	2,1	TO BE PROCURED FROM BIS APPROVED SOURCE
		2.DIMENSIONS	MA	MEASUREMENT	10%	-DO-	-DO-	-DO-	3	-	2,1	
		3.ACCEPTANCE TESTS	MA	-DO-	IS: 694	-DO-	-DO-	-DO-	3	-	2,1	
		4.ROUTINE TESTS	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2,1	
		5.TYPE TESTS	CR	ELEC.TESTS	ONE/TYPE & SIZE	IS:694 IS:1554	IS:694 IS:1554	TEST CERT.	3	-	1**	** Refer note 3 & 4
		NOTES:										

1. IN CASE TYPE TEST CERTIFICATE FOR DEGREE OF PROTECTION/EXPLOSION PROOFNESS FROM INDEPENDENT LAB. IS NOT AVAILABLE, THE ITEM SHALL BE TESTED AT AN INDEPENDENT LAB.

2. ITEMS LIKE CEILING FANS, EMERGENCY LIGHTING UNIT, FLEXIBLE CONDUIT, EARTHING WIRE & FLATS, 24V SUPPLY MODULE, LADDERS, HUME PIPE, SWITCHBOXES, EXIT SIGNS, STRUCTURAL STEEL ETC. WILL BE CLEARED BASED ON COC (CERTIFICATE OF COMPLIANCE).

3. TYPE TEST CERTIFICATES TO BE FURNISHED FOR VERIFICATION BY BHEL ENGINEERING/CUSTOMER.

4. CONDUCTION OF TYPE TESTS TO BE DONE IF REQUIRED BY BHEL TECHNICAL SPECIFICATION & TEST CERTIFICATES FOR THE SAME TO BE FURNISHED FOR VERIFICATION BY BHEL ENGINEERING/CUSTOMER.

5. TYPE TEST REPORT DULY VERIFIED BY BHEL ENGINEERING/CUSTOMER SHALL BE SUBMITTED FOR VERIFICATION DURING INSPECTION.

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
			BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-507-E006, REV. 0			SPECIFICATION TITLE:			
	SHEET 1 OF2		SYSTEM CABLING			ITEM : CABLE TRAY SUPPORT MATERIAL (WELDED TYPE)			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	**RAW MATERIAL**											
1.1	MILD STEEL SECTIONS (CHANNEL & ANGLES) AS PER SPECIFICATION	1.CHEMICAL & PHY. PROPERTIES	MA	VERIFICATION OF TC'S	100%	IS -2062	IS -2062	MILL TC	3	-	1/2	Steel shall be procured from SAIL/TISCO/RINL/BHUSAN/JINDAL STEEL/JINDA ISPAT/ESSAR/LLOYD/ IISCO/ authorised SAIL Re Rollers.
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS - 808/ IS - 1852	IS - 808/ IS - 1852	QC RECORD	3/2	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	IS:2062	IS:2062	QC RECORD	3/2	-	-	
1.2	ZINC	CHEM.COMP.	MA	CHEM. TEST	EACH HEAT	IS-209	IS-209	QC RECORD	3/2	-	1/2	
2.0	**IN-PROCESS**											
2.1	CUTTING	1.DIMENSIONS	MA	MEASUREMENT	100%	APP. DATA SHEET	APP. DATA SHEET	QC RECORD	2	-	1	
		2. WELDING QUALITY (IF APPLICABLE)	MA	VISUAL	100%	GOOD WELDING PRACTICE	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1	
		3.SURFACE FINISH	MA	VISUAL	100%	FREE FROM DEFECTS & SLAG	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1	
2.2	SURFACE PREPARATION	1.CLEANING, PICKLING, RINSING & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-	
		2. SURFACE QUALITY	MA	VISUAL	100%	IS-2629	IS-2629	QC RECORD	2	-	-	
2.3	GALVANISING	1.TEMPERATURE OF BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS-2629	IS-2629	QC RECORD	3/2	-	-	If vendor doesn't have his own galvanizing plant duly approved by BHEL PEM; then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

