



Name Of Work: Comp.operation,maintenance,repair & security for different makes of HSCF/SCF pumpset with all associated equipments/accessories,MCC panels and all elctro-mechanical equipments installed at Limbada HW & Jamsar HW under Wankaner RWSS Of Morbi district for 06 months and ITC of SCF pumpset at Hirapar GWIL HW.

VOLUME II

Technical Specifications

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GENERAL TECHNICAL CONDITIONS & REQUIREMENTS

1 SCOPE OF CONTRACT

- 1.1 This specification covers the manufacturing, testing at manufacturer's site, delivery at site, unloading, handling and storage at site, complete erection, final checkup painting, testing and commissioning of pumping machineries at various pumping stations with electrical & mechanical equipments like motor control center with Soft starter panel, , Cable etc. with valves suction and discharge pipe, power and control cable wiring and grounding (earthing) systems and associated accessories to be supplied under this contract and subsequent operation & maintenance of 60 Month to achieve a guaranteed performance coordinated with commercial conditions of the contract to the entire satisfaction of GWSSB.
- 1.2 Any minor / hidden item of work either supply and / or erection of materials / equipment which have not been specifically mentioned in the specifications but are necessary to complete the work for trouble free and efficient operation and guaranteed performance of the entire plant / system / equipment offered shall deemed to be included within the scope of this contract and shall be provided by contractor without any extra price to the GWSSB.
- 1.3 The project information is indicated in the enclosed specification. It is advisable that the bidder should visit the site and apprise himself of all the site conditions prior to preparing the bid.

2 EQUIPMENT AND SERVICES TO BE INCLUDED BY CONTRACTOR UNDER THESE SPECIFICATIONS:

- 2.1 Mechanical and electrical works required at various pumping stations under regional water supply scheme.
- 2.2 Pumping machineries at various pumping stations with all the accessories as per specifications and data sheets. Suction and discharge MS pipe work including fittings from sump outlet to pump house outlet is in to the vendor's scope as indicated by the GWSSB with necessary pipe support etc shall be included in the offer.
- 2.3 C.I. Sluice Valves, butterfly valves, DPC Valves, reflux valves, expansion bellows etc. as per specifications. The individual delivery of each pump shall be provided with butterfly valve and DPCV valves, with velocity in delivery piping and valves not exceeding 2.5 m / sec, while velocity for suction shall be ≤ 2.0 m / sec and for common discharge header around 1.0 m / sec.
- 2.4 Pressure gauges of suitable range of Glycerin filled as per specifications with installation and drain valve.
- 2.5 415 Volt motor control center panel with Soft starter Panel, MCC panel as per specifications.

- 2.6 Power and panel cables, cable trays etc as per specifications and requirement for the pumping stations.
- 2.7 Earthing systems for the pumping station as per specification and requirement
- 2.8 L. T. electrical wiring with XLPE cable etc.
- 2.9 The contractor shall take the responsibility for all the testing and inspections at manufacturer's works to be conducted in manner as specified in this specification in the presence of GWSSB's representative. The inspection will be at the cost of contractor. The third party inspection shall also be carried out in the presence of the GWSSB representative i.e. jointly and inspection charges of third party agency shall initially be born the contractor, which shall be reimbursed by GWSSB.
- 2.10 Transportation of all equipments packed in the specified way from the manufacturer's works to the project site inclusive of all intermediate handling.
- 2.11 Unloading of equipments from railway wagons / trucks at site handling and proper storing at site in the approved way under security.
- 2.12 Opening of package, checking, tallying, sorting out and inspection of equipment received at the site and lodging of insurance claims if any.
- 2.13 Taking delivery of equipments / materials from contractor's site stores, transportation to erection site. If erection is delayed arrange for proper storage of the equipment / material in approval ways.
- 2.14 Erection inspection testing start up and running of the equipment and complete plant at guaranteed performance.
- 2.15 Erection of pipe and valves including all necessary hot deep GI bolts, nuts sleeves insert plate etc to complete the piping system.
- 2.16 Furnishing all erection and commissioning supervision service. The contractor shall also arrange for maintenance of equipment during guarantee and commissioning period.
- 2.17 The contractor shall also arrange technical expert of equipment from proprietary supplier to site as and when felt necessary until the commissioning guarantee run of the plant is completed.
- 2.18 In case of range in the motor rating depending on the efficiency of the rating of the associated electrical equipment shall be modified accordingly.
- 2.19 Initial filling of oil lubricants, grease etc for the equipment.
- 2.20 Complete list of commissioning and maintenance spares parts for first 12 months trouble free operation and maintenance of the mechanical and electrical equipment.
- 2.21 Complete list of recommended spare parts for two years operation and special tools and tackles for erection and regular operation and maintenance of the mechanical and electrical equipment shall be furnished as per schedule of spare parts and accessories tools.

- 2.22 Require Nos. of all relevant drawings, Data and instruction manuals.
- 2.23 All ancillary work as per price bid.
- 2.24 Regular operation, routine maintenance break down maintenance inclusive of cost of replacement spares & materials of pumping station by qualified technicians, operators and electricians for Five years from the date of commissioning.
- 2.25 Any item of work either supply and / or erection of material equipment which have not been specifically mentioned in the specification but if necessary to complete the work for trouble free and efficient operation and performance of the entire plant / system / equipment offered, shall deemed to be included within the scope of his contract and shall be provided by contractor without any extra cost to the GWSSB.

2.26 **RESPONSIBILITY**

It is the intention of the GWSSB to achieve coordinate effect. The installation erection of machinery is linked up with civil construction of pumping station testing and commissioning work is linked up with the obtaining of electrical connection / power GWSSB no doubt will be doing his best to see that these inter connected activities are completed at appropriate time. However, contractor is not entitled for any claim, escalation of whatsoever commissioning at a date later than the stipulated time. Necessary extension of time will be granted in case if it is established that the erection/ testing /commissioning could not be achieved in stipulated time on account of reasons beyond control of contractor. This factor should be carefully noted as no claim what so ever nature will be entertained on an account of such situations.

2.27 **GUARANTEE**

The contractor has to furnish guarantee for all the equipments supplied by him and complete pumping station for a period of 12 months from the date of handing over the pumping station to GWSSB.

2.28 **DELIVERY**

The contractor has to furnish the BAR – Chart & PERT Chart for the pumping station and the same followed strictly so as to commence the pumping station as per the schedule

2.29 **CO ORDINATION BETWEEN DIFFERENT AGENCIES**

It is the responsibility of the contractor to co ordinate with different agencies i.e. sub supplier and civil contractor so as to commissioning the pumping station in scheduled time.

3.0 **EQUIPMENT & SERVICE TO BE EXCLUDED FROM THIS CONTRACT**

- 3.1 Rising main beyond the vendor's scope of supply.
- 3.2 Construction of the pumping station and M.C.C. Room.

4.0 **THIRD PARTY INSPECTION**

~~Inspection and testing of the major electro-mechanical equipments such as HSCF / SCF/HMSM pumping machineries (except vacuum pump, drain / dewatering, dredging / de silting and diesel driven pumps), Induction Motors, MCC, Flow Meter, Valves and HOT / Jib Crane, shall be carried out by third party inspection agency in the presence of GWSSB's representative (i.e. jointly) at manufacturers' works. QAPs along with manufacturers' cross sectional drawings, characteristic curves (if any), material (s) of construction etc. for vacuum/ drain / dredging pumps, expansion bellows, motorized chain pulley blocks etc. shall have to be submitted by the bidder & get them approved prior to their procurement invariably. For all other items like cable, GI-MS pipes with specials, pressure gauge etc. internal test / quality / calibration certificates shall have to be furnished for review / acceptance.~~

Note :1) Contractor shall have to Provide manufacturers internal test certificate for all the supplied items in this tender. The materials will be checked at site, if any defects or unsatisfactory performance is found then contractor shall have to replace the material.

2) The materials like all types of valves,Bellows,drain pumpset,pipes,panels shall be of the approved vendor of GWSSB:

- 4.1 That the equipment installed complies with specification in all particulars and is of the correct rating for the duty and site conditions.
- 4.2 That all items operate efficiently and quietly to meet the specified requirements.
- 4.3 That all non current carrying metal work is properly and safely grounded in accordance with the specifications.

The contractor shall provide all necessary instruments and labour for testing and shall make adequate records of test procedures and readings, shall repeat any tests requested by the consultant / GWSSB and shall provide test certificates signed by a properly authorized person such test certificates shall Cover all works.

- 4.4 It tests fail to demonstrate the satisfactory nature of the installation or any part thereof then no claims for the extra cost of modifications, replacements, or retesting will be considered. GWSSB's decision as to what constitutes a satisfactory test shall be final. The above general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere.
- 5 GWSSB reserves right to ask for the corporate guarantee from any or all the bidder for the performance and overall completeness in accordance to GWSSB's requirements. Specifically, for in time completion of contractual works in accordance to the technical requirements in best workmanship manner.
- 5.1 GWSSB reserves the right to spilt the work / distribute the works among bidders.
- 5.2 GWSSB reserves the right to accept or reject the tenders with technical deviation, at the discretion of competent authority.

GENERAL SPECIFICATIONS FOR SUPPLY OF EQUIPMENTS

1.0 GENERAL

This part covers conditions pursuant to the contract and will form an integral part of the contract. The following provisions shall supplement general conditions, detailed specification and requirements.

2.0 LIMIT OF CONTRACT

Equipments furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipments and/or needed for erection, completion and safe operation of the equipments as required by applicable codes though they may not have been specifically detailed in the technical specification, unless included in the list of exclusions. All similar standard components / parts of similar standard equipments provided shall be interchangeable with one another.

3.0 ENGINEERING DATA

- 3.1 The contractor shall furnish complete engineering data of each sets of equipment such as name of manufacturer, the type of model of each principal item of equipment proposed to be furnished and erected in the annexure, standard catalogues design, the specification number and the name of the project. If the standard catalogue pages are submitted the applicable items shall be indicated there in. All titles, noting, markings, and writing on the drawing shall be in English. All dimensions should be in metric units.
- 3.2 All manufacture fabrication works in connection with equipment prior to the approval of the drawing shall be at the contractor's risk. The contractor may make any changes in the design which are necessary to make any equipment conform to the provisions and intent of the contract and such changes will again be subject to the approval by the GWSSB. Approval the contractor's drawing or works by the GWSSB shall not relieve the contractor from any of the responsibility and liabilities under the contract.
- 3.3 Drawings shall include all installation and detailed piping drawings wherever applicable. All piping 100 millimeter and larger shall be routed in detail and smaller pipe shall be shown schematically or by isometric drawings. All drawings shall be fully corrected to agree with actual "As Built" construction.

4.0 DESIGN IMPROVEMENTS

- 4.1 GWSSB may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.
- 4.2 If any such agreed upon change is such that it affects the price and schedule of completion, the party shall agree in writing as to the extent of any change in the price and / or schedule of completion before the contractor proceeds with the change.

The following such agreement provision thereof shall be deemed to have been amended accordingly.

- 5.0 The following documents shall be sent by registered post to the GWSSB by contractor within 3 days from the date of dispatch, to enable the GWSSB to make progressive payments to the contractor.

INVOICE (6 copies)

PACKING LIST (6 copies)

TEST CERTIFICATE (3 copies)

- 5.1 The contractor shall prepare detailed packing list of all packages and containers, bundles & loose material forming each and every consignment dispatched to site. The contractor shall further be responsible for making all necessary arrangements or loading, unloading and other handling right from his work till the site and also till the equipment is erected, tested and commissioned. He shall be solely responsibility for proper storage and safe custody of all equipments.
- 5.2 All fine, rental, demurrages, warfare and other expenses incurred due to delayed clearance of the material or any other reason shall be to the account of the contractor.

6.0 PROTECTION TO PLANT

- 6.1 All coated surface shall be protected against abrasions impact, discolorations and any other damages. All exposed threaded portion shall be suitably protected with either a metallic or non-metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable device to protect them from damage. The parts which are likely to get rusted due to exposure to weather, shall also be properly treated and protected in a suitable manner.

7.0 MATERIALS HANDLING AND STORAGE

- 7.1 All the equipment furnished under the contract and arriving at the site shall be properly receive, un loaded transported and stored in the storage spaces by the contractor at his cost.
- 7.2 Contractor shall be responsible for examining all the dispatches and notify the GWSSB immediately of any damage, shortage discrepancy etc for the purpose of the GWSSB information only. The contractor shall submit to the GWSSB every week a report detailing all the receipts during the work. However the contractor shall be solely responsible for any shortages or damage in transit, handling and / or in storage and erection of the equipment at the site.
- 7.3 The contractor shall maintain and accurate and exhaustive record detailing out the list of all equipment received by him for the purpose of erection and keep such record open for the inspection of the GWSSB at any time.

7.4 All equipment shall be handled very carefully to prevent any damage or loss. No bare wire ropes, string etc shall be used for unloading and/or handling of the equipment stored. The equipment shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the store shall be moved to the actual location of the appropriate time so as to avoid damage of such equipment at site.

7.5 All electrical panels, control gears, motors and such other devices shall be properly dried by heating before they are installed and energized. Motor bearings, slip rings, commutators and other exposed parts shall be protected against moisture ingress and corrosion during storage and shall be periodically inspected. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion due to prolonged storage.

All the electrical equipment, such as Motors, Generators, etc shall be tested for insulation resistance at least once in three months from the date of receipt till the date of commissioning and record of such measured insulation values maintained by the contractor. Such records shall open for inspection by the GWSSB.

7.6 The consumables and other supplies likely to deteriorate due to storage must be thoroughly protected and stored in a suitable manner to prevent damage or deterioration in quality by storage.

7.7 All the materials stored in the open or dusty location must be covered with suitable water proof and flame proof covering material wherever applicable.

7.8 The contractor shall be responsible for making suitable indoor storage facilities to store all equipments which require indoor storage. Normally all the electrical equipment, such as motors, control gears, generators excitors and consumable like electrodes, lubricants, etc shall be stored in the closed storage space. The GWSSB in addition may direct the contractor to move certain other materials which in GWSSB opinion will require indoor storage, to indoor storage areas which the contractor shall strictly comply with.

8.0 CONTRACTOR'S MATERIALS AT GWSSB SITE

8.1 The contractor shall bring to site all equipment, component, parts, materials, including construction equipments, tools and tackles for the purpose of the works under intimation to the GWSSB. All such goods from the time of their being brought shall not on any account be removed or taken away by the contractor or his subcontractor without the written permission of the GWSSB. The contractor shall nevertheless be solely liable and responsible for any loss or destruction thereof and damage thereto.

8.2 The GWSSB shall have the lien on such goods for any sum or sums which may at any time be due to or owing to him by the contractor, under or in respect of or by reason of the contract. After giving a fifteen (15) days notice in writing of his intention to do so, the owner shall be at liberty to sell and dispose of any such goods in such a manner as he shall think fit including

public auction or private treaty and to apply the proceeds in or towards the satisfactions of such or sums due as aforesaid

After the completion of the works, the contractor shall remove from the site under the direction of the purchaser the materials such as construction equipments, erection tools, and tackles scaffolding etc with the written permission of the GWSSB if the contractor fails to remove such materials GWSSB to do so then the GWSSB shall have the liberty to dispose of such materials and credit the proceeds thereof to the account of the contractor.

9.0 FACILITIES TO BE PROVIDED BY THE GWSSB

9.1 SPACE

The contractor shall advice GWSSB within fifteen (15) days from the date of acceptance of the letter of intent, about his exact requirements of space for his office, mess rooms, storage area, pro-assembly and fabrication areas, labour colony area, toilets, etc the above requirement shall be reviewed by the GWSSB and land if available will be given to the contractor for construction of his temporary structures like office, storage sheds, labour and staff colony and other utilities, etc for his own as well as his sub use. It will not be binding to owner GWSSB to spare the land if not available. In that case contractor shall have to make his own arrangements. The material once supplied shall have to be stored and preserved by agency up till the commission Agency may deploy the person to protect the materials supplied by agency at their own cost.

10.0 CONSTRUCTION MANAGERMENTS

- 10.1 Time is the essence of the contract and the contractor shall be responsible for performance of his works in accordance with the specified construction schedule. If at any time the contractor is falling behind schedule, he shall make necessary action to make good for such delays by increasing his work force or by working overtime or over wise accelerate the progress of the work to comply with the schedule and shall communicate such action in writing to the GWSSB satisfying that his action will compensate for the delay . The contractor shall not be allowed any extra compensation for such action.

11.0 CONTRACTOR'S COOPERATION WITH THE GWSSB

In case where the performance of the erection work by the contractor the operation of the system facilities of the GWSSB such erection work of the contractor shall be scheduled to be performed only in the manner stipulated by GWSSB and the same shall be acceptable at all times to the contractor. The GWSSB may important such restrictions on the facilities if provided to the contractor such as electricity, water etc as the GWSSB may think fit in the interest of the itself and the contractor shall strictly

adhere to such restrictions and cooperate with the GWSSB it will be the responsibilities of the contractor to provide all necessary temporary instrumentation and other measuring devices required during the start-up and operation of equipment systems which are erected by him. Before commission of any machine all old lubricants, greases etc shall be thoroughly removed, the part cleaned of all deleterious material and shall be freshly lubricated by sealed lubricants, of exact specifications.

12.0 COOPERATION WITH OTHER CONSTRUCTIONS & FOR GWSSB

The contractor shall agree to cooperate with the GWSSB other contractor and consultants of GWSSB and freely exchange with them such technical information and economical design features to avoid unnecessary duplication of efforts. The contractor shall attend design coordination meetings at his own cost whenever required.

13.0 FIELD OFFICE RECORDS

- 13.1 The contractor shall maintain at his site office up to date copies of all drawings specifications and other contract documents and any other supplementary data complete with all the latest revisions thereto. The contractor shall also maintain in addition, the continuous records of all changes to the above contract documents, drawings, specifications, supplementary data etc. affected at the field and on completion of his total assignment under the contract shall incorporate all such changes on the drawings and other engineering data to indicate as installed conditions of the equipments furnished and erected under the contract. Such drawings and engineering data shall be submitted to the GWSSB in required number of the copies.

14.0 DESIGN COORDINATION

- 14.1 The contractor shall be responsible for the selection and design of appropriate equipments to provide the basic coordinated performance of the entire system. Their design requirements are detailed out in technical specifications. The design of various components, sub assemblies and assemblies shall be not got done, such that it facilitates easy field assembly and maintenance. All the relating components shall be so selected that the natural frequency of the compact unit is not critical at or close to the operating range of the unit.

15.0 QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under scope of this contract whether manufactured or performed within the contractor's work or at his sub contractor's premises or at the owner's site or at any other place of work are in accordance with the specifications. The contractor shall adopt suitable quality assurance programme to such activities at all points, necessary such programme shall be outlined by the contractor and shall be finally accepted by the purchaser after discussions before the start of contract, and such agreed programme shall form part of the contract.

16.0 DEFECTS IN WORK OF OTHER CONTRACTOR

- 16.1 The GWSSB shall be notified promptly by the contractor of any defects in the other contractor works, the GWSSB shall determine the corrective measures if any required to rectify this situation after joint inspection work and such decision by the GWSSB shall be binding on the contractor.

17.0 UNFORSEEN WORKING CONDITIONS

- 17.1 The contractor shall confirm all his field operations to those works which can be performed without subjecting the equipment and materials to adverse effects, during inclement weather conditions, monsoon, storms, etc and during other unfavorable construction condition. No field activities shall be performed by the contractor under conditions which might adversely affect the quality and efficiency thereof, unless special precaution or measures are taken by the contractor in a proper and satisfactory manner in the performance of such works and with the concurrence of the purchaser. Such unfavorable construction conditions will in no way relive the contractor of his responsibility to perform the works as per schedule.

18.0 PROTECTIVE GUARDS.

- 18.1 Suitable guards shall be provided for protection of personal on all exposed rotating and / or moving machine parts. All such guards with necessary spaces and accessories shall be designed for easy installation and removal for maintenance purposes.

19.0 WELDING

- 19.1 If the manufacture has special requirement relating to the welding procedures for welds at the terminals of the equipment to procedure procured by the owned separate specifications. The requirement shall be submitted to the GWSSB in advance of commencement of erection work.

20.0 NOISE AND VIBRATIONS

- 20.1 The equipment supplied and erection by the bidder will comply with best design and erection and its working shall within permissible noise and vibration levels.

21.0 EQUIPMENT BASES

- 21.1 A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agree by the GWSSB each base plate shall support the unit and its drive assembly shall be of a neat design with anchoring the units.

22.0 SHAFT ALIGNMENTS

All the shafts of rotating equipment shall be properly aligned to these of the machine equipments to as perfect and accuracy as practicable. The equipment shall be free from excessive vibration so as to avoid over heating of bearing or other conditions which may tend to shorten the life of the equipment. All bearings shafts and other rotating parts shall be thoroughly cleaned and suitable lubricated before starting.

23.0 DOWELLING

All the drive motors and other equipment shall suitable dowelled after alignment of shaft with tapered machine dowels as per direction of the GWSSB.

24.0 PAINTING

All exposed metal parts of the equipments including piping, structures railings etc. Wherever applicable after installation unless otherwise specified shall be surface protected and shall be first painted with at least primer paint used, after thoroughly cleaning all such parts of all dirt, rust Axles greases, oils and other foreign materials by wire brushing, scraping or sand blasting and the same being inspected and approved or sand blasting and the same being inspected approved by the board for painting. Afterwards the above parts shall be finished with two coats of alloyed resin machinery enamel paints The quality of the finished paints shall be as per standards of I.S.I or equivalent and shall be of the colour as approved by the GWSSB

25.0 COLOUR CODE FOR PIPE SERVICES

- 25.1 All pipe services wherever applicable are to be painted accordance with the owner's standard colour scheme by the contractor.

26.0 LUBRICATION

Equipments shall be lubricated by system suitable for duty of the equipment Lubricant level indicators wherever provided shall be furnished and parked to indicate proper levels under both stand steel and operating conditions.

27.0 FIRST FILLING OF CONSUMABLES OIL AND LUBRICANTS:

All the first fill of consumables such as oils, lubricants and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications into successful trial operation. They shall be furnished by the contractor unless specifically excluded under the in these specification and documents.

CHECKOUT CONTROL SYSTEMS:

After completion of wiring and cable furnished under separate specifications and laid as per the terms noted by the board the contractor shall check out the operation of all control system for the equipments furnished and installed under these specification and documents.

28.0 EQUIPMENT PERFORMANCE GUARANTEE

The performance guarantees of the equipments under the scope of the contract are detailed separately in the technical specifications. These guarantees shall supplement the general performance guarantee provisions covered under general terms and conditions.

29.0 GUARANTEE

In the event of any emergency where in the judgment of the board delay would cause serious loss or damage, repairs or adjustments may be made by the GWSSB or a third party chosen by the GWSSB without notice to the contractor or by surety. In the event such action is taken

by the purchaser the contractors will be notified promptly and he shall assist whenever possible in making the necessary corrections. This shall not extinguish the contractor's liability under the terms and conditions of the contractor.

The cost of any special or general overhaul rendered necessary during the maintenance period due to the defect in the plant or defective work carried out the contractor the same shall be borne by the contractor.

In case of this effective parts which are not repairable at site but are essential for the commercial operation of the equipment, the contractor and the GWSSB shall naturally agree to a programme of replacement of renewal which will minimize interruption to the maximum extent, in to operation of the equipment. At the end of guarantee period the contractors liability except for the latest defects in respect of goods supplied by sub contractor to the contractor where a longer guarantee (More than 12 months) is provided by sub - contractors, the owner shall be entitled to the benefit of such longer guarantee. Then provisions contained in this clause will not be applicable.

If the owner has not operated the equipment according to generally approved industrial practices and in accordance with the conditions of operation specified and in accordance the operating manuals, if any.

30.0 RECOMMISSIONING TRIALS - TESTS START – UP

On completion of erection of the equipment and before start up each items of the equipment shall be thoroughly cleaned and then inspected jointly by the GWSSB and the contractor for correctness and completion of installation and acceptability for start up, loading to initial pre-commissioning tests at site.

The list of pre-commissioning tests to be performed shall be as mutually agreed and include in the contractor's quality assurance programme. The contractors commissioning / start up board specifically identified as far as possible and the contractor shall be responsible for carrying out all pre-commissioning tests. On completion of inspection checking after pre-commissioning tests are satisfactorily over, the complete shall be placed on initial operation during which period the complete equipment shall be operated integral with sub systems and supporting equipments as complete plant.

31.0 TRIAL OPERATION

~~The plant shall then be on trial operation during which period all necessary adjustments shall made while operating over the full load range enabling the plant to be made ready for performance and guarantee tests.~~

~~The duration of trial operation of the complete equipment should be fourteen (14) days or 200 Hrs. (whichever occurs earlier) of initial operation or any other duration as may be agreed to between the contractors. The trial operation shall be considered successful provided~~

~~that each item of equipment can operate continuously at the specified operating characteristics, for the period of trial operation.~~

~~For the period of trial operation, the time of operation with any load shall be counted. Minor interruptions not exceeding four (4) hours at a time caused during the continuous operation shall not affect the total during of trial operation.~~

~~However, if in the opinion of the, purchaser, the interruption is long, the operation shall be prolonged for the period of interruption. A trial report comprising of observations and recordings of various parameters to be measured in respect of the above trial operation shall be prepared by contractor. This report, besides recording the details of the observation during trial run shall also including the dates of starts and finish of the trial operation and shall be signed by the representative of both the parties.~~

~~The report shall have sheets, recording all the details of interruptions occurred adjustment made and any minor repairs done during the trial operation, based on the observation necessary modification/repairs to the plant shall be carried out by the contractor to the full satisfaction of the GWSSB, to enable the latter on to accorded permission to carry out performance and guarantee tests on the plant.~~

32.0 PERFORMANCE AND GUARANTEE TEST

32.1 The final test as to the performance and guarantees shall be conducted at site by the GWSSB. The contractor's shall make the equipment ready for such tests and assist by the GWSSB conducting such tests free of cost, such test shall be commenced after the successful completion of trial operation.

32.2 These trends shall be binding on both the parties of the contract to determine compliance of the equipment with the performance guarantee.

32.3 The available instrumentation and control equipment will be used during such tests and the GWSSB will be calibrate, all such measuring equipment and devices as far as practicable. However, immeasurable parameters shall be taken into account in a reasonable manner by the G.W.S.S.B, for the requirement of these tests. The tests will be conducted for the specified duty and as near to the specified conditions as practicable. The GWSSB will apply proper correction in calculation to take into account condition, which should not correspond to the specified condition.

32.4 Any special equipment, tools tackles required for the successful completion of the performance and guarantee tests shall be provided by the contractor, free of cost.

32.5 The guaranteed performance figure of the equipments shall be provided by the contractor during these performance and guarantee cost should the results of these tests show any depressed from the guaranteed values, the contractor shall modify the equipments as required to enable them to meet the guarantees. In such case performance and guarantee tests shall be repeated one month, from the date of equipment is ready for re-tests and all

cost for modification including labour materials and the cost of additional testing prove that the equipment meets the guarantees shall be borne by the contractor.

32.6 The specific tests to be conducted on equipments have been brought out in the technical specifications.

32.7 Performance and guarantee tests shall make allowance for instrumentation error as may be decided by the GWSSB.

33.0 REGISTRATION AND STATUTORY INSPECTION:

33.1 All registration and statutory inspection fees if any in respect of this work pursuant to this contract shall be to the account of the contractor. However, any registration statutory inspection fees lawfully payable under the provision of statutory laws and its amendments from time to time during erection in respect of the plant equipment ultimately to be owned by the owner shall be to account of the owner. Should any such inspection or registration need to be rearranged due to the fault of the contractor or his sub-contractor the additional fees for such inspection and/or registration shall be borne by the contractor.

34.0 WORKS AND SAFETY REGULATION

34.1 The contractor will notify the GWSSB of his intention to bring on the site any equipment or any container with liquid or gaseous fuel or other substance which may create hazard. The GWSSB shall have the right to prescribe the conditions for un keep of such hazardous equipments.

Before the contractor connects any electrical appliances to any plug or socket belonging to the other contractor or owner he shall:

- (a) Satisfy the Engineer in charge of GWSSB that the appliance is in good working conditions.
- (b) Inform the GWSSB of the maximum current rating voltage and phases power factor the appliances.
- (c) Obtain permission of the Board detailing the sockets to which the appliances may be connected.

34.2 The GWSSB shall not grant permission to connect until it is satisfied that

- (a) The appliance is in good condition and is fitted with suitable plug
- (b) The appliance is fitted with a suitable cable having two earth conductors, one of which shall be an earthed metal sheet surrounding the cores.

34.3 No electrical cable in use by the contractor / GWSSB shall be disturbed without prior permission. No weight of any description will be placed on any such cable and no ladder or similar equipment will rest against or be attached to it, under which such equipment or container may be handled and used during the performance of the work and the contractor shall strictly adhere to such instruction. The GWSSB shall have

the right to inspect any construction plant and to forbid its use if in its opinion it is unsafe. No claims due to such prohibition shall be entertained by the GWSSB.

- 34.4 Where it is necessary to provide and / or store petroleum products petroleum mixtures and explosives, the contractor shall be responsible for carrying out such provision and / or storage in petroleum Act explosives Act 1948 and petroleum inspector of Explosives of India. All such storage shall have prior approvals of the GWSSB in case any statutory authority the contractor shall be responsible for obtaining the same.

35.0 ELECTRICAL SAFETY REGULATIONS:

- 35.1 In no circumstances shall the contractor interfere with fuse and electrical equipment belonging to the GWSSB or other contractors.
- 35.2 No work shall be carried out on any live equipment. The equipment shall be made safe by the GWSSB and a permit to work be issued before work is carried out.
- 35.3 The contractor shall employ the necessary number of qualified full time electricians to maintain temporary electrical installation

GENERAL REQUIREMENTS (ADDITIONAL)

1. Employer's Drawings (if any)

- 1.1. The drawings listed in the tender document are the Employer's drawings and are provided by the Employer as illustrative of the specification.
- 1.2. All data and information furnished in the drawings by the Employer is given in good faith but the Employer does not accept the responsibility for the completeness and accuracy thereof. The same shall be verified by the contractor promptly pointing out errors or discrepancies thereof to the Engineer.

2. Drawings Furnished by the Employer (if any)

- 2.1. The contractor shall carefully check all drawings and / or instructions furnished by the Engineer in charge before commencing any Work, and shall inform the EIC in writing, within a day from the receipt of the same, of any errors or omissions discovered, or of the difficulty to execute any works or part thereof in compliance with these drawings and / or the written instructions received from the EIC. Failing to do this, he shall be liable to execute at his own cost the necessary alterations to any works resulting from these errors or omissions.
- 2.2. The contractor will be furnished with 2 copies of any such drawings prepared by the Engineer. The contractor will also be furnished with two copies of all instructions as may be issued by the Engineer. One copy of all such drawings and instructions issued to the contractor shall be kept in his office at the site. No drawing or instruction shall be considered valid unless it has been signed by the Engineer.

3. Drawing Sheet Format

- 3.1. All drawings provided by the contractor shall be on standard size sheets, prepared on computer with Auto Cad 14 and shall show the following particulars in a title block located in the lower right hand corner, in addition to the name of contractor and equipment manufacturer, date, scale, drawing number, revision number (R0 for drawings submitted initially, R1, R2, etc. for drawings submitted subsequently) and title:

Gujarat Water Supply & Sewerage Board / Name of Project: Regional Water Supply Scheme

A blank space of 90 mm x 100 mm shall be provided for the Engineer's approval stamp and provision shall be made for details of revisions to be recorded.

- 3.2. All drawings submitted by the bidder / contractor shall use the English language and preferably SI units. All drawings shall be clearly and fully cross referenced to the other drawings as relevant.

4. Tender / Contract Drawings

- 4.1. Drawings submitted by the bidder shall show all the essential items of the plant offered together with sufficient details to enable the general arrangement of the Plant to be determined.
- 4.2. The outline dimensional drawings submitted by the contractor shall include the following in addition to overall dimensions:
- Parameters of equipment
- Load details
- Support details
- Foundation pocket details
- 4.3. The drawings to be provided by the Bidder / Contractor shall include the following, but shall not be limited to those listed: (* Indicates the drawings/documents to be submitted)

Sr. No.	Description	To be submitted with the Tender	To be submitted after the award of the Contract
Outline Dimensional Drawing			
.1	Pumping Machinery (VT/ SCF/HSCF/ ES)	*	*
.2	Induction motor with separate terminal box for:		
(a)	Line / Neutral side terminals with phase segregation	*	
(b)	Resistance temperature detectors		*
Cross Sectional Drawing with Materials of Construction			
.1	Pump	*	*
.2	Motor for above	*	*
.3	Pump Performance curves at rated RPM : Q Vs H, P, η & NPSH	*	
.4	Q Vs H curves super-imposed on system resistance curves	*	
.5	Performance Test Records of 2 pumps (same as the offered model)	*	
.6	Pump ISO efficiency Curve	*	
Motor Curves			
.7	Starting Current Vs time		*
.8	Characteristics under cold and hot conditions		*

5. Submission and Approval of Drawings

- 5.1. The following shall be the procedure for submission and approval of drawings:
 - 5.1.1. The contractor shall submit 3 copies of the drawings to the Employer. All the drawings are to be signed by the contractor or his authorized representatives
 - 5.1.2. The Engineer in charge's (EIC) representative will review the drawings and, if found fit for approval, the Employer will return 2 copies to the contractor duly approved.
 - 5.1.3. In case the drawings / documents are not fit for approval but worth for review, the EIC's representative will mark the comments on the drawings and return 2 copies to the contractor. In such case, the contractor shall resubmit the revised drawings within two weeks as per sub clause 5.1.1 above and the same shall be repeated till the drawings are finally approved as per sub clause 5.1.2 above.
 - 5.1.4. If the submitted drawings / documents are not worth for review, the contractor will be informed accordingly.
 - 5.1.5. On receipt of the approved drawings as per sub clause 5.1.2 above, the contractor shall submit floppy and documents to the employer.
 - 5.1.6. After tests on completion, the contractor shall submit, within 15 days of the conclusion of the tests, CD's of the "As Built Drawings" to the Employer.
- 5.2. When the drawings are received by the EIC's representative after revision by the contractor, he will only review the revision made and hence the contractor shall carefully identify all the revised details / dimensions and also describe the revisions in the revision block.
- 5.3. No drawings, with corrections made after taking the prints, will be accepted.
- 5.4. Approval of drawings by the Engineer shall not relieve the contractor of his responsibility in terms of the contract.

6. Operation and Maintenance Manuals

- 6.1. The operation and maintenance manuals shall be arranged to provide separate volumes for each principal section of the Works and they shall relate to as built conditions and shall include all necessary drawings and diagrams for a proper understanding of the works.
- 6.2. The operation and maintenance manual shall be approved in draft form initially prior to commencement of erection by the EIC's representative and shall cover all items of the Works. For this purpose, three draft copies shall be submitted to the EIC's representative. A mere collection of manufacturers' descriptive leaflets will not be acceptable in satisfaction of this clause. The operation and maintenance manual shall comprise both operating instructions and maintenance instructions.
- 6.3. The manuals shall include, but not be limited to the following information:
 - 6.3.1. Descriptive overview of the whole of the works.
 - 6.3.2. Descriptions of all systems installed, including mechanical, electrical, instrumentation, control systems with relevant design and operating parameters.

- 6.3.3. Descriptions of all equipment supplied including manufacturer's leaflets, which shall be scheduled for easy reference.
- 6.3.4. Schedules and manufacturer's catalogues for all equipment supplied, giving duties, electrical load, etc.
- 6.3.5. Schedules of all equipment suppliers (and their local agents) including names, addresses, telephone & facsimile numbers and e-mail ID.
- 6.3.6. Start up, operation and shut down instructions for all parts of the works. These shall include step by step directions on setting the plant to work listing all adjustments and settings necessary for the current functioning of the plant.
- 6.3.7. Instructions on monitoring of plant performance and sample log sheets for each plant item, to be filled by operators on a routine basis.
- 6.3.8. "Dos" and "Don'ts" in plant operation: Operator's attention shall be drawn to all operations considered to be dangerous to operators or likely to cause damage to the plant.
- 6.3.9. Procedures to deal with breakdown and emergencies
- 6.3.10. Safety requirements
- 6.3.11. Checking, testing and replacement procedures to be carried out on all plant items on a daily weekly and monthly basis or at longer intervals to ensure trouble free operation. Full maintenance instructions for all equipment including planned maintenance schedules or charts giving daily, weekly, monthly, quarterly, half yearly, annual overhaul instructions together with recommended lubricants and spares. These shall also include details of routine maintenance work that will be within the competence of the normal maintenance staff and notification of maintenance work that will have to be done by the manufacturer, his agent or other specialist operator.
- 6.3.12. Fault locations and remedy charts to facilitate tracing the cause of malfunctions or break down and correcting faults.
- 6.3.13. Complete list of recommended lubricants and lubrications charts.
- 6.3.14. A 'spares schedule' which shall consist of a complete list of item wise spares for all plant items with ordering references and part numbers.
- 6.3.15. A complete list of manufacturer's instructions for operation and maintenance of all bought out equipment. The list shall be tabulated in alphabetical order giving the name of supplier / manufacture, identification of the Plant item giving the model number and the literature provided including instruction leaflets and drawing numbers.
- 6.3.16. Step by step procedure for the dismantling, repair and re assembly of all items of equipment.
- 6.3.17. Part list and drawings or exploded diagrams for each item of plant with construction particulars, materials of construction, mating components, clearances and tolerances, maximum wear permitted before replacements are to be done, etc

6.3.18. Record drawings of all systems installed, including general arrangements, conduit and wiring trunking systems, wiring diagrams, control schematics and valve charts, etc., to a reduced scale.

6.4. The contractor shall furnish 3 copies of the Operation and Maintenance Manual for each station. Each volume shall be durable and permanently bound within a stiff binder of a design to be approved by the Employer. They shall permit the subsequent incorporation of revisions to be necessary during the defect liability period.

7. Protection and Packing for Transportation

7.1. Before any plant is dispatched from manufacturer's works it shall be properly prepared and packed and the contractor shall give the Employer at least 14 days notice that these preparations are to commence.

7.2. Prior to dispatch the plant shall be adequately protected by painting or by other approved means for the whole period of transit, storage and erection, against corrosion and incidental damage, including the effects of vermin, sunlight rain, high temperatures and humid atmospheres. The contractor shall be responsible for the plant being so packed and / or protected as to ensure that it reaches the Site intact and undamaged. The plant shall be packed to withstand rough handling in transit and all packages shall be suitable for storage including possible delays in transit.

7.3. The contractor shall be deemed to have included in the schedule of prices for all materials and packing cases necessary for the safe package, conveyance and delivery and storage of the plant with all protective and preservation measures.

7.4. Cases containing rubber rings, bolts and other small items shall not normally weigh more than 50 kg gross per case. No one package or bundle shall contain items of plant intended for incorporation in more than one section of the works. All items of plant shall be clearly marked for identification against the packing list.

7.5. Eye bolts, lifting hooks and brackets shall be provided for lifting the boxes, crates and packages. Every crate or package shall contain a packing list in a waterproof envelope. A duplicate copy of the packing list shall be sent by post to the EIC's representative at site.

7.6. All crates, packages, etc. shall be clearly marked with a waterproof material to show the weight and where the slings should be attached, and shall also have an indelible identification mark relating them to the packing lists. Packing cases shall be nonreturnable. Contractor shall have to clear the site including packing material.

7.7. Electrical equipment shall be enclosed in sealed air tight package with hygroscopic material, before being placed in packing cases on shock absorbent materials and secured by means of battens.

8. Delivery, Unloading and Storing at Site

8.1. The Contractor shall be responsible for checking all materials delivered to Site and shall keep the EIC or his representative fully informed of the state of deliveries. The contractor shall carry out, at his cost, all instructions of EIC or his representative for proper unloading, preservation, maintenance, storage and security of materials delivered to site until he fulfills all his obligations under the contract.

- 8.2. The contractor shall erect and maintain on the Site any temporary storage facility as required and approved by the EIC. If built up shed or area is provided by the Employer depending upon availability, the contractor shall have to pay rent as finalised by the EIC.
- 8.3. Multiple handling and movement of materials during storage and retrieval shall be avoided.

MATERIALS AND WORKMANSHIP

1. Introduction

- 1.1. This part of the specification sets out the general standards of materials to be supplied and the workmanship required to be ensured by the contractor. All component parts of the Works shall, unless otherwise specified, comply with the provisions of this part or be subject to the approval of the Employer. Particular attention shall be paid to a neat, orderly and well arranged installation carried out in a methodical competent manner.