LEGEND : **1 - BHEL/ CUSTOMER** **2 - VENDOR** **3 - SUB- VENDOR** **P - PERFORM** **W - WITNESS** **V - VERIFICATION**

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
			BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-507-E006, REV. 0			SPECIFICATION TITLE:			
	SHEET 2 OF 2		SYSTEM CABLING			ITEM : CABLE TRAY SUPPORT MATERIAL (WELDED TYPE)			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		2. DROSS	MA	VISUAL	PERIODIC	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	
		3. RATE OF IMMERSION	MA	VISUAL MEASUREMENT	100%	IS - 2629 / MFR'S PRACTICE	IS - 2629 / MFR'S PRACTICE	QC RECORD	3/2	-	2	
		4. SURFACE QUALITY	MA	VISUAL	100%	IS - 2629	FREE FROM BURRS ROUGHNESS, SLAG, FLUX, STAIN, ETC.	QC RECORD	3/2	-	-	
3.0	**FINISHED ITEMS**											
		1.DIMENSIONS	MA	MEASUREMENT	IS 2500 (PART 1) LEVEL S-4	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		2. SURFACE FINISH	MA	VISUAL	IS 2500 (PART 1) LEVEL S-4	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	INSP. REPORT	2	1	-	
		3.MASS OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-6745 / APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		4.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-2633	IS-2633	INSP. REPORT	2	1	-	
		5.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS - 4759	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		6.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP. REPORT	2	1	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

LEGEND : 1 - **BHEL/ CUSTOMER** 2 - **VENDOR** 3 - **SUB- VENDOR** **P - PERFORM** **W - WITNESS** **V - VERIFICATION**

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :				
			BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-507-E005, REV. 0			SPECIFICATION TITLE:				
	SHEET 1 OF 2		SYSTEM CABLING			ITEM : CABLE TRAYS & ACCESSORIES			DOC. NO. :				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS	
1	2	3	4	5	6	7	8	9	10			11	
1.0	RAW MATERIAL												
1.1	ROLLED SHEET	1.CHEM.& PHY. PROPERTIES	MA	VERIFICATION OF TC'S	100%	IS1079	IS1079	MILL TC	3/2	-	1/2	Steel shall be procured from SAIL/TISCO/RINL/BHUSAN/JINDAL STEEL/JINDAL ISPAT/ESSAR/LLOYD/ IISCO/ authorised SAIL Re Rollers.	
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS-1730/ APPD. DATA SHEET	IS-1730/ APPD. DATA SHEET	QC RECORD	3/2	-	-		
		3.SURFACE FINISH	MA	VISUAL	100%	IS-1079	IS-1079	QC RECORD	3/2	-	-		
1.2	ZINC	CHEM.COMP.	MA	CHEM TEST	EACH HEAT	IS-209	IS-209	QC RECORD	3/2	-	1/2		
2.0	IN-PROCESS												
2.1	FABRICATION	1.DIMENSIONS	MA	MEASUREMENT	100%	APPD.DRG.	APPD.DRG.	QC RECORD	2	-	1		
		2.WELDING QUALITY	MA	VISUAL	100%	GOOD WELDING PRACTICE	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1	Welding is to be done by qualified welders in accordance with ASME SEC. IX article III. WPS , PQR & WPQ to be reviewed during inspection.	
		3.SURFACE FINISH	MA	VISUAL	100%	APPD.DRG.	APPD.DRG.	QC RECORD	2	-	1		
2.2	SURFACE PREPARATION	1.CLEANING PICKLING & RINSING & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-		
		2. SURFACE QUALITY	MA	VISUAL	100%	IS:2629	IS:2629	QC RECORD	2	-	-		

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
			BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-507-E005, REV. 0			SPECIFICATION TITLE:			
	SHEET 2 OF 2		SYSTEM CABLING			ITEM : CABLE TRAYS & ACCESSORIES			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10	10	10	11
2.3	GALVANISING	1.TEMPERATURE OF ZINC BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS-2629	IS-2629	QC RECORD	2/3	-	-	If vendor doesn't have his own galvanizing plant duly approved by BHEL PEM; then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.
		2.DROSS	MA	VISUAL	PERIODIC	IS 2629	IS 2629	QC RECORD	2/3	-	-	
		3.RATE OF IMMERSION	MA	VISUAL	100%	IS 2629/ MFR'S PRACTICE	IS2629/ MFR'S PRACTICE	QC RECORD	2/3	-	2	
		4.SURFACE QUALITY	MA	VISUAL	100%	IS 2629	FREE FROM BURRS ROUGHNESS, SLAG FLUX. STAIN. ETC.	QC RECORD	2/3	-	-	
3.0	FINISHED ITEMS											
3.1	(CABLE TRAY, ACCESSO-RIES & HARDWARES)	1.DIMENSIONS	MA	MEASUREMENT	IS-2500 (PART 1) LEVEL S-4	APPD. DRG	APPD. DRG	INSP.REPORT	2	1	-	Fasteners shall be of reputed make. Overall thickness of finished product shall not be less than the thickness of cable tray & accessories defined in technical datasheet.
		2,SURFACE FINISH	MA	VISUAL	IS-2500 (PART 1) LEVEL S-4	APPD. DRG	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX. STAIN. ETC.	INSP.REPORT	2	1	-	Following shall be engraved/ punched on each standard length of cable tray at the center of both sides of runner:'PEM' (length of letter 90mm & height 30mm).
		3.RIGIDITY (FOR TRAYS)	MA	DEFLECTION TEST	2 No./ LOT/TYPE	APPD. DRG	APPD. DRG	INSP.REPORT	2	1	-	600MM wide cable tray to be testsed. Maximum deflection shall not exceed 7MM on mid span on uniform loading of 100KG/M.
		4.MASS OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-6745/ APPD. DATASHEET	APPD. DATASHEET	INSP.REPORT	2	1	-	
		5.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-2633	IS-2633	INSP.REPORT	2	1	-	
		6.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS-4759	APPD. DATASHEET	APPD. DATASHEET	INSP.REPORT	2	1	-	
		7.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP.REPORT	2	1	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

	QUALITY PLAN		CUSTOMER GSECL			PROJECT TITLE 1X800MW WANAKBORI TPS EXTN. UNI			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 1 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL & BOUGHT OUT CONTROL											
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	-DO-	INSPEC. REPORT	3	-	2	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-	3	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVENT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	3	-	2	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVENT IS/	SUPPLIER'S TC	3	-	2	HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER GSECL	PROJECT TITLE 1X800MW WANAKBORI TPS EXTN. UNI	SPECIFICATION : NUMBER :
		BIDDER/VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 2 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2	
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2	
		4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	2	
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	-DO-	3	-	2	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	2	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	2	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER GSECL			PROJECT TITLE 1X800MW WANAKBORI TPS EXTN. UNI			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 3 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	2	
		2. OTHER CHARACTERISTICS	MA	TEST	SAMPLE	MANUF'S SPEC.	MANUF'S SPEC.	LOG BOOK AND OR SUPPLIER'S TC	3	-	2	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	3	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG. .	MANUFR'S DRG.	-DO-	3	-	2	FOR MV MOTOR INSULA-TION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	LOG BOOK	3*	-	2*	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.
		2.ELECT. PROP, & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3	-	2	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER: GSECL			PROJECT TITLE: 1X800MW WANAKBORI TPS EXTN. UNI			SPECIFICATION : NUMBER :			
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 4 OF 9	SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	2	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2	
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER: GSECL	PROJECT TITLE: 1X800MW WANAKBORI TPS EXTN. UNI	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 5 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10	10	10	11
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVENT SPEC./ ASTM-E165	MANUFR'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER	GSECL		PROJECT TITLE	1X800MW WANAKBORI TPS EXTN. UNI		SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR	:		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 6 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1	(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	2	-	-	
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	FOR MV MOTOR
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-	
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	THREE DIPS TO BE GIVEN