2. Reference Specifications and Standards

- 2.1. Where reference is made in the Specification to a British Standard Specification (hereinafter abbreviated to 'B.S') issued by the British Standards Institution of 2, Park street, London W.I., or to an Indian Standard Specification (I.S.) issued by the Bureau of Indian Standards, (earlier known as Indian Standard Institution), Manak Bhavan, 9 Bahadur shah Zafar Marg, New Delhi 110 002, or American Society for Testing and materials (ASTM) issued by ASTM 1916 Race Street, Philadelphia, P.A., 19103, U.S.A. or American national Standards Institute (ANSI) issued by ANSI 1430, Broadway, New York, N.Y., 10018, U.S.A. or Japanese Industrial Standards (JIS) issued by Japanese Standards Association, 4-1-24, Akasaka, Minato-Ku, Tokyo 107, Japan or to any other equivalent Standard it shall be to the latest revision of that Standard at the tender opening date.
- 2.2. The contractor may propose at no extra cost to the Employer, the use of any relevant authoritative internationally recognized Reference Standard.
- 2.3. All details, materials and equipment supplied and workmanship performed shall comply with the specified Standards. If bidder offers equipment to other Standards, the equipment / material should be equal or superior to those specified and full details of the difference shall be supplied.
- 2.4. In the event of conflict between this specification and the codes for equipment, provisions of this specification shall govern. Certain specifications issued by national or other widely recognized bodies are referred to in this specification. In referring to the Standard Specifications the following abbreviations are used:

IS	:	Indian Standard
ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society of Testing and Materials

AWS	:	American Welding Society
AWWA	:	American Water Works Association
ISO	:	International Organization for Standardization
DIN	:	Deutsches Institute fur Normung
BS	:	British Standard
IEC	:	International Electro technical Commission
IEE	:	Institution of Electrical Engineers
IEEE	:	Institute of Electrical and Electronic Engineers
NEMA	:	National Electrical Manufacturers Association
AGMA	:	American Gear Manufacturer's Association

3. Materials General

- 3.1. All materials incorporated in the works shall be the most suitable for the duty concerned and shall be new and of reputed make / approved quality, free from imperfections and selected for long life and minimum maintenance. Non destructive tests, if called for in the Specification, shall be carried out. All submerged moving parts of the plant, or shafts and spindles or faces etc. in contact with them shall be of corrosion resistant materials. All parts in direct contact with various chemicals, shall be completely resistant to corrosion, or abrasion by these chemicals, and shall maintain their properties without aging due to the passages of time, exposure to light or any other cause.

4. Workmanship General

- 4.1. Workmanship and general finish shall be of first class quality and in accordance with best workshop practice.
- 4.2. All similar items of the plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as the originals and shall fit all similar items. Machining fits on renewable parts shall be accurate and to specified tolerances so that replacements can be readily installed. All equipment shall operate without excessive vibration and with minimum noise. All revolving parts shall be truly balanced both statically and dynamically so that when running at normal speeds at any load up to the maximum there shall be no vibration due to lack of balance.
- 4.3. All parts which can be worn or damaged by dust shall be totally enclosed in dust proof housings. All materials incorporated in the works shall be the most suitable for the duty concerned, free from imperfections and selected for long life and minimum maintenance. All necessary accessories required for satisfactory and safe operation of the plant shall be supplied by the contractor unless it is specifically excluded from his scope. Suitable provision by means of eyebolts or other means are to be provided to facilitate handling of all items that are too heavy or bulky for lifting and carrying by two men.

- 4.4. If, after installation, the operation or use of the materials or equipment furnished by the contractor proves to be unsatisfactory. The Employer shall have the right to operate or use such materials or equipment until correction of defects, errors or omissions, by repair or by partial or complete replacement, can be made without interfering with the plant operations. Except for any warranty provided for elsewhere in this contract or unless otherwise agreed upon in advance, the period of such operation or use, pending correction of defects, will not exceed 1 year.

5. Welding

- 5.1. Welding shall comply with the latest revision of the BS 5135 Code.
- 5.2. Welders shall be qualified in accordance with the requirement of the appropriate section of BS 4871. The Engineer shall have the right to call for further qualification from time to time from any welder who in the opinion of the EIC does not produce weld in accordance with the qualification. Each welder shall be assigned a number and letter. Each welded end shall clearly be identified as to its welder marking the welder's code adjacent to the welds. A record chart shall be maintained for each welder showing the procedures, for which he has qualified, the date of such qualification, the type of defects produced and their frequency. The EIC shall disqualify the welder whose work requires a disproportionate amount of repairs. All procedures where required shall be qualified as per BS EN 283-3.
- 5.3. Inspection and quality of surveillance shall not be limited to the examination of finished welds. The techniques employed shall be based on methods which are known to produce good results and which have been verified at Site by actual demonstration.
- 5.4. Haphazard striking of the electrodes for establishing an arc shall not be permitted. The arc shall be struck either on the joint or on a starting tag. The starting tag shall be of the same material or a material compatible with the base metal being welded. In case of any inadvertent strike on place other than the welding, the area affected shall be ground flushed and examined by liquid penetration method.
- 5.5. Generally, a stringer bead technique shall be used with a slight oscillation of necessary to avoid slag and to minimise the number of beads needed to fill exceed 3 times the wire diameter. Vertical welds shall be made in upward direction. For all pipes above 300 mm dia., welding shall be done whenever possible, by 2 welders working simultaneously along both sides of the pipe.
- 5.6. The root pass shall have less than 1.5 mm internal reinforcement. Defects like icicles, burn through and excessive "such back" etc. shall be cause for rejection of welds.
- 5.7. Final welds shall be suitable for appropriate fabrication of the non-destructive examination of the weld. If grinding is necessary, the weld shall be blended into the parent metal without gouging or thinning of the parent metal in any way. Uneven and excessive grinding may be a cause for rejection. Fillet weld shall preferably be convex and free from undercutting and overlap at the toe of weld. Convexity and concavity shall not exceed 1.5 mm. The leg lengths shall not exceed the specified size by more than 1.5 mm.

- 5.8. All attachments such as lugs, brackets and other non pressure parts shall also be done by qualified welders in accordance with the design details and materials specifications. Temporary attachments shall be removed in a manner that will not damage the parent metal. Areas of temporary attachments shall be dressed smooth and examined by ultrasonic or liquid penetration methods.
- 5.9. All tack welds shall be made using qualified procedure and welders, the number of size of tack welds shall be kept as small as to consist of adequate strength and joint alignments. All tack welds shall be examined visually for defects and if found defective shall be completely removed. As welding proceeds, tack welds shall be either removed completely or shall be properly prepared by grinding or filling their starting ends so that they may be satisfactorily incorporated in the welds. Unacceptable defects shall be removed by grinding machine or chipping or gouging. Flame gouging may be permitted provided gouged surfaces are ground at least by 1.0 mm below the deepest indentation.
- 5.10. All weld repairs shall be carried out using the approved welding procedures and welders. Re welded areas shall be reexamined by the methods specified for the original welds and repair procedures shall be duly qualified by the EIC's representative.

6. Pre heating and Post heating Treatment

- 6.1. Pre heating and post heating treatment shall conform to the relevant application codes. Preheating not exceeding 121⁰ C for all carbon steel construction above 25 mm thickness would be mandatory. Such pre heating would be maintained during flame cutting, flame or arc gouging, welding and repairs and may be done by gas heating by gas torches / gas rings with neutral flame. The temperature shall be checked by temperature indicating crayons. However, such pre heating will not be necessary for welds less than 6 mm size. In large diameter pipe fabricated out of plate materials, production control test plates in accordance with the BS 4870 part 1 Table 6 to represent 30 % of the long seams and each welder's performance would be mandatory.

7. Electrodes

- 7.1. All electrodes shall be stored in their original sealed containers under dry conditions. Electrodes shall remain identified until consumed. All electrodes shall be dried before use. Drying ovens shall be provided in work areas for drying purposes. Electrodes withdrawn from oven shall be promptly used and excess unused electrodes shall be promptly returned to oven.

8. Examination / NDT / Radiography

- 8.1. The various stages of examination and types shall be as stipulated in the respective fabrication Codes. Radiographic examination shall be carried out as per provisions of BS 2600 or BS 2910. Ultrasonic tests where called for shall be carried out as per provisions of BS 3926, magnetic particle tests shall be carried out as per BS 6072. Liquid penetration tests shall be carried out as per BS 6443.

9. Stainless Steel Welding

- 9.1. All welding consumable such as electrodes, filler weirs, argon gas for shielding and purging shall be of high quality and the proposed brand shall be furnished for approval of

the EIC. Weld deposits shall have similar or higher physical properties and similar chemical composition to the members joined.

- 9.2. All electrodes shall be purchased in sealed containers only and stored in their packing intact. The packets opened shall be consumed as early as possible. The electrodes removed from the containers shall be kept in holding ovens at temperatures recommended by electrode manufacturer. Special care shall be taken in avoiding mixing of electrodes in the oven. The electrodes and filling wires shall be free from rust, oil, grease, earth and other foreign matter.
- 9.3. Argon gas with purity 99.5 % shall be used for shielding and purging. The purity of gas shall be certified by the gas manufacturers.
- 9.4. Non destructive examination of the welds shall be carried out to ensure quality of weld.
- 9.5. The electric current for welding shall be direct current, straight polarity (electrode negative). The welding current shall be kept minimum possible to ensure minimum heat affected zone in the parent material. Other side of the weld joint shall be periodically flushed with argon gas.

10. Castings

- 10.1. Cast iron shall be of standard grey close grained quality. The structure of the castings shall be homogeneous and free from non metallic inclusions and other injurious defects. All surfaces of castings which are not machined shall be smooth and shall be carefully fettled to remove all foundry irregularities.
- 10.2. Minor defects in depth not exceeding 12.5 percent of total metal thickness and which will not ultimately affect the strength and serviceability of the casting may be repaired by approved welding techniques. The EIC shall be notified of large defects and no repair welding of such defects shall be carried out without prior approval of the EIC. If the removal of metal for repair should reduce the stress resisting cross section of the casting by more than 25 percent, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then casting shall be rejected. Test coupons cast simultaneously with the main castings shall be identified to check physical, chemical analysis of casting. Major defects on casting are not acceptable. Castings repaired by welding for minor defects shall be stress relieved after such welding. Non destructive tests as directed by the EIC will be required for any casting containing defects whose extent cannot otherwise be judged, or to determine where repair welds have been properly made.

11. Forging

- 11.1. All major stress bearing forging shall be made to a Standard specifications. Forging shall be subjected to magnetic particle testing or dye penetration test at the areas of fillets and change in section. The testing shall be conducted after rough machining (10 microns). Any defect which will not machine out during the final machining, will be gouged out fully, inspected by dye penetration or magnetic particle inspection to ensure that the defect is fully removed and repaired using an approved repair procedure. Any indication, which proves to penetrate deeper than 2.5 % of the finished thickness of the component, shall be

reported to the EIC giving the details like location, length, width and depth. For the magnetic particle inspection the choice of wet or dry particles shall be at the Contractor's discretion.

- 11.2. All forging shall be demagnetised after test and shall be heat treated for the relief of residual stresses.

12. Design Life

- 12.1. The works as a whole shall be new, of sound workmanship, robustly designed for a long reliable operating life and shall be capable of 24 hours per day continuous operation for prolonged period in the climatic and working conditions prevailing at the Site, and with the minimum of maintenance. Particular attention shall be given to temperature changes, the stability of paint finish for high temperatures, the rating of engines, electrical machinery, thermal overload services, cooling systems and the choice of lubricants for possible high and prolonged operating temperatures. The contractor shall be called upon to demonstrate this for any component part either by service records, or evidence of similar equipment already installed elsewhere or relevant type tests. Routine maintenance and repair shall as far as possible not requires the services of highly skilled personnel.
- 12.2. The plant shall be designed to provide easy access to and replacement of component parts which are subject to wear, without the need to replace whole units. No parts in contact with water shall have a life from new to replacement or repair of less than five years.
- 12.3. Design features shall include the protection of plant against damage caused by vermin, dirt, dust and dampness and to reduce risk of fire. Plant shall operate without undue vibration, and parts shall be designed to withstand the maximum stresses under the most severe condition of normal service. Materials shall have a high resistance to change in their properties due to the passage of time, exposure to light, temperature and any other cause which may have a detrimental effect upon the performance or life of the Works.
- 12.4. Plant located outside lockable areas / building shall have additional features to prevent unauthorised operation.

13. Lubrication

- 13.1. A complete schedule of recommended oils and other lubricants shall be furnished by the contractor. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the supplier of the lubricants shall be submitted to the EIC.
- 13.2. Contractor shall indicate indigenously available equivalent lubricants with complete specification, to enable the Employer to arrange for regular supply.
- 13.3. Where lubrication is effected by means of grease, preference shall be given to a pressure system which does not require frequent adjustment or recharging. Frequent, for this purpose, means more than once in a month and grease systems having shorter periods between greasing should be avoided. Where necessary for accessibility grease nipples shall be placed at the end of the extension piping, and, when a number of such points can be grouped conveniently, the nipples shall be brought to a battery plate mounted in a convenient position. All grease nipples shall be of the same size and type for every part of

the plant. Arrangements shall be provided to prevent bearings being overfilled with either grease or oil.

- 13.4. Where more than one type of special grease is required a grease gun for each special type shall be supplied and permanently labeled.
- 13.5. Oil containers shall be supplied complete with oil level indicators of the sight glass type, or where this is not practicable, with dipsticks. The indicators shall show the level at all temperatures likely to be experienced in service. The levels shall be clearly visible in the sight glass type from the normal access floor to the particular item of Plant and they shall be easily dismantled for cleaning. All sight glasses shall be firmly held and enclosed in metal protection in such manner that they cannot be accidentally dislodged.
- 13.6. All lubrication systems shall be designed so as not to cause a fire or pollution hazard and particular care shall be taken to prevent leakage of lubricants and to avoid leaking lubricants coming into contact with any electrical equipment, heated surfaces or any other potential source of fire.

14. Name Plate

- 14.1. Each item of the plant shall have permanently attached to it in a conspicuous position, a name plate and rating plate. Upon these shall be engraved or stamped, the manufacturer's name, type and serial number of plant, details of the loading and duty at which the item of plant has been designed to operate, and such diagrams as may be required by the EIC. All indicating and operating devices shall have securely attached to them or marked upon them designations as to their function and proper manner of use.
- 14.2. Name plates, rating plates and labels shall be of a non-flame propagating materials, either non hygroscopic or transparent plastic with engraved lettering of a contrasting colour. Fixing shall be by means of non corrosive screws, drive rivets or adhesives shall not be used.
- 14.3. Warning labels shall be provided where necessary to warn of dangerous circumstances or substances. Inscriptions or graphic symbols shall be black on a yellow background.
- 14.4. Instruction labels shall be provided where safety procedures such as wearing of protective clothing are essential to protect personnel from hazardous or potentially hazardous conditions. These labels shall have inscriptions or graphic symbols in white on a blue background.

15. Nuts, Bolts, Studs and Washers

- 15.1. Nuts, bolts, studs and washers for incorporation in the plant shall conform to the requirements of the appropriate standard. Nuts and bolts shall be of the best quality of specified grade, machined on the shank and under the head and nut
- 15.2. Fitted bolts shall be a light driving fit in the reamed holes they occupy, shall have the screwed portion of such a diameter that it will not be damaged in driving and shall be marked in a conspicuous position to ensure correct assembly at site.

- 15.3. Washers, locking devices and anti vibration arrangements shall be provided where necessary. Jointing hardware for the entire Plant shall be provided with sufficient spares to cater for site losses.
- 15.4. Where bolts pass through structural members taper washers shall be fitted, where necessary, to ensure that no bending stress is caused in the bolt. Where there is a risk of corrosion, bolts, nuts and studs shall be designed so that the maximum stress does not exceed half the yield stress of the material under any conditions. All bolts, nuts and washers which are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel bearing stainless steel.
- 15.5. The contractor shall supply all holding down, alignment and leveling bolts complete with anchorages, nuts, washers and packing required to attach the plant to its foundations, and all bed plates, frames and other structural parts necessary to spread the loads transmitted by the plant to concrete foundations without exceeding the design stresses.
- 16. Allowance for Wastage**
- 16.1. The contractor shall supply reasonable excess quantities to cover wastage of those consumable which will be normally subject to waste during erection, commissioning and setting to Work.
- 17. Painting – General**
- 17.1. The contractor shall be responsible for the cleaning, preparation for painting, and priming or otherwise protecting, as specified, all parts of the plant at the place of manufacture prior to packing.
- 17.2. Parts may be cleaned but surface defects may not be filled in before testing at the manufacturer's works. Parts subject to hydraulic test shall be tested before any surface treatment. After test, all surfaces shall be thoroughly cleaned and dried out, if necessary by washing with an approved de-watering fluid prior to surface treatment. Except where the specification provides to the contrary all painting materials shall be applied in strict accordance with the paint manufacturer's instructions.
- 17.3. All protective coatings shall be suitable for use in warm humid climates. All primers, under coats and finishes shall be applied by brush or airless spray, except where otherwise specified. Consecutive coats shall be in distinct but appropriate shades. All paints shall be supplied from the store to the painters, ready for application, and addition of thinners or any other material shall be prohibited.
- 18. Painting at Place of Manufacture**
- 18.1. Steel and cast iron parts shall be sand blasted to near white cleaning before painting. Edges, sharp covers etc. shall be ground to a curve before sand blasting. A primer coat of a zinc rich epoxy resin based coating with at least 75 microns dry film thickness is to be provided. In addition the parts are to be provided with adequate number of coats of coal tar epoxy polyamine coating to a dry film thickness of 175 microns including primer coating.
- 19. Painting at Site**

- 19.1. Immediately on arrival at the site, all items of plant shall be examined for damage to the paint coat applied at the manufacturer's works, and any damaged portions shall be cleaned down to the bare metal, all rust removed, and the paint coat made good with similar paint.
- 19.2. After erection, such items which are not finish painted shall be done so and, items that have been finish painted at the manufacturer's works shall be touched up for any damaged paint work. For finish painting, two coats of synthetic enamel conforming to IS: 2932 shall be applied. Dry film thickness of each coat shall be at least 25 microns.
- 19.3. The dry paint film thickness shall be measured by Electrometer or other instruments approved by the Employer. In order to obtain the dry film thickness specified, the contractor shall ensure that the coverage rate given by the paint manufacturer will enable this thickness to be obtained. Strength of adhesion shall be measured with an adhesion tester and this value shall not be less than 10 kg/cm². Painted fabricated steel work which is to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner that will ensure that no water or dirt can accumulate on the surface. Suitable packing shall be laid between the stacked materials. Where cover is provided, it shall be ventilated.

20. Noise and Vibration

- 20.1. The Contractor shall provide a quiet installation. All items of plant and equipment shall be carefully chosen with a view to minimizing sound levels.
- 20.2. The Contractor shall provide and fix all material for the prevention of transmission of noise and vibration through the structure. Where appropriate all fans, A/C package unit, compressors and other motif plant shall be mounted on resilient mountings. All rotating plant shall be statically and dynamically balanced.

21. Galvanising

- 21.1. Wherever galvanising has been specified the hot dip process shall be used. The galvanised coating shall be of uniform thickness. Weight of zinc coatings for various applications shall not be less than those indicated below:

a) Fabricated steel

- | | | |
|----|---|-----------------|
| i | Thickness less than 2 mm but not less than 1.2 mm | 340 gms / sq mm |
| ii | Thickness 2 mm and above | 460 gms / sq mm |

b) Fasteners

- | | | |
|----|------------------------|-----------------|
| i | Up to nominal size M10 | 270 gms / sq mm |
| ii | Over M10 | 300 gms / sq mm |

- 21.2. Galvanising shall be carried out after all drilling, punching, cutting, bending and welding operations have been carried out. Burrs shall be removed before galvanising. Any Site modification of galvanised parts should be covered well by zinc rich primer and aluminum paint.

22. Support for Pipe work & Valves

- 22.1. All necessary supports, saddles, slings, fixing bolts & foundation bolts shall be supplied to support the pipe work. Valve and other equipments mounted in the pipe work shall be supported independent of the pipes to which they connect.

DETAILED TECHNICAL SPECIFICATIONS

PART I: MECHANICAL

Submerged Centrifugal Pump Set(whichever is applicable)

1. The pump set shall be of compact unitary mono block type construction. The pump casing shall be of high efficiency, bowl diffuser or volute casing type with the impeller mounted directly onto the extended solid motor shaft (without any couplings). Numbers of stages shall preferably be one or two stages. The stages shall be decided as per maximum achievable efficiency as per HIS and / or as prescribed in data sheet.
2. The pump set should be single / two stage type i. e. it should have only one / two impeller (s) & one / two casing – two stages shall not be allowed (except for head ≥ 90 m). Pump casing shall be high efficiency, centrifugal volute type.
3. The pumps are to be installed directly into the water body (canal / sump / river or unscreened jack well), so it may suck up lot of silt, clay, pebbles & vegetation. Therefore it should be reliable & robust.
4. Installation
 - 4.1 The pumps should always be suitable for vertical or horizontal; permanent or portable installation & be interchangeable between these modes throughout their working life time (by suitable use of base frames / auto coupling systems which can be ordered either during the main purchase order or at a later stage).
 - 4.2 The detailed scope of supply & mode of installation shall be as per the specific tender data sheets or as per CDR instructions.
 - 4.3 Possible Installation Arrangements
 - 4.3.1 Horizontal, Portable, Wet (Submerged) Installation:
 - 4.3.1.1 The pump shall be offered with fully portable & robust MS portable base frame.
 - 4.3.1.2 In case the pump is to be installed on a concrete canal bed where vibrations are to be suppressed; the pump should be provided with anti vibration shock pads between the pump & the base frame.
 - 4.3.2 Vertical, Portable, Wet (Submerged) Bottom Rested Installation:
 - 4.3.2.1 The pump shall be offered with a fully portable & robust M S portable base frame which allows for installation of the pump in either vertical or horizontal mode – i. e. both modes should be possible with the same base frame which is rested on the bottom of the water body.
 - 4.3.3 Vertical, Portable, Wet (Submerged) Suspended Installation:
 - 4.3.3.1 The pump shall be offered with a fully portable & robust MS portable base frame which allows for installation of the pump in vertical suspended installation within deep water body. In such a case, the motor shall be at bottom & the pump portion shall be at the top. The

delivery column pipe shall be flange bolted on to the pumpset flange.

4.3.4 Vertical, Permanent, Wet (Submerged) Installation (Auto Coupling System):

- 4.3.4.1 The pump set should be coupled to the rising main by an automatic coupling system. The automatic coupling system should have a pedestal (which is bolted on to sump bottom by pre grouted foundation bolts) which is permanently bolted onto the rising main.
- 4.3.4.2 The automatic coupling system design should be such that a unibuilt bend is integrally cast with the pedestal. This design obviates the need of bolting on a separate duck foot bend to pedestal. Separately bolted CI IS DF bends are not allowed as they are not conducive to replace flange gaskets (between the CI IS DF bend and the pedestal).
- 4.3.4.3 To prevent swiveling of the pump set (while lowering into & pulling out of sump), larger (with discharge size $\geq 125\text{mm}$) & / or deep installed (with installation depth more than 10 m) pumps, the auto coupling system should preferably have two guide elements (either pipes or wires). Single guide element is not acceptable.
- 4.3.4.4 To "fish out" a vertically installed submerged pump set (even if a chain has not been attached to the lifting hook prior to the pumpset being lowered) the pump should have a self centering lifting hook. Its design should be such that the lifting chain's hook can be engaged to the pump's lifting hook without the need for man to enter the wet sump to engage the same.
- 4.3.4.5 The scope of supply shall include auto coupling system (with integral duck foot bend), SS foundation bolts, alloy steel chain & guide rail pipe / wire (as per depth of sump / jack well).

5 Pump End Design

5.1 Speed

- 5.1.1 To achieve best efficiency life, the speed of the pump set should be such that the specific speed (N_s) of the pump (calculated as per for single stage, single suction impeller pumps assuming duty point as the best efficiency point) is to be calculated as follows:

$$\text{Where } N_s = \frac{3.65 N \times \sqrt{Q \text{ m}^3/\text{s}}}{(H \text{ m})^{0.75}}$$

N_s = Specific speed

N = The operating speed of the pump in rpm

Q = The rate of flow in cubic meters per second

H = The rated head per stage of the pump in meters

The specific speed shall preferably be in the range of 140 to 200. It should be nearer to 170 as far as possible to achieve best efficiency. However calculation of specific speed for duty parameters given in data sheet (price bid) shall be given by the manufacturers' of the pump.

5.1.2 Further motors rated above 100 HP & / or with pump's duty point flow rate equivalent or in excess of 360 m³/hr shall be limited to not more than 1450 rpm.

5.2 The pump shall be capable of developing the required total head at rated capacity for its continuous operation. Pumps of particular category shall be identical and shall be suitable for parallel operation.

5.3 The head capacity curve shall be continuously rising towards shut off with the highest at shut off. The shut off head shall be at least 120 % of the specified duty point head.

5.4 The impeller shall be of high efficiency multi channel enclosed type (except for specific speed ≥ 90 where semi open impellers shall be allowable).

5.5 Suction Strainer

5.5.1 The pump is fitted directly with a suction bell mouth to which is compulsorily fitted a heavy duty strainer (to avoid pick up of gravel, pebbles, vegetation, etc.)

5.5.2 Sizing of the suction strainer should be larger of the following two:

5.5.2.1 At the duty point flow, the suction velocity (at strainer holes), should never exceed 3.0 m/s &

5.5.2.2 At the duty point flow, the total cumulative suction area of all the strainer holes should always be ≥ 2.0 times the impeller's suction eye area.

5.5.3 However large & slow speed pumps (with solid handling ability ≥ 75 mm & of speed ≤ 1000 rpm) may be offered without suction strainer.

5.5.4 The pump's solid handling size & maximum hole size of suction strainer should be as per below mentioned chart.

Table 1: Design of strainer		
Pump delivery size	Minimum thickness of suction strainer	Maximum permissible hole size of suction strainer
DN 25, DN 32 & DN 40	2 mm	Not more than 4 mm
DN 50 & DN 65		Not more than 6 mm
DN 80		Not more than 8 mm
DN 100		Not more than 10 mm
DN 125	3 mm	Not more than 12 mm
DN 150		Not more than 14 mm
DN 200	5 mm	Not more than 21 mm
DN 250		Not more than 30 mm
DN 300 & DN 350		Not more than 40 mm
DN 400 & above	7 mm	Not more than 50 mm

5.6 The pump set shall be suitable for starting with delivery valve open as well as closed at any

operating point. The motor should also start accordingly. The pump set shall be capable of withstanding the accidental rotation in reverse direction.

5.7 Complete performance curve, data sheets, G A drawings showing installation shall be submitted along with the technical bid.

5.8 Pumps having less than minimum guaranteed efficiency as mentioned in the data sheet of pump derived per HIS 2010 are not acceptable.

6 Submerged Induction Motor End Design

6.1 The motor shall be of squirrel cage, induction type, air filled yet capable of water immersion upto 20 mwc for S1 duty. Motors with oil or water filled windings shall not be allowed.

6.2 It is rated for $415 \pm 10\%$ V, 3 phase $50 \pm 5\%$ c/s AC.

6.3 Its winding should be of class “H” insulation (withstanding winding hot spot temperature of up to 185°C respectively) while the nominal temperature rise of winding hotspot should not exceed that of class “B”.

6.4 It should be wound using dual coated, super enamelled; Copper wire with high temperature index as per IS: 4800 Part 13. PVC / Polypropylene – polyethylene insulation for winding wires shall not be allowed.

6.5 Motor’s insulation should be vacuum varnish impregnated & oven baked to ensure a moisture impervious & mechanically robust insulation. Dip or pour type air dry varnishing shall not be allowed.

6.6 The Power rating of the motor shall be the larger of the following:

- a) Reserve power margin as tabulated in table I of the power input to the pump at duty point at a speed corresponding to the frequency of 50 Hz.
- b) Maximum power input while operating solo or in parallel within maximum and minimum system resistances corresponding to the speed at 50 Hz.
- c) Rating of motor shall be suitable to cover load for entire operating range (preferred / recommended area of operation i. e. – 30 % to + 20 % of design flow rate) of pump model offered with minimum rating of kW.
- d) Rating of motor shall be suitable to cover load for entire operating range of pump model offered with minimum rating of kW in case of pumps in parallel operation. In this case operating zone shall mean from shut off to run out position.
- e) Minimum rating of motor and efficiency at full working load shall not be less than prescribed rating in data sheet.

Table I

MOTOR BHP	% OF PUMPING DESIGN POINT BHP
10 to 20 BHP	120 %
20 to 100 BHP	115 %

Above 100 BHP	110 %
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- 6.7 The motor's rotor shall be of rugged construction either dual cage copper bar brazed / die cast aluminium type to ensure long corrosion free service

However motors rated above 300 HP rotors shall be dual cage copper bar brazed only to ensure ease of onsite repairing, beneficial fly wheel type inertial effect which reduces detrimental effects of water hammer & Better motor efficiency & cooler operating temperature.

6.8 **Motor Cooling**

- 6.8.1 To restrict the dead water level (in case of vertical installation) in the sump to 1 meter, medium sized, vertical pumps (≥ 75 HP) should have a cooling jacket i. e. motor cooling is accomplished by circulation of pumped water between the motor casing & the jacket shell. This jacket shell is fed by cold water from the pump casing & discharges its heated water back into the sump (in case of wet installation) or pump casing (in case of dry installation) by integrally cast ducts. There should not be any pipes, hoses etc. for this circulation.
- 6.8.2 In case the pumps are to be installed horizontally or the dead water level in the sump exceeds 1.5 meters from the pump centre line, the motor can be cooled just by water immersion i. e. no jacketing is required. The mode of cooling (either direct immersion or via jacket cooling) is clearly mentioned in the prescribed data sheet.

6.9 **Motor Protection**

- 6.9.1 Thermal overload protectors (Bi metallic over load relays) should be embedded in each phase of the stator winding to detect over heating & trip the motor from the control panel in the event of the temperature exceeding the safe operating limit (above 130°C).
- 6.9.2 To detect primary mechanical seal's leakage a moisture sensor shall be provided in intermediately oil chamber (& not in the motor casing or elsewhere) – this shall detect water mixing in oil by mode of increased leakage current from the moisture sensor.

6.10 **Cables**

- 6.10.1 A watertight cable junction box sealed from the motor shall be provided for the motor power and signaling cables.
- 6.10.2 The cable shall be brought directly out of the submerged motor without joints, and shall be of sufficient length, minimum 10 m to be terminated in an IP 67 junction box outside adjacent to the wet well & above the HFL. They shall be sized in accordance with the electricity utility regulations and BS 7671.
- 6.10.3 It should have power as well as control cables of dual sheathed EPRS / PVC round type with Copper core of required size as per detailed engineering. However the cross section of the cable shall be enough to ensure a voltage drop of not more than 2 % at actual site conditions.

7 Shaft & Bearings

- 7.1 The solid shaft shall be supported by heavy duty Ball or Roller bearings with a minimum **L₁₀** life of 75,000 hours in accordance with BS 5512. The bearings of pumpsets rated up to 200kW should be permanently greased with premium quality, high temperature, long life grease thereby obviating the need of relubrication for up to **L₁₀** life of the bearings. The bearing should be of Metric Series & not Imperial ones. Larger pump sets should be equipped with water proof regreasing nipples.
- 7.2 The bearings should be permanently greased with premium quality, high temperature, long life grease. The bearing should be of Metric series & not Imperial ones.
- 7.3 Oil lubricated bearings shall not be allowed.
- 7.4 In case the motor is to be driven via a VFD, atleast one of the bearings (DE or NDE) should be current insulated to prevent “electric fluting damage” caused by Harmonics.

8 Stuffing Box / Oil Chamber

- 8.1 The pressurised entry of water into the motor (from the pump’s volute casing) should be prevented by two separate mechanical seals in mounted in a tandem mode within an oil chamber.
- 8.2 The primary (inboard) seal should be of Silicon Carbide or Tungsten Carbide faces to withstand erosive wear due to any silt particles. The secondary (Outboard) seal should be of Carbon v/s Cast Chrome Molybdenum Steel or Silicon Carbide or Tungsten Carbide. Thermally unstable materials like Alumina / Aluminum Oxide are not allowed.

9 Energy Cost Loading

There shall not be any cost loading on grounds of efficiency. However pumps’ with efficiency lower than the minimum acceptable efficiency shall not be accepted. The manufacturer shall provide pump & motor efficiency at duty point.

10 Testing

- 10.1 The pump sets shall be tested at the in accordance of ISO 9906 or IS 9137 or IS 5120 (Tolerance Class 2) with or without VFD. However full load / speed testing is preferable.
- 10.2 In case the pumps are to be installed on specialised auto coupling device, where no external bolting between the pump and the delivery piping is possible – so it is absolutely essential that this joint is leak free or else there may be a substantial pressure/ leakage loss between the pump and the auto coupling system (as they are not clamped together like conventional gasketed & bolted flanged joints). So it is compulsory that such pumps should be tested on an auto coupling system only i. e testing the pump with flange, gasket bolted delivery piping is not allowed.
- 10.3 The Flow shall be measured by full bore electromagnetic or ultrasonic flow meters (of 0.5 % or less accuracy class).
- 10.4 In case of MNC pump manufacturer not having adequate testing facility within reasonable distance (i.e. decided by the area of operation of the TPI), the pumps should be tested at the

alternative facilities & internal test certificates shall be submitted for review to the TPI. The customer may demand field testing of such (unwitnessed) pumps within 30 days of installation which the contractor / manufacturer is bound to offer at no extra cost.

- 10.5 Pump testing should be carried out preferably with VFD, in case the pump sets are to be used with VFD then the testing has to be conducted compulsorily with VFD (to ascertain compatibility with VFD).
- 10.6 In case of MNC pump manufacturer(s) not having adequate testing facility within reasonable distance (i. e. decided by the area of operation of the TPI), the pumps should be tested at the alternative test bed or at field within 30 days of installation which the contractor / manufacturer is bound to offer at no extra cost. The field testing shall include the following:
 - 10.6.1 Motor Routine Tests:
 - 10.6.2 IR
 - 10.6.3 HV
 - 10.6.4 No Load Amperes, Vibration etc.
 - 10.6.5 Pump performance testing (in accordance with IS 5120 / ISO 9906, Grade 2 – 5 % / ISO 2548 – 5%)
 - 10.6.6 Measurement of head, discharge, motor input at least 6 different points to plot the actual Performance curves
- 10.7 The entire arrangement for such field test shall have to be made by the contractor & all the extra charges for such field testing shall exclusively be borne by the contractor. It is clarified that, in case of field testing failure, GWSSB reserves the right to detain the pumps in their custody until the contractor replaces the failed pumps with new pumps which shall again be subjected to retesting. No extra charges shall be paid by GWSSB to the contractor

Materials of construction

Motor casing, oil chamber & other parts		Cast Iron (FG 260 as per IS 210 or GG25 or EN JL1040)	
Motor 's (squirrel cage) rotor	Motors \leq 300 HP		Aluminum Die Cast or Dual Cage Copper Bar
	Motors > 300 HP		Dual Cage Copper Bar
Motor cooling jacket (if applicable)		SS 202 or Epoxy Coated MS	
Mechanical seals		Double mechanical seal should be fitted. Primary (Inboard): Silicon Carbide v/s Silicon Carbide or Tungsten Carbide v/s Tungsten Carbide	
		Elastomers: <ul style="list-style-type: none"> All "O" rings of Viton only Bellows of either Viton or Nitrile 	
Fasteners		Stainless Steel or Hot Dip Galvanised BHT Alloy Steel	
Auto coupling system (if applicable)	Pedestal cum Delivery Bend	Cast Iron (FG 260 as per IS 210 or GG25 or EN - JL1040)	
	Slider Bracket	Ductile Cast Iron or Cast Steel (SG 400/12 or EN - JS1050 or GGG 40) or WCB	
	Guide Rail Pipes / Wires & Foundation Bolts	SS 304 or Higher grade	
Pump (volute / bowl) casing		Pumps with Duty Point Head rating \leq 80 m & Delivery Size \leq DN 100 mm;	Cast Iron (FG 260 as per IS 210 or GG25 or EN -JL1040)
		Pumps with Duty Point Head rating \leq 60 m & Delivery Size \leq DN 125mm	
		Pumps with Duty Point Head rating > 60 m & Delivery Size > DN 125 mm Pumps with Duty Point Head rating > 80 m	Ductile Cast Iron or Cast Steel (SG 400/12 or EN - JS1050 or GGG 40 or ASTM 80 -55 - 06 or WCB)
Suction bell mouth & miscellaneous pump parts		Cast Iron (FG 260 as per IS 210 or GG25 or EN - JL1040)	
Impeller		Cast Austenitic Stainless Steel (SS 316 or CF 8M or 1.4406)	
Wearing rings (suction head casing & impeller)		Cast Austenitic Stainless Steel (SS 316 or CF 8M or 1.4406) or Bronze	
Pump motor shaft		Stainless Steel (SS 410 or SS 430 or 1.4021 or 1.4460)* * Larger Motors (i.e. > 265 HP) may be supplied with High Carbon Alloy Steel Shaft (EN 8 or DIN 1.7225 or others) protected with SS 316 Shaft Sleeves	
Suction strainer		MS (C15) Fabricated with Epoxy Coating	
Portable stand (if applicable)		MS (C15) Fabricated with Epoxy Coating	

Data Sheet for submerged centrifugal pump sets

1	Application	Submerged centrifugal pump is used for water intake / transfer / lift & mounted in canal, sump, lake or jack well either vertically or horizontally depending upon the site conditions (To be clearly specified)
2	Type of motor	Squirrel cage induction type with IP 68 enclosure
3	Rated flow	___ m ³ / hr at 50 Hz
4	Rated head	___ mwc at 50 Hz
5	Number of pump sets	As per price bid
6	Supply system fault level	20 MVA
7	Supply neutral	Solidly earthed
8	Rated voltage / rated HP	415 V / Suitable for pump as per previously outlined margin norms
9	Number of phases & frequency	3 Phase & 50 Hz
10	Supply conditions	± 10% voltage variation ± 5% frequency variation ± 10% combined voltage and frequency variation
11	Speed	960/1450/2900 rpm (To be specified in data sheet by the department)
12	Duty condition as per IS 325 or equivalent	S1 suitable for constant operation
13	Method of starting	DOL up to 7.5 HP Star Delta up to 20 HP ATS for up to 75 HP Soft Starter or VFD for above 100 HP & larger pump set
14	Starting torque & pull out torque	Sufficient enough to start the pump with delivery valve open and when other pumps are running. Sufficient to bring the motor to normal speed in minimum time
15	Class of insulation & temperature rise by thermometer	Minimum class "H" but temperature rise restricted to that of class "B" i. e. 75 ⁰ C
16	Ambient temperature	45 ⁰ C
17	a) Type of cooling b) Degree of protection	Surface cooled by circulation of water through jacket shell ≥ IP 68 (should withstand up to 20 m of water immersion) on S1 basis
18	Cable details	Four cores (minimum 1/4 cores required as Earth)
19	Shaft orientation horizontal / vertical	Pump set should be suitable for any position i. e. vertical / horizontal / inclined
20	Type of bearings	Ball / Roller / Thrust Anti Friction type (life time lubricated)
21	Bi metallic thermal overload relay for winding	Yes, one in each phase; for trip, alarming and indicating set to trip @ 130 ⁰ C

	required?		
22	Bearing over temperature detectors	Required for motors > 150 HP by bi metallic overload thermal switches set to trip @ 95 ⁰ C	
23	Winding connections	6 Terminals	
24	Standards to be followed	IS 325, 8225, 4889, 4772, 4029, 4691 and other relevant Indian Standard or equivalent BSS & Testing as per ISO 9906 / IS 9137 / IS 5120	
25	Scope of Supply	√	SITC of Pump set with ___ m cable along with ___ m alloy steel chain & install as per any of the 3 mentioned modes (shall be informed depending on site conditions)
		Any one of three to be given by the department	Pump set along with auto coupling system for permanent vertical wet installation along with ___ m guide pipe / wires (1/2 Nos) & S S foundation bolts
			Pump set fitted with base frame vertical & / or horizontal, portable, wet (submerged) installation
			Pump set suitable for vertical installation flange suspended on delivery column pipe

The Installation work for the Pump set including the foundation work shall have to be carried out in presence of Pump Manufacturers company representative and the pump manufacturer company will have to certify that the installation work carried out as per technical requirement and specification satisfactorily.

Note: Material testing certificates of all components shall be furnished at the time of inspection.

VALVES(whichever is applicable)

1.1 General

- 1.1.1 Valves shall be as per internationally recognized standards. Flanges shall be machined on faces and edges to ISO 7005, IS 6392 or BS 4504.
- 1.1.2 Valves shall be double flanged type and the face shall be parallel to each other and flange face should be at right angles to the valve centerline. Back side of valve flanges shall be machined or spot faced for proper seating of the head and nut.
- 1.1.3 Valve buried or installed in underground chamber, where access to a hand wheel would be impractical, shall be operated by means of extension spindle and/or keys.
- 1.1.4 Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position.
- 1.1.5 The valve stem, thrust washers, screws, nuts and all other components exposed to the water shall be of a corrosion resistant grade of stainless steel.
- 1.1.6 Valves shall be free from sharp projections.
- 1.1.7 Butterfly, non return valves and non rising spindle sluice valves size are small hence shall be provided without bypass arrangement. Butterfly shall have a gear mechanism operating arrangements with indicator to see the open close status.
- 1.1.8 Governing standards for butter fly, sluice, dual plate check (non return), reflux valves are tabulated below.

Sr. No.	Description	Standards
1	Sluice valves for water works purposes Class - I	IS: 14846 – 2000
2	Butterfly valve for water works purposes	IS : 13095 - 1991 / BS 5155
3	Dual Plate Check Valve	API 594 / API 598
4	Reflux valve	IS : 5312

- 1.1.8 The tolerance on the valve dimensions shall be as per relevant standard / code but not exceeding the following;

- 1) Face to face ± 3 mm
- 2) CD of flange ± 3 mm
- 3) Bolt circle diameter ± 2 mm
- 4) Thickness of flange ± 2 mm

Dimensional tolerance on casting shall be as indicated in IS : 5519

- 1.1.9 For sluice valves located below floor, suitable floor stands for extension bonnets as required shall be provided. These shall be complete with proper extension stamps, valve stem coupling hand wheel above offer shall be minimum 600 mm.
- 1.1.10 Testing for all types of valves
- 1.1.11 All valves shall be tested, hydraulically as per relevant is standards. Body test and test shall be carried out and check for water tightness.
- 1.1.12 Materials certificate physical & chemical analysis certificates of all component of the valve shall be furnished to GWSSB.
- 1.1.13 Certified hydraulic test report for all body casting shall be furnished to GWSSB.