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER GSECL			PROJECT TITLE 1X800MW WANAKBORI TPS EXTN. UNI			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 7 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
2.7	COMPLETE STATOR ASSEMBLY	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2		1	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1	VERIFICATION FOR MV MOTOR ONLY
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2		1	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER	GSECL		PROJECT TITLE	1X800MW WANAKBORI TPS EXTN. UNI		SPECIFICATION : NUMBER :				
		BIDDER/ VENDOR	:		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE				
	SHEET 8 OF 9	SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT.TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1$	1	$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1$	1	$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1$	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY $ NOTE - 2

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMEr GSECL			PROJECT 1X800MW WANAKBORI TPS EXTN. UNI TITLE			SPECIFICATION : NUMBER :		
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
	SHEET 9 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11

NOTES:

1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.

2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.

3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED.

4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMEI GSECL			PROJECT TITLE 1X800MW WANAKBORI TPS UNIT-			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION TITLE			
	SHEET 1 OF 2		SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
BHEL			**PARTICULARS**		**BIDDER/VENDOR**							
			NAME									
			SIGNATURE									

	QUALITY PLAN	CUSTOMEI GSECL			PROJECT TITLE	1X800MW WANAKBORI TPS UNIT-		SPECIFICATION : NUMBER :			
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION : TITLE :			
	SHEET 2 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	

NOTES:

1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON

2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	TITLE	SPECIFICATION NO.
BHEL	LV MOTOR DATA SHEET - C	VOLUME II B SECTION D REV NO. 00 DATE SHEET 1 OF 2

S. No.	Description	Data to be filled by successful bidder
A.	**General**	
1	Manufacturer & country of origin	
2	Motor type	
3	Type of starting	
4	Name of the equipment driven by motor & Quantity	
5	Maximum Power requirement of driven equipment	
6	Rated speed of Driven Equipment	
7	Design ambient temperature	
B.	**Design and Performance Data**	
1	Frame size & type designation	
2	Type of duty	
3	Rated Voltage	
4	Permissible variation for	
5	a Voltage	
6	b Frequency	
7	c) Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)	
9	Synchronous speed & Rated slip	
10	Minimum permissible starting voltage	
11	Starting time in sec with mechanism coupled	
12	a) At rated voltage	
13	b) At min starting voltage	
14	Locked rotor current as percentage of FLC (including IS tolerance)	
15	Torque	
	a) Starting	
	b) Maximum	
16	Permissible temp rise at rated output over ambient temp & method	
17	Noise level at 1.0 m (dB	
18	Amplitude of vibration	
19	Efficiency & P.F. at rated voltage & frequency	
	a) At 100% load	
	c) At 75% load	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

S. No.	Description		Data to be filled by successful bidder
	c) At starting		
C.	**Constructional Features**		
1	Method of connection of motor driven equipment		
2	Applicable Standard		
3	DOP of Enclosure		
4	Method of cooling		
5	Class of insulation		
6	Main terminal box		
	a) Type		
	b) Power Cable details (Conductor, size, armour/unarmour)		
	c) Cable Gland & lugs details (Size, type & material)		
	d) Permissible Fault level (kArms & duration in sec)		
7	Space heater details (Voltage & watts)		
8	Flame proof motor details (if applicable)		
	a) Enclosure		
	b) suitability for hazardous area		
	i	Zone	O / I / II
	ii	Group	IIA / IIB / IIC
9	No. of Stator winding		
10	Winding connection		
11	Kind of rotor winding		
12	Kind of bearings		
13	Direction of rotation when viewed from NDE		
14	Paint Shade & type		
15	Net weight of motor		
16	Outline mounting drawing No (To be enclosed as annexure)		
D.	**Characteristic curves/ drawings** (To be enclosed for motors of rating ≥ 55KW)		
	a) Torque speed characteristic		
	b) Thermal withstand characteristic		
	c) Current vs time		
	d) Speed vs time		