1.2 Butterfly Valve

- 1.2.1 Resilient seated butterfly valve shall be as per IS 13095 – 1991 / BS 5155. Valve shall be suitable for mounting in any position.
- 1.2.2 The valve seat shall be of integrally cast or replaceable design. When the valve is fully closed, the seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.
- 1.2.3 All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.
- 1.2.4 Valve shall be suitable for throttling purpose.
- 1.2.5 All valve, spindles and hand wheels shall be positioned to give good access for operational personnel.
- 1.2.6 Valve of diameter 450 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.
- 1.2.7 All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

Specifications & M.O.C. of Butterfly valve:

1	General	
1.1	Type	Both end flanged hand wheel / Gear operated / Actuator Operated
1.2	Rating of valves	PN 1.0 / 1.6
1.3	Manufacturing Standard	IS 13095 / BS 5155
1.4	Sizes and quantity	As per price bid

2	Materials of construction	
2.1	Internal Hardware	Stainless Steel AISI – 304
2.2	Body/ Disc	CI. IS 210 FG 260
2.3	Body ring (Retainer/seat)	Stainless steel AISI -304
2.4	Shaft	Stainless steel AISI-410
2.5	Disc seat	EPDM rubber/ Nitrile rubber
2.6	Bush & Thrust Pad	G.M. IS :318 LTB-2 / Teflon
2.7	Body seat	Stainless steel AISI -304

1.4 Dual Plate Check Valve

- 1.4.1 The valve shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valve body.
- 1.4.2 Valves shall possess high speed closing characteristics and be designed for minimum slam condition when closing.
- 1.4.3 Dual plate check valves shall conform to API 594 and API 598. They shall have metal to metal sealing. The spring action shall optimize the equal closing rates of each plate especially when the friction coefficients are uneven due to one plate resting upon one another. The plates shall not drag on the seat while opening. The plates shall not vibrate under full or partial flow condition.
- 1.4.4 In case of the nozzle check valve, the disc shall be correctly positioned at all times to achieve fully non slam closure. The spring shall be fully shielded from the flow stream by the central flow diffuser.
- 1.4.5 Tilting disc non return valve shall incorporate a double offset shaft with a variable angle tilt disc configuration. Sealing shall be metal to metal. The disc shall be stable and shall not vibrate under full or partial load conditions.
- 1.4.6 Valve of diameter greater than 450 mm shall be provided, in addition to others, feet and jacking screws. Hinge pins / shaft shall preferably be square in section to ensure positive location of flaps and provide for secure fixing.

Specifications & M.O.C. of Dual Plate Check Valve:

Sr. No.	General	
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1.1	Type	Both end flanged
1.2	Rating of valves	AS per Price Bid
1.3	Manufacturing Standard	API 594 / 598
1.4	Sizes and quantity	As per price bid
1.5	Maximum pressure drop at design flow rate (mwc)	0.5
1.6	Maximum permissible leakage rate (cc/hr/mm diameter)	7.0
2	Materials of construction	
(a)	Body	Cast Iron IS 210 Gr. FG 260
(b)	Door & Door Face	Cast Steel IS 2062 Gr. B A 216 GR WCB With 13% Cr. Steel overlay (On seating surface only)
(c)	Stop, hinge pin & washer	Stainless Steel AISI 431
(d)	Seat ring (Body)	EPDM Rubber
(e)	Bearings (Body & Plate lug)	PTFE
(f)	Seat ring (Body)	SS AISI – 410
(g)	Spring	Stainless Steel AISI 304
(h)	Hardware	Carbon Steel IS 1367 CL 4.6/4.0
(i)	End Cover	Mild Steel

M S PIPES & M S SPECIALS

All pipes, fittings, bolts, nuts, jointing materials and appurtenances for piping to be required for execution of the works shall be manufactured and erected in accordance with the erection plans, specifications and directives of the department. All pipe work and fittings shall be to a class in excess of the maximum pressure attained in service including any surge pressure.

The pipe work installation shall be so arranged to offer ease of dismantling and removal of pumps or other major items of equipment. Expansion bellows with tie rods shall be included in the suction and delivery pipe work of all pumps for easy dismantling as specified in price bid. All loose flanges shall be secured to fixed flanges by suitable tie bolts. All pipe work shall be adequately supported with purpose made fittings. When passing through walls, pipe

work shall incorporate a puddle flange. Flange adapters and unions shall be fitted in pipe work runs wherever necessary to permit the simple disconnection of flanges, valves and equipment. The final outlet connection of the pipe work shall match the connecting point of the transmission main.

Flanged joints shall be full face, fabric reinforced rubber gaskets, pierced to take the bolts, and the face of all flanges shall be machined to give a true angle of 90° to the center line of the pipe or fittings. All necessary supports, saddles, slings, fixing bolts and foundation bolts shall be supplied to support the pipe work and its associated equipment in an approved manner. Valves, meters and other devices mounted in the pipe work shall be supported independently of the pipes to which they are connected.

The whole of the jointing work and materials necessary to fix and connect the pipes, including adequate and efficient pipe support shall be included in the contract. The bidder shall be responsible for ensuring that the internal surface of all pipe work is thoroughly cleaned before and during erection and before commissioning. Cleaning shall include removal of all dirt, rust, scale and welding slag due to site welding. Before dispatch from the manufacturers' works, the ends of the pipes, branch pipes etc. shall be suitably capped and covered to prevent any accumulation of dirt or damage. This protection shall not be removed until immediately prior to connecting adjacent pipes, valves or pumps. All small bore pipes shall be blown through with compressed air before connection is made to instruments and other equipment. No point of passage of pipes through floors or walls shall be used as a point of support, except with the approval of the department.

Material of steel pipes and fittings shall conform to IS: 2062. Fabrication and testing shall be in accordance with IS: 1239 / IS: 3589 for pipes and IS: 6392, ISO 7005 or BS 4504 for flanges. Carbon content & other chemical properties shall be within specified limits of governing IS. Minimum corrosion allowance shall be 2 mm for pipes and fittings which are not mortar lined.

All the underground buried mild steel piping shall be protected by the application of hot coal tar enamel and fiber glass wrapping. The coating shall consist of one coal tar primer coat, one coal tar enamel coat, wrapping of fiber glass and one more coat of enamel and then final wrap of enamel impregnated fiber glass.

Thickness of pipe for pump house pipe system i. e. suction, delivery, common suction and discharge headers (if any) & header by pass and shall not be less than what is prescribed in relevant IS standards without negative tolerance if specified otherwise in the price bid.

RCC Work /thrust block

Providing & casting in situ reinforced cement concrete in grade M 20 (Ratio 1:2:4) using quartzite trap metal of size 6 mm to 20 mm for RCC work, including scaffolding centering, form work, consolidating, curing etc. inclusive providing and binding necessary size TMT steel bars of Fe 415 grade with water proofing compound as per directives for pipe support / thrust blocks.

PART II: ELECTRICAL

Design Criteria For Electrical Equipment

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1.0 Design Criteria for Electrical Equipment

1.1 Introduction

The 'Design Criteria' of electrical equipment covers the water pumping station of Gujarat Water Supply & sewerage Board.

1.2 General Power Distribution Scheme:

1.2.1 Load Requirement

The following assumptions shall be made to arrive at the load requirement of water pumping station

a)	<u>Load Factor</u>		
i)	Main motor	:	0.9
ii)	Auxiliary load suction valve motors etc	:	0.9
iii)	Lighting load	:	1.0
b)	<u>Diversity Factor</u>		
i)	Main motor	:	1.0
ii)	Auxiliary load, suction valve motors etc	:	1.5

- iii) Lighting load : 1.20
- c) Power Factor of L.V. Motors : As per Mfgr's catalogue
- d) Full Load Efficiency of L.V. Motors : As specified in data sheet

1.3 **Power Supply Scheme**

- 1 The source of power supply to these pumping stations will be through one no. 11 kV, overhead line from Gujarat Electricity Board or LT line as the case may be for particular pumping station.
- 2 One power transformer of 11 KV / 0.433 KV each for pumping station / is recommended to meet the load requirement. The capacity of power transformer shall be designed to sufficiently take the full working load of only working motors with auxiliary load of the each pumping station.
 - (i) Transformer sizing shall consider the following:
 - a) The load of all the normal working pumps and auxiliaries of the pumping station, which will be ON simultaneously.
 - i) Transformer shall be rated for full working load of the pumping station.
 - ii) The additional load requirement of starting of stand by pump (to compensate the loss of pumping, followed by a prolonged power failure) shall be met by over loading the transformer within the limits as specified in IS: 6600 – Guide for Loading of Oil Immersed Transformers. The cooling ONAN / ONAF is considered for 12.5 / 15.0 MVA rating.
 - d) The short circuit apparent power of the system at the proposed main switchyards shall be as follows as per IS: 2026 (Part I).

11 kV system	:	350 MVA
415 kV system	:	20 MVA
 - e) Pumping stations with L.V. motors shall have one main step down transformer of 11 KV/ 0.433 V with on load tap changers for a range of -15% to +5% in steps of 1.25%. Or off circuit tape changer for a range of $\pm 10\%$ in the steps of 2.50%. While the power for main pump motors as supplied at 11 kV/ .433 V and other loads such as control valves, lighting etc. shall be supplied at 230 V (1 phase, 4 wire).
 - f) Power factor correction capacitors shall be provided and their capacity shall be adequate to correct the power factor up to 0.98 or more at full station load.

- g) Suitable metering facility shall be provided for monitoring purposes.
- h) Protections **(Not Applicable)**

Protective Relays For IDMT Over Current, Earth Fault, Motor Protection Relay And Transformer Differential Relay Shall Be Numerical Based Only.

Following protective relays are proposed for incomer, transformer, motors and other plant feeders.

Incomer (11 kV Main Incomer From GEB)

Inverse time phase over current relays

Inverse time earth fault relay

Main Power Transformer with OLTC above 1500 KVA/ with OCTC

HV side: (11 kV)

- m) Inverse time over current relays with instantaneous over current element

Instantaneous earth fault relay

Transformer Buchholz/gas pressure relay with alarm and trip contacts

- p) Winding & Oil temperature indicators with alarm and trip contacts
- q) Transformer differential protection relay
- r) MOG Alarm Contact
- s) Transformer oil gauge (Alarm only)

L.V. side (11 KV/.433 V)

Inverse time phase over current relays

Inverse time earth fault relay

Restricted earth fault relay

Stand by earth fault relay

L.V. side (415 V)

415 V LV incomer shall be provided with air circuit breaker unit.

11 KV Plant Feeders

Inverse time phase over current relays.

Inverse time earth fault relay.

L.V. Main Motors:

Overload protection by thermal (bimetal) relays in all the three phases to trip

Short circuit protection in all the three phases through fuses

Moisture sensor relay (if required)

1.4 Metering

The following metering shall be provided.

a) Incomers (11 KV main incomer from GEB):

- i) Ammeters in all the three phases
- ii) Voltmeter with selector switch
- iii) Frequency meter
- iv) kW & kWH meter
- v) Power factor meter
- vi) Electronic Trivector meter (if specified)

b) Main Transformer

HV Side i) Ammeters in all the three phases

LV Side: i) Ammeters in all the three phases

c) H.V. Feeders: i) Ammeter in all the three phases

d) L.V. Feeders: i) Ammeter in all the three phases

1.5 Switchgear:

a) H.V. Switchgear

HV switchgear shall be of sheet metal enclosed indoor type. Incoming and other outgoing feeders shall be provided with draw out type vacuum circuit breakers. The degree of protection for switchgear shall be IP 4X for indoor installation.

b) L.V. Switchgear

415 V Power control centre, power distribution boards etc. shall be of fixed, compartmentalized double front construction, excepting circuit breaker modules which shall be of draw out type and single front construction.

The degree of protection for switchgear shall be IP 42 for indoor installation and IP 54 for outdoor installation.

H.V. indoor switchgear circuit breakers shall be suitable for 110V D.C. control power supply. Others shall be suitable for 110V/230V A.C. control power supply which shall be derived either through potential transformers or between phase and neutral.

1.6 Cables:

The H.V. Power supply from main substation to various plant sub stations and to the equipment shall be done by using aluminium conductor, XLPE insulated, PVC sheathed and armoured type. The LV power cables shall be aluminium conductor, PVC insulated, PVC sheathed and armoured type. The control cables shall be copper conductor, minimum 1.5 sq. mm PVC insulated. PVC sheathed and armoured type.

All power cable sizes shall be based on continuous current carrying capacity, permissible voltage drop and short circuit rating. The voltage drop shall be limited to 3%. For short circuit rating of H.V. cables, the fault clearing time shall be 0.5 second for H.V. plant feeders and 0.16 second for equipment feeders. For S.C. rating of H.V. cables the fault clearing time shall be 0.5 second. For L.V. incomers and L.V. outgoing feeders to equipment, the fault clearing time shall be 0.16 second.

Rating factors for variation in ground temperature, variation in ambient air temperature, grouping of cables, depth of laying etc. shall be based on the cable manufacturer's recommendations / catalogues.

1.7 Lighting

The lighting system will comprise the following:

a) Normal A.C. lighting.

All indoor and outdoor areas will be provided with A.C. lighting and the same will be available as long as A.C. supply is healthy.

b) Emergency Lighting for Switchyard and switchyard area.

Switchyard, main substation area, control room will be provided with emergency lighting of about 10% of normal A.C. lighting.

c) The wiring for lighting circuits shall be done by wires run in PVC conduits for indoor areas. For outdoor lighting, wiring shall be done by armored cables.

d) The illumination levels for various areas shall be as follows:

Sr. No.	Area	Illumination Level (Lux)
i)	Pump house	200 lux
ii)	Battery room	150 lux
iii)	Machinery service area	150 lux
iv)	Offices/conference room	300 lux
v)	H.V./L.V. switchgear rooms	200 lux
vi)	Plant/Switchyard control rooms	300 lux
vii)	Chemical/general stores	150 lux
viii)	Chemical plant room	200 lux
ix)	Cable basement	100 lux
x)	All other indoor areas	100 lux
xi)	Outdoor platforms and walkways	50 lux
xii)	Building entrances	100 lux
xiii)	Outdoor plant areas	20 lux
xiv)	Switchyard and transformer yard	
	i. General	10 lux
	ii. On equipment	30 lux
xv)	Roads (Secondary)	10 lux
e)	Lighting distribution board shall be provided and it shall supply power to various local lighting panels.	
f)	Lighting panels shall be provided in various areas and circuit wiring to the lighting fixtures shall be made from these lighting panels. Lighting panel shall comprise of 63A TPN MCB with ELCB for incomer and 16A/10A MCBs for each out going single phase circuits.	
g)	Lighting fixtures and fans will be grouped on the circuit wherever required. However, separate circuits shall be used for receptacles wiring.	
h)	For the purpose of calculating connected loads of various lighting circuits, a multiplying factor of 1.25 will be assumed to the rated lamp wattage for mercury vapour, sodium vapour and fluorescent lamp fixtures to take into account losses in the control gear. Also a loading of 100 watts and 500 watts shall be assumed for single phase 5 Amps and 15 Amps receptacles respectively.	

- i) Lighting fixtures, receptacles, switches, conduits and junction boxes shall be properly earthed using 12 SWG G.I. wire unless specified otherwise.
- j) Receptacles of 5A and 15A, single phase, 3 pin shall be provided with switch. Receptacles in offices and control rooms shall be decorative type and in other areas shall be industrial type. Three phase receptacles shall be associated with TPN switch housed in the same enclosure. The receptacle shall become live only when the associated switch in "ON" position. The enclosure for all outdoor receptacles shall be provided with degree of protection of IP 55.
- k) Generally maintenance factor of 0.8 shall be considered for lighting fixtures.

1.8 Safety Earthing & Lightning Protection

- a) The soil resistivity of the plant area has not yet been measured, the same should be carried out during detailed engineering by successful bidder.
- b) After soil resistivity measurement; length of conductor, no. of earth electrodes and no. of test pits shall be finalised.
- c) The material of earthing conductors will be as given below:
 - i) Conductors above ground shall be Galvanized steel to prevent atmospheric corrosion
 - ii) Conductors buried in ground or embedded in concrete shall be mild steel.
- d) The maximum values of the earth fault current for the design of the earthing system shall be considered as below:
 - i) 11 kV system : 22 KA
 - ii) 415 V system : 30 KA
- e) Fault clearing time for sizing the earthing conductor shall be taken as one (1) second.
- f) Maximum allowable temperature rise for steel welded joints will be taken as 50⁰ C and ambient temperature as 45⁰C.
- g) Plant earthing system will be designed such that overall earthing resistance is less than one (1) ohm.

- h) In case of different electrical systems operating at different voltages in an area/plant, the main earthing conductor for each system shall be decided on the basis of maximum fault current in that system. Earthing system for different systems shall be interconnected by inter connectors of maximum size conductor.
- i) In outdoor substation area, main earthing conductors will be planned for most economic earthing of the equipment, keeping the potential gradients at earth surface within maximum allowable limit. Step and touch voltages shall be within permissible limit. Main earthing conductors in outdoor areas shall be buried 600 mm below finished ground level. Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building.
- k) Main earthing conductors inside the building will be planned such that various equipments are connected to earthing system in most economical and reliable manner.
- l) Earthing conductors shall be provided around the outside edge of switchyard fence at a distance of approximately 1000 mm and every alternate fence post shall be connected to the grid by one lead and gates by flexible braid to the earthed post.
- i) Minimum 6000 mm spacing between rod / pipe electrodes and 8000 mm spacing between plate electrodes shall be provided.
- m) The detail earthing calculation furnishing the step potential (V_s) and the touch potential (V_t) for outdoor switchyard.

1.9 Power Factor Improvement

Capacitors for 415V motor shall be provided on 415V bus with automatic switching to improve power factor up to 0.95 in case of fixed power capacitor banks & 0.98 in case of automatic power factor correction panels.

POWER AND CONTROL CABLES

1. Applicable Standards

The cables shall conform to the latest applicable standards specified below. In case of conflict between standards and this specification, this specification shall govern.

Sr. No.	Description	Standards
1	PVC insulated cables (for voltage up to 1100 V)	IS: 694
2	HRPVC & PVC insulated cables heavy duty	IS: 1554
3	Cross linked polyethylene insulated PVC sheathed cables	IS: 7098
4	Low frequency cables and wires with PVC insulation and sheath	IEC: 189-1 & IEC: 189-2
5	PVC insulation and sheath of electric cables	IS: 5831
6	Polyethylene insulation and sheath for electric cables	IS: 6474
7	Conductors for insulated electric cables	IS: 8130
8	Methods of test for cables	IS: 10810
9	Specification for drums of electric cables	IS: 10418
10	Specification for PVC insulated cables for electricity supply	BS: 6346
11	Specification for PVC insulation and sheath of electric cables	BS: 6746
12	Laying & installation of cables	IS: 1255 / 84

3 Features of Construction

a) XLPE Armoured Screened Aluminium H.T. Cable

SITC of 1 x 3 x 120 sq. mm XLPE Armoured Screened Aluminium H.T. Cable -11 KV (Earthed)
As per IS 7098/II/85 With Latest amendment.

b) XLPE Insulated LV Power Cables:

Conductors shall be screened by extruded semiconducting compound and XLPE insulated. The cores shall be screened by extruded semiconducting compound in combination with nonmagnetic metallic tape (copper tape preferred). The inner sheath over laid up cores and outer sheath over the armour shall be extruded black PVC compound type ST - 2. Core identification shall be by printed numerals. Cable shall be constructed as per relevant IS standards. The material of conductor shall be Aluminium and / or Copper & number of cores shall be 3 and / or 3 ½ as specified in price bid. It shall be armoured as per relevant IS.

c) 1100 V Grade PVC Insulated Power and Control Cables

Cable shall be insulated with extruded PVC type A. The inner sheath over laid up cores and outer sheath over the armour shall be extruded PVC compound type ST-1. Core identification shall be by printed numerals. The material of conductor shall be Aluminium for power and Copper for control cables. Number of cores shall be 3 and / or 3 ½ for power & 1 core for control cables as specified in price bid. It shall be armoured / un armoured as per relevant IS.

d) 1100 V Grade PVC Insulated LV Submersible Round Cables

Multi core flexible copper conductors PVC insulated & sheathed heavy duty round cable suitable for submersible application (in case of submerged centrifugal pumps) shall be manufactured as per governing standards. High purity electrolytic grade bright annealed flexible bunched bare copper conductor as per IS: 8130 / BS: 6360 shall be used. Insulation of cable shall be done by PVC compounds as per IS: 5831 / 1984 by extrusion process. PVC compound shall be dielectric grade & shall be impervious to water, oils & grease etc. Similarly double PVC sheathing shall also be done as per IS: 5831 / 1984. Flexible inner sheath & high abrasion resistant flexible outer sheath is required for these cables. Double PVC sheathing shall be done so as to withstand abrasion & prevent ingress of water along the interstices of the cable. Heavy duty thermoplastic rubber sheathing is also acceptable as an alternate to PVC compound. Core identification shall be by printed numerals. Cable shall be constructed as per relevant IS / IEC standards. The material of conductor shall be Copper only & number of cores shall be 4 & size shall be as specified in price bid.

3 **Cable Drums**

Cables shall be supplied in non returnable wooden drums. The wood used for construction of the drum shall be properly seasoned and free from defects and wood preservative shall be applied to the entire drum. All ferrous parts shall be treated with a suitable rust preventive coating to avoid rusting during transit or storage.

The Bidder shall indicate in the offer, the maximum length for each size of cable, which can be supplied on one drum. The actual length supplied on each drum shall be within tolerance limit of $\pm 5\%$ without any tolerance on total ordered quantity of each size of cable. However

before winding the cables on drums, Contractor shall obtain Employer's approval for the drum lengths. Cable ends shall be sealed by non-hygroscopic sealing caps.

4 Drawings and Data

a) As a part of the Tender, bidder shall furnish the following:

- i) General information
- ii) Principal technical data
(Description of insulation, sheathing and screening: This should include data on resistance to attack by chemicals, fungus, termites, rodents, water and ultra violet radiation).
- iii) Installation and termination instrumentation.
- iv) Type / routine test certificates for all types of cables included in the Tender.

After award of contract it shall be the responsibility of contractor to work out a detailed layout for the complete plant cable system. The layout drawing shall be furnished for the approval of Purchaser's representative before commencement of installation including cable trays, cable racks, accessories, tray supports, conduits etc.

CABLE CARRIER SYSTEM

1 General

The cable carrier system covers the supply of cable racks, cable trays and its supporting accessories.

2 Applicable Standards

Sr. No.	Description	Standards
1	Steel for general structural purposes	IS: 2062
2	Dimensions for hot rolled steel beam, column channel and angle sections	IS: 808
3	Code of practice for use of metal arc welding for general construction in mild steel	IS: 816
4	Hot deep galvanizing of iron & steel	IS: 2629
5	Methods of testing uniformity of coating of zinc coated articles	IS: 2633
6	Hot dip zinc coatings on structural steel and other allied products	IS: 4759

3 Cable Racks and Trays

- a) Typical cable tray arrangement/trench arrangement / directly buried cable arrangement etc. are shown on drawing.
- a) Cable racks / trays shall be fabricated from standard structural steel members as indicated in drawing.
- b) All cable trays, vertical raceways, cable racks and cable tray supporting structures shall be hot dip galvanized.
- 2) Lines and grade for trays may be measured from building steel and finished floor elevations. Change in line or grade, or the addition of offsets by means of cutting standard tray sections and inserting additional tray fittings to match with the existing arrangement shall be considered as a normal part of the work.
- 3) Where embedded steel inserts in concrete floors / walls for welding the supports for cable racks / trays are not available, Contractor shall provide suitable anchor fasteners at no extra cost.
- 4) Cable shall be clamped to the cable trays at regular intervals.
- 5) Flexible metallic conduits shall be used for termination of connection to equipment such as motors, limit switches and other apparatus.

4 Galvanizing

Wherever galvanizing has been specified, the hot dip process shall be used. The galvanized coating shall be of uniform thickness. Weight of Zinc coatings for various applications shall not be less than those indicated below

a) Fabricated Steel

Thickness less than 2 mm but not less than 1.2 mm	340 gms / sq mm
Thickness less than 5 mm but not less than 2 mm	460 gms / sq mm
Thickness 5 mm and over	610 gms / sq mm

b) Fasteners

Up to nominal size M 10	270 gms / sq mm
Over M 10	300 gms/ sq mm

Galvanizing shall be carried out only after drilling, punching, cutting, bending and welding operations have been carried out. Burrs shall be removed before galvanizing. Any site modification of galvanized parts should be covered well by zinc rich primer and aluminium paint.

JUNCTION BOX

providing and erecting busbar chamber confirming to IS 375 & IP 68 Fabricated from 16 GMS sheet, dust and vermin proof having hinged door with rubber gasket and necessary busbar supports with Aluminium busbar duly wrapped with colour insulation tape for phase sequence. three phase and neutral each on meter long suitable for following current capacity with necessary painting mounted on wall or pedestal frame of required size with necessary

connection with proper size of alluminium strip/wire with lugs as directed 200 AMP current capacity having cross sectional area not less than 125 sq.mm.

INSTALLATION, TESTING AND COMMISSIONING(Whichever is applicable)

1. Erection - General

- 1.1. The Installation work for the Pump set including the foundation work shall have to be carried out in presence of Pump Manufacturers company representative and the pump manufacturer company will have to certify that the installation work carried out as per technical requirement and specification satisfactorily.**
- 1.2 The Contractor's staff shall include adequate and competent erection engineers with proven, suitable, previous experience on similar contracts to supervise the erection of the works and sufficient skilled, semi skilled and unskilled labour to ensure completion of works in time. The contractor shall not remove any representative, erector or skilled labour from the site without prior approval of the Engineer in charge (EIC) or Engineer in charge's representative.
- 1.3. The Contractor shall ensure that no installation or erection work shall commence until full and unconditionally approved working drawings, signed and stamped by the EIC are available at site.
- 1.4. The Contractor's erection staff shall arrive on the site on dates to be agreed by the EIC. Before they proceed to the site, however, the contractor shall first satisfy himself, as necessary, that sufficient plant of his (or his sub contractor's) supply has arrived on site so that there will be no delay on this account.
- 1.5. One erection engineer who shall be required to be the contractor's representative shall be conversant with the erection and commissioning of the complete works. Should there be more than one erector, one shall be in charge and the contractor shall inform the EIC in writing which erector is designated as his representative and is in charge. Erection engineer is to report to project manager.
- 1.6. The Contractor shall be responsible for setting up and erecting the plant to the line and levels of reference and of the positions, levels dimensions and alignment, appliances and labour in connection therewith. The checking of setting out of any line or level by the EIC or EIC's representative shall not in any way relieve the contractor of his responsibility for the correctness thereof.
- 1.7. Erection of plant shall be phased in such a manner so as not to obstruct the work being done by other contractors or operating staff who may be present at the time. Before commencing any erection work, the contractor shall check the dimension of structures where the various items of Plants are to be installed and shall bring any deviations from the required position, lines or dimensions to the notice of the EIC. Plant shall be erected in a neat and workmanlike manner on the foundations and at the locations shown on the approved drawings. Unless otherwise directed by the EIC, the contractor shall adhere strictly to the aforesaid approved drawings. If any damage is caused by the contractor during the course of erection to new or existing plant or buildings or any part thereof, the contractor shall, at no additional cost to the Employer, make good, repair or replace the damage, promptly and effectively as directed by the EIC and to the EIC's satisfaction.

- 1.8. The contractor shall align all equipment and holding down bolts and shall inform the Employer before proceeding with grouting in the items concerned. The contractor shall ensure that all equipment is securely held and remains in correct alignment before, during and after grouting in.
- 1.9. The approval by the Employer of the contractor's proposals for rigging and hoisting any items of the plant into final positions shall not relieve the contractor from his responsibility for damage to completed structures, parts or members thereof or other installed equipment. He shall at his own cost make good, repair or replace any damaged or injured items, whether structural, electrical, architectural, or of any other description, promptly and effectively to the satisfaction of the Employer.
- 1.10. No plants or other loads shall be moved across the floors of structures without first covering the floors with timber of sufficient size so that applied loads will be transferred to floor beams and girders of steel or concrete. If it is required to reduce bending stresses and deflection, the beams and girders shall be provided with temporary supports.
- 1.11. During erection of the plant the EIC will inspect the installation from time to time in the presence of the contractor's site representative to establish conformity with the requirements of the specifications. Any deviations and deficiencies found or evidence of unsatisfactory workmanship shall be corrected as instructed by the EIC.

2. Leveling and Grouting of Machinery

- 2.1. He shall undertake sufficiently in advance chipping of any unevenness of concrete on foundations, anchor bolt pockets, cutouts etc. to achieve uniform level of reference for erection. All concrete surfaces receiving grout shall be hacked as required to ensure better bonding with grouting.
- 2.2. Contractor shall undertake the inspection of all components to be erected sufficiently in advance to check their soundness and conformity to drawings and the inspection records shall be signed by the Engineer as approval for undertaking the installation of the components. Any damage, shortfalls etc. shall be made good to the satisfaction of the EIC.
- 2.3. All grout for equipment shall be carried out using non shrinkable continuous grout materials with suitable frame work of at least 12 mm thickness. Surfaces to receive the grout shall be hacked and roughened and laitance shall be removed by wire brushing or blast of air. Concrete surface shall be blown off by compressed air before commencing grouting. Grouting shall be done in one continuous operation from one side such that grout flows in a single wave until grout reaches all confined spaces with no air pockets and air from all confined spaces is expelled. A hydro static head of 150 mm shall be maintained during grouting operations. All grouting shall be carried out in the presence of the EIC's representative. All lines and levels shall be checked up after grout is set. Block outs shall be closed using cement concrete of the same grade as that of the parent structure.

3. Records, Procedures and Reports

3.1. The Contractor shall maintain records pertaining to the quality of installation / erection work and inspection, testing, compliance with all technical requirements in respect of all his works as described in the previous paragraphs. The reporting formats shall be in the approved formats. The contractor shall submit such records to the Engineer after the completion of any particular work before submitting the bill of supply / progress of work. Such report shall comprise shop inspection reports, shop testing reports, material test reports, based on which dispatch clearances are provided, all the quality control reports of welding, erection and alignment records.

3.2. All the above mentioned records shall be submitted in the final form duly countersigned by the EIC's representative attesting conformity to specifications and his approval of installation, and duly incorporating all the additions, alternations, and information as required by the EIC on the basis of preliminary reports giving the progress of the work. Such records notwithstanding, any records submitted earlier with bill of supply / progress etc. shall be duly bound and submitted to the EIC in six copies by the contractor on his notification of the mechanical completion of erection.

4. General Preparations before Completion of the Plant

4.1. The following documents should be completed in accordance with the contract schedule before completion of erection. The Employer and the contractor shall preserve and control these documents in a safe and appropriate place on Site in order the both parties personnel can make use of them at any time.

4.1.1. Technical Documents

- a) Operation and Maintenance manual
- b) Design documents including the contractor's design data, drawings and specifications.
- c) Tools and test equipment list
- d) Spare parts list
- e) Lubricant list

4.1.2. Procedures

- a) Mechanical testing procedure
- b) Electrical testing procedure
- c) Instrumentation testing procedure
- d) Detailed Pre commissioning and commissioning procedure

- e) Detailed Performance Test procedure

4.1.3. General and Coordination Documents.

- a) Detailed organisation charts for pre commissioning and commissioning showing lines of authorities and responsibility and functions of all key personnel.
- b) The job description of the members of the team.
- c) The scheduled dates of assignment of each member to pre commissioning and commissioning Organisation.
- d) A detailed schedule showing the time sequence which the contractor anticipates to follow for the various steps in completion of erection, pre commissioning and commissioning of each unit and equipment.
- e) The regulations for safety, hygiene and discipline.
- f) The practical organisation of the relationship (meetings, reports, etc.) between the contractor and the Employer at the phases of pre commissioning and commissioning.
- g) Emergency communication route.

4.2. Manpower

- 4.2.1. Required manpower shall be provided as agreed between the contractor and the Employer in a manpower mobilisation plan which shall include the number and qualifications of the operator and maintenance personnel to be furnished by the Employer for the plant.

5. Completion of Erection

- 5.1. The completion of plant under erection by the contractor shall be deemed to occur, if all the units of the plant are structurally and mechanically complete and will include among other such responsibilities the following:
 - 5.1.1. Plant in the scope of the contract has been erected, installed and grouted as per specifications.
 - 5.1.2. Installation checks are completed and approved by the EIC.
 - 5.1.3. The erected plants are totally ready for commissioning checks.
- 5.2. At the stage of completion of erection, the contractor shall ensure that all the physical, aesthetic and workmanship aspects are totally complete and the Plant is fit and sound to undergo tests on completion and subsequent pre commissioning checks.
- 5.3. Upon achieving the completion as described above the contractor shall notify the EIC by a written notice intimating completion of erection and notify the EIC for inspection. The EIC /

EIC's representative shall proceed with the inspection of such units within 14 days of such a notice.

- 5.3.1. The EIC shall certify completion when there are no defaults in the works or
- 5.3.2. The EIC shall inform the contractor list of deficiencies for rectification hereinafter referred as Punch list and the contractor shall complete the rectification work within a jointly agreed period before pre commissioning activities and obtain the EIC's acceptance or approval of the same before proceeding with the same.
- 5.3.3. The EIC may inform the contractor that the works are accepted with the 'Punch' list (items which do not hamper operability, safety or maintainability) and allow the Contractors to proceed with the pre commissioning checks when the contractor undertakes to complete such outstanding works within an agreed time during defects liability period. Taking over shall be based on rectification of all deficiencies as advised by Punch lists.
- 5.4. The erection period indicated by the contractor would be deemed to cover all the activities up to completion as stipulated in previous paragraphs, notice of completion by the contractor, inspection by the EIC for completion and contractor rectification of all deficiencies as noticed by the deficiency / Punch list, and acceptance by the EIC of such rectification's prior to tests on completion.
- 5.5. Minor defects, which in the opinion of EIC which do not hamper operability and maintainability will not be taken into account for deciding mechanical completion. Such defects shall be rectified concurrent to commissioning checks before tests on completion. However, the EIC's decision in this regard is final.
- 5.6. The commissioning period as notified by the contractor shall be deemed to occur beyond the date of completion and shall include all periods of pre commissioning, trials and tests on completion.
- 5.7. It is in the contractor's interest to offer the sections / units / systems progressively under identified milestones within overall erection period, duly completed for rectification of any deficiencies pointed out by the Engineer and to achieve mechanical completion before undertaking the tests on completion within the specified erection period. The EIC also reserves the right to withhold the cost as estimated to be equivalent to the rectification of deficiencies pointed out to the Contractor until such a time such deficiencies are rectified to the satisfaction of the EIC.

6. Pre commissioning

- 6.1. After the completion of erection, pre commissioning activities listed below shall be carried out to make the plant ready for commissioning. All instruments, materials and provisions necessary for conducting site tests shall be provided by the contractor at his own cost.
- 6.2. Upon completion of erection of each piece of equipment, facility or discrete part of the plant, mechanical checks and tests shall be carried out according to the contractor's check list. The mechanical checks and tests shall be to establish that:
 - 6.2.1. The Plant is erected in accordance with the contractor's construction drawings, pipe work drawings, instrument diagrams, etc. issued for the plant.
 - 6.2.2. The materials are installed and mechanically function in accordance with the contract and
 - 6.2.3. Applicable codes as listed in the contract are followed for materials and workmanship.
- 6.3. Items such as painting, thermal insulation and final clean up which do not materially affect the operation or safety of the Plant will be excluded. All these items shall be listed and completed after pre commissioning or commissioning at the discretion of the contractor but before acceptance.
- 6.4. The contractor shall prepare and maintain at site test forms and records which shall include:
 - 6.4.1. Description of type of test or check
 - 6.4.2. Date and times of test or check
 - 6.4.3. Identification of equipment and facilities
 - 6.4.4. Test pressure, test data and results, including remarks, if any
 - 6.4.5. Signature of the contractor's personnel attesting to data recorded, if any, checks, tests and records thereof shall be carried out by the contractors' construction forces.
- 6.5. Wherever the Employer's witness or attesting of the check or test is required, the Employer's personnel shall attend such check and test. For this purpose, the contractor shall keep the Employer informed of a day to day test plan schedule. The test plan schedule may be revised from time to time to reflect the actual progress of the work and test.
- 6.6. Any items found incomplete or requiring repair or adjustment shall be marked as such on the test records and then reported by the contractor to the Employer and the contractor's personnel in charge of the relevant construction area.
- 6.7. Checking procedures shall be repeated until all the items on the check list are cleared.
- 6.8. A complete set of test records shall be handed over to the Employer on completion.
- 6.9. The tests on the different mechanical and electrical equipment shall include but not limited to:

6.9.1. Pumps, Pipe work and Valves

- a) 1.5 times the shut off pressure or twice the working pressure whichever is higher to test the soundness of the joints. Provision of the necessary pumps, gauges, blank flanges, tapping etc. for carrying out these tests shall be included in the contract.
- b) Leakage tests shall be carried out on all erected pipe work, pumps and valves immediately after erection and where possible before being built in.
- c) Operating tests shall be conducted on valves.
- d) The pump set shall be tested for performance. The vibration and noise levels shall be checked to be within the specified.
- e) The pump shall be tested through the operating range as per BS 5316 Part I Class C / ISO 2548 with all working (excluding stand by) pumps at a time for all the pumps.
However, no negative tolerance shall be permitted on the tested pump efficiency.

6.9.2. Pump motors

Condition of winding insulation be tested and insulation values shall be restored to required level by suitable heating arrangements locally.

6.9.3. Cranes

The crane and lifting tackle shall be tested to 125 % of the safe working load. The contractor shall arrange the test load. Deflection and speed tests shall also be conducted.

6.10. Instrumentation

The tests on the instrumentation equipment shall include but not be limited to:

- a) All cables shall be tested for polarity, continuity and insulation resistance. The common mode dc voltage at each signal input terminal shall be measured and recorded.
- b) The pre commissioning tests on the various main categories of plant shall be as listed below:
- c) The resistance of each electronic loop shall be measured.
- d) Electronic equipment shall have been energised for at least 24 hours before testing begins.
- e) The zero setting of each display instrument including any local indicator on or associated with a transmitter shall be checked.
- f) The correct calibration of each item in each control or monitoring loop shall be checked by the introduction of appropriate signal at each source, at five cardinal points of the range for increasing and decreasing signals.

6.10.2. The following tests methods shall be used:

- a) Pressure operated devices – dead weight testers or portable calibrators
- b) Level operated devices – actual level variation or simulation thereof. Instrument zero reading shall be checked against a bench mark:
- c) For controlling devices the contractor shall demonstrate the correct operation of the loop including the regulating devices. Each automatic controller shall be set to the appropriate estimated values of the terms which shall be optimised during the plant start up. Each control valve shall be checked during the plant start up. Each control valve shall be checked by operation of the manual control on the associated controller and the correct stroking verified. Valve petitioners, electro pneumatic converters and gauges shall be checked during these tests.
- d) All systems shall be checked for “fail safe” operation.
- e) Initiating devices not covered by the foregoing e.g. plant stop / start controls shall be checked in conjunction with the testing of the associated switchgear and machine.

6.10.3. The contractor shall also demonstrate the data transfer as per data transfer schedule between pumping stations.

7. Commissioning

7.1. After the completion of pre commissioning activities the final checks and preparations necessary for start up of the plant shall be carried out. The contractor shall submit to the Employer a written notice of mechanical completion which shall include:

7.1.1. Identity of a part of the plant considered mechanically complete,

7.1.2. A copy of all relevant completed test reports,

7.1.3. The date on which the completion of the tests was achieved,

7.1.4. Check list and

7.1.5. A request for issuance of a mechanical completion certificate in respect of that part.

7.2. Within fourteen (14) days from the date of receipt of the contractor’s written notice, the Employer shall:

7.2.1. In the case of acceptance, issue a mechanical completion certificate.

7.2.2. In the case of objection, submit a rejection statement setting forth remaining items to be completed or defects or deficiencies to be corrected before mechanical completion status can be accepted. When the Employer rejects the contractor’s notice the contractor shall take any necessary action to complete or correct the items marked and give the Employer a second notice of mechanical completion.

7.3. After the issuance by the Employer of a mechanical completion certificate, commissioning activities listed below shall be carried out to enable the start up and operation of the plant. Procedures are described as below:

7.3.1. Commissioning Procedure shall be carried out in a methodical sequence as follows

- a) Warming up
- b) Start up
- c) Initial running

- d) Operability adjustment
 - e) Stable operation
 - f) Final adjustment
- 7.3.2. At all stages of commissioning sequence, the plant shall be operated at optimum plant conditions. To ensure this, the contractor may make minor adjustment to the conditions indicated in the operation and maintenance manual as necessary.
- 7.3.3. The contractor shall check the operating conditions of the plant by constantly monitoring operating data.
- 7.3.4. The contractor shall specify for each discrete part of the plant the operational data to be recorded and the manner in which the data is to be taken.
- 7.3.5. All the operating data shall be recorded by the Employer on the forms to be mutually agreed. A copy of the operating log and analytical data from initial operation through to the completion of performance test shall be made available by the Employer to the contractor for evaluation.

INSTALLATION, TESTING & COMMISSIONING – ELECTRICAL EQUIPMENT(Whichever is applicable)

6.1 Equipment Installation, Testing & Commissioning

Installation of Equipment

- a) In accordance with the specific installation instructions, as shown in contractor's drawings or as directed by the EIC's representative the contractor shall unload, erect, install, wire, test and place into commercial use of all electrical equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square, and properly aligned and oriented.
- b) The contractor shall furnish all supervision, labour, tools, equipment, rigging materials and incidental materials such as bolts, wedges, anchors, concrete inserts etc. required to completely install, test and adjust the equipment.
- c) Drawings, instructions and recommendations shall be correctly followed in handling, settling, testing and commissioning of all equipment and care shall be exercised in handling to avoid distortion to stationary structures, the marring of finish or damaging of delicate instruments or other electrical parts.
- d) The contractor shall erect and commission the equipment as per the instructions of the EIC representative and shall extend all cooperation to him.
- e) In case of any doubt / misunderstanding as to correct interpretation of drawings or instructions, necessary clarification shall be obtained from the EIC's representative. The contractor shall be held responsible for any damage to the equipment consequent to not following instructions correctly.

- f) The contractor shall move all equipment into the respective buildings through regular doors or floor openings provided specifically for the equipment. The contractor shall make his own arrangement for lifting of equipment.
- g) Where assemblies are supplied in more than one section, the contractor shall make all necessary mechanical and electrical connections between sections including the connections between bus bars / wires. The contractor shall also carry out the adjustments / alignments necessary for proper operation of the circuit breakers. All insulators and bushings shall be protected against damage during installation. Insulators or bushings chipped, cracked or damaged due to negligence or carelessness shall be replaced by the contractor at his own expenses.
- h) The contractor shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments or relays are supplied separately, they shall be mounted only after the associated control panels have been erected and aligned. The blocking material / mechanism employed for the safe transit of the instruments and relays shall be removed after ensuring that the panels have been completely installed and no further movement of the same would be necessary. Any damage to relays and instruments shall be immediately reported to the EIC's representative.
- i) Inspection, storage, installation, testing and commissioning of transformers shall be in accordance with the latest Indian Standards Code of Practice IS: 10028. All commissioning tests as applicable, vide Appendix B of IS: 10028 (Part II) shall be carried out.
- j) Switchgear control panels shall be installed in accordance with the latest Indian Standard Code of Practice 10118. The switchgear panels shall be installed on finished surface or concrete or steel sills. The contractor shall be required to install and align any channel sills which form part of the foundations. Tape or compound shall be applied where called for. The base of outdoor type units shall be sealed in an approved manner to prevent ingress of moisture.
- k) After installation of all power and control wiring, the contractor shall perform operating tests on all switchgear and panels to verify the proper operation of switchgear / panels and the correctness of the interconnections between various items of equipment. This shall be done by applying normal ac or dc voltage to the circuits and operating the equipment. Megger tests for insulation, polarity checks on the instrument transformers, operation tests on equipment, and installation tests shall be carried out by the contractor who shall also make all necessary for proper functioning of the equipment.
- l) Installation and testing of the battery and battery chargers shall be done in strict compliance with the applicable standards. Each cell shall be inspected for breakage and

condition of cover seals as soon as received at site. The battery shall be set up on racks as soon as possible after receipt, utilising lifting devices. The cells shall not be lifted by the terminals. Contact surface of the battery terminals and inter cell connectors shall be cleaned, coated with protective grease and assembled. Each connection shall be properly tightened. Each cell shall be tested with a hydrometer and thermometer and the results logged. A freshening charge, if required, shall be added. When handed over to the Employer, the battery shall be fully charged and the electrolyte shall be at the full level and of the specified specific gravity.

- m) Equipment furnished with finished coats of paint shall be touched up by the contractor if their surface is spoiled or marred while handling.
- r) Foundation work and grouting in of fixing bolts or channels for all transformers, switchgear, motor control panels will be carried out by the contractor.

6.2 Installation Work for Earthing and Lightning Protection System

- a) The Contractor shall install copper /steel conductors, braids, etc. required for the system and individual equipment earthing. All work such as cutting, bending, supporting, painting / coating, drilling, brazing /soldering / welding, clamping, bolting and connecting onto structures, equipment frames, terminals, rails or other devices shall be in the contractor's scope of work. All incidental hardware and consumables such as fixing cleats / clamps, anchor fasteners, lugs, bolts, nuts, washers, bituminous compound, welding rods, anti corrosive paint as required for the complete work shall be deemed to be included by the contractor as part of the installation work.
- b) The quantities, sizes, material of earthing conductors and electrodes to be installed as per requirement. Routes of the conductors and locations of electrodes shall be as shown on the project drawings.
- c) The work of embedment of earthing conductor in RCC floors / walls along with provision of earth plate inserts / pads / earth risers shall be done by the civil contractor when the floors are cast or during construction of walls. However when required to do so in those areas where flooring will be done after the Contractor is at site, the Contractor shall coordinate with civil contractor and shall install the earthing conductors before the commencement of the concrete work. In such cases the contractor's scope of installation shall include laying the conductors in position with 50 mm concrete cover, making welded connections to inserts / pads / risers above the floor near the equipments. The embedded conductors shall be connected to reinforcing rods wherever necessary.
- d) If the tap connections (earthing leads) from the floor embedded main earthing grid to the equipment are more than 500 mm long then the same shall be embedded in floor by the

Contractor where required, together with associated civil work such as excavation / chipping, concreting and surfacing, if not already done by the civil contractor. The concrete cover over the conductor shall not be less than 50 mm.

- e) Installation of earth conductors in outdoor areas, buried in ground, shall include excavation of earth up to 600 mm deep 450 mm wide, laying of conductors at 600 mm depth, brazing / welding as required, of main grid conductor joints as well as risers of length 500 mm above ground at required locations and then backfilling material to be placed over buried conductor shall be free from stones and other harmful mixtures. Back fill shall be placed in layers of 150 mm, uniformly spread along the ditch, and tampered utilising pneumatic tampers or other approved means. If the excavated soil is found unsuitable for backfilling, the contractor shall arrange for suitable material from outside.
- f) Installation of earth connection leads to equipment and risers on steel structures / walls shall include laying the conductors, welding / cleating at specified intervals, welding / brazing to the main earth grids risers, bolting at equipment terminals and coating welded / brazed joints by bituminous paint. Galvanized conductors shall be touched up with zinc rich paint where holes are drilled at site for bolting to equipment / structure.
- g) Electrodes shall be installed (a) directly in earth or (b) in constructed earth pits, and connected to main buried earth grid, The scope of work shall include excavation, construction of the earth pits including all materials required for construction of earth pits, placing the rod and fixing test links on those pipe / rod / plate electrodes in test pits and connecting to main earth conductors.
- h) Installation of lightning conductors on the roofs of buildings shall include laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying fastening / cleating / welding of the down comers on the walls/columns of the building and connection to the test links to be provided above ground level.
- i) Installation of the test links shall include mounting of the same at specified height on wall/column by suitable brackets and connections of the test link to the earth electrode.
- j) Whenever main earthing conductor crosses cable trenches, they shall be buried below the trench floor.
- k) Suitable earth risers shall be provided above finished floor/ground level. If the equipment is not available at time of laying of the main earth conductors. The minimum length of such riser inside the building shall be 200 mm and outdoors shall be 500 mm above ground level. The risers to be provided will be marked in project drawings.
- l) Earth leads and risers between equipment earthing terminals and the earthing grid shall follow as direct and short a path as possible.

- m) An earthing mat shall be provided under each operating handle of the isolator and operating mechanism of H.V. breakers. Operating handle of the isolator and supporting structure shall be bonded together by a flexible connection and connected to the earthing grid.
- n) A separate earth electrode bed shall be provided adjacent to structure supporting lightning arrestors. Each connection shall be as short and as straight as practicable. For arrestors mounted near transformers, earth conductors shall be located clear off the tank and coolers.
- o) Wherever earthing conductors pass through walls galvanized iron sleeves shall be provided for the passage of earthing conductor. The pipe ends shall be sealed by the contractor by suitable water proof compound.

6.3 Earthing Connections

- a) All connections in the main earth conductors buried in earth / concrete and connection between main earthing conductor and earth leads shall be of welded type.
- b) Connection between earth leads and earthing terminal provided on the equipment shall be bolted type.
- c) All bimetallic connections shall be treated with suitable compound to prevent moisture ingress.
- d) Metallic conduits and pipes shall be connected to the earthing system.
- e) Lightning protection system down conductors shall not be connected to other earthing conductors above ground level. Also no intermediate earthing connection shall be made to lightning arrester and transformer earthing leads which shall be directly connected to pipe electrode.

6.4 Earth Electrodes

- a) Electrodes shall as far as practicable be embedded below permanent moisture level.
- b) Test pits with concrete covers shall be provided for periodic testing of earth resistance. Installation of pipe electrodes in test pits shall be suitable for watering. The necessary materials required for installation of test pits shall be supplied and installed by contractor. The installation work shall also include civil work such as excavation and connection to main earth grid.
- c) Earth pits shall be treated with salt and charcoal if average resistivity of soil is more than 20 ohm metre.
- d) Soil, salt and charcoal placed around the electrode shall be finely graded, free from stones and other harmful mixtures. Back fill shall be placed in layers of 250 mm thick

uniformly spread and compacted. If excavated soil is found unsuitable for backfilling, the contractor shall arrange for a suitable soil from outside.

6.5 Lightning Protection System

- a) The lightning protection air termination rods and/or horizontal air termination conductors shall be fixed in such a way that they remain in their installed position even during severe weather conditions. The necessary accessories such as cleats, clamps, welding materials, bolts, nuts, shall be supplied by contractor.
- b) Air termination systems shall be connected to earthing system by down conductors as shown in project drawings. The down conductors shall follow a direct path to earth. There shall not be any sharp bends, turns and kinks in the down conductors.
- c) All joints in the down conductors shall be of welded type. All metallic structure within 2 metres of down conductors shall be bonded to lightning protection system.
- d) Every down conductor shall be provided with a 'test link' at about 1000 mm above ground level housed in a suitable GI enclosure made of adequate thickness steel sheet and hot dip galvanised. The test joint shall be directly connected to the earthing system electrode.
- e) The lightning protection system shall not be in direct contact with underground metallic service ducts, cables, cable conduits and metal enclosures of electrical equipment. However, all metal projections, railings, vents, tanks, etc. above the roof shall be bonded together to form a part of roof grid.

6.6 Installation of Cable Racks And Trays

- a) Lines and grade for trays may be measured from building steel and finished floor elevations. Change in line or grade, or the addition of offsets by means of cutting standard tray sections and inserting additional tray fittings to match with the existing arrangement shall be considered as a normal part of the work.
- b) Where embedded steel inserts in concrete floors / walls for welding the supports for cable racks / trays are not available, Contractor shall provide suitable anchor fasteners at no extra cost.
- c) Cable shall be clamped to the cable trays at regular intervals.
- d) Flexible metallic conduits shall be used for termination of connection to equipment such as motors, limit switches and other apparatus.

6.7 Installation of Cables

- a) The installation of cable shall be on tray and other support as per standard engineering practice.
- b) The contractor shall install, test and commission the cables specified in the specification in accordance with drawings and instructions issued by the EIC's representative. Cables shall be laid directly buried in earth, on cable racks, in built up trenches, on cable trays and supports, in conduits and ducts or bare on walls, ceiling etc. as per drawings. Contractor's scope of work includes unloading, laying, fixing, jointing, bending, and termination of the cables. The contractor shall also supply the necessary materials and equipment required for jointing and termination of the cables.
- c) All apparatus, connections and cable work shall be designed and arranged to minimise risk of fire and any damage which might be caused in the event of fire. Wherever cables pass through floor or wall openings or other partitions, suitable bushes of an approved type shall be supplied and put into position by the contractor.
- d) Standard cable grips and reels shall be utilised for cable pulling. If unduly difficult pulling occurs, the contractor shall check the pull required and suspend pulling until further procedure has been approved by the EIC's representative. The maximum pull tension shall not exceed the recommended value for the cable measured by the tension dynamometer. In general, any lubricant that does not injure the overall covering and does not set up undesirable conditions of electrostatic stress or electrostatic charge may be used to assist in the pulling of insulated cables in conduits and ducts.
- e) After pulling the cable, the contractor shall record cable identification with date pulled neatly with waterproof ink in linen tags. Identification tags shall be attached securely to each end of each cable with non corrosive wire. The said wire must be non ferrous material on single conductor power cable. Tags shall further be attached at intervals on long runs of cables on cable trays and in pull boxes. Cable and joint markers and RCC warning covers shall be provided wherever required.

All cables shall be allocated a unique number which shall be fixed to each end of the cable using a corrosion resistant label. Cables of different categories shall be tagged with the following subscripts and three digit numbers.

HV power	HV-P
LV power	P
Control	C
Instrumentation	I

Protection	PR
Telecommunication	T

- f) Sharp bending and kinking of cables shall be avoided. The bending radii for various types of cables shall not be less than those specified below:

6.6 kV XLPE multi core	15 times the overall armoured cable dia of the cable
650 / 1100 V PVC insulated	12 times the overall armoured cables dia of the cable

If shorter radius appears necessary, no bend shall be made until clearance and instructions have been received from the EIC's representative.

- g) Power, control and instrumentation cables shall be laid in separate cable racks / trays.
- h) Where groups of HV, LV and control cables are to be laid along the same route, suitable barriers to segregate them physically shall be provided.
- i) Cables of different categories shall be installed so as to maintain satisfactory clearances for safety and in order to reduce the possibility of electrical interference. The following table gives the distances in mm that shall be maintained between the different categories of cable.

Cable Category	HV Power	LV Power	C & I Protection	Telecommunication
HV Power	N/A	275	550	550
LV Power	275	N/A	275	275
C & I / Protection	550	275	N/A	275
Telecommunication	550	275	275	N/A

- j) Where cables cross roads and water, oil, gas or sewage pipes, the cables shall be laid in reinforced spun concrete or steel pipes. For road crossings the pipe for the cables shall be buried at no less than one metre depth.
- k) Cables laid in ground shall be laid on a 50 mm riddled earth bed. The cables shall then be covered on top and at their sides with riddled earth of depth of about 150 mm. This is then gently filled up to a depth of about 100 mm above the top of uppermost cable to provide bedding for the protective cable covers which are placed centrally over the cables. The protective cable covers for LV cables may be of earthenware and for HV cables of reinforced concrete. The RCC covers shall have one hole at each end, to tie them to each other with GI wires to prevent displacement. The trench is then backfilled with the excavated soil and well rammed in successive layer of not more than 300 mm in depth, with the trenches being watered to improve consolidation wherever necessary. To allow for subsidence, it is advisable to allow a crown of earth not less than 50 mm in the centre and tapering towards the sides of the trench.
- l) In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, should the cable develop a fault at a later date.
- m) Cables on cable racks, on cable trays and conduits shall be formed to avoid bearing against edges of trays, racks, conduits or their supports upon entering or leaving trays, racks or conduits. Cables shall be racked or laid directly into cantilevered cable trays where practicable, but in some cases it may be necessary that cables are pulled or threaded into trays. To facilitate visual tracing, cables in trays shall be laid only in single layers and unnecessary crossing of cables shall be avoided. Cables on trays shall finally be clamped in an approved manner.
- n) Cable splices will not be permitted except where permitted by the EIC's representative. Splices shall be made by contractor for each type of wire or cable in accordance with the instructions issued by cable manufacturer's and the EIC's representative. Before splicing, insulated cables shall have conductor insulation stepped and bound or pencilled for recommended distance back from splices to provide a long leakage path. After splicing, insulation equal to that on the spliced conductors shall be applied at each splice.
- o) Jointing of cables shall be in accordance with relevant Indian Standards Codes of Practice. Materials and tools required for cable jointing work, including cold setting bituminous compound shall be supplied by the contractor. Cables shall be firmly clamped on either side of a straight through joint at a distance of not more than 300 mm away from the joints. Identification tags shall be provided at each joint at all cable terminations.

- p) At cable terminal points where the conductor and cable insulation will be terminated, terminations shall be made in a neat, workmanlike and approved manner by men specialised in this class of work.
- q) Control cable termination shall be made in accordance with wiring diagrams, using colour codes established by the EIC's representative for the various control circuit, by code marked wiring diagram.
- r) When control cables are to be fanned out and cabled together with cord, the contractor shall make connections to terminal blocks, and test the equipment for proper operation before cables are corded together. If there is any question as to the proper connection, the contractor shall make a temporary connection with sufficient length of cable so that the cable can be switched to another terminal without splicing. After correct connections are established through operating the equipment, cables shall be cut to their correct lengths, connected to terminals in the specified manner, and corded together where necessary to hold them in place in a workmanlike manner.
- s) Cable seals shall be examined to ascertain if they are intact and that cable ends are not damaged. If the seals are found to be broken the cable ends shall not be jointed until after due examination and testing by the EIC's representative. Before jointing is commenced, insulation resistance of both sections of cables to be jointed shall be checked by megger.
- t) After installation and alignment of motors, the contractor shall complete the conduit installation, including a section of flexible conduit between motor terminal box and trench / tray. The contractor shall install and connect the power, control and heater supply cables as per equipment manufacturer's drawings, if any.
- u) Metal sheath and armour of the cable shall be bonded to the earthing system of the station. The size of conductor for bonding shall be appropriate with the system fault current.

6.8 Lighting System Installation

This covers the requirements of installation of the following:

a)	Lighting fixtures complete with lamps and accessories
b)	Main Lighting distribution board
c)	Lighting panels
d)	Receptacles and lighting control switches
e)	Point wiring

f)	HPSV lighting system
g)	Multi core cables for street and boundary lighting
h)	Maintaining equipment/materials during storage and being responsible for the equipment/material until they are handed over to Employer.
i)	Installation, testing and commissioning shall be carried out in accordance with the drawings and as stipulated in this specification.

6.9 Applicable Standards

a)	Electrical wiring installations (system voltage exceeding 650 V)	IS:732
b)	Code for practice for interior illumination (Part-1)	IS:3646/BS:8206
c)	Code of practice for street lighting installation	IS:1944
d)	Code of practice for industrial lighting	IS:6666
e)	Code of practice for fire safety of building	IS:1646
f)	Boxes for enclosure of electrical accessories	S:5133 (Part-1)
g)	Guide for safety procedures and practices in electrical work	IS:5216
h)	Ceiling roses	IS:371

6.10 Lighting Fixtures

- a) The installation of lighting fixtures shall be based on the mounting arrangement shown in the drawings. The unit rates quoted for installation shall include all materials required to mount the fixtures. Hooks in RC slabs for suspension of high bay fixtures shall be provided wherever not already provided. Cost of supply and installation of such hooks shall be included in the cost of installation of lighting fixtures. Unit rate for installation of lighting fixtures shall include cost of installation of control gear box wherever applicable.
- b) Installation of receptacles and switches shall be carried out suitably. Switch shall be mounted in flush with the front cover plate. Cost of supply and installation of necessary hardware shall be included in the unit rates quoted for installation of receptacles / switches.
- c) Lighting distribution boards shall be installed at the suitable location. Installation rates quoted for installation of lighting distribution boards shall include supply and installation of base channels, foundation bolts etc.

- d) Outdoor lighting distribution boards shall be installed on a concrete plinth. The top of plinth shall be 1000 mm (min.) above the grade level. Cost of construction of concrete plinth shall be included in the unit rates quoted for installation of outdoor lighting distribution board. No cement and steel will be supplied by Employer. Installation cost of lighting distribution board shall include cost of installation of earthing conductor from LDB to the nearest earthing grid.

6.11 Point Wiring

- 6.11.1 Wiring of lighting fixtures shall be on point wiring basis. Two types of point wiring have been envisaged viz. primary point wiring and secondary point wiring. Bidder shall quote primary point and secondary point wiring rates for each building/area specified, on the basis of lighting layout drawings prepared by the contractor.
- 6.11.2 Point wiring also covers the wiring of the associated control switches of lighting fixtures/control switches of receptacle units.

a) Primary Point Wiring

Primary point wiring covers the wiring between circuits of the lighting panel to the junction box of the first lighting fixture / receptacle unit and between junction boxes of the subsequent lighting fixture connected to that circuit of the lighting panel. In some cases where there are junction boxes, the primary point covers the wiring between junction box and the first lighting fixture/receptacle unit in that circuit.



Secondary Point Wiring

Secondary point wiring covers the wiring of the remaining lighting fixture s/ receptacle unit other than that covered under primary point of that circuit in the lighting panel.

Secondary point wiring also covers the wiring of the associated control switches of lighting fixtures / control switches and control switches of receptacle units.

6.11.3 Point Wiring for HPSV Lighting

a) Primary Point Wiring

Primary point wiring covers the wiring between the lighting distribution board to the junction box of the first lighting pole or flood light tower and between the junction boxes of the subsequent lighting poles or flood light towers connected to a circuit in the lighting distribution board.

b) Secondary Point Wiring

Secondary point wiring covers the wiring between the junction box and the lighting fixture on the pole in case of street light and between junction box mounted near the base of the tower and all subsequent junction boxes mounted on that tower and also between junction

box and the flood light fixture. The above refers to the remaining fixtures covered under the circuit referred under primary point wiring. Secondary point also covers the wiring of the associated control fuses, switches, looping of terminals, etc. as required.

6.11.4 Supply and Installation of Conduit Point Wiring

- a) The point wiring shall include supply of necessary materials for the conduit wiring such as galvanised rigid steel conduit, galvanised MS fixing saddles with spacer plates, nylon / fibre fixing plugs, galvanised M.S. fixing screws, 12 SWG galvanised steel earthing wire, PVC insulated copper or aluminium conductor wires, control switches and pulling, termination of the earthing / PVC insulated wires as required, installation of control switches, drilling holes in brick walls / RCC roof slabs for taking the wiring conduits and refinishing and any other works / material necessary for making point wiring complete in all respects.
- b) Wires used for conduit point wiring of lighting fixtures / ceiling fans, 5 A receptacles and receptacles above 15 A shall be 1100 V grade, PVC insulated, single core, stranded copper conductor wires of sizes not less than 1.5 sq mm and 2.5 sq mm respectively. Wires shall conform to IS: 694 and shall bear the ISI mark.
- c) Bidder shall take into consideration necessary galvanised MS fixing clamps when the wiring conduits are to be supported from steel roof truss / structural members.

6.11.5 Supply and Installation of Cable Point Wiring

- a) The point wiring shall include supply of necessary materials for the cable wiring such as 1100 V grade multi core, stranded aluminium conductor, PVC insulated, armoured cables of sizes 4 sq mm and 6 sq mm for wiring of lighting and receptacles in buildings and outdoor areas, where cable wiring is specified, conforming to IS: 1554, galvanised MS fixing saddles with spacing plates, junction boxes, nylon / fibre fixing plug galvanised MS fixing screws, control switches and installation / termination of cables including supply of cable glands as required, installation of control switches, junction boxes, drilling holes in brick walls / RCC roof and grouting necessary conduit sleeves for taking the cables and any other work materials necessary for making the point wiring complete in all respects.
- b) Bidder shall take into consideration necessary galvanized MS fixing clamps when the wiring cables are to be cleated along steel roof trusses / structural members.
- c) Bidder shall take into consideration any specific material finish other than galvanising, such as corrosion resistant, epoxy painting or chlorinated rubber painting of all the installation accessories as called for in the relevant lighting layout drawings.

6.11.6 Supply & Installation of Point Wiring for Street and Flood Lighting

Work includes supply and installation of cables required between LDB and junction box mounted on street lighting pole / flood lighting tower and also between junction box mounted on flood light tower to metal enclosed control gear box located near flood light fixture, supply and installation of all the termination accessories such as crimping type cable lugs and double compression cable glands at each junction box and fixture, termination, testing and commissioning of cables. Contractor's scope of work also includes excavation, preparation of riddled soil bedding, supply and installation of protective covers over the cable, backfilling, ramming, supply and installation of route markers, supply and installation of HDPE pipes for road crossing etc. supply and installation of necessary cleating arrangement for cabling on flood light tower, supply of labour, supervision, welding equipment, all tools and tackles and testing equipment as required. Contractor shall plan and cut the cables in such a way that there is no wastage and no cable jointing is required in any run. However should any joint become necessary the same shall be provided by the contractor and a joint marker shall also be provided without any extra cost. Earthing of street light pole / flood light tower, lighting fixtures, etc. are included under point wiring.

6.11.7 Point wiring rates shall also include / hold good for the following:

- a) Supply and installation of lighting control switches and switch boxes complete with fixing accessories.
- b) Drilling holes in brick / RCC wall and roof for taking cable or conduit, sealing and refinishing with cement plaster.
- c) Testing, commissioning and handing over the lighting system in commercial working condition.
- d) Marginal shifting of any fixture / accessory from the location indicated in the lighting layout drawings.

6.11.8 Outdoor Lighting (Street and Flood Lighting)

The following shall be deemed to be included as part of the installation work for outdoor lighting point wiring.

- a) Installation of multi core / single core cables between LDB and junction box mounted on street light pole/flood lighting tower, from junction box to metal enclosed control gear box.
- b) Supply and installation of crimping type cable lugs, double compression type cable glands at each junction box and fixture, termination, testing and commissioning of cables.
- c) Contractor's scope shall also include excavation and preparation for buried cables. Supply and installation of route markers, supply and installation of HDPE pipes for road crossing shall also be included in the scope of installation of point wiring.
- d) Supply and installation of necessary cleating arrangement for cabling on flood light poles.

- e) Contractor shall provide necessary foundation for erecting street light pole / flood light tower and install the same. Contractor shall prepare foundation drawings with necessary details to EIC for approval.
- f) Contractor shall plan and cut the cables in such a way that there is no wastage and no cable jointing is required in any run. However, should any joint become necessary, the same shall be provided by the contractor and joint marker shall also be provided without any extra cost.
- g) Earthing of street light pole/flood light tower, lighting fixtures, control gear boxes, junction boxes, etc. are also included in the scope of installation of point wiring. Contractor shall earth street light pole / flood light poles and junction box with 25 x 3 mm GI strip / flat tap off from the 25 x 3 mm MS flat earthing grid along the street lighting included in scope. The contractor shall interconnect earthing grid to plant main earthing grid at first and last pole of each feeder circuit and at one intermediate pole.

6.11.9 Installation of lighting brackets for switchyard area Outdoor Lighting

Work includes supply and installation of HPSV light brackets etc. including associated junction boxes with fuses, links and terminals for junction boxes and junction boxes near each flood light fixtures.

6.11.10 Installation of Lighting Distribution Board, Lighting Panels (AC), 240 V, AC Single Phase Distribution Boards

Installation of above items shall include necessary foundation channels, bolts / nuts etc. for grouting lighting distribution boards, iron brackets / grouting brackets, bolts / nuts for wall / column mounted panels and associated civil works.

6.12 Work Requirement

Details of work requirements are covered in lighting installation notes and details and typical drawings which form the part of specification. Any changes if necessary due to site conditions / requirements shall be carried out after obtaining approval of EIC. The changes carried out shall be marked clearly in the layout drawings by contractor and 'AS BUILT DRAWING' shall be prepared by the 'contractor' and this shall be forwarded to EIC's office.

6.12.1 Wiring

- a) Wiring shall be carried out strictly as per project drawings and technical specification. All exposed conduit wiring shall have provision for easy inspection. Exposed wiring when run along wall shall be as near the ceiling as possible. Where cable wiring is specified cable shall be cleated on to the wall as close to the ceiling as possible. In all types of wiring due consideration shall be given for neatness and appearance.

- b) Wherever DC emergency lighting is provided, emergency lighting wires shall run in a separate conduit. Colour of the wires used shall be as follows; white for positive, black for negative.
- c) Wherever lighting system has three phase distribution, separate conduits shall be used for different phases. For easy identification of phases and neutral wires the following colour wires shall be used.

i	R - Phase	Red
ii	Y - Phase	Yellow
iii	B - Phase	Blue
iv	Neutral	Black

- d) There shall be a circuit breaker or a linked switch on each live conductor of supply mains at the point of entry. The wiring throughout the installation shall be such that there is no break in neutral wire in the form of switch or fuse unit.
- e) Conductors not arranged for connection to the same system or supply different phases of the same supply, shall be kept apart throughout their entire run.
- f) Receptacles and lighting fittings in general shall be fed from different circuits. Five amps receptacles for toilet or small rooms can be fed from the lighting circuit with proper isolating arrangement.
- g) Each final sub circuit from a lighting panel shall be controlled by a single pole switch connected to the live conductor.
- h) For long conduit wiring runs, inspection / pull boxes shall be provided at intervals not exceeding 10 m. Such facilities shall also be provided at conduit bends.

6.13 General Practices

- a) All receptacles and switches to be installed in offices and control rooms shall be flush mounted within the wall and those in other areas shall be wall or column mounted.

- b) Ceiling roses shall not embody fuse terminals as an integral part. For voltages exceeding 250 volts a ceiling rose or any similar attachment shall not be used.
- c) A socket outlet shall not embody fuse terminals as integral part of it. The switch controlling the socket outlet shall be on the live side of the line.
- d) All exposed metal parts of the plug, when the plug is in complete engagement with the socket outlet, shall be in effective electrical connection with the earthing pin.

6.14 Earthing

- a) Conduits and fittings shall be earthed by 12 SWG GI wires run along the length of the conduit and secured by means of suitable clamps efficiently fastened to conduit tip. To achieve perfect electrical continuity, the conduits shall be bonded effectively on either end of a coupling and other joints.
- b) Conduits shall be earthed at the ends adjacent to switch boards at which they originate or otherwise at the earth clip, clamp or gland, in effective electrical contact with the conduit.
- c) For outdoor lighting poles the earthing conductor shall be terminated up to the junction box on the pole and 12 SWG wire shall be taken up to the pole fitting.

6.15 INSTALLATION OF OUTDOOR SWITCHYARD EQUIPMENT

6.15.1 HV Circuit Breaker (if any)

The outdoor HV shall be transported to the erection site in dismantled condition. The contractor shall check, clean and assemble all the different units as per manufacturer's instructions. The three poles of the circuit breaker shall be erected on the base steel structures, previously installed and leveled by the contractor. The operation mechanism shall be installed on a steel structure pedestal to be provided by some other agency and connected to the three poles of the circuit breaker. The breaker shall be operated slowly to the closed position and all adjustments carried out as per manufacturers' instructions. The poles and operating mechanism shall be accurately positioned so as to cause no UN - due strain on the terminals. Each pole of the breaker and operating mechanism shall be earthed.

6.15.2 HV Isolators (if any)

The isolators shall be transported to site in the dismantled condition. All the insulators will be also supplied loose. The contractor shall inspect, clean, assemble and install the isolator on the base structure previously fabricated, erected and leveled by him. The operating mechanism shall be installed on the structure and connected to the isolator poles. The operating mechanism shall be tested by slowly bringing the isolator to the closed position

and carrying out the necessary adjustment as per the manufacturer's instructions. The earthing switches, frames and operating handles etc. shall be earthed. Arcing horns shall be adjusted to the recommended gap setting, if provided.

6.15.3 Lightning Arrestor

The lightning arresters shall be transported to site. The contractor shall check, clean, assemble and install these on the base structure previously fabricated installed and leveled by him. The phase to phase clearance between three units shall be accurately adjusted so as to cause no strain on the terminals. Surge counters and other accessories shall be properly installed as per the recommendation.

6.14.4 Switchyard Fencing

All materials for fencing of the switchyard including double leaf hinged gate with all hardware including civil work shall be supplied and installed by the contractor.

6.14.5 Galvanised Steel Structure

All steel structures shall be fabricated from steel confirming to IS: 2026 and each section shall be hot dip galvanised after fabrication. Hot dip galvanising of steel structures shall confirm to IS: 728 and galvanising of each section shall be done in one complete impression. All bolts, nuts and washers shall be hot dip galvanised and shall comply with the requirements in section 3.5 of IS: 800 / 1962. EIC shall have a right to insist on re galvanising at the contractor's cost of any such batch of steel work found not confirming to specification and showing non-uniformity, roughness and acid spots. Prefabricated galvanised steel structures shall be installed and leveled as per requisite drawings.

6.15 Commissioning

All checks and tests shall be as per the Manufacturer's drawings manuals, relevant codes of installation and commissioning check lists as given below:

- a) Among other commissioning tests, the following shall be carried out at site after completion of installation. Contractor shall ensure to use calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards / International Standards. All tests to be carried out in the presence of EIC's representative.
- i) For Transformers

Dielectric strength of transformer oil, operation of all protective equipment, voltage / turns ratio at all taps, winding resistance at all taps, vector group test, phase sequence test, buchholz relay operation (alarm and trip) (if any), OLTC control indicating and alarm circuits (if any), lightning arrester installation, test the bushing oil for dielectric strength.

ii) For Switchgear

Power frequency high voltage test, operation tests.

iii) For Relays

Check internal wiring, relay settings.

Satisfactory operation over their whole operating range by secondary injection. Check minimum pick up voltage of D.C. coils, megger all terminals to body and AC to DC terminals.

iv) Circuit breakers

Manual operation of breakers, power closing/opening operation manually and electrically, breaker closing and tripping time, trip free and anti pumping operation, control wiring for correctness of connections, continuity and IR value, electrical and mechanical interlocks, all functional checks, checks on CTS, checks on spring charging motor.

v) Battery

Special gravity test, cell voltage check, capacity test as per IS, Initial charging cycle.

vi) Battery charger & D.C. Distribution board

Functional check of auxiliary devices such as alarms, indicating etc. measurement of voltage regulation.

vii) Isolators

Manual and electrical operation and interlocks, earth connection of structures and operating handle, clearance in open and closed position.

viii) Voltage transformers

Polarity test, ratio test on all cores, oil level and leakages, 'Insulation resistance test', earthing connection.

ix) Current Transformer

Megger between windings and winding terminal to body, polarity test., capacitance and tan delta test.

x) Cables

All new cables shall be megger tested before terminating / jointing. After terminating / jointing is completed of LV (i.e. 650/1100V) cable shall be megger tested by 1000V megger. All H.T. Cables (i.e. 6.6 kV) shall be megger tested by 2500 V motor operated megger and hipot.

Cable core shall be tested for

- Continuity
- Absence of cross phasing
- Insulation resistance to earth
- Insulation resistance between conductors

xi) Earthing and Lightning Protection System

The Contractor shall ensure the continuity of all conductors and joints. The Employer may ask for earth continuity tests earth resistance measurements and other tests which in his opinion are necessary to prove that the system is in accordance with design, specification, code of practice and electricity rules. Earth resistance value should be not greater than one (1) ohm.

xii) Lighting System

Before putting complete system into service, commissioning tests stipulated in applicable standards and code of practice shall be carried out by the Contractor in the presence of the Engineer's Representatives covering all lighting system equipment.

xxiii) The Contractor shall carry out insulation resistance tests by megger of following rating

- | | |
|------------------------------|---------------|
| Control circuits up to 220 V | 500 V megger |
| Power circuits up to 6.6 kV | 1000 V megger |

PART 7

PRE COMMISSIONING TESTS ON ELECTRICAL SYSTEM EQUIPMENT TO BE CARRIED OUT AFTER ERECTION

List Of Electrical System Equipment

- 01 Soft starter panel board
- 02 Lightning arrester
- 03 Isolator
- 04 Insulator
- 05 EOT Crane
- 06 Flow meter
- 07 LT Switchgear panels, motor control centre.
- 08 LT Bus duct
- 09 HT / LT Cable
- 10 Control panels for miscellaneous equipment
 - i) Earthing system
 - ii) Safety Procedure and Practice

TECHNICAL SPECIFICATIONS FOR PRE COMMISSION TESTS

01 Switchyard Bus, Shielding and Grounding (Not Applicable)

1. Insulation resistance test between each phase and earth and between phases. All transformer terminals, CT - PT connections and lightning arresters disconnected using 5000 V motorised megger

2. Thermography, if arranged by customer.

This is done after switchyard is charges and loaded. Scan all bus sections, insulators, droppers and joints with an AGA Thermo vision Camera and find out hot spot if any.

Defects noticed in the hot spot locations are to be rectified on priority basis.

02 Lightning Arrester

1. IR Values
2. Thermography, if arranged by customer

03 Isolator

1. IR Values
2. Contact resistance measurement by milli volt drop test method
3. Manual Closing and Opening
4. Drive motor operation for closing and opening in Local and Remote position
5. Mechanical interlock between isolator and earth switch
6. Electrical interlock between isolator, earth-switch and circuit breaker

04 Insulator

1. IR Values of insulator
2. Thermography - similar to item 1. If arranged by customer

05 Circuit Breaker

1. Mechanical charging - closing - tripping of breaker
2. Electrical charging - closing - tripping of breaker

3. Tripping of breaker through protective relays and trip circuit healthiness
4. Mechanical interlocks of breaker
5. Closing and opening time measurement of each pole
6. Contact resistance of measurement of each pole
7. IR Values
8. Operation of breaker auxiliary switches
9. Electrical closing at 85% of rated control voltage
10. Electrical tripping at 70% of rated control voltage
11. Space heater and illumination circuits of cubicle
12. Anti pumping device operation
13. Control circuit and operational tests in local - remote position
14. Check on spare contacts for customer use

06 Power Distribution Transformer

1. Insulation resistance test HV side, LV side and HV - LV sid.
2. Magnetising current test at rated ta.
3. Winding resistance test at rated ta.
4. Voltage Ratio & Tap continuity test at all tap.
5. Vector group test at rated ta.
6. Magnetic Balance Test at rated ta.
7. Bucchohz Relay Test (if any)
8. Neutral CT Test
9. Winding Temperature Indicator / Oil Temperature Indicator Test
10. Polarisation Index Test (For LV windings 3.3 KV and above
11. Cooling System.
12. Local / Remote operations of OLTC (if any)
13. No load test and performance observation

07 HT Switchgear Panels (if any)

1. Local / Remote operations in test as well as service position including all electrical interlocks
2. Control circuit and operational tests
3. Tripping through relays and trip circuit health
4. Anti pumping device operation
5. Auto - Manual bus-transfer scheme (ABT Scheme)

6. Protection system operation stability and sensitivity by primary injection testing method including testing of metering circuits
7. IR values of power and control circuits
8. HV Test - DC High voltage on switchboard
9. Panel indication, annuciation, space heater circuits
10. Spare contact for customer use

Breaker:

1. Mechanical charging - closing - tripping of breaker
2. Electrical charging - closing - tripping of breaker
3. Mechanical and opening time measurement of each pole
5. Contact resistance measurement of each pole
6. IR values
7. Operation of breaker auxiliary switches
8. Electrical closing at 85% of rated control voltage
9. Electrical tripping at 70% of rated control voltage
10. High voltage test on VCB Circuit breaker (if any).

Current Transformer:

1. IR Value between Primary and Earth, Secondary and Earth and Primary - Secondary
2. Polarity Test.
3. Ratio and circuit test
4. Knee point voltage, exciting current and secondary resistance in case of class - PS - CT - Magnetisation characteristic

Potential Transformer:

1. IR Value between Primary and Earth, Secondary and Primary - secondary
2. Polarity Test
3. Ratio & Circuit Test
4. Secondary winding resistance

08 LT Switchgear Panels - PCC - MCC:

1. IR Values of power and control circuits
2. Mechanical charging - closing - tripping of breaker
3. Electrical charging - closing - tripping of breaker
4. Trip circuit healthiness and tripping through relays
5. Remote closing / Tripping / Interlocks circuits
6. Indication / Annunciation / Panel space heater circuit / Space contacts for customer use.
7. Secondary injection testing of protective relays
8. Auto manual bus-transfer (ABT) scheme testing
9. CT testing for polarity, ratio, IR values and magnetisation for class PS characteristics
10. PT testing for polarity, ratio, IR values
11. IR Values of breaker
12. Testing of modules for either DOL or Star / Delta starting or any other starting method as per the schematic drawings applicable.

09 HT Bus Duct (if any)

1. IR Values before Hipot
2. Hipot Test
3. IR Values after Hipot
4. Measurement of contact resistance

10 HT Cable: (if any)

1. IR Values before Hipot
2. Hipot Test - Measurement of leakage current
3. IR Values after Hipot

11 Earthing Resistance:

1. Earthing resistance of each electrode
2. Earthing resistance of grid.

12 Safety Procedure And Practice

Following safety procedure and practice should be provided by electrical contractor in switchgear room / substation as per latest edition of IS 5216.

a) Rubber matting

- i) In front of 11 kV switchgear and 11 kV capacitor panel, soft start panel (if any).
- ii) In front of 415 V switchgear and other panel in switchgear room.
- iii) Shock treatment charts
- iv) One chart near 11 kV switchgear room
- v) One chart near 415 V switchgear room

b) Caution / Danger Board

- | | | | |
|------|-------------------------------|---|--------|
| i) | 11 kV switchgear | : | 2 Nos. |
| ii) | 11 kV switchgear | : | 2 Nos. |
| iii) | 11 kV capacitor panel | : | 2 Nos. |
| iv) | Soft start panel | : | 2 Nos. |
| v) | 415 V switchgear | : | 2 No. |
| vi) | Transformer near HT cable box | : | 2 Nos. |
| vii) | All power Distribution board | : | 1 Nos. |

c) Fire Safety

The requirement of hand appliance in switchgear room, electrical equipment room shall be provided as per Clause 4.0 of Fire Protection Manual by Regional Tariff Committee, 10th edition 1988.

d) Contractor's License

The Contractor shall possess the necessary License / Authorisation from the Licensing Board of the locality / State for carrying out the installation work. The persons deputed by the contractor's firm should also hold valid permits issued/ recognised by the Licensing Board of the locality / State in which the work is to be done.

The electrical installation work shall be carried out by licensed electricians only and approved by appropriate authorities. It is the responsibility of Contractor to get approval of complete system from the appropriate authority.

(e) Specials:

- a. Power system analysis, short circuit calculations, relay coordination using renowned software, relay settings for over current, earth fault and unit protection of motors etc. shall be submitted at the time of testing.
- b. Equipments / instruments which shall be used for testing should be calibrated as per ISO – 9000.

